

**Exploring and Expanding Capabilities,  
Sustainability and Gender Justice in Science  
Teacher Education:  
Case Studies in Zimbabwe and South Africa**

A thesis submitted in fulfilment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

RHODES UNIVERSITY

by

Charles Chikunda

February 2013

## **Declaration**

I declare that this thesis is my own work, and that all other sources used or quoted have been fully acknowledged and referenced. It is being submitted for the Degree of Philosophy at Rhodes University, and has not been submitted for a degree or examination at any other university.

Charles Chikunda

Signature.....

February 2013

## **Abstract**

The focus of this study was to explore and expand capabilities, sustainability and gender justice in Science, Mathematics and Technical subjects (SMTs) in teacher education curriculum practices as a process of Education for Sustainable Development in two case studies in Zimbabwe and South Africa. The study begins by discussing gender and science education discourse, locating it within Education for Sustainable Development discourse. Through this nexus, the study was able to explore gender and sustainability responsiveness of the curriculum practices of teacher educators in Science, Mathematics and Technical subjects; scrutinise underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices; and understand if and how teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a Southern African context. Influenced by a curriculum transformation commitment, an expansive learning phase was conducted to promote gender and sustainability responsive pedagogies in teacher education curriculum practices. As shown in the study, the expansive learning processes resulted in (re)conceptualising the curriculum practices (object), analysis of contradictions and developing new ways of doing work.

Drawing from the sensitising concepts of dialectics, reflexivity and agency, the study worked with the three theoretical approaches of Cultural Historical Activity Theory (CHAT), feminist theory and capabilities theory. The capability and feminist lenses were used in the exploration of gender and sustainability responsiveness in science teacher education curriculum practices. CHAT, through its associated methodology of Developmental Work Research, offered the opportunity for researcher and participants in this study to come together to question and analyse curriculum practices and model new ways of doing work.

Case study research was used in two case studies of teacher education curriculum practices in Science, Mathematics and Technical subjects, one in Zimbabwe and one in South Africa. Each case study is constituted with a networked activity system. The study used in-depth and focus group interviews and document analysis to explore gender and sustainability responsiveness in curriculum practices and to generate mirror data. Inductive and abductive modes of inference, and Critical Discourse Analysis were used to analyse data. This data was then used in Change Laboratory Workshops, where double stimulation and focus group discussions contributed to the expansive learning process.

Findings from the exploration phase of the study revealed that most teacher educators in the two case studies had some basic levels of gender sensitivity, meaning that they had ability to perceive existing gender inequalities as it applies only to gender disaggregated data especially when it comes to enrolment and retention. However, there was no institutionalised pedagogic device in place in both case studies aimed at equipping future teachers with knowledge, skills, attitudes and values to promote aspects of capabilities (well-being achievement, well-being freedom, agency achievement and agency freedom) for girls in Science, Mathematics and Technical subjects. Science, Mathematics and Technical subjects teacher educators’ curriculum practices were gender neutral, but in a gendered environment. This was a pedagogical tension that was visible in both case studies. On the other hand, socio-ecological issues, in cases where they were incorporated into the curriculum, were incorporated in a gender blind or gender neutral manner. Social ecological concerns such as climate change were treated as if they were not gendered both in their impact and in their mitigation and adaptation. It emerged that causal mechanisms shaping this situation were of a socio-political nature: there exist cultural differences between students and teacher educators; patriarchal ideology and hegemony; as well as other interfering binaries such as race and class. Other curriculum related constraints, though embedded in the socio-cultural-political nexus, include: rigid and content heavy curriculum, coupled with students who come into the system with inadequate content knowledge; and philosophy informing pedagogy namely scientism, with associated instrumentalist and functionalist tenets. All these led to contradictions between pedagogical practices with those expected by the Education for Sustainable Development framework.

The study contributes in-depth insight into science teacher education curriculum development. By locating the study at the nexus of gender and Science, Mathematics and Technical subjects within the Education for Sustainable Development discourse, using the ontological lenses of feminist and capabilities, it was possible to interrogate aspects of quality and relevance of the science teacher education curriculum. The study also provides insight into participatory research and learning processes especially within the context of policy and curriculum development. It provides empirical evidence of mobilising reflexivity amongst both policy makers and policy implementers towards building human agency in policy translation for a curriculum transformation that is critical for responding to contemporary socio-ecological risks.

## Acknowledgements

In this study that is guided by Cultural Historical Activity Theory, it is appropriate to acknowledge activity systems that contributed to its conception, shaping and development. Firstly, I want to thank my former colleagues in the science department at Mutare Teachers' College and in the ST<sup>2</sup>EEP activity systems for the priceless knowledge that became the foundation for this study. I also want to acknowledge the Gender Studies Department at Midlands State University. It was through this activity system that I gained tools and mediating artefacts to articulate tensions and contradictions in SMTs teacher education curriculum practices. I am also very grateful to the remarkable activity system of the Environmental Learning Research Centre at Rhodes University, with its associated activities of PhD weeks, Monday planning sessions, Friday reading group and the offshoot KwaZulu-Natal PhD study group. From these, I benefited substantially through my interactions with many colleagues including Caleb Mandikonza, Dick Kachilonda, Tich Pesanayi, Mumsie Gumede, Ingrid Schudel, Lausanne Olivitt, Daniel Sabai, Vannessa Agbedahin, Ninna Rivers, Andani Mphinyane, Clayton Zazu, Mirella Schwinge, Georgina Cundill, Lumka Qangule, Carol Thompson, Jabulani Sibanda, Linda Nelani, Presha Ramsarup, Million Belay, Thandeka Mkize, Ntabiseng Mohanoe, Sirka Tshiningayamwe, Madeyandile Mbelani, Sebastian Lewis, Arstide Baloyi, and Leigh Price. Thank you so much for the friendship that mediated this study in a critical way. In this activity system I should also mention Mutizwa Mukute, Chris Masara, Muchaitei Togo, Justin Lupele, Nthalivo Silo, and Soul Shava whose theses and proposal were mediating artefact tools in this research journey. I would also want to acknowledge the valuable input that I got from the 3rd International Society for Cultural and Activity Research Summer University in Moscow. Special mention goes to Professor Harry Daniels for the consistent and inspirational guidance.

My heartfelt gratitude goes to my supervisor, mentor and pillar of support, Professor Heila Lotz-Sisitka for her insightful guidance and tireless support in providing boundary objects in the form of readings and incisive comments. I am also highly indebted to your financial support throughout the study, without which this study would not have been possible. I am grateful to my co-supervisor Professor Rob O'Donoghue who always challenged me to think critically and seek a more nuanced and sophisticated understanding of education activity systems. Thanks a lot to the two of you for providing an enabling environment for cultivating scholarship that is always cherished by many.

To the Education Department and staff at Rhodes University, thank you for your support, valued critical input in my study and for your kindness which created such a friendly working environment. Special mention to my colleague Dr Ken Ngcoza for taking much of the workload off my shoulders during this voyage and to Professor Jean Baxen for assisting in shaping the proposal and providing inspiration throughout, Professor Mark Scheffer for going through some drafts and Robert Kraft for listening to my PhD stories. Sashay, Natasha, Gladys and Bronwyn, I am greatly indebted to you for your unrelenting support in one way or the other. Thanks are also due to the proofreader, Kim Ward, whose experience and efficiency is highly appreciated.

I am grateful to the Belvedere Technical Teachers' College, and its associated activity systems and the University of KwaZulu-Natal School of Education for being part of the research project. It was through my interaction with these communities of research participants, that I was able to explore on deep underlying mechanisms that mediate curriculum practices in science teacher education with respect to gender and sustainability.

Finally, I thank my family for allowing me to spend so much time away from them: my wife Plaxcedes for holding the fort and supporting me intellectually and emotionally throughout my research journey; and our children Ruvimbo, Tafadzwa and Fadzai Jean. Finally, I thank my mother, Ireen, and my late father, Weston Mabasa, for cultivating in me the desire to work hard and to always do my best.

## **Dedication**

This thesis is dedicated to all those who work towards socio-ecological justice in education.

## TABLE OF CONTENTS

<u>Abstract</u> .....	i
<u>Acknowledgments</u> .....	iv
<u>List of Acronyms</u> .....	xi
<u>List of Figures</u> .....	xiv
<u>List of Tables</u> .....	xiv
<u>List of Boxes</u> .....	xvi
<u>List of Appendices</u> .....	xvi

<b><i>Chapter 1: INTRODUCTION TO THE STUDY</i></b> .....	<b>1</b>
1.1 PERSONAL HISTORY AND MOTIVATION.....	1
1.2 RESEARCH CONTEXT .....	6
1.3. RESEARCH FOCUS.....	6
1.3.1 Research goal .....	6
1.4 RESEARCH OBJECTIVES .....	7
1.5 RESEARCH QUESTIONS.....	7
1.6 RESEARCH SITES .....	9
1.7 KEY CONCEPTS IN THE STUDY (Conceptual framework).....	9
1.7.1 Gender and Gender Relations.....	10
1.7.2 Gender stereotypes .....	13
1.7.3 Gender equality .....	13
1.7.4 Gender equity .....	15
1.7.5 Gender parity .....	18
1.7.6 Gender bias .....	18
1.7.7 Gender discrimination .....	19
1.7.8 Gender neutrality.....	19
1.7.9 Gender blindness .....	20
1.7.10 Gender sensitivity .....	20
1.7.11 Gender awareness .....	20
1.7.12 Gender responsiveness.....	20
1.7.13 Patriarchy and gender roles in society.....	21
1.7.14 Socio-ecological risk.....	23
1.7.15 Sustainability.....	26
1.7.16 Curriculum and SMTs teacher education.....	30
1.7.17 Practice.....	31

1.8 SENSITISING CONCEPTS .....	33
1.8.1 Agency.....	33
1.8.2 Reflexivity.....	38
1.8.3 Dialectics .....	40
1.9 THESIS OUTLINE .....	41
1.10 CONCLUSION.....	43
<b>Chapter 2: EDUCATION for SUSTAINABLE DEVELOPMENT and GENDER ISSUES in SMTs CURRICULUM.....</b>	<b>44</b>
2.1 INTRODUCTION.....	44
2.2 EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) .....	44
2.2.1 Sustainable Development (SD) .....	45
2.2.2 Education for Sustainable Development (ESD).....	46
2.3 ESD AND SOCIAL MOVEMENTS.....	55
2.4 GENDER ISSUES IN SMTs EDUCATION: A SUSTAINABILITY CONCERN .....	57
2.5 GENDER ISSUES AND SOCIO-ECOLOGICAL RISK IN SOUTHERN AFRICA.....	66
2.6 EFFORTS TOWARDS GENDER EQUALITY IN EDUCATION .....	71
2.6.1 Millennium Development Goals and gender equality in education.....	71
2.6.1.1 The story of the South African MDGs .....	73
2.6.1.2 The story of the Zimbabwean MDGs .....	75
2.6.2 Education for All and gender equality in education .....	76
2.6.3 Beijing Platform for Action and Gender Equality in Education.....	79
2.7 SADC POLICIES ON GENDER EQUALITY IN EDUCATION .....	82
2.7.1 Zimbabwe National Gender Policy.....	84
2.7.2 South Africa's National Gender Policy Framework.....	86
2.8 TOWARDS GENDER EQUALITY IN EDUCATION: A PHILOSOPHICAL ANALYSIS.....	88
2.8.1 Towards Gender Equality in Education: Feminists appraisal.....	88
2.8.2 Towards Gender Equality in Education: a capability appraisal.....	91
2.9 CURRICULUM TRANSFORMATION: SUSTAINABILITY AND GENDER JUSTICE IN SCIENCE TEACHER EDUCATION .....	96
2.9.1 Curriculum and curriculum practice .....	97
2.10 CONCLUSION.....	107
<b>Chapter 3: THEORETICAL FRAMEWORK.....</b>	<b>108</b>
3.1 INTRODUCTION.....	108
3.1.1 Assumptions of the theories/approaches.....	108
3.2 CAPABILITY APPROACH .....	111

3.2.1 Capabilities and SMTs teacher education.....	115
3.2.2 Applicability to the study .....	118
3.2.3 Critique of the capability approach .....	125
3.3 FEMINIST STANDPOINT EPISTEMOLOGY .....	127
3.3.1 Applicability to the study .....	130
3.3.2 Critique of the feminist epistemology on science .....	132
3.4 CULTURAL HISTORICAL ACTIVITY THEORY .....	133
3.4.1 Generations of CHAT.....	135
3.4.1.1 First generation of CHAT .....	135
3.4.1.2 Second generation CHAT .....	136
3.4.1.3 Third generation CHAT.....	140
3.4.2 Unit(s) of analysis in CHAT .....	143
3.4.3 Principles of Third Generation CHAT .....	144
3.4.4 Expansive learning: incorporation of praxis, reflexivity and agency .....	150
3.4.5 Boundary learning.....	151
3.4.6 Critique of CHAT.....	158
3.5 CONCLUSION.....	160
<b>Chapter 4: METHODOLOGY and METHODS .....</b>	<b>161</b>
4.1 INTRODUCTION.....	161
4.2 Methodological Framework.....	163
4.2.1 Critical Theory in research .....	163
4.2.1.1 Critique of Critical Theory in research .....	165
4.2.3 Developmental Work Research (DWR).....	166
4.2.4 Case Study as a Research Methodology .....	171
4.2.4.1 Multisite Case Studies with related Activity Systems .....	173
4.3 RESEARCH PROCESS .....	174
4.3.1 Choosing study sites.....	174
4.3.2 Phases of the study.....	175
4.3.2.1 Exploration Phase .....	176
4.3.4.1 Expansive Learning Phases.....	176
4.4 RESEARCH METHODS .....	177
4.4.1. Document analysis.....	177
4.4.2 Individual Interviews.....	180
4.4.2.1 Generating data with individual interviews.....	182

4.4.4 Focus group discussions.....	185
4.4.5 Change laboratory workshops (Boundary crossing laboratories).....	185
4.4.5.1 Structure and administration of Change Laboratories .....	187
4.4.6 Critical Discourse Analysis.....	188
4.4.6.1 Critical Discourse Analysis as research methodology .....	190
4.4.6.2 Critique of Critical Discourse analysis as a research method .....	195
4.5 ENSURING DATA QUALITY (TRUSTWORTHINESS) (VALIDITY).....	196
4.6 ETHICAL CONSIDERATIONS .....	199
4.7 DATA ANALYSIS .....	201
4.7.1 Category Construction in Data Analysis.....	202
4.7.2 Thinking of theory in data analysis .....	205
4.8 CONCLUSION.....	206
<b>Chapter 5: EXPLORING CAPABILITIES, SUSTAINABILITY AND GENDER JUSTICE IN SMTs TEACHER EDUCATION CURRICULUM: BTTC CASE STUDY.....</b>	<b>207</b>
5.1 INTRODUCTION.....	207
5.2 ACTIVITY SYSTEMS IN THE CASE STUDY.....	208
5.2.1 Activity Systems in the BTTC Case Study .....	209
5.2.1.1 Teacher Education Activity System (Central Activity System) .....	210
5.2.1.2 Department of Teacher Education Activity System .....	212
5.2.1.3 Higher Education Activity System .....	214
5.2.1.4 ESD Activity System.....	217
5.3 ASSESSING THE LEVEL OF GENDER AND ESD POLICY RESPONSIVENESS IN SMTs TEACHER EDUCATORS IN THE BTTC CASE STUDY .....	219
5.3.1 Knowledge of push out factors for girls from SMTs .....	220
5.3.2 Role that teacher education can play to improve the participation of females in SMTs ..	224
5.3.3 Level of engagement with gender and ESD related policies.....	230
5.3.4 SMTs Curriculum as capability enhancing for females in view of socio-ecological risk ....	231
5.4 CRITICAL DISCOURSE ANALYSIS .....	235
5.4.1 Making sense of data with Critical Discourse Analysis .....	236
5.4.1.1 Critical Discourse Analysis on spoken language. ....	237
5.5 CONCLUSION.....	250
<b>Chapter 6: EXPLORING CAPABILITIES, SUSTAINABILITY AND GENDER JUSTICE IN SMTs TEACHER EDUCATION CURRICULUM: UKZN CASE STUDY .....</b>	<b>251</b>
6.1 INTRODUCTION.....	251
6.2 ACTIVITY SYSTEMS IN THE UKZN CASE STUDY.....	251

6.2.1 Teacher Education Activity System .....	252
6.2.2 ESD Activity System.....	253
6.3 ASSESSING THE LEVEL OF GENDER RESPONSIVENESS IN SMTs TEACHER EDUCATORS IN THE UKZN CASE STUDY.....	256
6.3.1 Knowledge of push-out factors for girls from SMTs .....	257
6.3.2 Role that teacher education can play to improve the participation of females in SMTs ..	259
6.3.3 Level of engagement with gender and ESD related policies/ SMTs Curriculum as capability enhancing for females in view of socio-ecological risk.....	264
6.4 CRITICAL DISCOURSE ANALYSIS .....	270
6.5 CONCLUSION.....	278
<b>Chapter 7: SURFACING CONTRADICTIONS IN THE TWO CASE STUDIES .....</b>	<b>281</b>
7.1 INTRODUCTION.....	281
7.2 CONTRADICTIONS IN THE BTTC CASE STUDY.....	282
7.2.1 Contradictions in the teacher education activity system .....	283
7.2.1.1. Primary contradictions.....	283
7.2.1.2 Secondary contradictions .....	288
7.2.2 Contradictions within, between and among activity systems .....	291
7.2.2.1 Contradictions involving the Department of Teacher Education activity system .....	293
7.2.2.2 Contradictions within the Ministry of Higher Education activity system .....	296
7.3 CONTRADICTIONS IN THE UKZN CASE STUDY.....	298
7.3.1 Contradictions concerning gender and SMTs in general .....	298
7.3.2 Contradictions concerning gender, SMTs and socio-ecological risk.....	304
7.4 CONCLUSION.....	308
<b>Chapter 8: EXPANSIVE LEARNING IN THE TWO CASE STUDIES .....</b>	<b>309</b>
8.1 INTRODUCTION .....	309
8.2 EXPANSIVE LEARNING IN THE BTTC CASE STUDY .....	310
8.2.1 Expansive learning in the Teacher Education Activity System (central activity system) ...	312
8.2.1.1 Introducing conceptual tools .....	312
8.2.1.2 (Re)conceptualising the object, analysis of contradictions and developing solutions in groups .....	314
8.2.3 Expansive learning with other activity systems .....	326
8.2.3.1 Introducing conceptual tools .....	326
8.2.3.2 (Re)conceptualising the object and analysis of contradictions .....	327
8.2.4 Expansive learning with all the activity systems.....	331
8.2.4.1 Introducing conceptual tools .....	332

8.2.4.2 Boundary crossing from questioning to modelling.....	332
8.2.4.3 More tools for transformation of work .....	341
8.2.4.3 Analysis of expansive learning .....	347
8.3 EXPANSIVE LEARNING IN THE UKZN CASE STUDY .....	350
8.3.1 Activity systems as they emerged from the data .....	350
8.3.2 Challenges with expansive learning in the case study .....	353
8.3.3 Expansive learning with the ‘ESD moved’ teacher educators .....	354
8.3.3.1 (Re) conceptualisation of socio-ecological risk as gendered .....	355
8.3.3.2 Building agency .....	359
8.4 REPORTING ‘INTERVIEW’ WITH THE HEAD OF SCHOOL .....	364
8.5 CONCLUSION.....	366
<b>Chapter 9: SYNTHESIS, IMPLICATIONS and RECOMMENDATIONS .....</b>	<b>366</b>
9.1 INTRODUCTION.....	366
9.2 OVERVIEW OF STUDY.....	367
9.2.1 Research aim and purpose.....	367
9.2.2 Conceptual framing and location of study.....	367
9.3 KEY FINDINGS OF THE STUDY.....	370
9.3.1 Key findings in the exploration phase.....	370
9.3.2 Findings in the expansive phase .....	372
9.4 IMPLICATIONS OF FINDINGS FOR SMTs CURRICULUM DEVELOPMENT.....	375
9.4.1 Policy-practice gap .....	375
9.4.2 Implications for quality and relevance of SMTs teacher education .....	377
9.5 RECOMMENDATIONS.....	379
9.5.1 Need for closer cooperation between policy makers and implementers .....	380
9.5.2 Holistic curriculum transformation.....	381
9.5.3 Recommendations for further study .....	383
9.6 NEW KNOWLEDGE .....	383
9.7 LIMITATIONS OF THE STUDY .....	384
9.8 MY ROLE AS A RESEARCHER.....	385
9.9 CONCLUSION.....	387
<b>References.....</b>	<b>388</b>
<b>Appendices.....</b>	<b>416</b>

## **List of Acronyms**

BTTC	Belvedere Technical Teachers' College
CDA	Critical Discourse Analysis
CHAT	Cultural Historical Activity Theory
CL	Change Laboratory
DESD	Decade for Education for Sustainable Development
DTE	Department of Teacher Education
DWR	Developmental Work Research
EFA	Education For All
ESD	Education for Sustainable Development
GDP	Gross Domestic Product
GNP	Gross National Product
HOD	Head of Department
MDGs	Millennium Development Goals
NGP	National Gender Policy
SA	South Africa
SADC	Southern African Development Community
SD	Sustainable Development
SMTs	Science, Mathematics and Technical subjects
ST <sup>2</sup> EEP	Secondary Teacher Training Environmental Education Programme
UN	United Nations
ZPD	Zone of Proximal Development

## List of Figures

Figure 1.1	Three pillars of sustainability	27
Figure 1.2	Hattingh's alternative portrayal of sustainable development	28
Figure 2.1	Relationship between gender issues in SMTs and ESD	57
Figure 2.2	Relationship between gender inequality and gendered vulnerability	68
Figure 2.3	Situating the study within the ESD discourse	96
Figure 2.4	Three intersecting traditions in quality of education	106
Figure 3.1	Basic Mediation Triad	135
Figure 3.2	Second generation CHAT	137
Figure 3.3	Application of activity system to the teacher education activity system	139
Figure 3.4	Two interacting activity systems	141
Figure 3.5	The conflictual nature of activity systems	142
Figure 3.6	Boundary learning between activity systems	152
Figure 4.1	Research design and the research process	163
Figure 4.2	Cycle of expansive learning	168
Figure 4.3	Stepwise problem solving in CHAT	171
Figure 4.4	Networked activity systems (cases) in a case study	174
Figure 4.5	Depiction of the workshop layout	187
Figure 4.6	Fairclough's dimension of discourse and discourse analysis	193
Figure 4.7	Inductive logic process used in the study	204
Figure 5.1	Networked Activity Systems for the BTTC case study	210
Figure 5.2	BTTC Teacher Education Activity System	212
Figure 5.3	Department of Teacher Education (rule/tool producing) Activity System	214
Figure 5.4	Higher Education (rule/tool producing) Activity System	216
Figure 5.5	ESD: Culturally More Advanced Activity System	218
Figure 6.1	Non-ESD UKZN Teacher Education Activity Systems	253
Figure 6.2	ESD; Culturally More Advanced Activity System in the UKZN case study	255
Figure 7.1	Primary contradictions in the teacher education activity system	284
Figure 8.2	Conceptual framework showing the interrelatedness of learning, teaching and sustainability	344
Figure 8.3	Two activity systems identified after the exploration phase in the UKZN case study	352
Figure 9.1	Illustration of the Developmental Work Research holding the two phases of the study	368
Figure 9.2	Technicist teacher SMTs	378

## List of Tables

Table 1.1	Three layers of causality in human action	37
Table 2.1	Commonly adopted ESD pedagogies in higher education	54
Table 2.2	Percentage of men and women in Faculties of Science in SADC	59
Table 3.1	Capability template	124
Table 3.2	Elements of the second generation CHAT	138
Table 4.1	List of documents analysed in the two case studies	178
Table 4.2	Interviewee details in the BTTC case study	183
Table 4.3	Interviewees details in the UKZN case study	183
Table 4.4	Elements of CDA	195
Table 4.5	Data generating methods	201
Table 4.6	Data index	202
Table 4.7	Summary of data analysis processes	206
Table 5.1	Description of the elements of the SMTs	211
Table 5.2	Description of the elements of the two rule and tool making activity systems in the BTTC case study before expansive learning	216
Table 6.1	Description of the elements of the two activity systems within the UKZN case study before expansive learning	256
Table 6.2	Capabilities checklist in the UKZN case study	268
Table 7.1	Primary contradictions within the subject in the central activity system	283
Table 7.1	Summary of secondary contradictions in the Department of Teacher Education activity system	294
Table 7.3	Summary of secondary contradictions in the UKZN case study	306
Table 8.1	Change Laboratory sessions in the BTTC case study	310
Table 8.2	Summary of group reports and emerging contradictions	315
Table 8.3	Summary of reflections on gender issues in the curriculum	319
Table 8.4	Reflections on gender and social-ecological issues in the curriculum	323
Table 8.5	Tool to engage with the gendered nature of socio-ecological risk	323
Table 8.6	Inputs and output of the rule/tool making activity system change laboratory	328
Table 8.7	Focus group summaries in the combined Change Laboratory	332
Table 8.8	Outcomes from the two focus groups	334
Table 8.9	Simple gender inclusive checklist tool	341
Table 8.10	Capability based Tool for gender and sustainability responsiveness in SMTs teacher education curriculum	342
Table 8.11	SMTs tool based on the four pillars of ESD	345
Table 8.12	Representative cohorts that make up the two activity systems in the case study	351

## **List of Boxes**

Box 2.1	Rights, gender equality, and questions about (SMTs) curriculum	102
Box 8.1	Mirror data from the NGP	314
Box 8.2	Two aspects of the gender dimension in climate change	321
Box 8.3	Stimulating questions/points in the Change Laboratory	332
Box 8.4	Towards modelling solution in the BTTC activity system	335
Box 8.5	Strategy of Education for Sustainable Development in Sub-Saharan Africa	360

## **List of Appendices**

Appendix 1	Sample letter requesting partnership in research	415
Appendix 2	Sample letter: thanking participants and appreciation for extended contact	416
Appendix 3.1	Interview guide for teacher educators	417
Appendix 3.2	Interview guide for other activity systems	418
Appendix 3.3	Document analysis tool	420
Appendix 4.1	Interview analysis tool	421
Appendix 4.2	Capabilities checklist	422

## **Chapter 1: INTRODUCTION TO THE STUDY**

### **1.1 PERSONAL HISTORY AND MOTIVATION**

My motive for conducting research into curriculum practices of Science, Mathematics and Technology (SMTs) teacher education is informed and inspired by my social and professional background stretching back to my high school days. My professional work for nearly two decades has been concerned with science teaching at three levels: high school in Zimbabwe and South Africa, pre-service teachers' college and in-service teaching in a university context.

I recall, from my high school days, some experiences that I can interpret as gendered practices in science education. As boys we were convinced that sciences (chemistry, physics and mathematics) were a males-only domain. We employed various strategies to make sure that girls could not easily penetrate this domain. I remember very well a cartel that kept library books and other material, which was supposed to be shared, in the boys' dormitory. Scarce books were returned to the library or to the teacher only when the „comrade“ who wanted them next was present. The few girls who learnt this and tried doing the same were met with stiff confrontations; tactics included reporting to authorities, verbal and even physical force.

Science laboratory practical activities were always gendered and to my surprise, upon reflection, it was business as usual for all my science teachers. For instance, whenever there was group work, I was not the only one who thought it was normal to have girls taking down the readings because of their clear handwriting, while the boys did the manipulating and observing, telling the girls what to write. We had permanent groups with boys and girls in each group and it was an accepted norm that boys did the experiments and then told the girls what to write. Our teacher would move from group to group checking on progress, seemingly satisfied with the boys' dominance in science. Why was it not an issue for him to see girls being reduced to laboratory secretaries?

Classroom interaction was another space that we used as boys to cow girls out of sciences. Although not really planned, as in the book cartel, I am sure however, that behaviours such as laughing at girls' mistakes in a derogatory manner, using opportunities to remind them that

they were not that intelligent, and taking pride in explaining abstract concepts to them, would have contributed to reducing their self-confidence.

Boys also crafted out-of-class schemes targeting individual girls who were seen as threats in the sciences. Most of these were well calculated and really damaging to adolescent girls, forming their characters and identities. I remember a friend of mine starting rumours that a certain girl was a mother, and that she had left a baby at home, and that this was why she was so composed, mature and good at mathematics. Such rumours would be spread by cartoons and small letters moving from one friend to another, and ultimately to the targeted persons themselves. It was also common to write small love letters and support each other as boys targeting particular individuals. This obviously unsettled the targeted girls and distracted them from their studies. To my surprise, when I think back now, most teachers would worry and intervene to rescue boys who were showing signs of deterioration in performance, but not the girls. I later on learnt, in my early years of teaching, that there is a dominant belief that at a certain age girls concentrate on their physical appearance, identity and pay particular attention to love affairs; hence the drop in performance is justified and to a certain extent acceptable. Boys on the other hand, are always reminded of their future breadwinning role and the need to work hard.

Outside the normal school timetable, boys had more space than girls. Some rules were less strict for boys. For example, boys were allowed to remain in classroom studying well into the night but girls had to be in their dormitories. As boys we frequently visited teachers' quarters (male or female) during weekends or after school, with a mathematical problem or to borrow reading material (despite a rule stipulating these quarters were out of bounds for all pupils). The rule was however relaxed for the boys and unbreakable for the girls; I guess this may have been because of the fear of sexual abuse by young male teachers who made up the major complement of the teaching staff.

At home, socialisation was not in favour of girls either. This ranged from fewer female role models in science-related occupations to gender stereotypic social expectations of female occupations. In addition, as boys we were always told to work harder and to break all barriers, even those that seemed unbreakable. The vernacular Shona has sayings such as „*zvinoda varume, kufa kwemurume hubuda ura*” meaning no „matter how hard things are, men should always try their best”.

My college experience also exposed me to gendered situations that I question. To start with, the enrolment of females was remarkably lower than that of males in sciences. I recall in my group that was majoring in chemistry, we had three females out of eleven males; in physics, one out of nine; in mathematics, nine out of 21; with biology the best in terms of gender equity with 13 females out of 27 males.

To my surprise, there was nothing that was visible on the ground to improve gender equality in enrolment. As if that was not enough, I do not remember being exposed to discussion on gender issues in science education, neither in education courses nor during teaching practice.

Soon after graduating from college I started teaching. I joined a profession and an institution in a patriarchal society, with patriarchal virtues that I now perceive as vices. None of us in the science and mathematics department had had any exposure to gender dynamics and science education. In my view we therefore committed many errors of commission and omission. It was acceptable in the department that girls dropped in performance, especially after form two. None of us had any clue why, nor were we prepared to find out the causes of this. Most of us, if not all, had the traditional patriarchal belief that, at this stage girls become aware of their gender identity and behave accordingly; and it is a socially acceptable „norm“ that doing mathematics and sciences is not quite feminine. It's shocking for me now that none of us was able to link even visible issues such as traditional patriarchal roles, gender division of labour and gender stereotypes to girls' deteriorating performance in sciences as they grow up.

Most teachers in the department, me included, were reluctant to take girls into advanced level (pre-university level) mathematics and physical sciences. If the truth is to be told, we actively tried to discourage them from taking these subjects at this high level, fearing that they would lower the pass rate at the end of the course. One particular trick that was used by most of us was to teach the most difficult section of the syllabus during the orientation week. In most cases the teaching was done in the scariest ways using learner inhospitable methodologies. I remember one year I had a group of 20 learners (nine girls and 11 boys) who had registered to do chemistry at an advanced level. By the end of the orientation week I remained with ten, nine boys and a single girl. What this means is that I had scared away 89% of potential girls and 18% of boys. I later learnt in my profession that girls are not attracted to physical sciences that have no apparent visible human impact like the physical chemistry section that I

used in orientation weeks. In addition, the teaching methodology that I used centered on abstract and mathematical reasoning, which appeared to appeal less to girls.

After teaching for five years in a high school, I was promoted to join Mutare Teachers' College, a pre-service diploma awarding teacher training college. I joined the science department which had only male lecturers, eight of them; I became the ninth. My task was to teach chemistry, some courses in science education and teaching practice supervision. The student enrolment policy of the department stipulated having at least 20% females in each intake. It was clear in my first few years that it was not easy to reach the 20% female quota. We had to rely on affirmative action, accepting females at lower entry points than the cut-off point for males. What astonishes me now is that, as science teacher educators, we were not bothered about finding out about and addressing the causes of low participation of females in sciences.

There were some efforts though to encourage females' participation in science as indicated by the policy setting minimum admissions. For instance, there was an annual award for the best female student in science, in the form of a bursary for further studies. Science education too, mentioned some gender issues in science education; but from my view none of us had the capability to really conceptualise gender social relations, connect them to science education and transform this into relevant curricula. Efforts to tackle gender and science education therefore did not really contribute much in making trainee teachers gender responsive, that is equipping them with skills and attitudes to tackle gender issues in science education in their practice as stipulated in the National Gender Policy (2004).

It was during my stay at Mutare Teachers' College that I had an opportunity to do my masters degree. I chose educational sociology, which exposed me to gender issues in education. This really was a remarkable learning curve in my profession with regard to understanding the complexities surrounding education. Exposure to a variety of theories on education (Marxism, functionalism, symbolic interactionism, constructivism, socially critical theory, feminism and many other theoretical perspectives) gave me various lenses to analyse school, knowledge and educational practice. Notably, it was the emancipatory and critical theories that enabled me to reflect on society, schooling, and knowledge and make them objects of analysis. I then began to question the relationship between culture, power and schooling for instance. In my masters research I was able to develop tools to reflect on practice and

interrogate many socially accepted norms and their influence on curriculum practices. It was in the same masters course that I was also exposed to international initiatives such as Education for All (EFA), Millennium Development Goals (MDGs), the Beijing Declaration and many others, which were designed to drive curriculum transformation at a national level. All these opened up spaces and provided guidelines to achieve gender equality in education, which really made an impact on my professional development.

Later, in 2001, the college was tasked to integrate environmental education into the teacher education curriculum. I became a member of the college steering team of the Secondary Teacher Training Environmental Education Programme. We had a series of training workshops and this marked my first deep engagement with environmental issues and learning. Through this programme, I had an opportunity to attend the Rhodes University-SADC course in environmental education. The course lasted only two months; however, its impact on my professional development was enormous and lifelong. In addition to environmental education, I became more conversant with issues of sustainability and sustainable development. I developed more lenses to look at the nexus of development, culture, schooling, equality and power. Furthermore, I got to know and understand additional international initiatives such as the Education for Sustainable Development, the Southern Africa Development Community Regional Indicative Strategic Development Programme (SADC-RISDP) and many others, which all supported the need for equality in education and promoted reorienting education and training in view of the socio-ecological risks and vulnerabilities in the region. The SADC region, I learned, like most poor regions of the world, was particularly susceptible to socio-ecological risk, such as rapid natural resources depletion, climate changes that are influencing normal patterns of food production, poverty, health and population issues including HIV/AIDS, conflict and violation of human rights, rapid political and technological changes and many more.

From Mutare Teachers' College, I joined the Midlands State University. I was in a team that was tasked to develop and implement a gender studies module across all the faculties of the university. For me it meant more grounding in gender issues and education. I was further exposed to gender and development concerns. It came to my attention through literature and observation that females in the SADC region depend more on the natural environment for their livelihoods than their male counterparts (UNPF, 2009). It is they who are left to cope with fewer resources and greater workloads in terms of, for example, irrigation and food production in droughts, finding alternative sources of fuel, or looking after the terminally ill

and many more. It became apparent to me that females need to have more opportunities in Science, Maths and Technology for them to develop capabilities for engaging with socio-ecological risks facing the region; alternately, the technological changes and the instruments that are being proposed to mitigate the impact of climate change, will remain gender biased and may even negatively affect females or bypass them. Such SMTs work can be achieved as part of an Education for Sustainable Development (ESD) process.

It is my initial training as a science teacher, my experience as a science teacher educator, my professional growth into understanding gender issues in education and development and my heed to the call for ESD that compelled me to undertake this study which has a curriculum transformation disposition. The study, as will be explained in more detail, focused on exploring and expanding gender responsiveness in SMTs teacher education curriculum practices, in a way that considers the functionings and capabilities of females in relation to increased socio-ecological risks in a Southern African context, as a process of ESD.

## **1.2 RESEARCH CONTEXT**

This study is located within the discourse of Education for Sustainable Development, as will be further discussed in Section 2.2. As stated in the SADC ESD consultative report (UNESCO, 2006a), re-orienting education towards Sustainable Development has the potential to be an appropriate response for enhancing potential for realising the Millennium Development Goals (MDGs). Gender equality and female empowerment is central to fulfilling all eight of the MDGs and also for addressing the major concerns of quality and relevance of education within the UNESCO framework of Education for All (EFA) (Shumba et al, 2008; Unterhalter, 2007).

## **1.3. RESEARCH FOCUS**

### ***1.3.1 Research goal***

The main goal of this study was to contribute towards social justice through curriculum transformation. This took place in two phases. The first phase involved exploring gender responsiveness in SMTs teacher education curriculum practices to gauge the extent to which such curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a Southern African context. The second phase involved

supporting expansive learning for gender responsive science teacher education curriculum practices as a process of ESD.

The ultimate aim of the study was to advance gender and sustainability responsiveness in science teacher education curriculum practices as a process of ESD. The rationale for this was that the participation of females in sciences is critical for the sustainable development of society, where issues are increasingly more complex and difficult to navigate (Bäthge, 2010; Clegg, 2007). The nature of the research focus compelled me to work with teacher education institutions that train teachers in SMTs. I decided on a case study design and chose two sites: Belvedere Technical Teachers' College (BTTC) in Zimbabwe and the KwaZulu-Natal School of Education (UKZN) in South Africa.

#### **1.4 RESEARCH OBJECTIVES**

The intention of the study was to explore and expand gender responsiveness in SMTs teacher education curriculum practices as a process of ESD. The following objectives provided guidance:

- i. to assess the level of gender and sustainability responsiveness of SMTs teacher educators,
- ii. to scrutinise underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices in SMTs teacher education,
- iii. to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a Southern African context,
- iv. to support expansive learning for gender responsive teacher education curriculum practices as a process of ESD.

#### **1.5 RESEARCH QUESTIONS**

In line with the above objectives, the study sought to provide answers to the following questions:

- i. **What is the level of gender and sustainability responsiveness of SMTs teacher educators?**

The question supports the first objective in 1.4, in compliance with the Developmental Work Research Design, the methodology of the study (see Section 4.2.3); the question was designed for the needs analysis of the curriculum activity. As expressed by Engeström

(1987), through this question I intended to capture recurring problems that are expressions of a historically formed, relatively persistent, critical internal contradiction of the activity in question. In capability terms (another theoretical framework of the study, see Chapter Three), the question looks at the extent to which science teacher education curriculum practices are supportive of capabilities enhancement for female learners in SMTs in general. Working within the ESD framework (see Chapter Two), this question helped to interrogate the quality of education in SMTs teacher education, as quality is partly understood in terms of equity and sustainability aspects (see Section 2.2.2). Explorative questions, aligned with this research question, were formulated and translated into research tools to explore whether SMTs teacher educators were aware of:

- a. the differences that are perceived to exist between boys and girls in relation to learning SMTs,
- b. the disadvantages faced by girls in their attempt to learn science,
- c. the role of teachers in fostering bias between the two genders, and
- d. the cultural and socio-ecological significance of SMTs.

ii. **What are the underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices in SMTs teacher education?**

This question is guided by the principle of historicity of Cultural Historical Activity Theory (CHAT), a theoretical approach guiding the study ( see Section 3.4). The question opened space for understanding the systemic and historical causes of gendered curriculum practices in SMTs in general and in teacher education, in particular. With a curriculum transformation agenda in mind, the question was designed to interrogate the potential of SMTs teacher education as a „conversion agent“ (see Section 3.2.2) that pays attention to negative social conversion factors (patriarchal norms and other socio-cultural ills), personal conversion factors (in this case gender) and environmental conversion factors (climate change, poverty etc.). This education also needs to engage with enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD, factoring them into the curriculum. The key sub-questions associated with this question were:

- a. To what degree do SMTs teacher educators engage with gender and ESD policies related to SMTs education?

- b. What are the causes of current gender pedagogical tensions in science teacher education curriculum practices?
- iii. **What capability set (opportunity freedom) is available for girls and boys in SMTs in general and in view of socio-ecological risk in a Southern Africa context?**

This question is in line with objective iii above. It was meant to guide the studying of the nexus between gender, SMTs teacher education curriculum and socio-ecological risk in a Southern African context. The specific research interest arose in the context of the gendered nature of socio-ecological risk and the role that SMTs can play for mitigation and adaptation purposes as discussed in Chapter Two (see Section 2.5).

- iv. **What expansive learning and what mediation tools can the study develop to support gender responsive teacher education curriculum practices as a process of ESD?**

This question was crafted to direct the expansive learning phase of the study as articulated in the last objective. Expansive learning and mediation tools were intended to support the transformation of the teacher education SMTs towards gender and sustainability responsiveness.

## **1.6 RESEARCH SITES**

As further elaborated in Section 4.3, the study was situated in the Southern Africa Development Community, with two case studies: one in Zimbabwe and another South Africa. I purposefully sampled two teacher education institutions, Belvedere Technical Teachers' College (BTTC) in Zimbabwe and the KwaZulu-Natal School of Education (UKZN) in South Africa (see Sections 4.3, 5.2 and 6.2 for a comprehensive description of the case studies).

## **1.7 KEY CONCEPTS IN THE STUDY (Conceptual framework)**

I provide here, an overview of key concepts that I worked with as mediation tools in exploring and expanding gender responsiveness in SMTs teacher education curriculum practices. As discussed in Section 2.2, the study has a curriculum transformation interest and is located within the framework of Education for Sustainable Development (ESD). It follows, therefore, that the terms that needed specific attention are: gender (including a whole range of related concepts), curriculum, practice, and ESD (and associated concepts).

### **1.7.1 Gender and Gender Relations**

Gender is a socio-cultural construction of males and females in a given historical context. It carries with it societal expectations, often experienced as embodied practices which are taken for granted, as to the likely behaviour, characteristics, and aptitudes men and females will have and responsibilities that are not biologically determined (Charlesworth, 2005). Thus, while sex is a fact of biology, gender is a social construct, a direct product of nurturing, conditioning, norms and expectations (UNESCO, 2005c). The Centre for Development and Population Agency (CEDPA, 2000) added that, like the variable concepts of class, race, ethnicity, culture and economics, gender is an analytical tool for understanding social processes. Gender is also a politically loaded concept as gender perceptions often determine who shall access what resources, from whom, when and how (ibid.). With a similar conception of gender, Unterhalter (2005) stated:

*I consider gender as not just a descriptive term of biological difference; hence gender equality is not primarily about counting equal numbers of boys and girls in school. My analysis rests on an understanding that gender, like ethnicity, class and the notion of marginality shapes social structures and relations in education and many other spheres in ways that entail unequal access to resources and the undervaluing of the views of certain groups. Gender equality, which often intersects with equality in other areas of social division, thus entails reflecting critically on the causes and consequences of these gendered forms of power, value and distribution, and transforming those that do not provide women and men with lives they have reason to value. (p.112)*

The feminist paradigm (see also Chapter Three) has, over the years, battled with the concept of gender. Feminism means essentially that women's or a gender perspective is applied to a variety of social phenomena. Feminism sees society as dominated by, and practised as patriarchy, a system of male power control where females are pushed to the margins of society by male dominated institutions and practices (Nyoni, 2005). Considering variations and conflicts within the feminist movement, three central elements can be said to characterise mainstream feminism (Alvesson and Skoldberg, 2000). First, gender represents an essential theme in the attempt to understand virtually all social relations, institutions and processes. Secondly, gender relations are seen as problematic, since they are associated with conditions of dominance, inequality, stress and conflict. Thirdly, gender relations are regarded as socially constructed and can be radically altered by human action.

Feminist researchers have gradually been moving gender research away from a view of gender as something simple and unequivocal towards a conception of gender as something

rather complicated and difficult to pin down (Alvesson and Skoldberg, 2000). They list three fundamental approaches corresponding to different phases in the development of this field of research. The first, referred to as the gender-as-variable approach (ibid., p.211) is concerned that male-dominated research disregards the gender variable. The argument is that any understanding of economic, social and psychological phenomena ranging from division of labour, class conditions and wage setting to recruitment and selection, leadership and political and moral values, must start from recognising the differences between males and females in terms of the situation and experiences. This perception of gender and corresponding approaches to gender research can easily be linked to the liberal feminist paradigm (ibid.). Liberal feminism dates back to the writings of Wollestonecraft who believed gender equality would be achieved through political and legal reforms (Gaidzanwa, 1992). Just like its theoretical proponents, the biggest setback of the gender-as-variable approach was its simplistic and unproblematic conception of gender (Alvesson and Skoldberg, 2000). Nevertheless, the approach has been commended especially for aiding researchers to collect gender disaggregated data that made inequality and inequity visible (ibid.). In a study with an expansive learning interest such as this one, mirroring quantitative disaggregated data, showing the low participation of females in SMTs, provided a much required stimulation for discussion (see Section 2.2.1).

The concept of gender was broadened under the feminist standpoint to an extent that gender can theoretically be „read“ into anything (ibid.). Feminist standpoint theorists therefore called for research based on females“ concrete experiences of discrimination. For example, Ferguson, in Alvesson and Skoldberg (2000), advocates for a feminist attack on the bureaucracy that is prevalent in organisational forms and the kind of male-oriented rationality that characterises them, revealing itself in individualism, hierarchy, lack of feeling, impersonality and competitive mentality, etc. One of the problems faced by this approach is the extent to which females“ experience can be uniform (Alvesson and Skoldberg, 2000). Females differ greatly among themselves depending on ethnicity, nationality, class affiliation, age, profession, sexual orientation and so on (ibid.). Despite this limitation, the approach has illuminated the concept of gender as it applies to science learning (see Section 3.3).

The third category in the evolution of the concept of gender is provided by post-structural and postmodernist feminism. This group of feminists distanced themselves from the emphasis given by the other two approaches to a particular females“ perspective, based on females“

experience (Alvesson and Skoldberg, 2000). Instead of speaking of men and females as existing side by side, clearly separable as integrated and consistent subjects, this approach emphasises that gender relations are crucial and these cannot be understood as unambiguous (ibid.). In other words this approach problematises gender relations, concentrating on deconstruction, language, discourse, meaning and symbols (ibid.). This perception of gender and gender relations resonates well with cultural historical activity theory, the theoretical framework of the study, in that the central goal is to make visible and open to critical scrutiny the cultural historical and situated emergence of gender issues and discourses in SMTs teacher education within a curriculum practice setting, with a view to transforming pedagogical practice. This, however, differs from mainstream post-structural / postmodern forms of feminism, as it does not only seek to deconstruct existing relations of power and domination, but also to re-imagine and expand possibilities and options for new practices that emerge from critical deconstructions and examination of gender relations that exist in cultural historically constituted activity systems (Charlesworth, 2005).

Post-structuralism has famously brought questions of power to the fore in social analysis. Thus, a conceptual analysis of the term „gender“ is incomplete without giving further attention to the dimension of power. The significance of gendered power structures has been a key analytic concern for the theoretical and practical approach termed „Gender and Development“. This approach was heavily influenced by socialist feminists, and emerged in the late 1980s as a critique of Women in Development, another theoretical and practical approach to development. Major Gender and Development scholars such as Kabeer (1994) and Elison (1995), amongst others, paid relatively little attention to issues concerning formal schooling, focusing instead on relations of production and macro-economic questions (Unterhalter, 2007). Nonetheless, the Gender and Development concern with power yielded some illuminating studies of gendered power relations in households and the impact of macroeconomic policies on decisions about which children went to and remained in school, as well as what they do in school (Leggat, 2005; Kingdom, 2003). Furthermore, the power dimension in the conception of gender and gender relations inspired some studies on science education which are very pertinent to this study. For example, in Lesotho, Prasad (2004) traced how social norms, tradition, culture and power relationships were used to maintain that females are not good in exact sciences like mathematics, physics and chemistry. In Nigeria, Kalu (2005) found that boys who were socialised to be aggressive, persevere and to engage in activities that involve physical strain and logical thinking, were likely to do better in the

perceived hard sciences than girls who were stereotyped to be docile, soft, less logical and to do things considered to be of a lesser importance. Kalu's (2005) study also showed that boys tend to be more assertive and more forceful in getting teachers' attention while the girls tend more towards compliance and conformity. O'Connor (2000) also observed that boys taunt and harass girls so as to discourage them from active participation in science lessons. This results in girls deliberately avoiding the answering of questions, fearing taunting and harassment by boys. These studies attributed such pedagogical behaviours to patriarchal power socialisation and sex-role expectations inherent in most African communities. Such research findings were necessary mediating tools in the expansive learning phase of the study as discussed in Chapter Eight.

### ***1.7.2 Gender stereotypes***

Stereotypes are rigidly held and oversimplified beliefs that males and females, by virtue of their biological make-up, possess distinct psychological traits and characteristics (African Development Bank, 2009). Stereotypes have serious negative economic and social consequences because of their tendency to treat gender roles as if they were fixed (ibid.). At a societal level, stereotypes are used as standards for evaluating categories of people, in terms of their mental capabilities, social roles, position and qualities possessed (Charlesworth, 2005). When stereotypes are used in this way, they lead towards discrimination and prejudice; for example, in the workplace, stereotypes result in certain jobs being the preserve of a particular sex (occupational stereotyping) and in school, certain subjects will be dominated by a particular sex. Rwodzi (2006) concluded that by allocating girls mostly to non-science subjects, teachers in Zimbabwe seem prejudiced against girls learning science. It is a proposition of this research that it will be worthwhile to develop an expanded teacher education curriculum that will equip future SMTs teachers with skills, knowledge, attitudes and strategies to respond to such cultural stereotypes that restrict females' participation in sciences.

### ***1.7.3 Gender equality***

Gender equality is an often-used but infrequently defined term. In most literature and in policy it is often used interchangeably with related concepts of gender parity and gender equity. Gender equality means that males and females have equal opportunities to realise their full human rights and contribute to and benefit from economic, social, cultural, and

political development (UNESCO, 2003). According to UNESCO (2005c), it is the symmetrical distribution of rights, power, opportunities, treatment and control of resources as well as equal access and control of benefits from those resources between males and females. Gender equality is therefore not only the absence of discrimination and bias, but “equal valuing by society of both the similarities and differences between females and men and the varying roles that they play” (Status of Women Canada 2004-05 Estimates, p.5). Gender equality in education occupies a central place in human rights and social justice (UNESCO, 2005b). The same sentiments of gender equality in education are echoed by international initiatives of Education for All (EFA), Millennium Development Goals (MDGs), the Beijing Platform for Action and ESD. These transnational policy discourses agree that human rights especially and not only females’ rights, are fundamental to poverty reduction and development.

My argument for gender equality in SMTs goes beyond the rights issue. In this regard, I found it appealing to use Amartya Sen’s capability theory and Shultz’s human capital theory to illuminate the discussion on the concept of gender equality in education, as well as trace its historical development. It is worth pointing out at this juncture that the Global Social Justice gender equality and education agenda, the Education for All agenda and the Millennium Development Goals are all grounded in rights and capabilities (Unterhalter, 2007). Rights to gender equality in education entail process freedoms in formulating the content of that education, and opportunity freedoms in being able to have access to and progression through education in combination with other valued functions (Sen, 2005). Combining rights and capabilities in curriculum terms would imply a curriculum that is learner centred, in which the interests of all are represented. With this in mind, I agree with Sen who saw the primary aim of educational institutions as establishing conditions that expand people’s substantive freedoms to do things they have reason to value for their own sake (Sen, 1999 in Elliot, 2007). In an ESD context, this includes the socio-ecological-economic sphere in which such freedoms may emerge or be contained.

Gender equality in education is thus intrinsically important because it enlarges capabilities of both sexes (Sen, 2005). For example, a science curriculum which is masculine in nature, that is riddled with gender stereotypes and biases against girls, limits girls’ capabilities because such a curriculum may limit their opportunities to access it. By not fully participating in SMTs, females are not only left with fewer options to choose from during their school days,

but this further narrows their capability-set and will tend to leave little space for them to make autonomous and reasoned choices between alternative functions in adult life (Peter, 2005). This will then leave them more vulnerable in the face of socio-ecological risks.

#### **1.7.4 Gender equity**

The standard definition of equity is ‘the quality of being equal and fair’ and ‘that which is fair and right’ (Oxford English Dictionary. 2007). “Equity might thus be thought of as equality turned into an action, a process of making equal and fair” (Unterhalter, 2009, p.416). She went on to comment that although the term equity appears more frequently than equality in policy texts, the academic literature which uses the term equity in education does not stress this active dimension separating equity from equality, but concentrates primarily on fairness in distribution, collapsing equity into aspects of equality (ibid.).

In simple terms equity in education means the process of treating girls and boys fairly. To ensure fairness, measures must be available to compensate for historical and social disadvantages that prevent girls and boys from operating on a level playing field. Responses may include “equal treatment or treatment that is different but which is considered equivalent in terms of rights, benefits, obligations and opportunities” (ILO, 2000, p.73). A basic principle of equity is equality of opportunity among people: “that a person’s life achievements should be determined primarily by his or her talents and efforts, rather than by pre-determined circumstances such as race, gender, social or family background” (World Bank, 2005, p. 7). This resonates with Sen’s capability approach (see Section 3.2) that makes the argument that the metric of interpersonal comparison needs to take human diversity as a central concern (Sen, 1992). He further adds that capabilities are thus responsive to heterogeneities which are central, not incidental to the ways in which equality is conceived (Sen, 1999 in Unterhalter, 2009).

Unterhalter (ibid.) saw equity in delineated forms of social arrangement which, given a range of human heterogeneity, can shape expansion of a capability set. In tracing how the term „equity“ appears in English, she came up with three different guises associated with three very different forms of social relationships: equity from above, equity from below and equity in the middle.

Equity from below is seen as a virtue that one does and performs. It has Christian/biblical origins to mean reasonableness between people, a quality of avoiding insisting on one's own rights or views too vigorously, taking in the idea of fairness and justice between people (ibid.). Unterhalter (2009) summarised:

*equity from below in education entails some acceptance of a space of negotiation in which particular concerns of groups or individuals on say curriculum content or the form of assessment or the treatment of girls and boys or the approach to management are negotiated not on the basis of majority rule, or the intensity of one person's view with regard to another, but through a process of reasonableness and reflection that considers each person participating in the discussion has a valuable opinion, but what is most valued is the process of establishing the considerate and fair relationships that support negotiation, questioning and discussion. (p.417)*

This form of equity would expect teachers for instance, especially SMTs teachers to be able to engage with issues such as whose perspective is favoured more in the ontology and epistemology of their disciplines, male or female? This is a professional capacity that one has to be taught at a formative stage as a teacher.

Equity tools such as math and science camps for girls in most African countries that have been implemented to increase achievement and encourage retention in SMTs, fall within equity from below. The camps bring together girls at secondary school level, usually during their school holidays (UNESCO, 2009) to open them up to Science, Maths and Technological subjects by demystifying them. Usually subjects taught during the camp include: Physical Science, Biology, Mathematics, Environment and Computers. In some cases the girls are also taught about gender, HIV and AIDS, communication skills, among others (FAWE, 2005).

Equity strategies such as these are needed to eventually attain gender equality over the long term and need to be reflected in policies and practices directed toward learners, teachers, and the community. Unterhalter noted that equity from below seems to align with the emphasis in the capability approach on agency and process freedoms and in Sen's interest in deliberative democracy (ibid.). She reasoned that social conditions that foster equity from below would also support the development of agency and process freedoms in education for diverse individuals and thus enhance the range of real alternatives very heterogeneous people can consider for themselves and others in expanding a capability set.

Equity from above according to Unterhalter (2009) concerns rules that have been decided as fair and reasonable by some widely recognised body of opinion, for example the government. Equity from above ensures laws about fair access and participation which could expand a capability set across profound differences of gender, class and caste (Unterhalter, 2009). Examples include setting up national gender policies and frameworks in various countries. The legal requirements laid down by international and regional bodies, for example the Convention on the Rights of the Child and the Convention on the Elimination of Discrimination against Women, EFA as well as the SADC gender protocol, are all examples of equity from above.

Equity from the middle in education is associated with the movement of ideas, time, money, skill, organisation or artefacts that facilitate „investments“ in the learning of children or adults and the professional development of teachers (ibid., p.421). Distribution of these on an equal shares basis may not be fair nor just at all times in expanding a capability set. Distribution would need to be attentive to redistribution, particularly when forms of diversity and their history entail discrimination. As Unterhalter argues, just giving equal shares of time or money will not mitigate the unfairness of existing social arrangements with regard to education, in the many societies where the consequences of the past are written in the present (ibid.). As an example, the Department of Education in SA channels more resources to formerly disadvantaged black schools as a way of equity from the middle (ibid.).

Equity from the middle may also present in the form of structures that guarantee smooth flow of education resources, as Unterhalter pointed out:

*... we were thus concerned to chart the ways in which equity from the middle articulated with equity from above, that is some rules regarding the provision of quality education to all children, and equity from below, which would ensure the participation of community discussion of that education that would include even the poorest parents. (ibid., p.421)*

In this study, in the BTTC case study, for example (see Chapters 5 and 8), structures such as the gender focal person in the Ministry of Higher Education, the teacher education college, and the department of teacher education are there to ensure equity from the middle: they are supposed to translate policy, e.g. national gender policy pronouncements, into curriculum practices.

In this study I concur with Unterhalter who sees value in distinguishing different forms of equity to highlight a number of processes that complement each other in expanding a capability set; from the bottom it is important to look at agency, from the top to look at rules and institutions that frame negative and positive freedoms linked to a theory of justice, and from the middle to ensure flows of resources, “a dynamic between ideas and values that is attentive to limits and judgments, but not just meagerly constrained by these assessments” (ibid., p 421). In this research, informed by CHAT (see Chapter Three), this distinction was facilitated by the construction of activity systems, and by making some assessment of equity from the middle. This allowed for some understandings of equity from above and below in the context of this study. Expansive learning mirror data was developed according to such assessments in an effort to expand gender capabilities in SMTs teacher education within the ESD framework (see Chapter Eight). This resonates with Unterhalter’s conception of “pedagogies of connection”, which is associated with equity from the middle that would ensure “flows of resources and information between differently situated people” (Aikman and Unterhalter, 2013, p.35).

### ***1.7.5 Gender parity***

As noted in *Gender and education for all: The leap to equality*, “gender parity and gender equality in education mean different things” (UNESCO, 2003, p.44). Parity is attained when the same proportion of boys and girls – relative to their respective age groups – enter the education system, achieve educational goals, and advance through the different cycles (UNESCO, 2003). Reaching parity in enrollment is necessary, but not sufficient, for achieving equality and should be considered a „first stage“ measure of progress towards gender equality in education” (ibid.).

### ***1.7.6 Gender bias***

Gender bias is the tendency to be in favour of or against an individual or a group on the basis of the individual’s or a group’s sex rather than on anything else. Gordon (2003, p.61) argued that “gender bias in science classroom continues and is manifest, and maintained by a variety of learned, non-conscious, verbal and non-verbal messages initiated in interactions between teachers and students”. Some examples of this are provided in my opening reflexive narrative (Section 1.1).

### ***1.7.7 Gender discrimination***

Discrimination refers to the prejudicial or distinguishing treatment of an individual based on their actual or perceived membership in a certain group or category, such as their race, gender, sexual orientation, ethnicity, national origin, or religion (Faith, 1994). Gender discrimination refers to the practice of granting or denying rights or privileges to a person based on their gender (ibid.). In some societies, this practice is longstanding and acceptable to both genders, and certain religious groups embrace gender discrimination as part of their dogma (Momsen, 2010).

Although gender discrimination is traditionally viewed as a problem normally encountered by females, it has significantly affected males as well. Jobs customarily and historically held mainly by women were often denied to men based on social stigmas. Some of the more common jobs that fell into this category were nurses, childcare providers and flight attendants (ibid.).

In countries where it is considered an affront, gender discrimination is also often difficult to prove. It is normally not as overtly evident as racial discrimination since the offender can claim other reasons for why a person was denied equal consideration (ibid.). For instance, if a male person claims he was not hired as a nurse based on his gender, the employer can simply maintain his qualifications were substandard or his personality was not a good fit with the rest of the staff. Such ambiguities frequently make it hard to prove gender discrimination.

### ***1.7.8 Gender neutrality***

This is the claim that one is indifferent to issues of gender, as he/she has no ultimate gender practice. It assumes that all people are affected by programmes (or policies) in the same way. It is premised on the theory that all people are already equal, therefore treating all people the same way is fair. Dieltiens et al.'s (2009) work in South Africa discovered that policy makers who ascribe to gender neutrality argue that there are no real principled differences between girls and boys and no competing interests that require education policy to show bias towards one or the other. In this way "gender differences are erased or neutralized in bureaucratic policy on „equality“ for pragmatic and intrinsic reasons" (ibid., p.369). They cite Fraser (1989) who noted that "feminist scholars have demonstrated again and again that authoritative views purporting to be neutral and disinterested actually express the partial and interested perspectives of dominant social groups" (p.370).

### ***1.7.9 Gender blindness***

When one is blind one cannot see. This is total failure (out of sheer gender ignorance) to recognise the differences between males and females and subsequently leads to failure to provide or cater for the differences. Gender blind people fail to realise that policies, programmes and activities can have different effects on men and females and this often leads to rigidity and unchanging attitudes. Unterhalter (2009) argued that a gender-blind approach in education “discounts the need to focus on girls as a disadvantaged group and views policy as having no differential impact on girls and boys (p.368). A further problem with the gender-blind approach, noted by Dieltiens et al. (2009, p.370), “is an implicit assumption that schools are not locations of inequitable gender reproduction and that the problem stems from culture or from the private sphere”.

### ***1.7.10 Gender sensitivity***

This is the ability to perceive existing gender inequalities. It is gender perceptiveness or gender consciousness i.e. looking at an issue with a „gender eye“. It is the beginning of gender awareness.

### ***1.7.11 Gender awareness***

This is the ability to identify problems arising from gender discrimination and bias which affect males“ and females“ ability to access and control resources and /or even access and control of benefits from the resources even when problems are swept under the carpet. For instance, in socio-ecological risk, gender awareness will entail identifying how gender inequality in general results in gender specific impact (who is more vulnerable to climate change?) and the need for a gender responsive approach to come up with solutions (see Section 2.5).

### ***1.7.12 Gender responsiveness***

Gender Responsiveness mainly constitutes responding to gender issues with a bid to find ways of eradicating bias and discrimination in order to ensure equality and equity. Gender responsiveness refers to taking action to correct gender bias and discrimination so as to ensure gender equality and equity (Mlama et al., n.d). In most cases the three terms gender sensitivity, awareness and responsiveness are conflated. However gender responsiveness involves taking action to redress gender imbalances and action can only be taken when one is aware and sensitive to gender issues. Chisholm“s (2005) paper showed the relationship of

these concepts at a practical level in the South African education context. She commented on the enabling environment of gender-sensitive decision-making structures, the development of a core curriculum which problematises notions of masculinity and femininity, takes up health, sex and reproductive education and provides the basis for recasting syllabi (learning programmes) and rewriting textbooks. All these showed gender awareness and sensitivity at policy making level and to some degree some responses were developed. However, at school level, gender responsiveness was lacking as there was no guarantee for gender-sensitive pedagogical processes either in teacher education, schools or in the production of learning support materials. This indicated that sensitivity and awareness at the top was not translated into responsive action at the lower levels. Unterhalter (2009)'s different conception of equity (equity from above, equity from below and equity in the middle) discussed in Section 1.7.4 is applicable to the situation raised by Chisholm. The enabling environment she described ensured equity from above. However, as she explained, there were no corresponding measures put in place by the system to guarantee equity from the middle and equity from below.

### ***1.7.13 Patriarchy and gender roles in society***

Patriarchy (rule by fathers) is a social system in which the male is seen to be the primary authority figure central to social organisation, political leadership, moral authority, and control of property, and where fathers hold authority over women and children (Wells, 2003). It implies the institutions of male rule and privilege, and entails female subordination (ibid.). Many patriarchal societies are also patrilineal, meaning that property and title are inherited by the male lineage (ibid.). The female equivalent is matriarchy. In feminist theory the concept of patriarchy often includes all the social mechanisms that reproduce and exert male dominance over women. Feminist theory typically characterises patriarchy as a social construction, which can be overcome by revealing and critically analysing its manifestations (Tickner, 2001).

In a patriarchal society, aspects of society and personal attributes that are highly valued are associated with men, while devalued attributes and social activities are associated with women (Schmidt, 1994). Most African societies are patriarchal with a few pockets of matriarchal arrangements among the Luapula in Zambia, the Ashanti and the Akan in Ghana, the Yoruba and the Bidjogo in West Africa, the Tuareg people and the Kabylei of Sudan (Farrar, 1997).

Zimbabwe and South Africa are largely patriarchal. Male domination in these societies does not mean that all men are powerful or all women are powerless, only that the most powerful roles in most sectors of society are held predominantly by men, and the least powerful roles are held predominantly by women (ibid.). The public/productive sphere (paid work) has been a male preserve, and the private sphere, identified interchangeably as the reproductive or the domestic sphere, is the designated venue of women (Moser, 2001). A plethora of cultural norms, traditions and myths successfully keep women out of the public sphere (ibid.). Moser (1993, 2001) developed the following gender roles:

**Productive roles:** relate to the production of goods for consumption or the generation of income through work within or outside the home. In many societies men have more visible and recognised productive roles than women, largely because men are more commonly paid for their productive work and women are not. Productive work tends to take place outside the home more often for men than for women. In general, women's productive work is often less visible and less valued than men's.

**Reproductive roles:** relate to domestic or household tasks associated with children and family. This involves the care and maintenance of the household and its members, including bearing of and caring for children, food preparation, water and fuel collection, shopping, housekeeping and family health care. Reproductive work is crucial to human survival and the maintenance and reproduction of the labour force, yet it is seldom considered „real work“. In poor communities, reproductive work is often labour-intensive and time-consuming. Men do not often perform domestic or household tasks and often have more leisure time. Men, in general, are able to focus on one productive role at a time and play their multiple roles sequentially rather than by multi-tasking. Furthermore, women's activities in the reproductive activities of the private sphere are so time consuming that there is hardly any time for women to get involved in political activities of the public sphere.

**Community management roles:** involve a wide range of activities undertaken voluntarily by men and women in the community with the common purpose of

benefiting the community as a whole. Activities include: the collective organisation of social events and services, ceremonies and celebrations; initiatives to improve the community, participation in groups, clubs and organisations etc. In many countries, men have a higher profile in terms of decision-making in the public sphere and tend to hold the majority of positions in local politics. They sit on more community councils and direct more local volunteers than women. Women, on the other hand, are involved in community-type work that could be defined in general terms as being less prominent and involving more drudgery.

#### ***1.7.14 Socio-ecological risk***

As mentioned above, we are living in an historical epoch characterised by climate change (influencing normal patterns and food production), poverty, health and population issues including HIV/AIDS, conflict and violation of human rights, rapid political and technological changes and many others. These issues are all bound up with risk (Giddens, 1999). Giddens (ibid.) traced the origin of the word „risk“ to the sixteenth and seventeenth Spanish and Portuguese explorers, where it was used to refer to sailing into uncharted waters. In this sense, the word had an orientation to space; later it included time and was used in banking and investment, to mean calculation of the probable consequences of investment decisions for borrowers and lenders; currently the word has come to refer to a wide range of uncertainty (ibid.). The notion of risk is therefore inseparable from the ideas of probability and uncertainty.

Risk refers to hazards that are actively assessed in relation to future possibilities. It comes into wide usage only in a society that is future oriented, which sees the future precisely as a territory to be conquered or colonised (Giddens, 2009). It presumes a society that actively tries to break away from its past – the prime characteristic of modern industrial civilization (ibid.).

Beck (2000) talked of „risk society“ arguing that issues arising from risk are diverse, complex and have the potential to affect all. He argued that the social production of wealth in advanced modernity is systematically accompanied by the social production of risk (Beck, 1992). He added that “risk may be defined as a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself” (ibid., p.21). In a risk society, Beck (1992) explained, the unknown and the unintended consequences come to be a

dominant force. In concurrence with Giddens (1999), Beck (ibid.) argued that risk is not the same as hazard or danger, but is a consequence which relates to the threatening force of modernisation and to its globalisation of doubt.

Beck (1992, p.22) developed the following theses to explain the social architecture and political dynamics of the potential of self-endangerment of the risk society, which I find illuminating to this study:

- Risks such as those produced in late modernity differ essentially from wealth. By such risks he meant for example radioactivity, toxins, pollutants in the air, water and foodstuffs which completely evade human perceptive abilities but induce systematic and often irreversible harm. Beck's argument is that such risks "generally remain invisible, are based on causal interpretations, and thus initially only exist in terms of the (scientific or anti-scientific) knowledge about them" (p.23). Such risks are open to social definition and construction. It is my argument that SMTs knowledge is key to everyone in this uncertainty and for the interpretation of such risks. "Education and attentiveness to information open up possibilities of dealing with and avoiding risks" (ibid., p.35).
- Some people are more affected than others by risks and in some of their dimensions, risks follow social inequalities. Risks seem to strengthen, not to abolish social strata. The poor and the weak attract an unfortunate abundance of risks. "On an international scale it is emphatically true that material misery and blindness to hazards coincide" (ibid., p.41). In patriarchal capitalist societies, it is the women who make up the majority in the poor, weak and semi-skilled or unskilled class. London et al. (2002) pointed out that in commercial agriculture (probably the biggest industry that employs women) in developing countries, women are typically located in lower-paid, low status work, often in casually employed jobs. They add that women's exposure to pesticides and resultant impacts is grossly underestimated and because of lack of knowledge and skills, they have very little opportunity to get safer jobs. Naidoo (2011) claimed that the majority of women working with moderate to highly hazardous pesticides had no knowledge of the implications of their exposures. As explained in Sections 2.3 and 2.4, SMTs are the foundations for the required knowledge and skills.

- Beck also added that risks have a „boomerang effect“, which breaks up the pattern of class and national society: “ecological disasters and atomic fallout ignore the borders of nations” (p.23). Like in the capitalist mode of production, risk is commercialised and there are losers but also winners in risk definitions. In the example above, for instance, risks are commercialised through agri-business, commercial farmers, some of which are multinational corporations from the industrialised world are the winners and the poor; in most cases, women are losers. In this way, risks produce new international inequalities, with poorer regions of the world being the losers. The logic of capitalism in all this is that hunger is sated, more food is produced, jobs are created but, as Beck (1992) argued “civilisation risks are a bottomless barrel of demands, unsatisfiable, infinite, self-producible ... the economy becomes self-referential independent of the surrounding satisfaction of human needs” (p.23).
- Beck argued that in risk, knowledge gains a new political significance. Accordingly, the political potential of the risk society must be elaborated and analysed in a sociological theory of the origin and diffusion of knowledge about risk.
- A risk society is characterised by political explosion: “what was until now considered unpolitical becomes political” (p.24). Suddenly the public and the politics extend their rule into the private sphere of industrial operations in check of industrial spill, a smog alarm, health problems for nature and humankind, as well as the social, political and economic consequences of the envisaged side effects.

Given such characteristics of a risk society, Beck, Giddens and many others seem to be calling for a dialectical approach to overcome monocultures of the mind and bring different minds and voices to engage authentically. It is important to use reflexivity by drawing on different forms of accredited expert knowledge and practical, local, experiential knowledges to work with risk. Beck (1992) argued that:

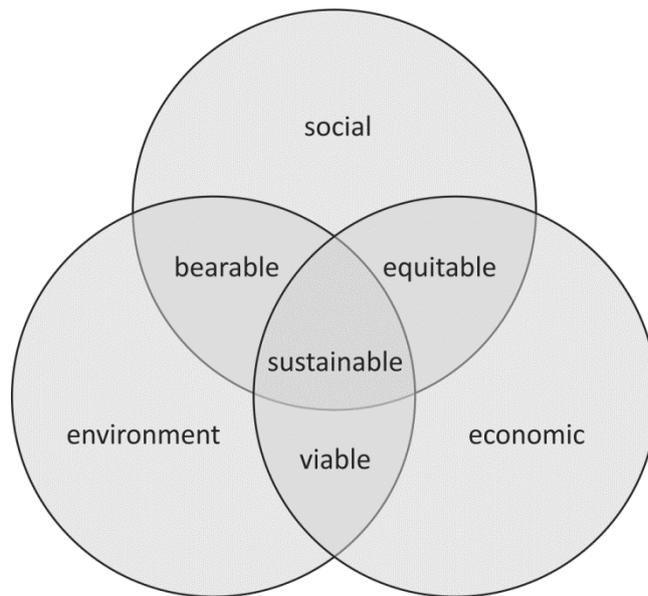
*determinations risks are the form in which ethics, and with it also philosophy, culture and politics, is resurrected inside the centres of modernisation – in business, the natural sciences and the technical disciplines ... risk determinations are an unrecognised, still undeveloped symbiosis of the natural and the human sciences, of everyday and expert rationality, of interest and fact ... they require a cooperation across the trenches of disciplines, citizens' groups, factories, administration and politics.*

It is with the conception of risk discussed here that this study sought to explore and expand on capabilities, sustainability and gender justice in SMTs teacher education curriculum practices guided by the research question in Section 1.5.

Linking this argument to Shiva's (2012) gender approach to socio-ecological risk and B athge's (2010) gender dimension in climate change (see Section 2.5), I argue that a good scientific and technical base to every citizen offered by SMTs has the potential to bring a good foundation to different minds and voices to engage with socio-ecological risk in a more effective way and for the good of the majority of people.

#### **1.7.15 Sustainability**

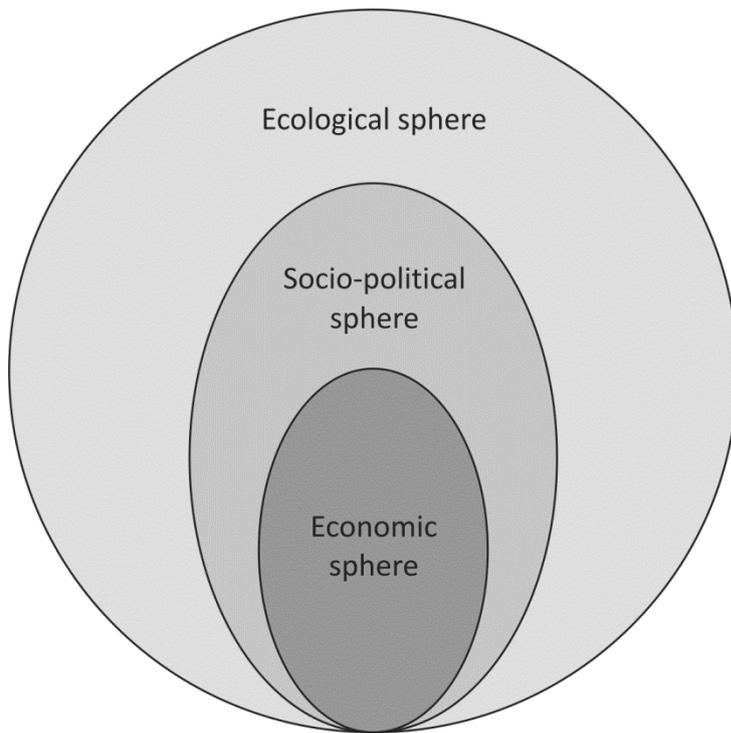
The word „sustainability“ is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up), (Onions, 1964, p.964). The dictionary provides more than ten meanings for *sustain*, the main ones being to “maintain”, “support”, or “endure” (ibid.). The idea of sustainability dates back more than three decades, to the new mandate adopted by IUCN in 1969 (Adams, 2006). It was a key theme of the United Nations Conference on the Human Environment in Stockholm in 1972. The concept was coined explicitly to suggest that it was possible to achieve economic growth and industrialisation without environmental damage (ibid.). Since the 1980s „sustainability“ has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability as a part of the concept sustainable development, that of the Brundtland Commission of the United Nations (see Section 2.2). At the 2005 World Summit on Social Development it was noted that development requires the reconciliation of environmental, social equity and economic demands – the “three pillars” of sustainability (UN, 2005) as shown in Figure 1.1. This view has been expressed as an illustration using three overlapping ellipses indicating that the three pillars of sustainability are not mutually exclusive and can be mutually reinforcing (ibid.). Lotz-Sisitka (2008b, p.3) defined sustainability practices as “practices that take full account of the economy-environment-society nexus in development interventions and initiatives (e.g. production processes), and that are oriented towards ecological sustainability, social justice, and a more benign economic system”. This understanding of sustainability is conceptualised within the broader discourse of Sustainable Development (Section 2.2).



**Figure 1.1** *Three pillars of sustainability* (Source: Hattingh, 2004, p.159)

Hattingh (2004) reacted to the language of the three pillars of sustainable development as presented in Figure 1.1. He acknowledged that while the three pillar image is useful to catch the imagination of a corporate audience and policy makers, the language is not as innocent and ideologically neutral as it seems to be (ibid.). He cites problems such as “the three pillar model creates an impression of three separate spheres, each with its own set of values and working according to its own internal logic” (ibid., p.160). He added that the three pillar model says nothing about the manner in which the pillars interact, or affect one another, or how they are dependent on one another. He also laments that without clarity on this interaction, in policy and decision-making, the interaction between the different spheres is usually reduced to making trade-offs as discussed below. He further argued that the pillar model is embedded in a version of conventional, instrumental reality that is not strong enough to resist current exploitation, depletion and destruction of the biophysical environment.

With this critique Hattingh developed an alternative portrayal of sustainable development in terms of three embedded spheres as shown in Figure 1.2 below.



**Figure 1.2** *Hattingh's alternative portrayal of sustainable development in terms of three embedded spheres* (Source: Hattingh, 2004, p.161)

Hattingh (ibid.) pointed out that the most important implication of this model is that the activities in one sphere may have a negative impact, even to the point of disruption or destruction, on the larger sphere. He added that this perception of sustainability “locks us into a language of prevention of impacts, precaution, minimum standards, non-negotiable thresholds in our economic activities instead of mitigation as in the three pillars image described previously.

The philosophy underpinning sustainability as it applies to education is that education should lead to the creation of harmony and balance in our relationship with the environment as well as in our social and economic relationships (Down, 2010). The pedagogy needed for sustainability is “one that is focused on real world tasks, is community oriented, values-centered and has a strong future’s perspective” (ibid., p.60). The real tasks in Southern Africa, like in most parts of the third world, hinge on the same nexus of the biophysical environment, social and the economic aspects. The region is faced with innumerable challenges such as poverty reduction, eliminating hunger and diseases, mitigating impacts of climate change, redressing social inequality and many more that impact negatively on livelihoods and whose solutions may be found in sustainable development. Likewise

education needs to be reorienting in the sustainability direction so that it can contribute towards resolving these challenges.

The discourse of sustainability is not without critiques. Concerns have been raised that the concept is vague, as is the associated discourse of sustainable development. For instance, Adams (2006) traced the development of the discourse raising the following historical inconsistencies: Our Common Future located environmental issues within an economic and political frame, moving sustainability to the core of international development debate; Rio emphasised global environmental change, and the problems of biodiversity and resource depletion and climate change; the World Summit on Sustainable Development returned poverty to the top of the agenda, reflecting the Millennium Development Goals agreed at the United Nations Millennium Summit in September 2000. Sustainability was one of eight Goals, associated with 18 targets and 48 indicators, intended to be yardsticks for measuring improvements in people's lives.

Some analysts agree that one reason for the widespread acceptance of the idea of sustainability and sustainable development is precisely this looseness (Reinecke, Manning and Von Hagen, 2012). It can be used, they add, to cover very divergent ideas. They further emphasised that environmentalists, governments, economic and political planners and business people use „sustainability“ or „sustainable development“ to express sometimes very diverse visions of how economy and environment should be managed (ibid.).

Trade-offs is another problem raised by some critiques. The International Institute for Sustainable Development (2012) proposed that the conventional understanding of sustainable development, based on the „three pillars“ model, is flawed because it implies that trade-offs can always be made between the environmental, social and economic dimensions. They underlined that, in practice, development decisions by governments, businesses and other actors allow trade-offs and emphasise the economy above other dimensions of sustainability. This is a major reason why the environment continues to be degraded and development does not achieve desirable equity goals (ibid.).

The problem of metrics in sustainability is another issue raised by analysts. There is no agreed way of defining the extent to which sustainability is being achieved in any policy programme. Sustainability and sustainable development are effectively ethical concepts,

expressing desirable outcomes from economic and social decisions. Everywhere the rhetoric of sustainable development is ignored in practical decisions.

Such analyses of sustainability were priceless in this study. The SMTs disciplines have been driven for centuries by the economic need to produce more and this has been to the detriment of the environmental and social aspects of development. Beck (1992, p.29) raised this in what he calls a “polygamous marriage” of sciences to business, politics and ethics. In this case he accused science of abandoning their foundation of experimental logic and living with the latter in a sort of ,permanent marriage without a license“ (ibid.). It is for this reason that I saw it fit to use the ESD lenses (see Section 2.2a), the capability and feminist approaches (Chapter Three) to interrogate aspects of sustainability and gender justice in SMTs teacher education practices.

My intention in this study was to explore and expand such sustainability aspects in SMTs teacher education curriculum. My argument is a SMTs curriculum that embraces sustainability, is more relevant to the needs of the community. This has the potential to attract young people, more so girls, as discussed in Section 2.4. More participation in SMTs potentially leads to a greater number of people, different minds and voices, engaging with issues of socio-ecological risk.

#### ***1.7.16 Curriculum and SMTs teacher education***

Curriculum can best be understood in this study through Cornbleth (1990)“s two major themes of curriculum. The first is that curriculum is conceived as what actually occurs in learning situations, that is, an ongoing social process comprised of the interactions of students, teachers, knowledge, and milieu. Of particular concern here is curriculum knowledge, which is selection, organisation, treatment and distribution of knowledge to students. The second theme is that curriculum is contextually shaped. The relevant context is both structural and socio-cultural. By structure, Cornbleth (1990, p.6) meant “established roles and relationships and operating procedures, shared beliefs and norms”. The socio-cultural context looks at social, political and economic conditions, traditions, ideologies and events that actually or potentially influence curriculum. Section 2.9 provides a more expansive discussion on curriculum.

### ***1.7.17 Practice***

Practice is a concept widely used in social sciences referring broadly to anything people do. It overlaps with the Weberian notion of social action and the Marxist concept of praxis (Green, 2009). Praxis is the process by which a theory, lesson, or skill is enacted or practiced, embodied and/or realised and it may also refer to the act of engaging, applying, exercising, realising, or practising ideas; it is a practical and applied knowledge to one's actions (ibid.).

Dean (2009, p.138) pointed out that “practices are structured and relatively enduring activities which involve the imposition of particular forms of raw materials ... consist in the transformation of ... raw materials into a product, a transformation effected by human behaviour, using means of production”. Green (2009) added that practice is in itself a form of action knowledge, also called practical sense, practical logic or practical knowledge, characterised by phenomena such as agency, knowledge, language, ethics, power and science.

Drawing on scholars like Heidegger and Wittgenstein, Bourdieu, Dreyfus and Hall, Green (2009) noted that practice is more than merely an epistemological question because it is not only about what goes on in the head of a person but also in the body, and is therefore closer to praxis. He further argued that practice ontology is concerned with “what people do, not what people say they do”, their everyday practices rather than their conceptualisations or their thinking (Green, 2009, p.41). Practice is concerned with the vernacular, the everyday; the life-world and (practices) are the source of intelligibility. Practice is made up of three dimensions according to Green (2009, p.19): “learning how to do something or improving one’s ability to do something by repeatedly working on something and carrying it out; temporally unfolding and spatially dispersed nexus of doings and sayings; and performing an action”.

Bourdieu (2004) theorised practice arguing that practice is a complex social activity involving habitus, field and capital; it occurs in space and time; it is guided by tacit knowledge which is not fully unconscious or fully conscious; and is purposeful and strategic. Within a Bourdieuan approach, habitus is a central construct which aligns closely with identity: “systems of durable, transposable dispositions, structured structures predisposed to function as structuring structures” (Elder-Vass, 2010, p.326). Zevenbergen (2005) added that habitus predisposes the participant to act, think and behave in particular ways. Elder-Vass (ibid.) added that habitus is a product of history which is both a product of, and produces,

individual and collective practices. Hodkinson, Ford and Hawthorn (2007) described habitus as: made up of a battery of dispositions which orientate a person towards all aspects of life; embodied, incorporating the emotional, the physical and practical as well as the cognitive; dispositions that are thus at least partly tacit, and enduring, but can and do change. They are developed (learned) throughout life, but can be seen as social structures operating through the person (ibid.).

Practice cannot be fully comprehended without making reference to Bourdieu's concept of „field“: a system of social positions (e.g. a profession such as law) structured internally in terms of power relationships (e.g. the power differential between judges and lawyers) (Bourdieu, 1993). More specifically, a field is a social arena of struggle over the appropriation of certain species of capital (Thorpe, 2009). Capital refers to the different forms of power held by social agents. Bourdieu (1986) identified various forms of capital (power), including economic (e.g. wealth), social (e.g. social connections), cultural (e.g. artistic taste), symbolic (e.g. prestige), linguistic (e.g. vocabulary and pronunciation), academic (e.g. tertiary qualifications), and corporeal (e.g. physical attractiveness).

In this study, the notion of practice is used to refer to a collection of related activities that serve a particular purpose. It includes doings, sayings, training and habituations, and is both bodily and mental. In short I use practice to refer to a way of doing things in a curriculum setting which is informed by place, thoughts, values, interests and habitus. In analysing SMTs teacher educators' curriculum practices in relation to gender, I will look at dispositions that shape tendencies to act in ways that may not be fully conscious and then agential work to develop gender responsive curriculum practices that are mindful not only of the ontology and epistemology of SMTs but also of the need to develop capabilities of both girls and boys in view of socio-ecological risk. As supported by Green (2009), practice involves improvising as people (agents) invent in the interplay between freedom and constraints. This leads to agency (see Section 1.8), the ability to reflect on current practice, work on tensions and disturbances to improve on it as discussed in Chapter Eight.

Relevant to this study is the Activity Theory conception of practice which argues that cognition, emotion, or motivation cannot be understood outside of actual praxis, which is always conceived in terms of activity as a system of relations (Leont'ev, 1978). The main conceptual entities include the subject (individual, group) of the activity, its object, the means

of production (tools, instruments), the community in which the subject is part, the division of labour, and the rules or norms of behaviour that the community has adopted (Engeström, 1999) (see Section 3.4).

## **1.8 SENSITISING CONCEPTS**

Sociologist Charmaz (2003) has referred to sensitising concepts as background ideas that inform the overall research problem and offer ways of seeing, organising, and understanding experience as well as interpretive devices for a qualitative study. Gilgun (2002, p.42) believed “research usually begins with such concepts whether researchers state this or not and whether they are aware of them or not”. Domahidy (2003) added that sensitising concepts draw attention to important features of social interaction and provide guidelines for research in specific settings.

In this study I worked with three sensitising concepts which fuse together the research objectives, the theoretical framework, and the research process. The sensitising concepts are agency, reflexivity and dialectics.

### ***1.8.1 Agency***

The concept of agency is dialectically linked to that of structure. Agency and structure are different but potentially complementary terms; a conceptual analysis of one can hardly be done without the other. Archer (2003, p.1) highlighted that the terms structure and agency have been a source of controversy: in some sense structure is “objective” whilst in some sense agency entails “subjectivity”. Archer (1982) simplified it as individual actions of what happens in society (agency) vis-à-vis the wider social, economic and political institutions and processes (structure). Archer (1982) added that on one hand, structure enables or constrains the agency of different groups and, on the other, the agency of different groups is able to impact on structure. In other words, structures are perpetuated (and modified) by agency-individual and collective actions or non-actions (ibid.). Barker (2005) provided a straightforward definition: agency refers to the capacity of individuals to act independently and to make their own free choices. By contrast, structure refers to those factors (such as social class, religion, gender, ethnicity, customs, ideologies, traditions etc.) which seem to limit or influence the opportunities that individuals have.

The debate concerning the primacy of either structure or agency on human behaviour is one of the central ontological issues in social sciences, with questions such as "What is the social world made of?", "What is a cause of the social world, and what is an effect?", "Do social structures determine an individual's behaviour or does human agency?" (Archer, 1982, 2003; Barker, 2005).

For functionalists such as Durkheim, structure and hierarchy were essential in stabilising the very existence of society. Theorists such as Karl Marx, by contrast, emphasised that the social structure can act to the detriment of the majority of individuals in a society. Theoretical systems aligned with this view include: structuralism and some forms of functionalism and Marxism, all of which in this context can be seen as forms of holism: the notion that the whole is greater than the sum of its parts (Archer, 1982).

As the opposite of the holist position, other theorists stressed the capacity of individual "agents" to construct and reconstruct their worlds. Theoretical systems aligned with this view include: methodological individualism, social phenomenology, interactionism and ethnomethodology.

A third option is taken by many modern social theorists (Bourdieu, 1977, 1990; Archer, 2003; Giddens, 2006, 2009), which attempts to find a point of balance between the two previous positions. They see structure and agency as complementary forces – structure influences human behaviour, and humans are capable of changing the social structures they inhabit. Structuration is one prominent example of this view. The term "reflexivity" is used by Archer (2003) to refer to the ability of an agent to consciously alter his or her place in the social structure. She argued that it is important to analytically differentiate structure and agency to avoid conflation.

In this study, I was interested more in agential work; the focus therefore is mainly on the interplay between agency and structure. "Agency entails an ability to coordinate one's actions with others and against others, to form collective projects, to persuade, to coerce, and to monitor the simultaneous effects of one's own and others' activities. Moreover, the extent of agency exercised by individual persons depends profoundly on their positions in collective organizations" (Sewell, 1992, p.21). Edwards (2007, p.1) added "... one's ability to engage with the world is enhanced by doing so alongside others". Barnes (2000, p.25) defined agency thus: "For an individual to possess agency is for her to possess internal powers and

capacities, which, through their exercise, make her an *active* entity constantly intervening in the course of events going on around her”. It is implicit in this quotation that agency is change oriented and can be perceived as the human will to act towards a given end in relation to something or some other people. The idea of agency assumes purposive, autonomous, and creative actors capable of some degree of choice. It involves actors’ engagement with structures to reproduce or transform them.

The above conceptions of agency and structure are central to this study, bearing in mind that the study has some curriculum transformation interest. The interplay between agency and structure in curriculum terms can be conceptualised using Cornbleth (1990)’s two major themes of curriculum (Section 1.8.11). Agential capacity would imply teacher educators being able to be reflexive, that is to mediate between structure and agency in favour of emancipatory pedagogy. In other words this will imply putting on gender lenses and reflecting on social norms and how they impact on selection, treatment and distribution of SMTs curriculum knowledge and praxis.

The concept of agency is also central to the capability approach which is one of the theoretical approaches informing this study (see Chapter Three). Sen (1999; 2009) was concerned with agency freedom and agency achievement and “a free and sustainable agency” as the “engine” of development (ibid., 1999, p.4). Agency freedom entails having the freedom (opportunities) to bring about the achievement one values (Sen, 1992). This is concerned with being free to do and achieve our valued goals (Walker, 2006): “More freedom makes more (agency) alternatives available” (ibid., p.34). Agency achievement refers to a person’s success in pursuit of the totality of her considered goals and objectives (Sen, 1992; Walker, 2006). In this sense, Walker added agency is then one’s ability to pursue goals that one values and that are important for the life an individual wishes to lead. This demonstrates that agency and human flourishing are deeply connected (see Section 3.2).

Pertinent to this study is that the capability conception of agency effectively brings out two strands of agency: agency opportunities (freedom) and agency outcomes (achievements). Of considerable importance to curriculum analysis is that the capability approach provides lenses to evaluate agency based on individual circumstances, the relation one has with others, and social conditions and contexts within which potential options (freedom) can be achieved. Sen insisted individual agency (freedom) depends on social arrangements:

*... the freedom of agency that we individually have is inescapably qualified and constrained by the social, political and economic opportunities that are available to us. There is a deep complementarity between individual agency and social arrangements. It is important to give simultaneous recognition to the centrality of individual freedom and to the force of social influences on the extent and reach of individual freedom. To counter the problems we face, we have to see individual freedom as a social commitment. (Sen, 1999, p.xi-xii)*

What does this mean to a curriculum transformation project such as the one examined in this study? It would follow that curriculum development, particularly in SMTs teacher education and pedagogic practice should aim at agentic development in future teachers to produce teachers with the capacity to provide opportunities (agency freedom) for both genders in SMTs. Such curriculum practice would contribute immensely towards agency achievement of both genders in sciences. One would expect a teacher education curriculum that engages with the social arrangements that constrain girls from participating in SMTs at the same level with boys. In their formative stages as teachers, they should be exposed to those social opportunities (e.g. progressive policies) and social norms that expand or diminish agency freedom of girls and boys in SMTs.

This study also draws on Engeström's (2008) notion of agency and links agency to Cultural Historical Activity Theory (CHAT) (see Section 3.4), the epistemological framework of the study. Traditionally, CHAT hardly makes mention of agency, which has been a major critique of it as well as of expansive learning (Daniels, 2001; Edwards, 2007; Leesa, 2007). Nonetheless, Edwards (ibid.) argued that more in-depth understandings of relational agency in activity systems can address this critique of CHAT. She cited Stetsenko who saw the transaction between subject and object in an activity system presenting an opportunity to bring human subjectivity (agency) into CHAT. This "default slippage" (ibid.,p.7) of the individual into the system in the systemic analyses of activity theory is a welcome opportunity for examining relational agency more carefully. Relational agency allows us to work with others in pursuit of ever expanding objects and to explore the possibilities that these new objects reveal (ibid.).

Addressing earlier critiques, Engeström (2008) in more recent work, presented three layers of human causality (see Table 1.1) to assist in visualising agency in human activity.

**Table 1.1** Three layers of causality in human action

Interpretive layer	In the actor	Takes into account according to this and that logic	If X, then Y Rule, law
Contradictory layer	As participant in collective activities	Is driven by contradictory motives	Searching for resolution by often unpredictable actions
Agentive layer	As potential individual and collective agent	Takes intentional transformative action	Inventing and using artefacts to control the action from the outside

Source: Engeström, 2008, p.17

The primacy of Engeström’s argument here is that humans do not merely react as physical objects; they act based upon their activities, interpretations and logics (ibid.). This is represented here as the *interpretive layer* of causality. He further claimed that human beings not only interpret, they also face contradictions between multiple motives embedded in and engendered by their historically evolving communities and objects. He therefore developed the *contradictory layer*. Lastly there is a layer that shows the human potential for agency, for intentional collective and individual actions aimed at transforming the activity (ibid.).

The CHAT conception of agency was enlightening to this study. The explorative phase of the study falls within the interpretive layer, allowing the researcher to make sense of the curriculum practices, taking into consideration the structure and development of the activity in which the actors are involved and its meaning for the different actors, the laws and rules that actors take into account in their activity, as well as their logic and interpretations (see Chapters Five and Six).

The expansive learning phase illuminated the contradictory and agentive layers of human causality. First it involved surfacing contradictions that constrain gender responsive curriculum practices in SMTs teacher education. Next it was important to make the contradictions visible to and analysable by others. My agentic capacity as an interventionist researcher entailed the ability to coordinate change laboratory workshops as collective projects, to persuade, to illuminate, and to provide mirror data and additional stimuli to make contradictions visible and analysable. Throughout the expansive phase, I sought to identify how and if relational agency came to the fore in that joint action as SMTs teacher educators and officials from related activity systems were brought together in a process of (re)conceptualising the object through joint analysis of tensions and contradictions (Mukute, 2010). This coming together of several subjectivities has the potential to expand interpretation of the problem and as well as sets of conceptual tools on the problem

(Engeström, 2008; Mukute, 2010). Multiple-voices, as argued by Engeström (1987, 2000, 2001), raise more tensions and further learning as well, assisting with modeling a solution, an agentic way of doing work. As discussed in Chapter Eight this meant modeling a teacher education curriculum that has potential to equip future SMTs teachers with tools to engage with negative social conversion factors as well as with enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD, and factor them into the curriculum.

### ***1.8.2 Reflexivity***

Abercrombie, Hill and Turner (2006) defined three aspects of reflexivity: the ability to look into oneself; to examine one's own practice and change it; and to reflect on and talk about the social world. Delanty (2005, p.120) saw reflexivity as "self-transformative capacity involving the use of knowledge to generate further knowledge". Delanty further elaborated that reflexivity is not simply reducible to subjectivity or to inter-subjectivity but arises out of the relational encounter of subjectivity with objectivity.

This conception of reflexivity resonates well with CHAT, the epistemological theory of this study. CHAT provides the framework for subjectivity (the ability to look into oneself), inter-subjectivity (the interaction between researcher social, cultural customs and participants and participants among themselves) and relational encounters of subjectivity with objectivity (subjects engaging with the object of study, in this case curriculum practices) (Roth and Lee, 2007). All this provides in-depth perspectives on improving individual and institutional practice (self-transformation). In the context of this study, the exploration phase of the study was used to generate knowledge on current SMT teacher educator curriculum practices. This knowledge, together with gender responsive pedagogy knowledge in literature, will be reflected on so as to generate new knowledge (improved gender responsive curriculum practices).

May (2000) in Delanty (2005) characterised the critical nature of reflexivity in social sciences in terms of endogenous reflexivity and referential reflexivity. The former refers to an agent's everyday knowledge while the latter refers to the process of recognition in which the agent comes to understand their situation in a more adequate manner. He added that referential reflexivity is a critical reflexivity aimed at identifying the effects of power on social action. In this study, social circumstances such as patriarchy, social gendered power gradients and the

impact on curriculum will be open to scrutiny in change laboratory workshops to enhance potential for self-transformation of teacher educators (see Chapter Eight).

According to SADC REEP (2002) reflexivity means the ability of people in the workplace to develop their own capacity to reflect on, review and change in response to contextual factors and improved understanding of practice. In this study contextual factors are drawn from the need to improve on quality and relevance of education in view of socio-ecological risk as well as improving on gender equality in education as called upon by ESD, MDGS, Education For All and other initiatives discussed in Chapter Two.

The concept of reflexivity also highlights the characteristics of a reflexive researcher in social science: the researcher must question their own role in the research process and be able to adopt multiple standpoints as opposed to a single standpoint as in a critique (Delanty, 2005). My use of different approaches namely feminist theories and the capability approach as well as CHAT (see Chapter Three) to engage with the epistemology and ontology of SMTs education as it relates to gender, is typical of the strategies employed by a reflexive researcher.

Bourdieu (2004) in his conception of reflexive constructivism tied up the concepts of reflexivity, agency and structure: “this involves the freeing of agency from oppressive social structures by raising to the level of reflexivity the degree to which existing forms of cultural production are limited by social structures” (p.94). Bourdieu’s point of departure here is that social science is an intellectual practice embedded in a cultural context which is always greater than what an individual scientist can consciously reflect upon (ibid.). Like social actors, he added, the social scientist has a social location, or „habitus“, which conditions knowledge. For him, the ethical role for social science is transformative by enhancing the reflexive power of social agency, aimed at creating a new subjectivity in its confrontation with the objectified social structures (Delanty, 2005).

I read here that Bourdieu's call is for intellectual space for agency; the social scientist is seen as a member of the intellectual community and as a constructivist to reflect upon oppressive social structures, and work upon the production of knowledge and the construction of a rationalised society. The implication for this study is to use expansive learning to create an intellectual space for the intellectual community (researcher and SMTs educators) to reflect

on work practice (curriculum practices), bring in intellectual critique on oppressive social structures and come up with new knowledge of practice that hopefully will bring in rationally organised curriculum practices (gender responsive practices). In this way curriculum transformation is likely in the creation of what Sen (1999) coined the “the space of functionings” (p.27), that can potentially result in SMTs acting as a „gender conversion agent“ (Section 3.2.2).

### ***1.8.3 Dialectics***

The word dialectic originated in ancient Greece, and was made popular by Plato in the Socratic dialogues (Blankenship, 1996). Dialectics is rooted in the Hegelian-Marxist belief that reality evolves from contradictions between antagonistic and non-antagonistic forces (Gadotti, 1996). Abercrombie et al. (2006, p.107) defined dialectics as “the view that development depends on the clash of contradictions and the creation of a new, more advanced synthesis out of the clashes”. Visible in this is the Hegelian process of arriving at the truth by stating a “thesis, developing a contradictory antithesis, and combining and resolving them into a coherent synthesis” (Blankenship, 1996, p.16). Macey (2000) outlined three laws of dialectics as: the law of unity and conflict, which states that all phenomena consist of mutually contradictory elements, and that change is a result of addressing their internal contradictions; the law of the transition of quantity into quality, which argues that quantitative change leads to qualitative ones; and the law of negation of the negation referring to the fact that the new order is negated again as contradictions arise and new solutions are sought.

Cultural historical theorists also draw on the concept of dialectics in their attempts to reduce the Cartesian divide between object and subject. For instance Stetsenko (2005) and Edwards, (2007) noted the dialectics that exist between object and subject; as we work on the object, the object works back on us and impacts on our subjectivity and how we in turn approach the object. This was very useful in this study in theorising the transactional relationship between subject (SMTs educators) and object (curriculum practices). By transforming the object through contesting gendered curriculum pedagogies, we also potentially transform ourselves. This transaction between subject and object in CHAT brings human subjectivity to the fore (Edwards, 2007) and therefore connects well with reflexivity and agency (discussed above) as well as with standpoint epistemology (see Section 3.3).

## 1.9 THESIS OUTLINE

Chapter 1 opens the study by explaining my personal history and provides a contextually situated motivation for the study. It discusses the context within which the research emerged. A conceptual framework, in the form of defining and elaborating on key terms of the study makes up a sizeable contribution to the chapter. Another significant section is the articulation of goals and research questions holding the study together. The chapter ends by describing the sensitising concepts, drawing attention to important features of research.

Chapter Two is a review of literature around critical aspects of the study namely gender issues in education in general and in SMTs education in particular, socio-ecological risk and ESD. A philosophical appraisal as well as a historical analysis of the efforts towards gender equality in education is provided. This opened up policy-practice gaps that the research attempted to address as well as raising pointers towards a paradigm shift to reduce the policy-practice gap. A review of different conceptualisations of curriculum was significant in view of the curriculum transformation interest of the study.

Chapter Three discusses the main theoretical approaches that underpin the study namely Cultural Historical Activity Theory, capability approach and feminist approaches. The chapter opens up by valuing the harmony of the three approaches as anchored in critical research. It goes on to highlight the tenets of each approach, discussing their applicability to the research and the advantages and to some extent, the challenges of working with research tools offered by each approach.

Chapter Four explains the processes by which data was generated, analysed and managed. It starts by discussing the methodological framework of Developmental Work Research developed by Engeström and others. The study further discuss the case study approach as used in the study, highlighting multiple embedded case studies and relating these to the activity systems of the study. Data generating methods namely in-depth and focus group interviews; change laboratory workshops and document analysis as well as data analysis tools such as critical discourse analysis are given substantial attention in the chapter. Issues pertaining to trustworthiness and ethics in research are also discussed in this chapter. Chapter Five discusses findings in relation to the exploration phase of the study. It particularly focuses on the first two objectives of the study in the first case study: to assess

the level of gender responsiveness of SMTs teacher educators and to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a Southern African context. Thick description is used as a tool to tell the story as it is found in the activity systems concerned. A Critical Discourse Analysis is presented in the chapter to respond to the research question: what are the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs teacher education?

Chapter Six is very similar to Chapter Five in structure except that it reports on the second UKZN case study. It also focuses on the first two objectives of the study, and in a similar way Critical Discourse Analysis is undertaken to unearth the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs teacher education.

Chapter Seven focuses on surfacing contradictions in the two case studies. The chapter is located within the contradictory layer of Engeström's three layers of agency and human action. It responds to the research question: what are the current gender pedagogical tensions in science teacher education curriculum practices? The chapter also traces the object of study from one activity system to a nexus of activity systems in the two case studies. By raising the disturbances and discontinuities the study prepares the ground for expansive learning, reported in Chapter Eight.

Chapter Eight is dedicated to expansive learning in the two cases studies. It gives an account of how participants and researcher together navigated across the zone of proximal development in curriculum transformation. The chapter chronicles the process of developing conceptual artefacts to support gender responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context. Boundary learning processes, as well as boundary objects are described in each case study.

Chapter Nine presents a summary of the key research findings, implications, main argument, and recommendations made by the study. The chapter also discusses the new knowledge contribution of the study and identified areas for future research in relation to sustainability in SMTs teacher education curriculum development. In this chapter I also reflect on the role of

the interventionist researcher in expanding capabilities, sustainability and gender justice in SMTs teacher education curriculum practices within the ESD framework.

## **1.10 CONCLUSION**

This chapter sets the scene and shares the research goals that guided the whole research process. In this chapter I also raised and discussed my historical experiences as a researcher with an effort to show subjectivity and reflexivity in this critical and interventionist research with curriculum transformation intent. The chapter also discussed key and sensitising concepts to open up the conceptual thinking behind the study. The chapter briefly located the study within the ESD discourse, an aspect that is further accounted for in detail in Chapter Two. The chapter closes with a brief outline of each of the chapters in the thesis. In the next chapter (Chapter Two), the focus is on reviewing literature related to gender and SMTs education and socio-ecological risk. This chapter also concentrates on locating the study within the ESD discourse.

## **Chapter 2: EDUCATION for SUSTAINABLE DEVELOPMENT and GENDER ISSUES in SMTs CURRICULUM**

*This pedagogy (non-dualist pedagogy) represents a critical practice, to be sure, promoting a certain kind of critical awareness of self and other, of place and context; it seeks to foster a connected and interdependent sense of self that undermines separateness, hierarchy, and anthropocentrism. In this sense, this non-dualist pedagogy is not about knowledge or transcendent truth but about sensitivity to our relationships with each other and with the world of which we are inextricably a part. It is about the consequence of our practices, habits, and ways of being for those relationships. (Yagelski, 2011, p.3)*

### **2.1 INTRODUCTION**

Bearing in mind that the broad aim of this study is to contribute towards a socially just and a more sustainable society through curriculum transformation (see Section 1.3.1), I found the above quotation appealing and engaging with respect to a kind of pedagogy that has relevance to this study, a pedagogy that is *sensitive to our relationships with each other and with the world of which we are inextricably a part*. This chapter provides the context within which the study was conceptualised. It opens up by engaging with and locating the study within the Education for Sustainable Development (ESD) discourse. Gender issues in SMTs education in general and gender issues in relation to socio-ecological risk in a Southern African context are appraised using ESD lenses. Efforts made so far towards gender equality are appraised within the ESD discourse using capability and feminist approaches. Finally, the chapter points towards the need to have an ESD informed SMTs teacher education curriculum transformation process that has potential to contribute towards social justice and sustainability by focusing on the capability set for both girls and boys in SMTs in general and in view of socio-ecological risk.

### **2.2 EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)**

For one to be conversant with ESD discourse, one needs to trace its historical development. As implied in the name, ESD was born out of the sustainable development (SD) discourse. There is a need therefore to foreground this discourse as a way to conceptualise ESD.

### **2.2.1 Sustainable Development (SD)**

The discourse of SD has a long history stretching back to the 1970s. Internationally, during the 1980s and 1990s, the use of the language of sustainable development and sustainability began to emerge, was popularised by the World Conservation Strategy in 1980, the World Commission on Environment and Development in 1987 (the Brundtland Commission) and revisited in 1992 through the United Nations Conference on Environment and Development (the Earth Summit in Rio de Janeiro) (Gough, 2006). Since this time, a much stronger emphasis has been placed upon trying to integrate thinking and action around ecological, social and economic systems (ibid.). The Brundtland report, for instance, captured the thinking in a definition for SD as *development that meets the needs of the present generation without compromising or jeopardising the capacity of future generations to meet theirs* (Brundtland, 1987). Robert Solow further refined the concept of sustainability as the requirements that the next generation must be left with: „whatever it takes to achieve a standard of living at least as good as our own and to look after the next generation similarly“ (Sen, 2009, p. 250).

These two definitions, especially the Brundtland one have been the working definitions for SD in many circles for many years. Some concerns have, however, been raised over the two definitions, by, for example, Amartya Sen who claimed we need to think not just about sustaining the fulfilment of our needs, but more broadly about sustaining or extending our freedom (including the freedom to meet our needs) (ibid.). He went on to suggest that the definition of SD be broadened to encompass “the preservation, and when possible the expansion, of substantive freedoms and capabilities of people today „without compromising the capability of future generations“ to have similar or more-freedom” (ibid., p.253-4) (see Section 3.2). This submission by Sen broadened the understanding of sustainability and SD.

It was the 2002 World Summit for Sustainable Development in Johannesburg that reaffirmed the three interrelated pillars of SD, namely society, environment and economy (UNESCO, 2004; UNESCO, 2005a). UNESCO (2009) explained these: a sustainable environmental development (planet) refers to the development of natural ecosystems in ways that maintain the carrying capacity of the Earth and respect for the non-human world. The same document defines sustainable economic development (prosperity) as focusing on the development of the economic infrastructure, in which the efficient management of our natural and human resources is important. It is the finding of balanced ways to integrate these dimensions in

everyday living and working that poses, perhaps, the greatest challenge of our time as this requires alternative ways of thinking, valuing and acting (ibid.).

These pillars are intertwined, and any proposed advances on social sustainability or a socially just society have to take these into consideration. To emphasise this point, UNESCO (2009) saw the need to have SD as a vehicle around the globe for expressing the need to depart from present dominant models of development which appear unable to balance the needs of people and the planet in the pursuit of peace and prosperity.

Social sustainability implies that the majority of people should benefit from development (Rosenberg, 2004). The principle calls for fairness in access to and benefits from the Earth's resources including access to quality education, health services, security and opportunities for recreation (Lotz-Sisitka et al., 2006a, 2006b, 2006c). Sustainable social development is aimed at the development of people and their social organisation, in which the realisation of social cohesion, equity, justice and well-being plays an important role (UNESCO, 2009). In a study that is interested in contributing towards social justice Sen's proposed addition to the definition for sustainable development becomes significant: the preservation, and the expansion of substantive freedoms and capabilities of people today „without compromising the capability of future generations“ to have similar or more freedom” (Sen, 2009, p. 250).

UNESCO (2003, 2004) acknowledges that across the globe there is a surge of interest in sustainability issues in governments, communities and organisations and in business and industry. More importantly, perhaps, more and more people are beginning to understand that the creation of a sustainable world that includes humanity depends on fundamental changes in our socio-economic systems as a whole, supported by a critical re-orientation of our principles, values, behaviours and lifestyles (ibid.). As a way of coordinating learning towards this, the discourse of ESD arose and the United Nations even dedicated a decade (2005-2014) as a Decade of Education for Sustainable Development.

### ***2.2.2 Education for Sustainable Development (ESD)***

As highlighted above, while the roots of ESD can be traced back to the early 1970s, its first flowering occurred at the United Nations Conference on Environment and Development, also known as the Earth Summit, held in Rio de Janeiro in 1992 (UNESCO, 2009, 2011). The

creation of the Decade of Education for Sustainable Development was seen as a means to re-emphasise the overarching goals in a context of SD by emphasising the role of education and learning. Resolution 57/254 on the United Nations Decade of Education for Sustainable Development (2005–2014) was adopted by the United Nations General Assembly in December 2002, shortly after the World Summit on Sustainable Development (Rio plus 10) which was held in Johannesburg in August/September of the same year (UNESCO, 2009). This resolution requested UNESCO, as the designated lead agency for overseeing the Decade, to develop an International Implementation Scheme, which would also clarify the relationship of the DESD with existing UN-supported educational processes (e.g. the Dakar Framework for Action and the United Nations Literacy Decade) (ibid.). According to UNESCO:

*... the basic vision of the Decade is of a world in which everyone has the opportunity to benefit from education and learn the values, behaviours and lifestyles required for a sustainable future and for positive societal transformation. (ibid., p.8)*

Participation to ensure sustainability in development was also given prominence in that the DESD seeks to promote the meaningful development and implementation of ESD on all geographical scales (locally, nationally, regionally and internationally) with the involvement of a wide range of stakeholders (ibid.).

Fien and Tilbury (2000) pointed out that education with the objective of achieving sustainability varies from previous approaches of education by focusing sharply on developing closer links among environmental quality, human equality, human rights and peace and their underlying political threads. They added that in ESD issues such as food security, poverty, sustainable tourism, urban quality, emancipation of women, fair trade, green consumerism, ecological public health and waste management, as well as those of climatic change, deforestation, land degradation, desertification, depletion of natural resources and loss of biodiversity are primary concerns.

From this discussion it is clear that the United Nations uses sustainability as an overarching paradigm to address numerous interrelated challenges (e.g. poverty reduction, environmental protection, social justice, and Education for All) (UNESCO, 2012). It follows that ESD as a broad concept brings a distinctive orientation to many important aspects of education on the whole, including access, relevance, equity and inclusivity (ibid.). This further implies that

ESD is far more than teaching knowledge and principles related to sustainability, but in its broadest sense, is education for social transformation with the goal of creating more sustainable societies (ibid.).

ESD has four thrusts or areas of emphasis (UNESCO, 2012):

- Improving access and retention in quality basic education;
- Reorienting existing educational programmes to address sustainability;
- Increasing public understanding and awareness of sustainability; and
- Providing training to all sectors of the workforce.

The first two thrusts primarily involve formal education and are very pertinent to this study. The first thrust argues for enrolling and retaining both boys and girls in quality basic education as important to their well-being throughout their lives and to the society in which they live (ibid.). UNESCO (ibid.) further argues that basic education focuses on helping pupils gain knowledge, skills, values and perspectives that encourage sustainable livelihoods and on supporting citizens to live sustainable lives.

The same thrust also emphasises quality education, which according to UNESCO (2012), implies that the needs of individual learners will be considered and addressed in developing and delivering lessons. The document further elaborates that by using a variety of teaching techniques, the teacher attends to the diverse needs of the pupils in the class, emphasising that meeting the learning needs of all pupils in the classroom is a form of social equity, which is a core concept of sustainability. Gender equity is singled out as another form of equity inherent in sustainability. Considering that men and women, particularly in rural and indigenous societies, tend to have quite different socio-cultural roles, classroom teaching techniques need to be employed in locally relevant and culturally appropriate ways that foster gender equity (UNESCO, 2010, 2012). The same is true for access to educational resources for both boys and girls (ibid.).

The second thrust on reorienting education requires rethinking what is taught, how it is taught, and what is assessed, with sustainability as the central theme (UNESCO, 2010). The emphasis here is a futures-orientation because the learners of today will need to be able to

address the challenges of tomorrow, which will require creativity as well as analytical and problem solving skills (UNESCO, 2012).

These areas of emphasis in ESD helped me to interrogate the SMTs teacher education curriculum with regard to gender issues in SMTs and considering socio-ecological risk reported in Sections 2.4 and 2.5 below. It is my argument that gender inequality in education particularly science education is a major drawback towards social, economic and environmental sustainability for any society. If girls and women do not access SMTs in the same manner as their male counterparts, then there is no fairness in access to and benefits from the resources and this is a major social and economic sustainability issue. Furthermore quality of education is highly compromised if there are such clear signs of inequity (UNESCO, 2004, 2008). Quality of education is further compromised if it fails to prepare learners adequately for future challenges, such as those posed by social-ecological risk (as discussed below); hence access, equity and re-orientation are key processes necessary for education quality and relevance.

The argument put forward in the first thrust therefore helped to craft the exploration phase of the study. In exploring gender responsiveness in SMTs teacher education curriculum practices, the study sought to establish the contribution of the SMTs teacher education curriculum in improving access and retention of both boys and girls in SMTs as an ESD practice. Part of the exploration phase of the study was to find out whether trainee teachers were being equipped with necessary knowledge, skills, values and attitudes to attend to the diverse learning needs of both girls and boys in SMTs in ways that take into consideration the socio-cultural aspects of the learners.

The second ESD thrust offers room to reorient curriculum to address sustainability, as UNESCO (2012) encourages educational communities to identify the knowledge, issues, perspectives, skills, and values central to sustainable development in each of the three components of sustainability – environment, society, and economy – and integrate them into the curriculum. It further adds that the education community also needs to decide which of the many existing sustainability issues (e.g. biodiversity, climate change, equity, and poverty) will be part of the curriculum. Taking a cue from this, the study focused on gender equity in SMTs education, with its links to other sustainability issues that are brought into focus by socio-ecological risk such as climate change and poverty.

The perspectives on sustainability which are commonly statements that expand upon the principles of sustainable development found in Agenda 21, also provided theoretical lenses for this study. Those pertinent to this study include:

- Environmental protection and human-centered development are considered together, not separately.
- There must be a balance and integration of environment, society, and economy.
- Systems thinking or a whole-systems approach should be used in problem solving rather than looking at problems in isolation.
- Technology and science alone cannot solve all of our problems. (UNESCO, 2010)

At the start of the decade of education for sustainable development alluded to above, the vision of ESD was translated into four objectives (Lotz-Sisitka et al., 2006a, p.2; UNESCO, 2009):

- 1) facilitate networking, linkages, exchange and interactions among stakeholder in ESD;
- 2) foster an increased quality of teaching in learning and education for Sustainable Development;
- 3) help countries make progress towards, and attain the MDGs through ESD effort; and
- 4) provide countries with new opportunities to incorporate ESD into education reform efforts.

While all four objectives could be of interest in this study, the last three are particularly relevant. Objectives two and four of the DESD open the door to the rationale of this study, given the following research findings in most African countries and beyond:

- Teacher education, especially science education, has traditionally not dealt much with issues of social justice and equality, so by the time teachers reach the school they have very little idea about gender imbalance or strategies to address them (Clegg, 2007);
- Though it is now common knowledge that gender imbalances in SMTs areas exist, teachers are often unaware or unaccepting of the situation and would not naturally feel the need to address them (FAWE, 2005; Kalu, 2005; Chikunda 2010);
- Most SMTs teachers confirmed their allegiance to scientism (Lederman, 1998; Prasad, 2004; Aikenhead, 2002; Clegg, 2007; Chikunda, 2010): a belief that science is a factual, neutral or objective discipline that is not affected by people's background, culture,

attitudes or gender. Such teachers do not see how norms and values of a society affect science learning in the school.

Such observations seem to point out that the very same teacher education institutions producing these teachers are not „engendered“ themselves. The study however, recognises the pivotal role that teacher education institutions can play in achieving sufficient gender transformation in schools, which will lead to positive impact on improving females“ participation in SMTs. This calls for curriculum reform or simply re-orienting of teacher education as a training sector and this is well in accordance with objective 4 of the DESD.

Objective 2 of the UNDESD basically emphasises issues of quality education. The concept of quality education is not new; neither did it originate with the DESD. It was raised in 1990 in Jomtien under the Education for All (EFA) and re-emphasised a decade later in Dakar. The Dakar Framework for Action affirmed that “quality was at the heart of education ... a fundamental determinant of enrolment, retention and achievement” (UNESCO, 2005 p.29). In 2004, UNESCO affirmed the central role of the teacher in achieving quality education. Notwithstanding this global consensus about the need to provide access to education of good quality, the term „good quality“ remains fluid. Without much ado, as discussed above, it is my contention that education can never be of good quality when one section of society cannot equally access some disciplines, be it because of their gender, class, creed or race. As highlighted by Koichiron Matsuura, Director General of UNESCO, education will not be of good quality if it does not pass the test of equity (UNESCO, 2004 in Lotz-Sisitka, 200 UNDP (2005) *Human Development Report*. New York. Oxford University Press

8a). He further added that “quality must be seen in light of how societies define the purpose of education” (ibid., p.5). In the same paper, Lotz-Sisitka questions whether educational quality “should not also pass the test of future socio-ecological resilience and sustainability” (ibid.). A study by Shumba et al. (2008) validated that people see the quality and relevance of education in its ability to address the socio-ecological concerns that face them. Judging from these assertions, education should therefore considered to be of good quality if educational systems are developing learners“ cognitive skills, and their values and attitudes in ways that contribute to a wider re-orientation of society towards equity and sustainability (ibid.).

UNESCO (2011) published an expert review on ESD, and identified key processes and learning that underpin ESD frameworks and practices. The term „processes“ in this context, refers to engagement opportunities, pedagogical approaches or teaching and learning styles

adopted to implement ESD in different levels and settings of education and in other informal and social learning scenarios (ibid., p.39). These include:

- processes of collaboration and dialogue (including multi-stakeholder and intercultural dialogue);
- processes which engage the „whole system“;
- processes which innovate curriculum as well as teaching and learning experiences; and,
- processes of active and participatory learning.

These ESD processes and the perspectives above became part of the blueprint for constructing and engaging with ESD as an advanced activity system for this study (see Chapters Five and Six). For example, processes which engage the „whole system“ inspired me to work with a collective of activity systems, that is going beyond the confines of the teacher education institutions to include other stakeholders and activity systems that would directly or indirectly contribute towards a transformative teacher education environment (see Section 5.2.1). This is located within the ESD strategic intention to reorient education to support sustainable development (UNESCO, 2002, 2005). In this study it meant that the ESD inspired curriculum transformation in teacher education gives attention to not only specific learning approaches and techniques within it but also to the professional and management processes adopted across the whole system.

The processes of collaboration and dialogue became the methodological vehicle through which multi-stakeholders, under the auspices of Developmental Work Research, supported by the principle of multi-voicedness of CHAT, could come together to engage on intercultural issues that constrain the SMTs teacher education curriculum from passing both the (gender) equity and sustainability tests (see Chapter Three). As said by Edwards (2007) this is characterised by the division of labour, diverse histories of participants as well as artefacts and rules (see Section 3.4 and Chapter 8. The processes of curriculum innovation as well as teaching and learning experiences, resonate with the modelling of the new solutions in expansive learning (see Figure 4.1) as reported in Chapter Eight.

Lastly, the processes of active and participatory learning would imply agency in teacher education. That is developing the ability in teacher educators to inculcate knowledge,

attitudes and skills in future teachers for the pedagogy of action taking and participating in correcting social ills like gender discrimination and sustainability issues such as those revealed by social-ecological risk (see Section 1.7.13). In this study it meant probing (exploration phase) and engaging with ways in which the SMTs teacher education curriculum can promote (expansive phase) pedagogical strategies such as those listed in the UNESCO document (2011, p.26-27): These include role plays and simulations, group discussions, debates, critical incidents, case studies, reflexive accounts, problem based learning, and modelling good practices.

As mentioned above, the information provided by this review was also very useful in designing tools for both the exploration and the expansive phases of this study. For instance, as highlighted in the review, ESD learning goes beyond the usual gaining of knowledge, values and theories related to sustainable development, to include:

- learning to ask critical questions;
- learning to clarify one's own values;
- learning to envision more positive and sustainable futures;
- learning to think systemically;
- learning to respond through applied learning; and,
- learning to explore the dialectic between tradition and innovation. (UNESCO, 2011, p. 29)

The ESD expert review (UNESCO, 2011) also highlighted a number of suitable pedagogical strategies with associated learning processes as indicated in Table 2.1.

**Table 2.1** *Commonly adopted ESD pedagogies in higher education*

<b>Pedagogical strategies</b>	<b>Learning process involved</b>
Reflexive accounts	Considering their own position in relation to new knowledge about sustainability can help students understand how individual actions contribute to sustainability. This pedagogical approach provides opportunities for learners to reflect on personal roles, attitudes and responsibilities in relation to a range of sustainability issues.
Critical reading and writing	Reading and writing are seen by tutors as important social practices and the key to progressing sustainability and literacy. Learners can gain from deconstructing discourses to identify the possible motivation of the author. They may also be able to envisage alternative futures, and write a contrasting account based on differing perspectives.
Problem-based learning	Problem-based learning is an iterative learning process that is used to teach a whole range of subject matter. In the context of ESD, a sustainability-related issue may be identified and students asked to investigate this to generate a body of knowledge. They can then develop a vision of alternative actions and potential solutions to the problem, which they use to devise a plan of action. The action may then be carried out, followed by a period of reflection and evaluation. This process promotes both the conceptual and practical aspects of sustainability literacy.
Modelling good practice	Learning also taking place implicitly through the hidden curriculum. The research captured how many educators sought to reduce paper use and turned off lights out at the end of sessions as a means of teaching learners the importance of action-taking.
Fieldwork and outdoor learning	Research has shown that fieldwork is an example of experiential pedagogy that can influence students' emotions and help develop the critical thinking skills so essential to understanding the complexity of sustainability. Fieldwork for sustainability is often based on issues in the local community and environs, linking theory to real-world examples. There is also evidence that outdoor experience is an important precursor to understanding sustainability and promotes learning by encouraging active learning.

Source: UNESCO, ESD Expert Review (2011, p. 26)

As further argued in Section 7.3.2 the South African formal curriculum expects that teachers are in a position to operate within some of these ESD encouraged pedagogical strategies. For instance, learning outcome 3 for physical sciences expects high school learners to be able

identify and critically evaluate scientific knowledge claims and the impact of this knowledge on the quality of socio-economic, environmental and human development (Kelder, Govender and Govender, 2007). The outcome expects learners at this level to be able to discuss or argue issues relevant to the impact of science on the environment and the sustainability of resources, as well as to evaluate the impact of scientific research on management, utilisation and development of resources to ensure sustainability (Brooks, Gibbon and Patrick, 2006, p.3). It is for this reason and many more (see Section 6.2) that one can argue that some ESD tenets are already treasured in the SA curriculum. It was the onus of this study to explore the adherence of the teacher education curriculum to such expectations and to offer opportunities for expansive learning in this regard. I was therefore guided by such ESD lenses to extract information pertaining to enablers and constraints of similar pedagogic practices and later used the acquired information as mirror data in Change Laboratory Workshops (see Chapter Eight).

### **2.3 ESD AND SOCIAL MOVEMENTS**

ESD as “harnessing” all aspects of education, including public awareness and training, in order to make progress towards more sustainable societies (UNESCO, 2012) resonates well with different social movements across the globe with similar agendas. Social movements can be thought of as “historically and spatially located expressions of social and cultural responses to prevailing political and economic dynamics” (Chesters and Welsh, 2011, p.2). This means that in each historical epoch, key aspects of social, sexual, cultural, racial, political and economic equality and equity are contested by social movements utilising the range of resources available in a given place and at a given time (ibid.). One can argue that social movements such as the civil rights, disability rights, environmental justice, feminist, friends of the earth, peace, indigenous peoples and many more have been bearers of knowledge about forms of oppression and injustice, expressing political claims, identifying social and economic grievances and bringing new or neglected issues to public prominence (ibid). Put in a different way many of these social movements are geared towards socially just and more sustainable livelihoods as expressed in the ESD agenda.

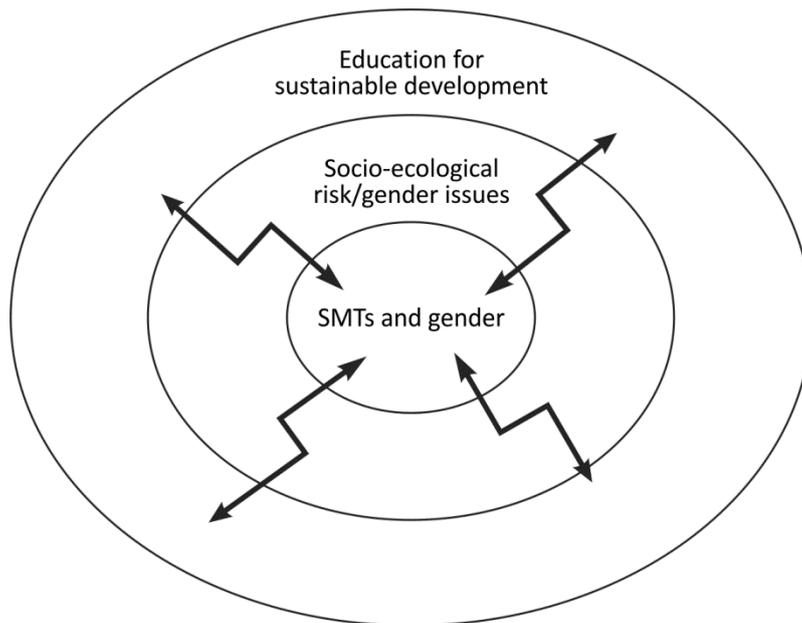
The environmental social movement and the gender in science movement (under the feminist umbrella) fall within a category known as the new social movements, an approach that stemmed from a critique of the Marxist paradigm’s inability to explain emerging collective phenomena (ibid.). Many such movements rose in the 1960s, and were considered new in the

sense that they raised different possibilities for collective action around issues that had previously been marginalised – identity, gender, sexuality, race and ethnicity, age, the environment, health and so on (ibid., p.122). Feminism and ecologism (another term for the environmental social movement) also represented diversions from the class struggle that characterised the old social movements (ibid.).

Most of these new social movements have influenced policy and practice at different levels from local to global. The United Nations as an international coordinating body has, over the years, blended the demands of various movements into numerous frameworks to stimulate policy formulation in governments and non-governmental organisations. International directives that have had a lot of influence on formal education such as the MDGs, Education for All, Beijing Platform for Action and later ESD were conceived under the UN banner and they manage to harness considerable conceptual and other social researches from the second wave new social movements. This common historical origin binds the science and gender and ESD interests in this study. In addition to this common origin, the two have a socially just and more sustainable purpose in that both:

- seek to enhance quality education in contemporary societies;
- are more inclusive (people-people-environment relations);
- are relationally interested in agency and relational agency;
- have curriculum transformative interest;
- are capability (freedom) centred;
- are informed and interested in critical pedagogy; and
- consider a system as whole, issues are intertwined (e.g. exclusion from SMTs could predispose to socio-ecological risk).

This relationship led me to study gender issues in SMTs teacher education using ESD lenses. Figure 2.1 is a schematic representation that shows the inter-relatedness of ESD and gender issues in SMTs as conceived in this study.



**Figure 2.1** *Relationship between gender issues in SMTs and ESD*

While many studies concerning gender and SMTs education have been published (see Section 2.4), most of these take a socio-cultural perspective and neglect socio-ecological aspects of gender and SMTs education. Situating the study within the ESD framework as shown in Figure 2.1 was also helpful in that I was able to review the progress made so far towards gender equality in education through the efforts of international bodies such as MDGs, Education for All, Beijing Platform for Action (see Section 2.6) with a wider perspective. In addition the ESD framework enabled the appraisal of the implementation of national policies related to gender in education e.g. the Zimbabwe National Gender Policy and the South Africa's National Gender Policy Framework (Section 2.7.2). The expansive learning reported in chapter 8, allowed for considering SMTs guided by this framework, curriculum transformation in teacher education that takes into consideration gendered socio-ecological risk and SMT education as an ESD process, opening up the space for new knowledge generation through this thesis.

## **2.4 GENDER ISSUES IN SMTs EDUCATION: A SUSTAINABILITY CONCERN**

In this section I review literature related to gender and the teaching of SMTs in general. My argument in this review is to show the need for gender responsive pedagogies in SMTs teacher education so as to equip future teachers with the necessary knowledge, skills, attitudes and values to handle such issues in their own practice. The review forms the basis

for the goals of assessing the level of gender responsiveness of SMTs teacher educators and to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a Southern African context (Section 1.4). The review also provided data that was mirrored in the expansive learning phase of the study, reported on in Chapter Eight.

The significance of gender equality for development is widely recognised globally. Economic and social development in any country, under modernity, relies heavily on a sound scientific and technological base. This can be achieved by putting emphasis on SMTs at all levels (Hopkins and McKeown, 2005; Clegg, 2007). There is need therefore for any country to harness the intellectual and scientific capacity of both men and women for sustainable social, ecological and economic development. Science, Mathematics and Technology Education constitute an area of any nation's education system where many of the skills that stimulate development, are learned. Securing good health, fighting diseases, protecting the environment, farming and developing agriculture and developing new industries and technologies, and even building resilience to climate change, are all activities that require knowledge and skills in sciences, mathematics and technology. Ironically, SMTs also constitute the areas within the educational system where gender disparity, in several of the poorest countries of the world, is greatest (Clegg, 2007; Sinnes, 2004). Despite the documented benefits to economic and social development of granting females education, relatively fewer girls than boys are given the opportunity to participate and perform in SMTs education disciplines in several of the poorest countries of the world (ibid.). There is also evidence that in most countries, perhaps all the countries of the world, technological careers are far more likely to be taken up by men. These careers tend to be financially more rewarding and are often seen to be more prestigious than those predominantly occupied by females (MacKay and Parkinson, 2010). This to me is a social justice and a sustainability issue that requires intervention, most aptly an educational one.

In Zimbabwe where one of the research case studies is located, for example, in the formal school system girls make up only a third of the students who study sciences at advanced (pre-university) level and at tertiary level, the level of participation of females in science disciplines such as engineering is as low as 2% (Clegg, 2007; World Bank, 2004; Chikunda, 2010; Madziva, 2000). The situation is not very different in other Southern African Development Countries (SADC) as shown in Table 2.2.

**Table 2.2** Percentage of men and women in Faculties of Science

Angola		Botswana		Lesotho		Malawi		Mozambique		Swaziland		Tanzania		Namibia		South Africa		Zimbabwe	
F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
40	60	28	72	26	74	37	63	23	77	28	72	30	70	39	61	39	61	24	76

Sources: SADC Gender Protocol Barometer, 2011 (Morna and Jambaya-Nyakujara, 2011. p.7) and SARDC, 2008

Over the years, research has pointed to the lack of gender responsiveness in the pedagogy applied in schools as one major hindrance to improving access, retention and performance of females in sciences (Madziva, 2000; Herz and Sperling, 2004; McCullough, 2004; Forum for African Females Educationalists (FAWE), 2005; Kalu, 2005; Clegg, 2007; Chetcuti, 2009; Chikunda, 2010; Christidou, 2011; Chetcuti and Kioko, 2012). As initially pointed out in Section 2.2, it seems that even whilst it is common knowledge that gender imbalances exist in SMTs, teachers are often unaware or unaccepting of the situation, and would not naturally feel the need to address such issues, implying that they are graduating from training institutions without adequate knowledge to handle gender issues in their practice (FAWE, 2005; Kalu, 2005).

Various studies around gender and SMTs education report on different factors which affect girls' attitudes towards science, factors that I feel teacher education should engage with if gender equality in SMTs is to become a reality. A number of researchers studied self-concept and performance in science, concluding that if girls think that they are doing well in science they continue to study it at further levels; however, if they think that they are not doing well the likelihood is that they will drop out (Murphy and Whitelegg, 2006; Osborne, Simons, and Collins, 2003; MacKay, 2011). Unfortunately girls do not believe they are as good as boys in subjects such as mathematics and physics even where this is objectively not the case, as concluded by Clegg (2007) after a comprehensive summarising of international studies. The case in point is that girls are socialised into this low SMTs self-concept by various social forces circulating at home, school and wider society.

Some studies have actually demonstrated that teachers can come up with gender responsive pedagogies that can raise the self-efficacy levels of girls without negatively affecting their male

counterparts. MacKay (2011) for instance, in a South African teacher education institution, studied the nexus of self-efficacy<sup>1</sup>, attitude towards technology and gender responsive pedagogies. His point of departure was female technology trainee teachers who had expressed “we shouldn’t have to do this; we’re girls” (p.1) when asked to design an electrical model as part of their school task. The results show that a gender familiar context focusing on projects attractive to females and contextualising learning of electro-technology concepts improved female students’ attitudes towards technology as well as their self-efficacy. They performed as well as their male counterparts on tasks that they were initially hesitant to do. In a different study, Christidou (2011) showed that contexts that are familiar to girls do not seem to disadvantage boys. My argument here is that MacKay’s practices can potentially be expanded within teacher education institutions. Such gender responsive pedagogies can be the focus of attention in an effort to equip future teachers with knowledge and skills that they may need to raise girls’ self-efficacy levels in SMTs in their own pedagogical practices.

MacKay’s findings concur with Christidou (2011) who argued that students’ and especially girls’ low interest in SMTs and their relatively negative attitudes are at least partially attributed to the way relevant disciplines are taught at school. She elaborated that SMTs curricula, school textbooks, teachers and their teaching practices are crucial factors considered to negatively affect students’ attitudes towards an interest in SMT disciplines, since they tend to “emphasize its academic, strongly intellectual and abstract character, and to present it in a decontextualised way, distanced from everyday life” (p.146). Chetcuti and Kioko (2012) and Osborne and Collins, (2001) had similar sentiments: they report on girls’ experience of school science and the science curriculum, pointing out that sometimes girls have the impression that science is a dry subject and only for the super brilliant involving mainly the recall of factual knowledge rather than skills. Semela (2010) supported the idea, pointing out that students in general and girls in particular state that science as a school subject is irrelevant, and therefore not useful in everyday life. This concurs with earlier assertions by several researchers that students identify a considerable mismatch between science-in-society and science-in-school; school science is unattractive since it does not involve topics of interest; it does not provide students with opportunities for creative expression; and it is fairly alienated from society (Brickhouse, Lowery, and Schultz, 2000; Buck et al., 2009; Gibson and Chase, 2002; Gough, 2002; Kelly, 2000; Millar and Osborne, 1998; Osborne and Collins, 2001; Osborne et al., 2003; Ryder, 2002; Sjøberg, 2002). Moreover, others see school

---

<sup>1</sup> Belief in one’s own ability to carry out a particular task, or the belief that one has about one’s capability within

science as usually fragmented into different, strictly isolated disciplines, and/or presented in contexts of limited interest for students, thus failing to provide students with a coherent picture (McSharry and Jones, 2002; Siegel and Ranney, 2003). This perspective of science and related SMTs disciplines is similar to what Aikenhead (2002) called scientism.<sup>2</sup> The perspective was proposed after the realisation that science teachers the world over tend to harbour a strong allegiance to the values of scientism, yet conventional science teaching, claiming to transmit value-free knowledge to students, subliminally inculcates scientific as well as societal values (ibid.). In my earlier research (Chikunda, 2010), I discovered that teachers who believe in the values of scientism tend to ignore other forces such as students' and teachers' home background and patriarchy that influence science knowledge and its uptake in schools.

While some of these comments above were commenting on the decline of young people's interest in science in general, Calabrese Barton, Tan, and Rivet (2008) and Christidou, (2007, 2011) are of the opinion that girls are negatively affected more than boys. Kalu (2005) supports this point raising a concern that boys who are socialised to be aggressive, to persevere and to engage in activities that involve physical strain and logical thinking, are likely to do better in the perceived hard sciences than girls who are stereotyped to be docile, soft, less logical and to do things considered to be of a lesser importance.

The context in which science is taught has been a core focus of research by a whole host of researchers over the years (e.g. Christidou, 2011; Murphy and Whitelegg, 2006; Gosling, 2004; McCullough, 2004). Although such studies raise the issue of relevance and applicability as discussed above, they tend to frame notions of context within the ontology and epistemology of school science. For example McCullough (2004) determined if the contexts of the physics assessment questions were affecting performance. She did this by changing the original test from the usual male-oriented or school- or lab-oriented contexts (rockets, cannonballs, hockey, steel balls rolling off a horizontal table and male figures) to questions that used *stereotypically* female contexts such as shopping, cooking, jewellery and stuffed animals. The physics was kept identical in both assessments. From this study it became clear that context does interact with gender to affect how students perform on test questions and she further concluded that replacing male-oriented contexts with female-oriented ones did reduce the gender gap on a popular physics conceptual test.

---

<sup>2</sup>The belief that science is authoritarian, non-humanistic, objective, purely rational and empirical, universal, impersonal, socially sterile and unencumbered by human bias, dogma or cultural values.

She also further ascertained that boys were as much familiar with the so-called feminine contexts and their performance was not negatively affected by such contexts.

Christidou (2007) also detailed other attributes that push girls out of science. She pointed out that young women are frequently uncertain about choosing a scientific career because of the “super-woman” role that is required to balance a science career and family life (p.1187). She argued, that girls are more likely to have gendered self-concepts and perceptions of science that keep them from science careers. Science self-concept, being their confidence in their ability to perform and succeed in science-related careers, is similar to what MacKay called self-efficacy. Added to that is the stereotypic view that male-dominated science seems to negatively affect adolescent girls’ attitudes toward science. Thus, commonly held beliefs related to the nature of scientific research make science seem a rather unattractive career choice for young women. She further adds that young people, especially girls, have the perception that to be a scientist requires total commitment to and immersion in the scientific enterprise, and that extreme competitiveness is essential for the pursuit of excellence in science (Gilbert and Calvert, 2003). Such an environment is not hospitable for women, who apparently prefer an environment of cooperation rather than competition (Christidou, 2007) and whose scientific interests and experiences often have a powerful affective and interpersonal dimension (ibid., 2011). Niederle and Vesterlund (2007) provide evidence of a significant and substantial gender difference in the extent to which skills are reflected in a competitive performance. They report on effects in mixed-sex settings range from women failing to perform well in competitions, to women shying away from environments in which they have to compete. Niederle and Vesterlund (2010) concluded that the response to competition differs for men and women. In their study sample they found that in the examined environment, gender difference in competitive performance does not reflect the difference in non-competitive performance.

Gender preferred learning styles is another factor that is widely reported in research that SMTs teachers need to be aware of if gender equality is to be achieved. As early as 1994 in Botswana Mutasa and Willis (1994) highlighted that boys are attracted to the physical aspects of science whilst girls suffer from the lack of involvement and mechanical experiences. They argue that the traditional methods of physics involving wires, tools, abstract objects and mechanical things are not always attractive to girls.

Lau and Yuen (2010) in Christidou (2007) in the context of assessing learning in SMTs observed that males would prefer to develop their own strategies for taking tests. They like long answer test questions that require their ability to analyse information; students would rather be evaluated using take-home writing assignments and product-oriented projects. They would prefer open ended and problem solving questions that ask for their inquiry and investigation. On the other hand, female students prefer tests that require concrete and objective answers based on detailed information. Girls in their study prefer testing environments which are quiet and uninterrupted and they find it stressful to work alone in a traditional testing situation. They prefer short essay questions instead of objective items.

Aalbers, Kok and Poelman (2012), in a study involving gender and assessment, showed that a memorisation-oriented learning style is negatively correlated with grades, especially for girls. Aalbers et al. (2012) reporting on an earlier work by Severiens and Ten Dam (1994) who performed a meta-analysis of the gender effect on two learning style instruments, namely Kolb's Learning Style Inventory and Entwistle's Approaches to Studying Inventory, found a significant gender preference on subscales of these instruments; men tended to prefer the abstract conceptualisation mode of learning more than women in the Kolb's instrument. Men were likely to adopt a deep approach, be extrinsically motivated and achievement oriented, compared with women, according to Entwistle's instrument. This implies that teachers, during the course of study, should design tests in a variety of formats including objective questions, short answer questions, long answer questions, and open-ended questions in order to match and mismatch different learning styles of students, and to deconstruct continued differentiations in learning style preferences.

Clewell and Campbell (2002) added that science and many other classes are normally organised around a competitive model while research has indicated that women are discouraged by highly competitive environments and tend to respond better to cooperative learning styles.

Some studies pay particular attention to the relationship between the home culture and SMTs education. Typical is Kalu (2005) who suggests that teachers, who are central to the transformation of society in general and the school system in particular, are a product of gender construction in any society. She points out that in most African communities, teachers and students alike are socialised in basically patriarchal structures that foster gender

inequality, economically, socially and culturally. Giving examples of gender inequality in most African societies, Kalu (2005) includes attitudes and practices that see women as basically inferior to men, without the right to ownership of the means of production and property. Women are also expected to be subservient to men, leave decision making to the men, not to speak out in public, not to be outspoken especially against men and generally to accept the injustices of the system without a fight (ibid.). Kalu (2005), in her study in Nigeria, involving high school physics teaching, further analysed the quality of teacher-pupil interaction and concluded that teachers interact more with girls than boys in the social dimension of classroom life, rewarding them for social oriented behaviours and criticising them for misbehaving. On the other hand, boys received more frequent interactions than girls in those behaviours that addressed the intellectual quality of their work (reinforcement of responses, content-specific criticisms, and supervision of work). O'Connor (2000) also observed that boys taunt and harass girls so as to discourage them from active participation in science lessons. This results in girls deliberately avoiding answering questions fearing taunting and harassment by boys.

In Lesotho, Prasad (2004) traced how social norms, tradition, culture and power relationships are used to maintain that women are not good in exact sciences like mathematics, physics and chemistry. Added to this, as infants, children are given gender specific toys: boys get technical toys such as cars, trains and guns while girls are given dolls and miniature kitchen utensils. Their reproductive roles are enhanced and not their scientific aptitude. The argument here is that the technical toys are likely to boost boys' confidence to study science later on in life. Related to this, Kost, Pollock, and Finkelstein (2009) discovered that the gender gap that exist in interactive physics classes was largely associated with differences in previous physics and maths knowledge and incoming attitudes and beliefs. One can argue that gendered socialisation at home can result in gendered aptitudes towards sciences.

Social expectations of males and females also affect classroom interactions. It seems that teachers are consciously or unconsciously perpetuating the long-held view of science and technology not being considered an appropriate occupation for girls and women. Various studies have shown that teachers enjoy teaching boys more, spend more time with boys, hold higher expectations for boys' achievement, use resources more suitable for boys and value and urge more male participation (e.g. Huyer and Westholm, 1999; Duffy, Warren and Walsh, 2001; Oldham, 2001). At school, girls and boys are frequently told by teachers, parents and peers that sciences are difficult (ibid.). This long held view has detrimental

effects on both genders but more so girls, as boys are socialised in most patriarchal cultures to be aggressive and to persevere.

Considering the research findings presented in this review, it is my argument that the SMTs teacher education curriculum should have the mandate to equip future teachers with knowledge and pedagogical skills in line with such research findings, if gender equality in these disciplines is to be attained. The main argument here is that the low participation (low enrolment, poor performance and low retention) of females in SMTs from secondary education level and beyond, is caused or exacerbated by gendered curriculum pedagogies in schools, because teachers often leave training without necessary exposure to such gender responsive pedagogies. This study therefore has curriculum transformation intent, to explore and expand gender responsive curriculum practices at teacher education level, with the hope that this will be cascaded to trainee teachers. Note that the latter remains outside the scope of this study.

It is perhaps ironic that the findings reported here continue to perpetuate foundational assumptions of difference. Most fail to fully analyse the socio-cultural histories that create, and perpetuate such research findings. And while such research findings are intended to „equalise“, they could, ironically seed new forms of stereotyping of learning, if not deeply and critically examined. It is for this reason that I argue for the re-orientation of SMTs teacher education curricula towards SD within the ESD framework, a framework that has the potential to engage with the socio-cultural-ecological relevance of curriculum development as discussed in Section 2.2. As noted by Shumba (2005), at the heart of ESD is the fact that educational initiatives must promote sustainable development and strengthen capacity for ESD leading to improved quality of life. This implies learning must be related to social problems of gender, peace, human rights, democracy, ecological and cultural diversity, and others.

Engaging with SMTs education as an ESD process at a teacher training level has the potential to build the agential capacity of future teachers in several ways. Firstly an ESD SMTs embracing curriculum (as shown in Figure 2.1) has the potential to take into consideration socio-ecological challenges, and this has the potential to make SMTs more meaningful and more relevant, an innovation that has been regarded as key in attracting young people, especially females to study sciences. Secondly, as discussed in Section 2.1, the ESD process has the potential to enable future teachers to be critical and to learn to clarify their own values

(including patriarchal values). In being critical, trainee teachers are likely to question the everydayness (Daniels, 2010), the taken-for-granted in curriculum practice and perhaps engage with underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs. Thirdly, the ESD process provides room for learning to think systemically. For SMTs teacher education this would imply inculcating into future teachers, knowledge, values, skills and attitudes to holistically engage with the socio-cultural, economic, political and ecological issues in curriculum innovation. In this way, future teachers will be in a better position to learn to envision more positive, inclusive and sustainable futures (UNESCO, 2011).

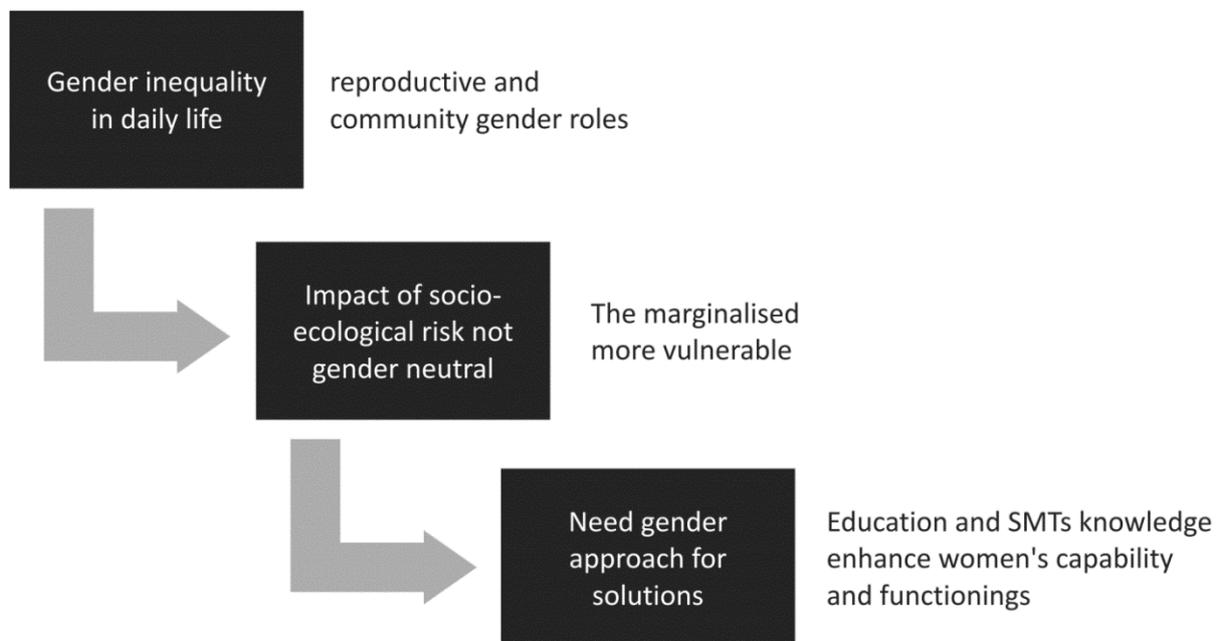
## **2.5 GENDER ISSUES AND SOCIO-ECOLOGICAL RISK IN SOUTHERN AFRICA**

*Climate change is a global phenomenon, with impacts that are already being experienced on a human level. It is recognised that it is those who are already the most vulnerable and marginalised who experience the greatest impacts and are in the greatest need of adaptation strategies in the face of shifts in weather patterns and resulting environmental phenomena. At the same time, it is the vulnerable and marginalised who have the least capacity or opportunity to prepare for the impacts of a changing climate or to participate in negotiations on mitigation. As women constitute the largest percentage of the world's poorest people, they are most affected by these changes. Children and youth – especially girls – and elderly women, are often the most vulnerable. (BRIDGE, 2008, p.1)*

I open this section with the above quote, which highlights the gendered nature of socio-ecological risk. The purpose of the literature reviewed here is to show the nexus of SMTs education, socio-ecological risk and gender. This is necessary to locate gender-based SMTs work as an ESD process. As mentioned in Chapter One, we are living in a society facing socio-ecological risk characterised by climate change; this influences normal patterns of food production, poverty, health and population issues including HIV/AIDS, conflict and violation of human rights, rapid political and technological changes and many others. In this review, I use more examples related to climate change as it is the most current and devastating socio-ecological phenomenon of our times and in many ways exacerbates and incorporates others such as biodiversity loss or poverty related vulnerabilities.

The gender dimension in climate change comprises primarily two aspects (Bäthge, 2010): women, particularly in developing countries, are more vulnerable than men to the consequences of climate change (higher vulnerability); second, men and women play different roles in dealing with climate change, whereby women are the major actors in several areas of mitigation and adaptation (agents of change).

Regarding the first dimension, as a rule, poor social groups bear the brunt of climate change not only because they are more dependent on natural resources, but also because they lack the requisite capacity to adapt to climate change. In this regard, the UNDP (2010) shares that about two thirds of the world's population living in poverty are women, which underlines their greater vulnerability to the changing climate. Neumayer and Plumper (2007) clarify that in societies where women and men enjoy equal rights, disasters have the same impact, but in most cases women and girls suffer disproportionately because they have not received enough information, education and empowerment capital to manage disaster. B athge, (2010) citing Schalatek (2009), added that the differential impact of climate change on women and men is due to social norms, traditional roles and different power structures. Dupont (2012) and the United Nations Population Fund (2009) pointed out that women are among the poorest of the poor, and are traditionally in charge of their family's water and food supply, health care, and education of children. In times of any socio-ecological crisis, women are often hit the hardest – in drought they walk further to find water; in famine they eat less to feed their family; and in times of natural disasters, children cannot attend school, leaving their mothers to care for and educate them. Shiva (2012) added that particularly in developing countries (like the case of Southern Africa), climate change brings droughts, floods, loss of plants and animals and women who largely bear the responsibility of agricultural production, struggle more from low productivity of agriculture, extreme poverty and low quality of life. She went on to illustrate (Figure 2.2) how gender inequality in general results in gender specific impact (higher vulnerability of women) of socio-ecological risk and the need for a gender approach to come up with solutions.



**Figure 2.2** Relationship between gender inequality and gendered vulnerability  
Adapted from Shiva (2012)

In the same relationship (see Figure 2.2.), Shiva (2012) backed a gender approach to socio-ecological risk, in support of Bätthge’s (2010) second gender dimension in climate change – women as agents of change and major actors in several areas of mitigation and adaptation. The two argued that a gender approach may contribute to building more capacities to adapt to risks because “a solution for women is a solution for more proportions of victims” (Shiva, 2012). This position was taken during the Earth Summit in Brazil back in 1992. In this summit Agenda 21 was developed as an action plan for sustainable development. Chapter 24 of this action plan is about global action for women towards sustainable and equitable development. In this chapter, the Summit confirmed the importance of consideration for women and women’s role in managing environmental issues:

*... particularly with regard to women’s participation in national ecosystem management and control of environment degradation; (Section 24.8a)... including the promotion of women’s literacy, education, training, nutrition and health and their participation in key decision-making positions and in management of the environment, particularly as it pertains to their access to resources... (Section 24.2f). (Agenda 21, Earth Summit in Brazil, 1992)*

Zakieldeen (2009) went on to argue that women are also more likely to act as positive agents of change by taking actions that reduce their environmental impact; yet they have the least input in planning, policy-development and decision-making. Masika (2002) is of the opinion that policies need to shift to accommodate the equity and sustainability implications of

climate change. Closely linked to this argument is a body of research that calls for the need to research Climate and Gender Justice; this embraces a collection of disaggregated data and ensures all policies and measures with regards to climate change, sustainable development, environment and natural resource management and disaster risk management and reconstruction of strategies are gender responsive (Women and Gender Constituency, 2009). UNESCO (2012) concurred that women play a vital role in environmental management and development; their full participation is therefore essential to achieving sustainable development. Their extensive theoretical and practical knowledge of the environment and resource conservation is not given due consideration (ibid.).

The Women and Gender Constituency (2009) further called for the creation of an enabling environment for the full and effective participation of women, especially rural and indigenous women, in decision-making processes for all related policies and measures. This call follows the realisation that women, as the world's primary farmers for example, tend to be better stewards of the Earth than men. In this regard the UNPF (2009) cites the UN Secretary General Ban Ki-moon who argues that women are also the most sustainable consumers, and their participation is crucial to navigate climate change successfully. In the same report the secretary general went on to mention living examples spearheaded by women either as mitigation or adaptive measures in climate change. In India, Nepal and Bolivia, a collective of women in villages worked on chemical-free, non-irrigated, organic agriculture as a response to global warming. An iconic example here is Wangari Maathai of Kenya, who won the Nobel Peace Prize for her work through the Green Belt Movement she founded in Kenya, to rejuvenate the environment by planting trees, while empowering many women as agents of change.

There are several other examples that point to the fact that the potential of women as agents of sustainability, for example, of change for climate mitigation and adaptation, remains untapped. For instance, B athge (2010) argued that the economic empowerment of women through climate mitigation and adaptation fosters economic growth and socio-economic development, reduces poverty, keeps environmental problems in check, and increases the potential for adaptation, which is to the benefit of both women and men. She gave examples in the promotion of renewable energies that help avoid greenhouse gas emissions. She argued that, not only are jobs created for women who can be engaged in the upkeep and maintenance of solar plants, but solar-powered lamps also extend the productive time available to street

vendors. To this argument, I will add that women are in a better position than men to do this since they, most often in a southern African context at present, deal with energy issues in most households. However, more often than not, women are found wanting, looking for assistance even for minor technical operations. This is largely due to their lower exposure to technology. I therefore argue for SMTs education as an ESD process, which has the potential to broaden the capability set for women.

Additionally, pilot experiences in climate adaptation have shown that women, given their vast knowledge, are able to develop and disseminate innovative cultivation methods that are adapted to climate change. It goes without saying that the involvement of men in gender and climate related issues is of crucial importance. Nevertheless, the main focus of this study is on the advancement of women's empowerment and gender justice through curriculum reform for the reasons cited above.

Developing countries, though low emitters, have the potential to reduce or store greenhouse gases, particularly in areas in which women are already active (Bäthge, 2010). Providing energy for the household is usually a woman's job and she often resorts to the energy-inefficient open burning of biomass, e.g. firewood (ibid.). The use of efficient energy systems at the household level (e.g. special cooking stoves and ovens) could reduce emissions and harness the potential of women as actors for mitigation measures. It is my argument in this study that a solid base in SMTs will enhance women's capabilities in all these measures, while also strengthening their capabilities to critically engage with such socio-culturally inscribed roles.

As noted in many national and international policies, minimising vulnerability to climate change and environmental degradation will require sustainable development interventions in multiple sectors (agriculture, health, employment, education, and many more), all of which need to be anchored in a good SMTs knowledge base. It is therefore my argument that a good grasp of SMTs education will broaden women's capability to participate in such endeavours, ensuring that women have a strong voice in all aspects of the socio-ecological vulnerability – as scientists, advocates, and policy makers, as well as practitioners.

## **2.6 EFFORTS TOWARDS GENDER EQUALITY IN EDUCATION**

This section discusses the efforts made so far towards gender equality in education in general and in SMTs in particular. Such efforts are seen in the progress that countries have made in working towards Education for All and in achieving the Millennium Development Goals. As highlighted in Section 2.2, ESD provides an opportunity for countries to meet their Millennium Development Goals as well as their Education for All goals. This means that ESD can be addressed through the perspective of the Millennium Development Goals, contributing to the realisation of the goals of Education for All and those of the United Nations Literacy Decade. Other platforms such as the Beijing Platform for Action are also key drivers towards quality and relevant education that seek to empower people towards a socially just and sustainable society. For that reason, this also forms part of the review in this chapter. It is worth noting that these three policy directives were advisory to countries and from them and others policy initiatives, individual countries came up or modified mandatory policies like the National Gender Policies for South Africa and Zimbabwe.

### ***2.6.1 Millennium Development Goals and gender equality in education***

The United Nations Millennium Declaration, signed in September 2000, commits world leaders to combat poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women (UNDP, 2010). The declaration culminated in eight goals that all 191 UN member states have agreed to try to achieve by the year 2015 (Unterhalter and North,, 2011). The goals are:

1. Eradicating extreme poverty and hunger,
2. Achieving universal primary education,
3. Promoting gender equality and empowering women,
4. Reducing child mortality rates,
5. Improving maternal health,
6. Combating HIV/AIDS, malaria, and other diseases,
7. Ensuring environmental sustainability, and
8. Developing a global partnership for development. (UNESCO, 2003)

While acknowledging that these goals are interrelated, this study's specific interests in gender equality in education and sustainable development led to a focus on Goals 3 and 7. Each of

the eight goals has indicators and targets. Below are the targets for the two goals and their relevant targets for this study.

Goal 3 was broadly framed to 'promote gender equality and empower women' (Aikman, Unterhalter, and Challender, 2005, p.44). Within the Goal, the target relating to education was set in terms of eliminating gender disparity in primary and secondary education preferably by 2005 and in all levels by 2015. Commentators raised concerns that a wide goal of gender equality in political, economic, social and cultural relations is thus interpreted in a limited form as equal numbers, for example, of boys and girls in formal schooling (for example, Aikman et al., 2005; Unterhalter, 2005; Unterhalter and North, 2011).

Goal 3 dealt with aspects of gender and schooling and derived from goals set out at the Education for All conference in Dakar (which took place in April 2000) and falls directly within the frameworks of Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), and the Beijing Platform for Action developed at the Fourth World Conference on Women held in Beijing in 1995 (South African government, 2010; Unterhalter and North, 2011). The three processes, Education for All, the Convention on the Elimination of All Forms of Discrimination Against Women and the Beijing Platform for Action, have generated a wealth of understanding and experience that illuminates the nature of gender-based discrimination and clarifies the steps needed to achieve gender equality (ibid.).

Goal 7 of ensuring environmental sustainability was set with the understanding of the role that the biophysical environment plays in the achievement of the majority of the other seven goals. For example, environmental preservation is an essential foundation for sustainable development and poverty alleviation. Failure to achieve biodiversity stability, for instance, will undermine social and economic development efforts and similarly, poor environmental management practices impact on food security and health. This may result in high poverty levels, that may cause widespread school dropout and high mortality rates especially among children. Historically such socio-ecological stresses have impacted negatively on social relations particularly for women and children.

Against this background, I review the progress made so far in relation to the two goals in South Africa and Zimbabwe. The purpose of the review was to appraise the progress towards the two goals using ESD lenses.

### *2.6.1.1 The story of the South African MDGs*

The 2010 MDGs country report shows that South Africa has in effect achieved the goal of universal primary education before the year 2015, and its education system can now be recognised as having attained near universal access (South African government, 2010). The report shows that primary education in South Africa is characterised by very high rates of enrolment and retention. These rates show strong gender equity, and where small differences do exist, they are in the girl child's favour (ibid.). Unterhalter and North (2011) also reported that sixteen years of democracy have seen many initiatives to address gender and poverty; schooling to the end of Grade 9 is compulsory.

Specifically related to Goal 3, the SA government 2010 report noted the following on parity in the tertiary education system:

- In 1990 women accounted for 47.8% of total university enrolment in South Africa.
- Technikon enrolments were heavily male-dominated; in 1987 the overall gender breakdown for technikons was 71% male and 29% female.
- By 2008, the situation had changed markedly, with the overall female: male ratio at 1.29:1.00.
- The ratio differed across types of institutions, but was greater than a unity for all three types – 1.05:1.00 for universities of technology, 1.36:1.00 for comprehensives, and 1.34:1.00 for the traditional universities.

Although enrolment ratios in tertiary institutions generally are in favour of women as shown above, the situation is different in faculties of science. Table 2.1 shows that males still dominate in science faculties in tertiary institutions across the country. The report also gave recommendations to improve the quality of teaching and learning in general and a particular pointer was given to SMTs:

- Open teachers' training colleges and reconceptualise the educators training so as to motivate, instil and inspire a culture and love for education and learning;
- Parents/guardians should be supported in raising the children in their care to prevent teenage pregnancies, risk-taking behaviour and abuse by their elders. This can be achieved through parent education programmes and community care networks; and

- Train a sufficient number of teachers who will be proficient in the delivery of mathematical and science subjects to learners.

The proposed curriculum transformation investigated through this study will hopefully contribute, in a small way, towards promotion of gender equality as articulated by this goal.

For Goal 7, the SA government (2010) reports that the inclusion of environmental rights in the South African Constitution, the development of a plethora of new environmental management policies committed to sustainable development, and a marked increase in donor funding for environmental management, are positive changes in the South African political context that provide favourable conditions for this goal. These changes have arisen from both national and international drivers, and are impacting on redirection of resources within the country from traditional conservation to people-centred sustainability management (ibid.).

The goal relates to sustaining the environment and the population's access to housing, water, energy and sanitation amongst others. South Africa is relatively poorly endowed with water resources and is exposed to significant risks associated with water quality and availability over time and space (ibid.). As a result, water availability is predicted to be the single greatest and most urgent development constraint facing South Africa (Turpie, Marais and Bignaut, 2008). Climate change and rising demand will worsen water availability problems (ibid.). In the face of these challenges, the SA government (2010) recommends that progress towards the goal requires more effective management of South Africa's limited water resources, and many players need to come on board.

The 2010 government report shows that the forestry area decreased from 1.266 to 1.257 million hectares from 2007 to 2008, which represents a decrease of 9,000 ha. The main reasons for deforestation are conversion of forests for agriculture and harvesting for construction, timber, and fuel wood. Meanwhile CO<sup>2</sup>-equivalent emissions increased significantly largely due to transport and industrial emissions as well as residential fuel-burning. These challenges and many more suggest that the timetable for implementing the indicators of MDG 7 will not be met in South Africa (SA government, 2010).

This study was interested in finding out the role played by the SMTs teacher education curriculum in towards this goal. Judging from some curriculum outcomes, for example

learning outcome 3 for physical sciences stated in Section 2.2.2, the South Africa school curriculum has for quite some time been engaging with issues related to Goal 7. An analysis of the Curriculum and Policy Assessment Statement (CAPS<sup>3</sup>) by Lotz-Sisitka (2011, p.31) showed that in some subjects, up to 50% of content is „environmental“ or is related to „sustainability“; environment and sustainability content permeates a wide range of subjects, in line with a curriculum principle that seeks to ensure an environmentally literate citizenry. It was therefore pertinent in this study to explore the role that teacher education was playing developing future teachers towards such socio-ecological sustainability initiatives. The expansive learning phase of the study was later conducted to strengthen such a contribution by the teacher education institution involved in the study.

#### *2.6.1.2 The story of the Zimbabwean MDGs*

Status and trends in the Zimbabwe MDGs status report (2010) shows that Zimbabwe has consistently maintained relatively high levels of primary school enrolments. For Goal 3, the 2010 MDG country report shows that while there is gender parity at a primary school level, and near gender parity at lower secondary level, particularly in the lower forms (Forms 1 to 4), the gender parity decreases in upper levels, where there are low representation and completion rates amongst girls. It was also noted that although both girls and boys have dropped out of school as a result of a decade of economic crisis, the percentage is higher for girls (Zimbabwe Women’s Resource Centre Network, 2009). There is also a low enrolment of women in universities, particularly in the fields of mathematics and sciences as shown in Section 2.1, Table 2.2.

For Goal 7, the 2010 Millennium Development Goals Status Report for Zimbabwe reported that the economic crisis between 2000 and 2008 saw a significant proportion of the population forced to rely more heavily on natural resources for their livelihood, including firewood, bush meat, traditional medicines, and wild fruits and vegetables, causing increased biodiversity loss. The sporadic power cuts that began in 2007, coupled with inaccessibility of paraffin (the main energy source for low-income urban-dwellers), led to significant deforestation, particularly in peri-urban areas. Estimates suggest that between 100,000 and 320,000 hectares of forest cover per annum were lost during this time (ibid.).

---

<sup>3</sup> South Africa’s new curriculum framework

Prior to the economic crisis, Zimbabwe had sound systems in place for the management of protected areas. However, the capacity of state institutions to enforce environmental laws was severely weakened during the crisis period, resulting in the illegal occupation of protected forest and wildlife areas as well as other negative environmental practices such as illegal alluvial gold mining, diamond mining, accidental and deliberately set bush fires, all of which destroyed both plant and animal biodiversity (ibid.).

Results from the 2009 Multiple Indicator Monitoring Survey (UNICEF, 2009) indicated that the proportion of people in rural areas with access to safe drinking water declined from 70% in 1999 to 61% in 2009. Furthermore, according to the Department of Infrastructural Development, more than 65% of all rural water points are non-functional at any given time (Zimbabwe National Statistics Agency, 2011). Zimbabwe's extensive rural sanitation programme has also experienced a sharp decline in quality (ibid.). The 2005/2006 Zimbabwe Demographic and Health Survey revealed that since 1999, 69.5% of all rural households had no access to hygienic sanitation facilities (ibid.).

The UNDP (2012) reported that the major challenges affecting the provision of clean water and good sanitation in the country include eroded institutional and community capacity at all levels in terms of human, financial, and material resources, a weak policy framework, and a weak sector information management and monitoring system. In addition, failure to invest in the routine maintenance of water and sanitation facilities has resulted in deterioration of physical assets and, inevitably, failure to provide a safe and reliable basic level of service.

It is my argument that the burden of this socio-ecological risk falls heavily on women and girls because of the gender division of roles in most households in the country as discussed in section 1.7.17. For example it is women who have to work harder in search of clean water, firewood and other basics in order to perform their daily household chores (see Section 2.5).

### ***2.6.2 Education for All and gender equality in education***

*Basic learning needs . . . comprise both essential learning tools . . . and the basic learning content . . . required by human beings to be able to survive, to develop their full capacities, to live and work in dignity, to participate fully in development, to improve the quality of their lives, to*

*make informed decisions, and to continue learning.* (World Declaration on Education for All, UNESCO, 2000, p.9)

The Education for All movement is a global commitment to provide quality basic education for all children, youth and adults. The movement was launched at the World Conference on Education for All in Jomtien, Thailand in 1990 by UNESCO, UNDP, UNFPA, UNICEF and the World Bank (UNESCO, 2000). Participants endorsed an 'expanded vision of learning' and pledged to universalise primary education and massively reduce illiteracy by the end of the decade as articulated in the quote above (ibid.).

Ten years later, with many countries far from having reached this goal, the international community met again in Dakar, Senegal, and affirmed their commitment to achieving Education for All by the year 2015. Participants at the Dakar Framework for Action endorsed that education is a fundamental human right. It is the key to sustainable development and peace and stability within and among countries, and thus an indispensable means for effective participation in the societies and economies of the twenty-first century, which are affected by rapid globalisation (ibid.).

The Dakar Framework for Action reaffirmed six key education goals that were raised ten years earlier in Jomtien which aim to meet the learning needs of all children, youth and adults by 2015 (UNESCO, 2009).

- Goal 1: Expanding and improving comprehensive early childhood care and education, especially for the most vulnerable and disadvantaged children.
- Goal 2: Ensuring that by 2015 all children, particularly girls, children in difficult circumstances and those belonging to ethnic minorities, have access to, and complete, free and compulsory primary education of good quality.
- Goal 3: Ensuring that the learning needs of all young people and adults are met through equitable access to appropriate learning and life-skills programmes.
- Goal 4: Achieving a 50 percent improvement in levels of adult literacy by 2015, especially for women, and equitable access to basic and continuing education for all adults.
- Goal 5: Eliminating gender disparities in primary and secondary education by 2005, and achieving gender equality in education by 2015, with a focus on ensuring girls' full and equal access to and achievement in basic education of good quality.

- Goal 6: Improving all aspects of the quality of education and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills.

As evidenced in the framing of some of these goals, the Education for All goals also contribute to the global pursuit of the eight Millennium Development Goals (MDGs) discussed above. The Education for All 2000 Assessment conducted at national, regional, and global levels showed that progress was made over the decade towards the vision reflected in the Jomtien Declaration. Some of the successes highlighted by the UNESCO (2000) report are: increase in early childhood care and education, increase in primary school enrolments, increased by some 82 million pupils since 1990, with 44 million more girls in school in 1998 than in 1990. Virtually all countries in the world ratified the United Nations Convention on the Rights of the Child and have thereby accepted an obligation to ensure the right of every child to a basic education. Despite these successes, the report raised that the education of girls remains a major challenge.

The 2010 South Africa Education for All country report showed that although the country has done well to systematically expand its educational system and to lengthen the schooling experience of successive learner cohorts, there is little dispute that the quality of its schooling remains an impediment to development (Department of Basic Education, 2010). Some of the concerns raised were: learner scores for literacy, numeracy and science remain low – even in relation to less developed and less resourced African countries, very poor achievement levels of both boy and girl candidates in mathematics and physical sciences (although males outperformed females in both subjects, the difference between males and females is not significant. The gender difference is far less striking than the poor achievement levels of both). Bloch (2009) pointed out that, sadly, the poor learning outcomes impact far more heavily on poor, rural and township (i.e. predominantly black) schools than on the more privileged urban and white schools. The Department of Basic Education (2010) and other commentators have for a long time been sceptical of the quality of teaching and learning that goes on in schools, in some instances pointing a finger at teacher qualifications. The 2010 Education for All country report showed a marked increase in the proportion of qualified educators since 1990, with an overall percentage of qualified educators increasing from 53% in 1990 to 94% in 2009 of educators who met the formal qualification requirements of the system. This translates into a massive 41% increase in the number of qualified teachers,

however, the Department of Basic Education is concerned that this dramatic improvement in educator qualifications over the past 20 years does not appear to have had a visible impact on learner performance (Department of Basic Education, 2010).

The Zimbabwe Education for All country report raised the following as challenges the country is facing to meet the goals (UN, 2010):

- Declining access to basic, post basic, vocational and higher and tertiary education;
- Declining quality of the education provided at all levels;
- Inadequate funding for the sector;
- Exclusion of children with special learning needs, particularly those with disabilities;
- Inadequate learning, teaching, and training materials,
- Outdated equipment in schools, vocational institutions and Higher and Tertiary Education Institutions;
- Shortage of school infrastructure and learning and teaching materials in new settlements;
- Loss from vocational and tertiary institutions of teachers, trainers and lecturing staff, particularly in mathematics and sciences, medicine and engineering, through migration;
- Poor connectivity between Head Office and provincial offices, district offices, schools and tertiary institutions;
- An education sector response to HIV that is not comprehensive or effective; and
- An outdated school, vocational and tertiary education curriculum that is long overdue for reform.

Some of the challenges raised here from the two countries are directly related to inadequacy in teacher education. It is my hope that reorienting teacher education within an ESD framework would contribute to addressing some of the challenges that are linked to quality and relevance of education.

### ***2.6.3 Beijing Platform for Action and Gender Equality in Education***

The concept of bringing gender issues into the mainstream of society was clearly established as a global strategy for promoting gender equality in the Platform for Action adopted at the United Nations Fourth World Conference on Women, held in Beijing, China in 1995 (Economic Commission for Africa, 2010). It highlighted the necessity to ensure that gender

equality is a primary goal in all area(s) of social and economic development. The Governments participating in the Fourth World Conference on women were determined to advance the goals of equality, development and peace for all women everywhere in the interest of all humanity (Beijing Declaration, 1995). The conference came up with numerous pronouncements, and related to this study the leaders reaffirmed their commitment to:

- The equal rights and inherent human dignity of women and men and other purposes and principles enshrined in the Charter of the United Nations, to the Universal Declaration of Human Rights and other international human rights instruments, in particular the Convention on the Elimination of All Forms of Discrimination against Women and the Convention on the Rights of the Child, as well as the Declaration on the Elimination of Violence against Women and the Declaration on the Right to Development (Beijing Declaration, 1995, pp. 2-3);
- Women's rights are human rights;
- Equal rights, opportunities and access to resources, equal sharing of responsibilities for the family by men and women, and a harmonious partnership between them are critical to their well-being and that of their families as well as to the consolidation of democracy;
- Take all necessary measures to eliminate all forms of discrimination against women and the girl child and remove all obstacles to gender equality and the advancement and empowerment of women;
- Promote people-centred sustainable development, including sustained economic growth, through the provision of basic education, life-long education, literacy and training, and primary health care for girls and women;
- Ensure equal access to and equal treatment of women and men in education and health care and enhance women's sexual and reproductive health as well as education;
- Develop the fullest potential of girls and women of all ages, ensure their full and equal participation in building a better world for all and enhance their role in the development process.
- Ensure women's equal access to economic resources, including land, credit, science and technology, vocational training, information, communication and markets, as a means to further the advancement and empowerment of women and girls, including through the enhancement of their capacities to enjoy the benefits of equal access to these resources, inter alia, by means of international cooperation.

It was at this conference that the concept and framework of gender mainstreaming was strengthened and given a practical scope. Gender mainstreaming was seen to provide an efficient and equitable way of applying national resources to the whole population (Goetz, 2007).

As a follow-up to all these international initiatives, respective countries developed their own national frameworks to implement the declaration of the Beijing Platform for Action (see national policies below). In terms of education, the Beijing Platform for Action +15 pointed at Education and Training for Women as one of its areas of concern. The Beijing Platform for Action recognised education as the nexus around which most of the principles and other critical areas of concern can be attained (Economic Commission for Africa, 2010).

Governments therefore need to be committed to among others (ibid.) providing universal access to basic education; close the gender gap in primary and secondary school education by the year 2005; providing universal primary education in all countries before the year 2015; and eliminating gender disparities in access to all areas of tertiary education by adopting positive action when appropriate. The synergy of the Beijing Platform for Action and other initiatives such as the MDGs, and Education For All saw programmes towards gender equality in education being rolled out as discussed in the respective sections above. In order to accelerate progress in achieving the Beijing platform for action objectives in education and training, the 2004 Ministerial Conference urged countries to institute and strengthen affirmative action measures including scholarships at all levels for female students; establish distance and non-formal education and literacy programmes for women; and use innovative and aggressive strategies to redress the under-representation of women and girls in the sciences, mathematics and technology-related disciplines and careers, including the promotion of science among children in general and young girls in particular. In addition, it was proposed that women's access to professional training should also be strengthened.

Nevertheless, the education sector is being confronted with its inability to ensure the steady progression of both girls and boys beyond primary to secondary and tertiary education (ibid.). The situation is dire in sciences and technical subjects where girls tend to shy away more than boys as they progress in their education (FAWE, 2005). Based on this, the Economic Commission for Africa 2010 report concluded that Africa may be facing the challenge of inadequate human capital formation in critical areas of their respective economies in the

medium to long term. It is for the same reason that this research focused on the education and training sector as a way of contributing towards quality and relevance of education as well as social justice.

As discussed above, situating the study within the ESD discourse has the potential to contribute to curriculum reform in several ways. Firstly, integrating socio-ecological risk in SMTs teacher education curriculum has the potential to add quality and relevance to the discipline. Developing in future SMTs teachers the capacity to engage with issues that bedevil society, has potential to attract more young people to study the disciplines, especially females students as many studies have shown that females shy away from science because they perceive it as abstract, dry, irrelevant, not useful in everyday life, decontextualised, distanced from everyday life, alienated from society (Osborne and Collins, 2001; Semela, 2010; Chetcuti and Kioko, 2012) (see Section, 2.4). Situating SMTs curriculum transformation in this way has also the potential to develop a wider capability set for all students, more so for females who bear the brunt of socio-ecological risk as discussed above.

## **2.7 SADC POLICIES ON GENDER EQUALITY IN EDUCATION**

As discussed above most governments in regional clusters developed policy formulations to fulfil the goals of UN mandated bodies such as Education For All; Beijing Platform for Action and the MDGs. Notable to the Southern African Development Community (SADC) region is the signing by Heads of States or Government Declaration on Gender and Development (1997) and later on the SADC Protocol on Gender Equality (2008). These two committed governments and countries, inter alia, to:

- embedding gender firmly into the agenda of the SADC Programme of Action and Community Building Initiative;
- ensuring the equal representation of women and men at all levels of the decision making structures of member states as well as in SADC structures;
- promoting women's full access to and control over productive resources;
- repealing and reforming all laws and changing social practices which subject women to discrimination;
- enhancing access to quality education by both women and men and removing gender stereotypes from the curriculum, career choices and professions;

- making quality reproductive and other health services more accessible to women and men;
- protecting and promoting the human rights of women and children;
- recognising, protecting and promoting the reproductive and sexual rights of women and the girl child;
- taking urgent measures to prevent and deal with the increasing levels of violence against women; and
- encouraging the mass media to disseminate information and materials in respect of the human rights of women.

It is perhaps ironic that, despite all the global and regional policies focusing on gender equality, in 2008 SADC found the need to note the problem of increasing violence against women and that socio-ecological risk (prolonged droughts, HIV/AIDs, poverty and many more) has in some cases worsened the plight of women (UNDP, 2009). Such perspectives point to the need for ongoing critical engagement with relations between policy and practice, as policies alone are not a full enough response.

Drawing especially from the Beijing Platform for Action, the caption term was gender mainstreaming. The SADC gender monitor (1999) defined gender mainstreaming as a transformation process. Mainstreaming is not about adding a "woman's component" or even a "gender equality component" into an existing activity (UNDP, 2005, p. 3). It goes beyond increasing women's participation; it means bringing the experience, knowledge, and interests of women and men to bear on the development agenda (ibid.). It may entail identifying the need for changes in that agenda. It may require changes in goals, strategies, and actions so that both women and men can influence, participate in, and benefit from development processes. The goal of mainstreaming gender equality is thus the transformation of unequal social and institutional structures into equal and just structures for both men and women (ibid.). Unterhalter, (2007) saw gender mainstreaming as meant to orient values, policies, organizational processes and forms of evaluation so that these take due account of gender equality.

The question to ask here is what would gender mainstreaming mean in ESD oriented curriculum transformation (based on Sen's concept of sustainable development mentioned in

Section 2.2.1 above)? Gender mainstreaming would mean a critical approach to the curriculum that would seek to establish capabilities (opportunity freedom) for both boys and girls. This would imply pedagogics that takes into consideration the experiences and curriculum needs for both girls and boys. In a teacher education scenario this would call for a curriculum that alerts trainee teachers to the socio-cultural and socio-ecological constraints that hinder the progress of mostly girls in SMTs and in societal activities more broadly, equipping them with the necessary knowledge, skills, artefacts, attitudes and values to engage with such cultural constrains. This implies re-orienting values, attitudes, policies and organisational practices towards gender equality. Hence, this study sought to establish a platform in which both men and women reflect on issues of epistemology and the nature of knowledge that is accepted as school science as outlined by the UNDP (2005) conception. In this way gender mainstreaming will consequently imply agency (Section 1.8).

In the following sections, I review relevant policy frameworks in Zimbabwe and South Africa that provide this study with intellectual space to engage with gender issues in SMTs teacher education context.

### ***2.7.1 Zimbabwe National Gender Policy***

The quest for social justice, equity and respect for human rights anchored on democratic principles spurred the Zimbabwean government to develop the National Gender Policy (NGP) as a mandatory policy to inform practice in different government sectors. Initially a government based on egalitarian ethos with a view to transforming the nation through a policy framework underpinned by the essence of "Growth with Equity", the government had plans designed that sought to redress social, political and economic inequities in society (Zimbabwe National Gender Policy, 2004, p. 2). The SADC Gender Protocol Barometer (Morna and Jambaya-Nyakujara, 2011), however described Zimbabwean society, like most countries in the SADC region, as highly unequal in terms of gender, and this factor impacts on income distribution, political participation, power relations, access to, control and ownership of economic and productive resources. This situation continues to haunt development, especially human development efforts which are aimed at addressing issues of equity, social justice, human rights and democracy that place value and worth on each person's contribution to society at all levels (National Gender Policy, 2004).

The NGP further pointed out that despite the fact that 52 percent of the population are women, men continue to have a higher human development index compared to their female counterparts. Women still lag behind men in political and decision making positions and in education (ibid.). They continue to be marginalised in the economy and in the enjoyment of legal and human rights. The policy affirms that such disparities between women and men cannot be allowed to continue for they pose a serious impediment to sustainable development and the attainment of equality and equity between women and men. Issues of equality and equity are a matter of social justice and good economics. The Zimbabwean government sees gender equality as core development issue; and “a development objective in its own right” (National Gender Policy, 2004, p.2).

The NGP adopted a sectorial approach. It acknowledged that the education and training sector poses a big challenge to the eradication of gender imbalances and inequality since it is the foundation of economic and social development. The strategies of the education and training sector are:

1. Amend all relevant education and legal instruments to promote gender equality and equity.
2. Incorporate gender issues in all curricula at all levels of education.
3. Provide equal and equitable educational resources to women and men at all levels.
4. Appoint more competent women at decision-making levels in the education sector to create equitable representation of the sexes.
5. Educate and encourage parents to treat boys and girls equally.
6. Introduce measures which abolish or discourage the traditional harmful practices which affect the health and even the future of the children, especially girls.
7. Eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology.
8. Enact statutes to punish perpetrators of child abuse including teacher/student lover affairs.
9. Provide facilities and a policy framework to enable girls who fall pregnant to continue with their education.
10. Provide information on alternative career paths especially for women.
11. Support gender studies and research activities that will provide disaggregated data for planning purposes.

12. Provide greater support and encouragement to women, girls and the disabled to participate in sport and culture.
13. Promote and encourage girls to take on science, mathematics and technology at all levels of education.
14. Introduce gender awareness programmes to pre- and post-training teacher courses.

(National Gender Policy, 2004, p.9)

While all these strategies have some relevance to this study, strategies 2, 7, 13 and 14 have potential for gender related curriculum transformation, which is key to this study. In its effort to contribute towards closing the gap between policy and practice, these strategies, in conjunction with the main objectives set above, provided a research space to look at issues as spelt out in the research questions in Section 1.5.

### ***2.7.2 South Africa's National Gender Policy Framework***

South Africa's definition of and goals towards achieving gender equality are guided by a vision of human rights which incorporates acceptance of equal and inalienable rights of all women and men. This ideal is a fundamental tenet under the Bill of Rights of The Constitution of the Republic of South Africa, 1996 (Act 108 of 1996). It emerged from a long period of struggle for a democratic society that respects and promotes the rights of all its citizens irrespective of race, gender, class, age, disability, etc. (Bill of Rights, Sections 9.1 to 9.4)

This Gender Policy Framework as a mandatory policy establishes guidelines for South Africa to take action to remedy the historical legacy of inequality by defining new terms of reference for interacting with each other in both the private and public spheres, and by proposing and recommending an institutional framework that facilitates equal access to goods and services for both women and men (South Africa's National Gender Policy Framework, un). The Gender Policy Framework proposes a process that moves away from treating gender issues as "something at the end-of-the-day" (ibid., p.i). Often, while discussing development issues, it is presumed that gender issues can be addressed after the "hard-core" issues have been dealt with (ibid., p.ii). This Gender Policy Framework attempts to ensure that the process of achieving Gender equality is at the very centre of the transformation process in South Africa

within all structures, institutions, policies, procedures, practices and programmes of government, its agencies and parastatals, civil society and the private sector.

The South African Gender Policy Framework highlights the basic assumptions which underpin its formulation. The central assumptions (ibid., p.ii; 12 and 16) related to the education and environment sectors are that:

- despite enormous efforts at transforming the education system, the following factors continue to contribute to high drop-out rates and lower secondary school pass rates for girls: (i) Unplanned pregnancies affect girls more negatively than unplanned paternity affects boys. In a survey quoted in the *Women's Budget*, 28% of female drop-outs were a result of pregnancy compared to the 3% of male drop-outs. (ii) Domestic responsibilities lead to school absenteeism for girls, especially in rural areas. (iii) Girls, more often than boys, are likely to be the victims of sexual harassment, rape and other forms of violence. The resulting trauma frequently leads to a drop in school attendance. (iv) Despite innovative advances in the South African education system, gender stereotypes and women's subordination continue to pose a challenge for curriculum development.
- At the higher education level, in 1999 women comprised 55% of all university students and 46% of all technikon students. However, the representation of women is greater in subject areas such as health, education and social sciences than in science and engineering subject areas where rewards and career prospects are generally better.
- In the Environment sector; given the large proportion of women in rural areas who are dependent on natural resources and who are affected by poverty, access to these resources is a gender issue.
- In general, women struggle to get water, wood and fuel as well as access to land, mineral and other resource rights.
- The initiatives taken by the Department of Water Affairs and Forestry to include women in its planning and implementation strategies have been welcomed. Afforestation programmes, dam building projects and all other environmental programmes have attempted to take into account the specific needs of women. The Department's regulations stipulate that 30% of the representatives on all water boards and other water committees must be women. There are, however, several limitations:

- i) Water schemes have tended to favour houses which are easy to connect to water supplies. This has disadvantaged poor rural women who live far away from water supplies.
- (ii) There are few training and empowerment programmes to prepare women as managers and custodians of natural resources.
- (iii) Environmental impact assessments have not paid enough attention to the impact of policies and practices on all women.
- (iv) Few women are involved in making decisions aimed at the creation of a healthy and sustainable environment.

It is my argument in this research that improving girls' participation in SMTs will not only enlarge their capabilities during school days but will potentially also increase their human flourishing by actively engaging with some of the constraints noted here.

## **2.8 TOWARDS GENDER EQUALITY IN EDUCATION: A PHILOSOPHICAL ANALYSIS**

Many efforts have attempted to improve the status of girls and women in education in general and in SMTs in particular. Efforts such as those discussed above are underpinned by philosophical background that governs the way in which the gender issue is handled in education. To shed light on this, I now present a critique of the philosophical lenses that have informed efforts towards gender equality in education. I use the two ontological approaches, capability theory and feminist theory for a philosophical appraisal of such efforts.

### ***2.8.1 Towards Gender Equality in Education: Feminists appraisal***

Different philosophical approaches have been adopted in the history of gender equality in education. The most common approach adopted worldwide, and in Zimbabwe and South Africa, has a liberal feminist base. Liberal feminism dates back to the writings of Wollstonecraft (see Section 3.3). For liberal feminist theorists gender equality is to be achieved through political and legal reforms (Gaidzanwa, 1992). This thinking informed early attempts on gender mainstreaming which focused on questions of access, sex stereotyping in curriculum and male bias overall (Mbilinyi, 1991). It is also worth mentioning that efforts towards gender equality which were undertaken within Education for All and MDGs frameworks were influenced by liberal feminists. Most governments and donor agencies worked on girls/women's access to education and positions of authority. Affirmative

action implemented in various ways to allow women to access university education with lower entry points than their male counterparts, for example, were efforts of liberal feminists.

Liberal feminism tends to be descriptive, not explanatory or historical (Moser, 1993). This usually leads to rather limited policy interventions, including the reform of textbooks and teaching strategies, career and course counseling for girls, and sensitisation programmes for teachers, administrators and sometimes students (*ibid.*). The underlying assumption is that the provision of information and facilitation of attitude change are adequate to change the system. This ignores the depth of sexism in power relationships within education institutions (Weiler, 1988). As Mbilinyi (1991) argued, the role of gender relations in producing existing power relations in wider society, and reproducing them, suggests that there are strong interests at stake who will resist efforts to undermine male dominant gender systems, both within and without a given educational organisation. Observations in science classrooms show similar power relations with boys deliberately harassing girls to scare them away from their perceived male domain (O'Connor, 2000) or use of unorthodox means to demand teachers' attention (Kalu, 2005), as discussed above in Section 2.4 .

Nevertheless, liberal feminists have made a major contribution in raising the visibility of girls and women within education and policy-making circles, and documenting the extent of gender inequities throughout the system (Moser, 2003).

Socialist feminist perspectives have also had an influence on efforts towards gender equality in education. Socialist feminism is a dualist theory that broadens Marxist feminism's argument for the role of capitalism in the oppression of women and radical feminism's theory of the role of gender socialisation and patriarchy (*ibid.*) (see Chapter Three). The Socialist feminist uses the Marxist gaze to draw attention to the relationship between education and the political economy including how schools reproduce sexual and social division of labour within the family and the workplace (Arnot, 2002). Linkages are made between the world of work (public and private, paid and unpaid) and the world of education (Stromquist, 1990). In the socialist feminist tradition, the school or university is thus perceived to be a state ideological apparatus, reproducing values, attitudes, behaviours and practices expected in the workplace (Moser, 2003). Stromquist, (1990) further critiques the modern capitalist economy demands that require that female products of schooling fit the demands for unpaid domestic work and provide a reserve army of labour. Other feminist writers in Africa with a socialist

orientation (Gaidzanwa, 1992; Gordon, 1994; Kalu, 2005) have examined the unequal representation of women in authority patterns and staffing, the way knowledge is distributed in the classroom and through sex stereotyping in curriculum, and teacher discrimination against girls and women. The emphasis in each case is on how the education institution reproduces certain kinds of girls and women, or constructs „femininity“, so as to meet the demands of the dominant economic system (Gaidzanwa, 1992, p.65). This approach guides us to ask „who benefits from the existing male dominant education system?“ „and how?“

While it is an improvement on the liberal feminist approach, in recognising the systemic nature of gender relations and structures of power in education, the socialist feminist tradition did not actually result in practical ways of ensuring gender equality in education different from those adopted by liberal feminists (Moser, 2003).

Third world feminism arose as a critique to the preceding feminist theories. This strand of feminism brought factors of race, class and ethnicity in examining the condition of women. McKay (1994, p.357) described it as the “triple oppression of women”. However, Third world feminism is heavily criticised for being only critical and offering no solutions. It nonetheless illuminates this study in that it recognises the emancipatory role that education can play for girls/women coming from working class, black or post-colonial backgrounds. Third world feminism also sees schools and universities as sites of negotiation, resistance and struggle over gender relations interacting with other social relations in society.

Third world feminism adopts transformative approaches in trying to achieve gender equality, be it in education or in other sectors of society. Transformative feminist research addresses the relationship between structural oppression and the realities of everyday lives, between the public and the personal (Walby, 2005). Moreover, it includes analysis and action, theory and practice. It also analysed the extent to which education contributed to a transformative process in alleviating basic societal problems which constrain or oppress women (ibid.). Questions such as does education reinforce these basic problems, or does it equip women with the knowledge, skills and attitudes needed to challenge them? To what extent are teachers, students and others contributing to a transformation process? How are they confronting or accommodating basic problems? What are the qualitative aspects of curriculum, pedagogy and school environment which affect the status of gender relations, either for change or entrenchment of the status quo?

The voice of eco-feminists is still to be heard in SMTs curriculum. Examples are Carolyn Merchant (1980) and Vandana Shiva (1989) who have identified western science and its patriarchal assumptions and attitudes to nature, women and development as a major cause of environmental exploitation and the increasing marginalisation of many of the world's people.

By asking such questions as raised by third world feminists and eco-feminists in a SMTs teacher education set-up implied developing agency to establish a capability set for girls in these disciplines. The critical element in third world feminism resonates with the critical paradigm of CHAT, feminist stand point theory on science, and the capability approach. The voice of eco-feminists brings in the ecological dimension to the curriculum, potentially adding relevance and quality to SMTs as the curriculum will be more oriented towards engaging with socio-ecological concerns facing communities.

### ***2.8.2 Towards Gender Equality in Education: a capability appraisal***

The right to education occupies a central place in human rights and social justice (UNESCO, 2005b). As discussed above, the same sentiments are echoed by international initiatives that feed into the ESD narrative, for example the Education for All, MDGs, the Beijing Platform for Action and many more. I considered it valuable to do a historical appraisal of the efforts of these international initiatives with a focus on gender equality in education. For this purpose, I found Amartya Sen's capability lens (Chapter Three) useful to illuminate the discussion on the synergy between global gender equality agenda in education and the efforts of international initiatives.

It is worth pointing out at this juncture that the Global Social Justice gender equality and education, the Education for All agenda, the Beijing Platform for Action and the MDGs are all grounded in rights and capabilities (Unterhalter, 2007). Rights to gender equality in education entail process freedoms in formulating the content of that education, and opportunity freedoms in being able to have access to and progression through education in combination with other valued functions (Sen, 2005). Combining rights and capabilities in curriculum terms would imply a curriculum that is learner centered, in which the interests of all are represented and deliberated with emphasis on valued beings and doings. With this in mind, I agree with Sen who sees the primary aim of educational institutions to be establishing

conditions that expand people's substantive freedoms to do things they have reason to value for their own sake (Sen, 1999 in Elliot, 2007). This thinking originates from Sen's capability approach, which stresses that evaluations of the quality of life should be made in the space of capabilities, that is „the various combinations of functionings (beings and doings) that a person can achieve“ (Sen, 1992, p.40), rather than resources, income or utility only. He argues that capabilities – the various beings and doings a person has reason to value – should be taken as the way to assess any policy or practice (Sen, 1999) (see Chapter Three). In support, Goetz (2007) in Unterhalter and North (2011, p.500) saw gender justice as:

*an end to inequalities between women and men that result in women's subordination, a distribution of opportunities, resources, and agency to secure dignity, autonomy and choice, together with accountability of power-holders at all levels so that any actions to prohibit women realizing their rights will be prevented or punished through some form of redress or restitution.*

It is from this view point, of what gender justice or gender equality in education should mean that capability approach orientated commentators are less satisfied with the gender philosophy and hence the efforts behind the MDGs and Education for All. For instance, Unterhalter and North (2011) argue that in the MDGs the rich field of debate is bracketed and gender equality is reduced to gender parity. They adds that within this view, global obligations can be satisfactorily seen to have been met if gender parity at all levels of education has been secured and all children complete primary schooling. Other commentators have also pointed out that, gender parity is not the same as gender equality in education (e.g. Aikman and Unterhalter, 2005; Unterhalter 2005) (see Section 1.7.4 above). Similarly, the right to education cannot be reduced to merely completing a particular level (McCowan, 2010). Unterhalter (2005), for example, queried how the third goal „To promote gender equality and empower women“ is to be assessed by a very narrow target, that is the elimination of gender disparity in primary and secondary education, preferably by 2005, and to all levels of education by 2015“. Her concern is on having a wide goal of gender equality in political, economic, social and cultural relations being interpreted in a limited form as ensuring equal numbers of boys and girls in formal schooling. The argument is, according to Unterhalter, (2005, p.119) that

*gender inequality that is deeply imbued in the norms of institutions, their decision-making processes, forms of exercising power, their rules, unwritten cultures, and approaches to allocating resources cannot be washed away by mere parity on enrolment.*

Taking such complexity into consideration, like Unterhalter (2005), I see Sen's distinction of aspects of capabilities into well-being achievement, well-being freedom, agency achievement and agency freedom useful in mapping out policies and practices in gender equality in education in ways that move beyond the parity perspective (see Table 3.1 in Chapter Three).

As Unterhalter (2005, pp.116-117) argued:

*Translating this into education [especially the very gendered SMTs education] would imply firstly measuring access, retention and achievement in schooling up to a certain level; secondly measuring agency in how decision-making regarding education is taken in households, schools, education ministries, or local authorities; and thirdly measuring achievements that flow from education.*

At a teacher education level, this would mean equipping future teachers with necessary knowledge, skills, values and attitudes to engage with socio-ecological issues that impact on these capabilities described by Sen, and addressing gendered practices in teacher education institutions.

Sen's capability approach can also provide us with philosophical lenses to assess the historical journey towards gender equality in education. After the pronouncements of the need for gender equality in education by international bodies (Education for All, Dakar and the MDGs, as discussed in Section 2.6 above) most governments and non-governmental organisations mobilised and combined resources to facilitate access for girls into school as a way of fulfilling the UN call of education as a basic human right. Herz and Sperling (2004) identified four key areas that research evidence confirmed "worked" as a means for governments to get girls into school. These were (i) eliminating school fees and offering scholarships to certain populations, (ii) providing a safe school near every village, (iii) making school a safer place where girls were encouraged to learn, and (iv) providing quality education associated with educated and trained teachers, up-to-date books and curriculum oriented to the contemporary world.

While these efforts were fruitful, research findings show, however, that all these efforts towards gender in education were heavily influenced by an instrumentalist view of education in which gender equality in education is viewed as enhancing economic growth or national status (Herz and Sperling, 2004; Unterhalter, 2007).

The instrumental argument for gender equality in education was a combination of ideas that see economic „good sense“ and cost benefit in educating women (Unterhalter, 2007, p.43).

This emphasis on economic benefit of gender equality is shaped by Shultz's Human Capital theory (ibid... Initial formulations of the theory pointed to the importance of studying investment in humans through formal education, or on the job training and quantifying the rate of return on the investment (Elliot, 2007).

Thus for many years, the argument for gender equality agenda concerning access to education for women and girls was seen in instrumentalist terms, that is in terms of the benefits that would flow to women's existing and future children's health and to the GDP of their countries. This thinking also drove policy formulations at the UN, the World Bank, Education for All, and MDGs levels (Aikman and Unterhalter, 2005; Jackson, 2005). The following quotations make this explicit.

*Mothers with more education provide better nutrition to their children, have healthier children, are less fertile, and are more concerned that their children be educated. Education – in particular female education – is key to reducing poverty... (World Bank education policy document, 1995 in Unterhalter, 2007, p.43)*

Almost ten years later Kofi Annan, then UN secretary general, was cited in the UNICEF report of 2003:

*... study after study has shown us that there is no tool for development more effective than the education for girls ... no other policy is likely to raise economic productivity, lower infant and maternal mortality, improve nutrition and promote health-including to prevent the spread of HIV/AIDS... (Unterhalter, 2007, p.43)*

Unterhalter (2007) argued that most global efforts towards gender equality in education were thus driven by this economic „good sense“ spirit and were directed mainly towards enrolment of girls into school. Notably, MDG 3 called for gender parity in primary schooling by 2005. A critical scrutiny of this target shows that it demanded no more than that there should be equal numbers of girls and boys in primary school by 2005 and at all levels by 2015. A lot though, has been done within this spirit in most countries, Zimbabwe and South Africa included, in terms of enabling access for females to basic education and even higher education. Be that as it may, females still continue to shun SMTs and the few that enter the supposedly male domains seem to struggle (Clegg, 2007). It is therefore my argument, drawing from the arguments of Unterhalter, Clegg and others, that while gender parity is a

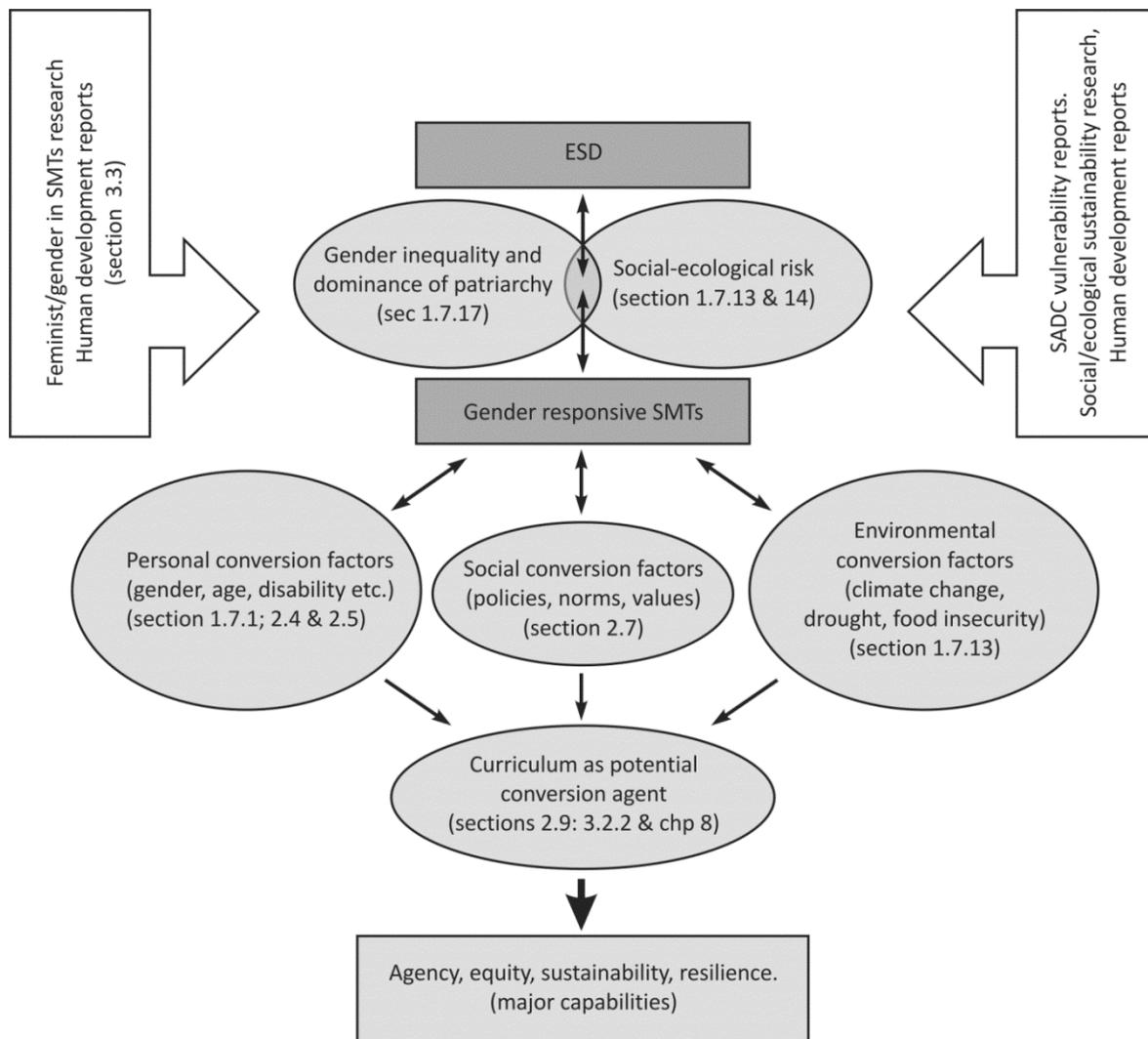
big step towards a gender responsive institutions, it does not on its own bring about gender equality in a curriculum.

This vision positions women's education primarily for others. The process of global policy making took Schultz's tentative suggestions and turned them into certainties. The slogan "if you educate a woman you educate the nation" (Unterhalter, 2007, p.45) captures this thinking. The assumptions at Jomtien and Dakar were that quality of education for everyone would entail equality (Unterhalter, 2007). But this assumption overlooked the existing gendered social relations in school bureaucracies and in the societies of which they are part (ibid.). Adequate learning and teaching linked to the prevailing curriculum does not necessarily address the intensity and force with which views about gender inequality are held nor do they overcome the consequences of a long history of gender inequality (Brighouse and Unterhalter, 2002). Lotz-Sisitka (2008a) citing the Education for All Global Monitoring Report added that physical access to education does not necessarily lead to epistemological access to knowledge or to relevant education being offered.

It can be concluded that for many years, many governments led by Education for All and MDGs adopted interventionist approaches towards gender equality in education. These approaches did a lot to bring about gender parity especially at primary level in most African countries as discussed above, but did little to challenge gendered power relations of institutions and re-orient curriculum so as to empower the marginalised. Little was also achieved in terms of increasing women's participation in SMTs at tertiary education level as shown in Table 2.2, Section 2.1.

With this in mind, this study undertook to contribute towards social justice and sustainability through investigating and expanding teacher education curriculum transformation related to gender and sustainability. Figure 2.3 below illustrates the nexus of ESD, gender and SMTs curriculum and capability as conceived in this study. My argument in the following diagram is that an ESD framework has the potential to support the (re)conceptualisation of SMTs teacher education curriculum practices towards developing agency and relational agency in SMTs teacher educators through critical engagement with gender and SMTs research as well as socio-ecological vulnerability in Southern Africa. The diagram further illustrates that for a curriculum to be of quality and relevant, it should engage with the three conversion factors

(personal, social and environmental). By so doing the curriculum will have the potential to act as a conversion agent as proposed in Sections 2.9 and 3.2.2.



*Figure 2.3 Situating the study within the ESD discourse*

## **2.9 CURRICULUM TRANSFORMATION: SUSTAINABILITY AND GENDER JUSTICE IN SCIENCE TEACHER EDUCATION**

The purpose of the study was to contribute towards quality and relevance of SMTs teacher education through re-orienting it towards gender equity and socio-ecological sustainability. In Zimbabwe and in South Africa this was also a move to close the gap between theory and practice since the national gender policies for the two countries call for the introduction of gender awareness programmes in pre- and post-teacher training courses as discussed in Section 2.7. Furthermore, situating the study within the ESD framework as shown in Figures

2.1 and 2.3 facilitated the interrogation of quality and relevance in the existing SMTs teacher education curriculum. The framework also provided conceptual tools for curriculum transformation in view of socio-ecological risk in a southern African context.

### ***2.9.1 Curriculum and curriculum practice***

As discussed above, the study is located within the ESD and Education for transformation paradigm. The unit of study in this research is teacher education curriculum practices as they relate to gender and sustainability in SMTs. It is therefore worthwhile to discuss the concepts of curriculum and curriculum practices as they are used in this study. As Stenhouse once said “definitions of the word curriculum do not solve the curriculum problems; but they do suggest perspectives from which to view them” (in McKernan, 2008, p.3). Likewise the purpose of reviewing these two concepts here is to clarify the curriculum transformation pathway for the study, at the same time highlighting perspectives from which current curriculum challenges were viewed. In a study with a curriculum transformation interest, I found highlighting pedagogic devices and pedagogical access helpful in discussing curriculum and curriculum practices. In this regard, Bernstein’s comment on the curriculum was useful:

*knowledge or indeed different types of knowledge are therefore not relayed in an unmediated fashion from the external to the internal environment of the school and thence to the pupils, but are recontextualised in terms of the way pupils access them. The focus is therefore on the pedagogic device, rather than the contents of the curriculum per se; and this pedagogic device works according to distribution, recontextualisation and evaluation rules. (Scott, 2008, p.72)*

In this case, the two phases of the study, exploration and expansive learning, focused on the pedagogic device in SMTs teacher education curriculum as a way of understanding and transforming curriculum in this sector. In other words, the study focused on the more tangible aspects of the curriculum such as distribution, recontextualisation and evaluation rules as highlighted by Bernstein.

McKernan (2008) considered curriculum as a field of study that has both theoretical and practical knowledge. He adds that theory yields rational explanations for worthy models, and models function as representations of theory. The practical matter of curriculum involves the action of humans, and as such it constitutes a challenge for praxis, raising the who, when,

why and how as key questions in negotiating and implementing a curriculum (ibid.). Of interest to this study is McKernan's definition of curriculum:

*by the concept of curriculum, I refer not to a syllabus – a mere list of content topics ... nor a prescription of aims, methods and content. Such initiatives equate curriculum with outcomes and objectives – an out puts model. I understand by curriculum the offering of valued knowledge, skills and dispositions (such as affective and value development) through a variety of experiences and arrangements while students are in education.*  
(ibid, p.150)

With a critical stance on these two conceptions of curriculum, one can ask whose knowledge is publicly valued or whose beliefs and norms shape up the SMTs curriculum in general? Expressed in Bernsteinian language the question interrogates the pedagogic devices that govern the distribution, recontextualisation and evaluation of curriculum knowledge.

Related to such conceptions of curriculum, Foucault argued that there is a dialectical relationship between knowledge and power (Scott, 2008). He emphasised that “knowledge structures create power arrangements, and in turn and in different ways power arrangements form knowledge structures” (ibid., p.55). Foucault further suggested that the expression of any universal truth, in a curriculum for example, takes a particular form which is historically specific, and it is the determination of these forms that is of concern to curriculum theorists (ibid.). True to this study, my interest was to explore what actually occurs in a SMTs teacher education curriculum specifically focusing on gender and ESD. As Cornbleth (1990) suggested (Section 1.7.15), the exploration phase focused on socio-cultural context looking at social, political and economic conditions, traditions, ideologies and socio-ecological events that actually or potentially influence the SMTs teacher education curriculum.

It is Henry Giroux's contribution to curriculum that I found most illuminating in this study. In common with Bernstein, Giroux makes it clear that different forms of pedagogy produce different types of knowledge and identities in learners. The intention of critical pedagogy is transformative: to transform society and individuals towards social democracy (Giroux, 1992). This resonates well both with the capability and feminists approaches that seek to contribute to a more just, egalitarian society in which individual and collective freedoms are practised. It also resonates with the fundamental premises of ESD and transformative education.

Giroux outlined a fundamental question: “how can we make education meaningful by making it critical, and how do we make it critical so as to make it emancipatory” (ibid., p.3). The point he raises here, which is pertinent to this study, is to make curriculum knowledge the object of analysis in a twofold sense: on one hand examining it for its social function, the way it legitimates social function and the existing society; on the other hand, he proposes knowledge could also be examined to reveal in its arrangement words, structure and style those unintentional truths that may contain „fleeting images“ of a different society, more radical practices and new forms of understanding (ibid.). This was very informative in this study as SMTs curriculum knowledge was made the object of analysis starting with critical discourse analysis (see Chapters Four, Five and Six) as well as in the expansive learning process (Chapter Eight).

Scott (2008) outlined Giroux’s principles which underpin his notion of critical pedagogy. The first one is that educators need to focus on pedagogy as a means of reconstructing schools as democratic public spaces. In this way Giroux establishes a relationship between schooling and the wider society, both in that one reflects the other and in that changes in pedagogy in schools will eventually result in changes in society. Paraskeva (2010), while stressing that there is no social justice without cognitive justice, added that the main goal for critical progressive educators should be social justice and real democracy. Fien (1998) added a socio-ecological dimension to this. He argued for concrete links between social justice and ecological sustainability in education. For instance, he argued that education about biodiversity (and other nature-based themes) now needs to be immersed in concepts of human rights, equity and democracy which are the core issues of sustainability (ibid.).

A cue from this principle motivated me to take curriculum mediation in SMTs teacher education as the unit of analysis. The essence was to infer whether SMTs teacher educators provide for social and cognitive justice by taking cognisance of gendered complexities in their pedagogy, a move that would inculcate in trainee teachers, skills, knowledge, attitudes and values to do so in their own practice. In this way, teacher education institutions will contribute to develop what Scott (2008) refers to as a cadre of educated people who have developed the knowledge, skills and habits of critical citizenship and through which democratic institutions can be formed. According to Giroux’s (1992, p.74), critical pedagogy means:

*providing students [trainee teachers in this case] with the skills they will need to locate themselves in history, find their own voices, and provide the convictions and compassion necessary for exercising civic relations that are essential to democratic public forms.*

In support of this argument, Aikman, Unterhalter and Challender (2005, p.49) were convinced that it is essential to support and train teachers to promote gender equality “even in contexts in which there are extensive gender inequalities outside school, teachers can make a difference inside school, they can work with a diversity of girls' and boys' learning styles so that all children's styles can be accommodated in the class”. This conversation is pointing towards building agency in teacher education. It also touches on issues of quality and relevance as discussed in Section 2.2. In the same vein, UNESCO (2009) identified teacher education as a key priority for the second half of the UN Decade of Education for Sustainable Development in ensuring quality and relevance in education. Lotz-Sisitka (2011), commenting on the new South African curriculum, also supported the idea of prioritising teacher education in coming up with a more strongly content-referenced curriculum which has commitments to active and critical approaches to learning, and to socio-ecological sustainability.

In the second principle, Giroux argued that critical pedagogy is an ethical project. With roots in critical theory, the ethical project incorporates both a vision of how society should be constructed and a theory of how current society exploits, dehumanises and denigrates certain groups of people (Scott, 2008). Furthermore, this ethical project reflects a sense of responsibility that one should have to the other (ibid.). It has three forms: power, subject positions and social practices (ibid.). The aim of this study was to explore understanding of each of these with reference to current forms of teacher education and expand possibilities for changing those forms to better realise a socially just and more sustainable society. Critical pedagogy as an ethical project should, as Yagalski (2001) said in the opening quote of this chapter, “be sensitive to our relationships with each other and with the world of which we inextricably a part”; that is it should be inclusive of both the social and the social-ecological.

The third principle of critical pedagogy is about political implications of celebrating difference in schooling. Giroux urged teachers and students to engage with difference in two ways (Scott, 2008): (a) student identities and subjectivities need to be understood as multiple and embedded construct which may be contradictory, and furthermore need to be surfaced for

and by the students in the act of creating new, more satisfying and more socially just forms of identity, (b) critical pedagogy needs to allow students to understand how these differences between groups are embedded in history and how they can be and have been manifested in public struggles. Putting their weight behind such critical thinking on curriculum, but with direct reference to gender-equitable pedagogies, Aikman et al. (2005) commented that, with the curriculum being a key piece of national legislation, there are important questions to be asked regarding what girls are being taught about themselves in formal schooling, whether education institutions allow girls effective participation, and whether the existing situations of girls and women are enhanced or diminished by the schooling they receive.

This principle motivated me to dwell on some socio-ecological categories that have the potential to shape learner identities and subjectivities (e.g. poverty, patriarchy, gender). The exploration phase of the study was designed to interrogate how teacher educators engage with such categories in their curriculum practices. The expansive phase was meant to make teacher educators reflect on their own practice and possibly re-conceptualise the SMTs teacher education curriculum with such categories in mind.

The fourth principle according to Giroux relates to the construction of curriculum texts and the need to avoid a master narrative that suppresses multiple interpretations (Scott, 2008). Giroux's (1992) point is that curriculum knowledge should not be treated as sacred text, but developed as an ongoing engagement with a variety of narratives and traditions that can be reread and reformulated in politically different terms.

Related to this argument, Huckle (1996) pointed to how education for sustainability invites us to question the assumptions of dominant discourses in education, particularly those objectives, content and teaching methods which favour initiating people into the concepts and skills needed for finding scientific and technological solutions to environmental problems without addressing their root social political and economic causes. He argued that this approach is guided by technocentric rationality and behaviourist goals of reductionist Western science. Gough (1997, p.56) added that:

*In essence, the dominant worldview has become so ingrained in our way of thinking ... that it acts hegemonically to maintain itself as the dominant ideology ... this has led to a view of inquiry as analytical, reductionist and based on scientific neutrality, rationality, divisibility of knowledge and emphasis on quantitative measurement and*

*observable phenomena which often ignores the issues of justice and ecological sustainability.*

Aikman et al. (2005) further supported this, noting that the „who“ and the „what“ of curriculum are not confined to the content, but also to the processes of curriculum development and the forms of consultation and debate that underpin the choice of ideas, documents, and materials that comprise a curriculum and its process of review. Box 2.1 below shows suggestions on rights, gender equality, and questions about (SMTs) curriculum. As said above, one would expect teacher education to engage with similar issues as a way of instilling attitudes, knowledge and skills in future teachers.

**Box 2.1** *Rights, gender equality, and questions about (SMTs) curriculum*

**Rights and participation:** Who (which groups) are defining what is to be taught and how it is to be delivered? (To what extent are women a part of this?)  
through the education they receive?

**Rights and conceptions of the person:** What are girls being taught about who they are in their education?

**Rights and institutions:** Do the processes in which education is institutionalised and delivered allow girls' effective participation? Are girls'/women's existing situations enhanced or diminished through the education they receive?

Aikman et al. (2005, p.46)

These contestations resonate with some of the values of ESD discussed in Section 2.2.2 such as learning to ask critical questions, learning to clarify one's own values, learning to think systemically and learning to explore the dialectic between tradition and innovation (UNESCO, 2011).

The fifth principle for critical pedagogy refers to the need to create new forms of curriculum knowledge and breakdown disciplinary boundaries so that new ways of thinking are not constrained by the old delineations and boundaries that divided up the corpus of knowledge (Scott, 2008). Aikman et al. (2005) strongly believed that maintaining gender inequalities in a classroom, for example, is not a 'natural' process: it entails deciding not to change (p.47). They further contended that across the world, schooling has not always fulfilled its potential as a change agent capable of challenging existing gender inequalities. For example, in many societies, it is assumed that girls cannot learn mathematics, and that boys cannot learn about the care of young children (ibid.). They pointed out that historical and geographical contexts

play a crucial role in shaping these assumptions, and creating the conditions in which an agenda for gender equality does or does not develop. Curriculum divisions and the pedagogies that accompany them may entrench gender inequalities, for example, if only boys practise public speaking or play the sports that are linked with national prestige (football or cricket, for example) and girls are excluded from these activities but encouraged to concentrate on learning domestic skills, inequalities regarding how young people express citizenship are entrenched (ibid.).

Eisner's (1985) conception of the three curricula that schools teach can illuminate this discussion. SMTs teacher educators may need to appreciate that although teachers may not actually practise gender discrimination in the explicit curriculum that is through goals and objectives of sciences (ibid.) they can, however, unconsciously do this through the implicit and null curriculum. Through the implicit or hidden curriculum the school culture communicates values through the ways in which people treat one another and through school policies on such issues as discipline and decision making (Inlay, 2003). Through this curriculum students internalise norms for functioning effectively as members of a smaller society, the school and later as productive citizens of a larger society (ibid.). Examples given by Aikman et al. (2005) above are some of the typical instances of the implicit curriculum and how it can perpetuate gender inequalities.

By null curriculum Eisner (1985, p.97) meant "what schools do not teach". It is his thesis that "what schools do not teach may be as important as what they do teach" (ibid.). He supports this by arguing that:

*...because ignorance is not simply a neutral void, it has important effects on the kinds of options one is able to consider, the alternatives that one can examine, and the perspectives from which one can view a situation or a problem. (Eisner, 1985, p.97)*

For me this argument is about capabilities, that is the set of alternatives and opportunities or realised functionings (what a person is actually able to do) (Walker, 2006) after going through a curriculum. For instance if a science curriculum does not engage with socio-ecological risk, or if the teacher concerned cannot satisfactorily engage with such risk, the consequence is that the learner who goes through the curriculum will have not only limited

perspectives from which to view a situation or a problem but also restricted options to consider as alternatives.

In line with Giroux's principle of the need to create new forms of curriculum knowledge and breakdown disciplinary boundaries, Aikman et al. (2005), citing Weiner (2004), recommended a pedagogy that promotes gender equality to include the following:

- changes to the curriculum and to classroom organisation that allow for increased participation of girls and women (and other under-represented groups of students);
- encouragement of critical questions about the curriculum and what counts as school knowledge;
- a breaking down of hierarchies and power-networks that exclude girls and women, whether they are students or teachers;
- greater understanding of the conditions that lead to bullying, racism, sexism, and homophobic behaviour, and more successful forms of intervention;
- greater valuing of students' experience and knowledge, and closer involvement of students in planning and evaluating their educational work .

This pedagogy resonates with the ESD processes and values discussed above. In agreement with Aikman et al. (2005) I would add that this pedagogy at teacher education level might result in an increased consciousness among trainee students of misconceptions, prejudices, and stereotypes, and the ability to criticise and challenge these. It may also result in a stronger sense of agency in all involved in learning, which would enable them to visualise wider and more varied options in life (ibid.).

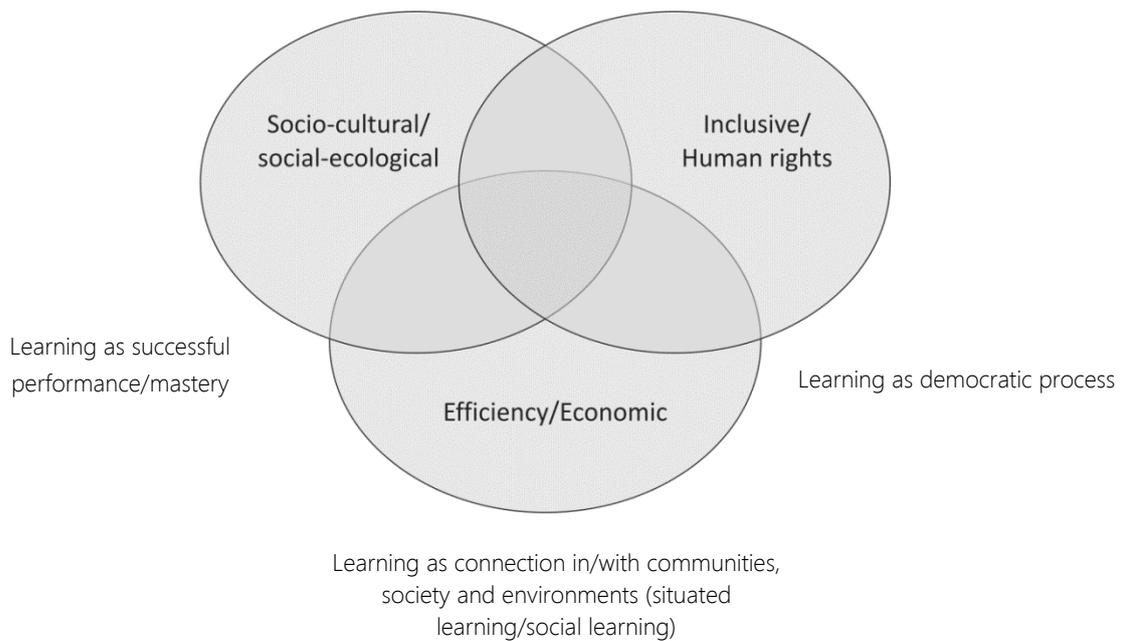
In this study, bringing this criticality to teacher educators was done through boundary crossing learning in change laboratory workshops as part of the expansive learning process (see Chapter Eight). As Giroux encouraged, cultural forms (related to gender issues) embedded in the curricula were exposed and understood as part of the discourse of power that has the potential to perpetuate (gender) inequality.

Giroux's sixth principle addressed the issue of epistemology directly (Scott, 2008). For him rationality is never neutral and as he puts it "reason is not innocent" (ibid. p.105). The principle illuminated that what we call objectivity, in SMTs circles as well, is a cultural script that serves to give authority to a set of presuppositions that in reality are historical artefacts

(Giroux, 1992). This calls for teacher educators, as Giroux said, to view curriculum as a cultural script that introduces students to particular forms of reason, that structure specific stories and ways of life. In this sense, he suggested that we reject claims to objectivity in favour of partial epistemologies that recognise the historically and socially constructed nature of their own knowledge claims and methodologies (Scott, 2008). Giroux (1992) further added that curriculum knowledge should be redefined so that the different ways by which groups of people learn and take up particular subject positions should be incorporated into the curriculum. With the abundance of research evidence pointing to lack of gender responsiveness in the SMTs pedagogy applied in schools as one major hindrance to improving access, retention and performance of females in SMTs as highlighted in Section 2.4, it would make much sense for teacher education to expose future teachers to such ideas. This would alert trainee teachers to look critically at, for example, preferred learning styles of girls and boys, incorporating their experiences in science learning.

In addition to these principles Giroux argued for transgressive activities for critical pedagogic form. Of particular interest to this study is the need for teachers to read texts critically and in particular those cultural artefacts that are produced and used in classrooms (ibid.). In a teacher education set-up this would mean providing student teachers with learning opportunities that enable them to read critically not only how cultural texts are regulated by various discursive codes, but also how such texts express and represent different ideological interests.

To end this discussion on curriculum transformation, I thought it useful to revisit the issue of quality and relevance of education touched on briefly above in Section 2.2.2. As highlighted in the same section there is no one definition, list of criteria, a definitive curriculum, or list of topics for a quality education (Lupele and Lotz-Sisitka, 2012). Quality of education is understood differently in different countries in sub-Saharan Africa. Lotz-Sisitka (2008) in Lupele and Lotz-Sisitka (2012) worked with different conceptions of quality education to „re-frame“ education quality (p.39). She described three intersecting traditions as shown in Figure 2.4 that follows.



**Figure 2.4** *Three intersecting traditions* (Source: Lupele and Lotz-Sisitka, p.40)

Using the three intersecting traditions, quality of education is measured by the democratic process in learning which includes human rights and inclusivity. With gender equality concerns in this study the framework was helpful to examine efforts towards gender inclusivity in SMTs teacher education curricula.

Learning as connected in/with communities assisted in examining the meaning that occurs at the interface between context and concept (ibid). Tickly (2010) argued that this notion includes well-being and capabilities. Tickly and Barrett (2013, p.19) added that “a socio-economically relevant education enhances the capabilities of learners to lead sustainable livelihoods in their diverse local environments and to benefit from a globalized world”. This resonates well with the argument of researchers on gender and science education who argue that one of the reasons why girls shy away from SMTs is because science is taught out of „familiar“ contexts and seems irrelevant and detached from everyday life (Christidou, 2011; Chetcuti and Kioko, 2012; Semela, 2010), (see Section 2.4).

Learning for efficiency and mastery as discourse of quality seeks “efficiency and learner achievement and performance against set standards and expectations as measure of quality” (Lupele and Lotz-Sisitka, 2012, p.39). One can argue that this discourse historically has influenced the discourse of quality education, with little room given to the other two. This left

education, in particular the SMT disciplines, divorced from democratic processes as well as detached from community and society environments. This conception of quality education (three intersecting traditions) was therefore one of the lenses that I used to examine the SMTs teacher education curriculum in this study.

## **2.10 CONCLUSION**

The chapter focused on reviewing literature that helps to situate this study within the ESD discourse. The first few sections focus on the nexus between ESD, gender issues in SMTs and socio-ecological risk. Following a review of the international, regional and national efforts towards gender equality, efforts of the international drivers (MDGs, Education for All and Beijing Platform for Action) were highlighted. This section tried to open up gaps; the study then focused on these gaps through a philosophical review of the uptake of efforts at national levels. The chapter is a cornerstone to the study in that it forms the basis on which conceptual lenses for the exploration phase were built, as well as mediation tools for the expansive phase of the study.

## **Chapter 3: THEORETICAL FRAMEWORK**

### **3.1 INTRODUCTION**

This chapter discusses the theories/frameworks which I drew on in this study. I drew on two related ontological approaches which are the capability and feminist approaches (not fully fleshed theories, hence my use of the term „approach“). I also drew on the epistemological theory of Cultural Historical Activity Theory (CHAT), the main guiding theory to illuminate current curriculum processes and expand them with research participants. The chapter links to Chapter One in the sense that the theories discussed here enabled me to respond to the research questions in Section 1.5. The theoretical framing also links to the three sensitising concepts discussed in Chapter One – dialectics, reflexivity and agency. The theories discussed in this chapter assisted in situating the study within the ESD framework as discussed in Chapter Two and also link to the critical methodological orientation discussed in Chapter Four.

In this chapter, firstly I explain the ontological, axiological, epistemological, and methodological assumptions connecting the three approaches. I go on to explain in greater detail the main features of each approach, reasons for drawing on it and how and why I worked with specific theoretical concepts.

#### ***3.1.1 Assumptions of the theories/approaches***

The assumptions of the three approaches can be traced to Critical Theory, which challenges the assumptions of logical positivism and that of interpretive epistemology, going beyond fact gathering and into a research process that encompasses multiple facets of self-reflecting, planning, acting, and working with others (McTaggart, 1997, as cited by Kidd and Kral, 2005). Critical theory opens space for critical research, with an ontological assumption that reality is „out there“; it is material but interpretations of it can be controlled by human power relations (Robottom and Hart, 1993; Price, 2007). Critical theory is based on a constructivist epistemological paradigm that incorporates the element of science as an approach to evaluating comprehension and understanding, interactions, transformations that promote personal growth, in addition to embracing the concept of empowerment associated with this dynamic process (Hutton, 2009). This supports the curriculum transformation intent of the study, which involves understanding present curriculum practices and the effects of power and inequality, critiquing present curriculum practices and together constructing newer ones, enhancing empowerment and agency in the whole process.

Axiology relates to ethical considerations and our own viewpoints (the „why“), (Dillon and Wals, 2006). The axiological assumption of this study is that the under-representation of females in SMTs is an indicator of certain injustices in society caused by several socio-cultural and economic factors. This injustice is self-perpetuating as Clegg (2007) observed. This justifies the curriculum transformation intent of this study, an endeavour to contribute towards a just and socially sustainable society through gender equality in education. This resonates with feminist standpoint epistemology; the capability approach and CHAT, which consider the process of change to be a predominant factor in the lives of people (see below). In this regard, closely linked to critical research, the role of the researcher is valuable; participants are aware that the researcher is engaging with them in the research process to offer an innovative and critical engagement perspective, understanding that through socio-cultural and structural understanding it is feasible to empower lives and motivate others to change (Kidd and Kral, 2005). This implies agency as discussed in Section 1.7.

In choosing these approaches, I was conscious of the need for a high level of subjectivity in the research process in order to promote change. Reason (1994) cited by Kidd and Kral (2005) argued that in critical research, the researcher undergoes a process of partnership formation with the participants and ultimately establishes a form of critical consciousness within the construction and development of goals, methods, and the gathering of data. Marcus (1994) asserted that this process of criticality expressed by the researcher resonates well with reflexivity (Section 1.7).

The epistemological assumptions of critical theory embrace a subjective stance versus that of an objective or empirical position. Epistemologically, critical research acknowledges that knowledge is not objective but subjective, that values and power play a pivotal role in shaping what counts as knowledge, and that knowledge and issues of equity and power are closely intertwined (Robottom and Hart, 1993; Price, 2007). Rahman (1991) therefore proposes that the process of producing knowledge should involve an openness to learning that is equated with sharing ideas and respecting the knowledge of others as a means to implement action (as cited by Kidd and Kral, 2005). Through the researcher, participants are provided access to expertise pertaining to research and political action (ibid.). Critical theory allows partnerships in relation to obtaining knowledge, establishing reciprocal meeting places in which cultural differences are accepted and misinterpretations are minimised (ibid.). In the same manner, in this study, CHAT through its associated methodology of Developmental Work Research (Section 4.2.1) offered the opportunity for researcher and participants in this

study to come together to question and analyse curriculum practices using research evidence mainly supported by feminist epistemology on SMTs education. It offered the opportunity to model as well as examines new ways of working based on the need for capabilities development of both genders in view of socio-ecological risk as an ESD process. The whole process sought to enhance agency in curriculum practice.

Critical theory also looks at knowledge critically. According to Giroux (1983, p.36), knowledge becomes an object of analysis in a twofold sense: on one hand it is examined for its social function, the way in which it legitimates existing social relations. On the other hand, knowledge could also be examined to reveal in its arrangement words, structure and style of those unintended „truths“ that may contain „fleeting images“ of a different social, more radical practice and new forms of understanding. Critical Discourse Analysis (see Chapters Four, Five and Six) was used in this study to unearth such „truths“. This also resonates well with the principle of historicity in CHAT as described in Section 3.2.

Methodological assumptions of the three approaches again arise from critical theory, which as noted above underpins and shapes this study (see Chapter Four): methods are created and shaped over time through the development and progression of action and reflection (Smith, 1997, cited by Kidd and Klar, 2005). Research seeks to understand the practices and the effects of power and inequality, and to empower people to transform (Robottom and Hart, 1993; Price, 2007). For this reason the study employed qualitative research methods (Section 4.4) to identify challenges and examine obstacles pertaining to the entrance, retention, and advancement of women in SMTs. According to Habermas (1972) in Cohen, Manion and Morrison (2000), the emancipatory interest of critical theory subsumes naturalistic and interpretive approaches; it requires them but goes beyond them, it is concerned with praxis-action that is informed by reflection with the aim to emancipate. The twin intentions of critical research resonate with the goals of this study: to explore and expand; the exploration phase employs qualitative/interpretive methods and the expansive phase relies more on Developmental Work Research methodology as developed within CHAT.

The three approaches are also underpinned by relational ontology which argues that subjects and objects do not exist in an isolated state, but as a complex relational web (Donati, 2011). Relational ontology recognises that it is in the interactions between past-present-future, between mind and body, individual and collective, social and ecological, powerful and less powerful and so on, that human agency, learning and change come to be constituted (ibid.).

This ontology negates a typically western scientific abstractionist ontology that considers all things in the world to be self-contained and thus independent of (abstracted from) context (ibid.). In the field of SMTs, such Cartesian dualism that delineates subject and object, mind and body, person and world brought about scientism, the belief that science is authoritarian, non-humanistic, objective, purely rational and empirical, universal, impersonal, socially sterile and unencumbered by human bias, dogma or cultural values (Aikenhead, 2002, p.68).

Deciding on the three approaches to guide this study which, as noted above, has curriculum transformation intent, I drew inspiration from Stetsenko (2008) who explained that within a relational ontology, learning unfolds dynamically as individuals relate to their world in relational, open-ended ways. Development and learning are not totally constrained by pre-determined scripts or rules, nor are they the “products of solitary, self-contained individuals endowed with internal machinery of cognitive skills that only await the right conditions to unfold”, (ibid., p. 477). Such a relational view, she argued, may help to liberate educational research and practice from a positivist legacy of control and testing, and replace it with “a broad dialectical view on human nature and development underwritten by ideology of empowerment and social justice” (ibid., p. 473). In summary, all three approaches I worked with in this study are dialectical and ontologically relational and historical material, epistemologically constructivist and epistemologically committed to social justice and sustainability principles. Development, praxis and learning are guided by CHAT and empowerment and social justice interests are guided capability and feminist approaches, as explained in the following sections.

### **3.2 CAPABILITY APPROACH**

*Every normative theory of social arrangements that has at all stood the test of time seems to demand equality of something... equal consideration at some level. (Sen, 1995, in Garnham, 1997).*

The capabilities approach is based on the work of Amartya Sen and largely extended by Martha Nussbaum and others. Much of their work has focused on poverty and inequality, with specific reference to gender justice in society, making it a suitable approach for this study. Sen developed the concept of capabilities in a context of theorising human welfare, alternative to traditional welfare theory (Kronlid, 2009; Hill, 2005). Sen started from an egalitarian perspective, as alluded to by the above quote; he phrased the question „Equality of What“ (Sen, 1995, in Garnham, 1997, p.26). Sen argued that any form of equality generally takes the form of arguing for equality of something else e.g. liberty as opposed to income. He

stressed the importance of being clear about the space within which we are arguing for equality (ibid.). Sen argued that policies on distribution and measurement should focus not on income, or on resources as proposed by both Rawls and Dworkin, but on what he calls “The Space of Functionings” (ibid., p.27).

Sen’s core concepts are capabilities and functionings. But what are these capabilities and functionings? Robeyns (2005) described capabilities as people’s potential functionings. Functionings are “beings and doings” (ibid., p.65). The Human Development and Capability Association (2005) added that functionings are valuable activities that make up people’s well-being. Examples are being well fed, taking part in the community, being sheltered, relating to other people, working in the labour market, caring for others, and being healthy, having an educated mind (ibid.). Robeyns (2005) further clarified that the difference between a functioning and a capability is similar to the difference between an achievement and the freedom to achieve something, or between an outcome and an opportunity. Capabilities therefore correspond to the overall freedom to lead the life a person has reason to value (Sen, 1992; 2009; Nussbaum, 2005; Robeyns, 2005). The concept of capability is derived from the Aristotelian concept of „dunamin“ meaning “capability of existing or acting” (Garnham, 1997, p.26).

Sen’s theory of development as an expansion of capabilities is the starting point of the human development approach that defined human development as the process of enlarging a person’s functionings and capabilities. The purpose of development is to improve human lives by expanding the range of things that a person can be and do (Fukuda-Parr, 2003). Being scientifically educated to negotiate socio-ecological risk, for example, would be a set of vectors of functions, reflecting a person’s freedom to choose from possible livings. Seen from a curriculum angle, this would mean an education system that is designed to offer such capability. For Sen, from this viewpoint, development is about removing the obstacles to what a person can do in life, obstacles such as illiteracy, ill health, lack of access, or lack of civil and political freedoms (ibid.). I add here that curriculum development, especially teacher education science curriculum, would mean engaging with socio-cultural constraints that impede learning for any socio demographic group.

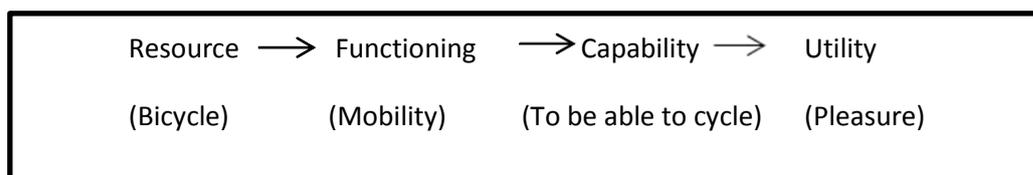
It is important to emphasise that the human development approach contains two central theses about people and development: the evaluative aspect and the agency aspect (Sen, 2002; Fakuda-Parr, 2003; Crocker, 2008). The first is concerned with evaluating

improvements in human lives as an explicit development objective and using human achievements as key indicators of progress. In support of this, Nussbaum and Sen (1993) claimed that the functionings make up a person's being, and the evaluation of a person's well-being has to take the form of an assessment of those constituent elements. In advancing this idea, Sen stressed the significance of „reasoned value“, pointing out that we need to scrutinise our motivations for valuing specific lifestyles, and not simply value a certain lifestyle without reflecting upon it (Robeynes, 2005, p.65). By advocating that in normative evaluations on lifestyles (Garnham, 1997, p.26) we should look at people's capabilities, Sen critiques evaluations that are based exclusively on utilities, resources, or income, (Sen, 1992, 1999, 2009; Nussbaum, 2005; Peter, 2005; Robeynes, 2005). For example, he critiques the dominant emphasis on economic growth based on inanimate objects, for example, gross national product (GNP) and/or the gross domestic product (GDP) as an indicator of a nation's quality of life (Nussbaum, 2005; Sen, 2009) for the reason that these fail to tell us how deprived people are doing. Thinking of development goals only in terms of increase in GDP per capita occludes distribution inequalities which are particularly central in the context of gender relations as already shown in Chapter Two (Nussbaum, 2005).

Sen also criticised the idea of equality of resources as a central political value and measure of people's well-being. His argument is based on what he calls conversion factors, where equality of resources falls short for two reasons: firstly it fails to take account of the fact that people differ in their abilities to convert these resources into capabilities and actual functionings, due to personal, social or environmental factors such as physical and mental handicaps, talents, traditions, social norms and customs, legal rules, a country's public infrastructure, public goods, climate and so on (Nussbaum, 2005; Robeynes, 2005). In his famous example (Sen, 1980 in Nussbaum, 2005, p.37), a person in a wheelchair requires more resources connected with mobility than will a person with „normal“ mobility if the two are to attain a similar level of ability to get around.

The second reason as to why equality of resources falls short is that it fails to take account of the fact that individuals need different levels of resources if they are to achieve the same level of capability functionings. For example, a child needs more protein than an adult to achieve a similar level of healthy functioning; a pregnant woman needs more nutrients than a non-pregnant one.

Advancing Sen's ideas, The Human Development and Capability Association (2005) argued that the basic objective of development is to create an enabling environment for people to enjoy long, healthy and creative lives. This may appear straightforward and obvious but it is often forgotten in the immediate concern with the accumulation of commodities and financial wealth. The Human Development and Capability Association (ibid.) gave an example of a bicycle to relate different concepts. A person may own or be able to use a bicycle (a resource). By riding the bicycle, the person moves around, and let us presume, values this mobility (a functioning). If the person is unable to ride the bicycle (because, perhaps, she has no sense of balance), then having a bicycle would not create this functioning of mobility. But in this case, the access to the bicycle (resource), coupled with the person's own characteristics (balance etc.), creates the capability for the person to move around, going to a movie, visiting friends, giving her pleasure (utility) whenever she wishes. So having the capability contributes to happiness or utility. The layout below illustrates the chain.



Source: The Human Development and Capability Association (2005, n.p.).

According to Alkire (2005), the bicycle example illustrates how various concepts are all related to one another. But which concept do we focus on? The capability approach argues that utility can be distorted by personality or adaptive preferences; functionings can be enjoyed in prison or in stifled environment; and a bicycle can be useless if you cannot balance, so capability (access to the resource coupled with the person's characteristics (balancing, etc) represents the most accurate space in which to investigate and advance the various forms of human well-being (ibid.).

According to Sen therefore, a utility based evaluation of individual well-being does not give the full picture of all the related aspects. Although he sees merit in that this kind of evaluation shows what processes do for people, he argues that it is inadequate to capture the heterogeneity and diversity of development (ibid.). In support of this, Robeyns (2005) added that a utilitarian evaluation will only assess a person's satisfaction and will not differentiate between a happy, healthy, well-sheltered person, and an equally happy, but unhealthy and badly sheltered person who has mentally adapted to her situation. Similarly, Sen criticised approaches that measure well-being in terms of utility pointing to the fact that women or the

marginalised frequently exhibit “adaptive preferences” preferences that have adjusted to their second-class status (Nussbaum, 2005, p.36).

The agency aspect looks at what human beings can do to achieve well-being, particularly through policy and political changes. In other words, the agency aspect looks at the achievement of states of well-being. The agency aspect is concerned with the role of human agency for changing policy, social commitment, and norms as well as human rights (Fakuda-Parr, 2003; Crocker, 2008). Human beings can be agents of change through both individual action and collective action (ibid.). It is for this reason that Sen regards agency (Section 1.7) as itself a valued functioning (Garnham, 1997).

### ***3.2.1 Capabilities and SMTs teacher education***

*“We do not mean merely freedom from restraint or compulsion...we speak of freedom as something to be so highly prized, we mean positive power or capacity of doing or enjoying something worth doing or enjoying”* (Sen, 2002, p.586)

The capability approach is a broad normative framework for the evaluation and assessment of individual well-being and social arrangements, the design of policies, and proposals about social change in society (Robeynes, 2005). It becomes suitable for this study because it is an evaluative tool used to evaluate several aspects of people’s well-being, such as inequality, poverty, the well-being of an individual or the average well-being of the members of a group (ibid.). Robeyns further pointed out that the capability approach is not a theory that can explain poverty, inequality or well-being; instead, it provides a tool and a framework within which to conceptualise and evaluate these phenomena (ibid.). Walker (2006) saw the space of capabilities as an evaluative space where what can be evaluated can be either realised functionings (what a person is actually able to do) or the capability set of alternatives she has (her real opportunities).

My reasons for using the capability approach to explore and expand gender responsiveness in SMT teacher education were further inspired by Sen (2009), Unterhalter (2007) and Robeyns (2005) who, in exploring the idea of capabilities in support of the intrinsic importance of gender equality in education, came up with three fundamental motives:

1. it helps establish conditions in which a wider capability set (opportunity freedom) is available to girls and boys;
2. it alerts us to differential conversion processes linked to gender and other social divisions with regard to how resources are utilised to establish the capability set, and

3. because of the importance of gender equality in basic education in preventing human insecurity and establishing conditions for capabilities and freedoms.

In considering the first motive cited above, in SMT teaching and learning contexts, I sought guidance from the feminist standpoint framework (Section 3.3), finding theoretical and conceptual tools for deeper understandings of the state of gender issues in science teacher education curriculum. This in turn enabled critical analysis of teacher education curriculum practices and understanding of gendered processes that could constrain girls' capabilities in SMTs. It also exposed potential pedagogical situations that can be exploited in enlarging capability sets for both girls and boys to flourish in SMTs in a context of socio-ecological risk (see Chapters One and Two).

The second motive identified above, highlights the ability of capability lenses to draw attention to gender and other social divisions with regard to how resources are utilised to establish the capability set. If we take a teacher as a resource crucial in any learning situation, one would expect learners of both sexes to access this resource equally. However, research findings point to the contrary (see also Section 2.4). A substantial body of research suggests that most SMTs teachers enjoy teaching boys more, spend more time with boys, hold higher expectations for boys achievement, use resources more suitable for boys and urge more male participation (Kalu, 2005; McCullough, 2004; Prasad, 2004; O'Connor, 2000). In turn, boys tend to believe SMTs is their domain; therefore they tend to be more assertive, more forceful in getting the teacher's attention through taunting and harassing girls who tend more towards compliance and conformity as described in Section 2.4. Kalu (2005) attributed such gender specific classroom behaviours to socialisation and gender-role expectations inherent in most African communities. In a gender responsive teacher education curriculum in such a context, one can argue that it is important for trainee teachers to be afforded the opportunity to engage with cultural and classroom underpinnings that may be detrimental to girls, so as to develop skills and attitudes that widen the capability set for girls as well. The curriculum, in such a context, becomes an important conversion factor (see Section 3.2.2 below).

Most efforts towards gender equality in education have been heavily influenced by theories of utilitarianism and maximising resources as highlighted by Herz and Sperling (2004) in Section 2.8.2. While such responses have tremendously improved school attendance, especially for the girl child, they paid little attention to the real curriculum transaction between teacher and learner, leaving most gendered aspects in curriculum activities

unattended to as discussed in Section 2.4. Such interventions fell into a trap of believing in the same functionalist, meritocratic fallacy that such improvements benefit learners in the same manner. Sen's conversion factors, on the other hand, viewed through a curriculum transformation lens, would require teachers and the entire education system to support learners to achieve what they are actually able to do or be (functionings) in and through the learning process. This involves more than being articulate in what learners are exposed to in terms of resources. Adding a gender perspective, this would mean that conversion factors will enable teachers to analyse for example the ontology and epistemology of science and understand the uptake of science by girls and boys. In other words, teacher education curriculum should foster critical skills of trainee teachers to ask questions about the abilities of girls and boys to convert educational resources into capabilities and actual functionings, in view of personal and patriarchal social environmental factors and social-ecological risk and sustainability.

In relation to motive three cited above, I notice that Sen and colleagues talked about the relevance and quality of education in relation to improving lives in general and equipping people with alternatives in view of socio-ecological risk to prevent human insecurity. The ESD process similarly emphasised this as discussed in Chapter Two. Take for example climate change, currently one of our most serious environment and development challenges (Kronlid, 2009), which, in the Southern African context, combines with poverty, hunger and starvation and conflicts due to dwindling resources, and other vulnerabilities exacerbating social ills like HIV/AIDS. Evidence shows that all these socio-ecological risks are gendered and stratified, that is the impacts are heavier on women and children than on their male counterparts (see Section 2.2.2). From this perspective, it is not possible to "remove" gender based arguments for SMT participation from a social-ecological context.

The capability approach sees real poverty (which is mostly feminised in Southern Africa and other parts of the developing world (UNFPA, 2009; FAWE, 2008) not only as deprivation of income but also as deprivation of capability (Elliot, 2007). A sound scientific and technological base, if conceptualised within an ESD framework, is likely to offer more solutions and alternatives to social-ecological challenges and as Beck (1992) argued, it allows for necessary societal reflexivity and risk responsiveness (see Section 1.7.13). It is therefore desirable, from a social justice sustainability perspective, to have an SMTs teacher education curriculum that puts all this into perspective and equips trainee teachers with knowledge, values and attitudes to expose both girls and boys alike to sciences and SMTs education in

ways that will support them to build resilience and responsiveness in terms of socio-ecological risk.

Of significance to this study, the capability approach sees the relevance of education beyond instrumental importance of economic growth and increased GDP. It is important to reiterate that Sen developed the concept of capabilities in a context of theorising alternatives to economistic and welfarist views to poverty (Kronlid, 2009). It follows therefore that the capabilities approach's argument for gender equality in education differs from the argument put across by instrumentalism associated with the human capital theory and universalism associated with the rights based approach (Unterhalter, 2007). Sen saw the importance of gender equality in education going considerably beyond its instrumental importance; he is concerned with social changes too, not simply economic changes (Unterhalter, 2007). In his most recent work, he is also concerned with environmental and sustainable development issues as indicated in Section 2.2. This is a pattern that is also showing up in the Human Development Reporting (the last five years have included comments on environment, sustainability and climate change), reflecting wider concern for social-ecological risk. For instance, Sen (2009, p.249) argued that "in thinking about the steps that may be taken to halt environmental destruction, we have to include constructive human intervention". He went on to give an example that greater female education and women's employment can help reduce fertility rates, which in the long run can reduce the pressure on global warming and the increasing destruction of natural habitats.

For Sen, widening opportunities enable the realisation of other capabilities and alert us to human differences and diversity (Sen, 2005, 2009). In this particular case, a gender responsive SMTs teacher education curriculum would acknowledge and encourage differences between learners as they engage with SMTs. Within such an initiative, girls would also be encouraged to value and appreciate their own experiences and interests in SMTs as girls (Sinnes, 2006).

### ***3.2.2 Applicability to the study***

In this study I use Sen's concept of conversion factors to argue for curriculum transformation towards a „gender responsive conversion agent“ curriculum. I am inspired by Robeyns (2007) who argues that the relation between a good and the functionings to achieve certain beings and doings is influenced by the following three groups of conversion factors.

- Personal conversion factors are internal to the person (e.g. metabolism, physical condition, sex, gender, reading skills, intelligence) and influence how a person can convert the characteristics of the commodity into a functioning. She gives an example of a person who is disabled, or in a bad physical condition, or has never learned to cycle, for whom the bicycle will be of limited help to enable the functioning of mobility (ibid.). In the same vein, feminist standpoint theorists on science support the view that men and women have different standpoints in life, (personal conversion factor) yet science is developed primarily from the perspectives of one group, which is male (e.g. Harding, 1991; Kelly, 1985; Roychoudhury, Tippins and Nichol, 1995). Miller, Blessing and Schwarz (2007), concluding from a number of studies, show that girls have low interest in science, rather than low ability or achievement. This is an example of a personal conversion factor because females with this low interest are less likely than those with high interest to have high science achievement scores and to start a science, mathematics, or engineering major in college (ibid.). Therefore personal characteristics such as low interest, lack of confidence, lack of exposure or experience to science related knowledge are all examples of personal conversion factors that influence how a person can be, or is, free to convert resources into functionings. In view of such arguments, the capability approach will help us evaluate, for example, the predisposition of girls and boys to convert goods and resources like laboratory equipment such as batteries, wires, electrical equipment and other instruments that ordinarily are deemed to be for men, into their well-being in physics.
- Social conversion factors are factors from the society in which one lives (e.g. public policies, social norms, discriminating practices, gender roles, societal hierarchies, power relations related to class, gender, race or caste) (Stanford Encyclopedia of Philosophy, 2011). As discussed in Section 2.4, there are several studies that point at social conversion factors as causal to girls' low participation in SMTs. For example, Clegg (2007) discovered that girls do not believe they are as good as boys in subjects such as mathematics and physics even where this is objectively not the case. He further argued that girls are socialised into this low SMTs self-concept by various social forces circulating at home, school and wider society. Pollock and Finkelstein (2009) discovered that the gender gap that exists in interactive physics classes was largely associated with differences in previous physics and math knowledge and

incoming attitudes and beliefs coming from society. Prasad (2004) in Lesotho traced how social norms, tradition, culture and power relationships are used to maintain that women are not good in exact sciences like mathematics, physics and chemistry.

- Environmental conversion factors emerge from the physical or built environment in which a person lives (Stanford Encyclopedia of Philosophy, 2011). Examples of one's geographical location are climate, pollution, the proneness to drought or floods. Among aspects of built environment are the stability of buildings, accessibility of buildings even by wheelchair users, roads, the means of transportation and communication. A good example of environmental conversion factors is cited by Shiva (2012) of climate change induced droughts resulting in reduced agricultural yields, impacting negatively on livelihoods but more so on women who bear largely the responsibility of agricultural production (see Section 2.5).

It is important to note that these conversion factors are interrelated. For example girls' declining interest or low self-concept in science, may appear as a personal conversion factor, it is nevertheless related to many social and environmental conversion factors. For instance, research has shown that most girls' low interest in science is caused by several social and environmental factors (see also Section 2.4). For example, girls do not see science as connected with their personal lives, science courses often fail to address issues of interest to females and to include pedagogical techniques that engage with females (Miller et al., 2007). Some studies show that girls are less attracted by or feel insecure in science laboratories because of the physical setup (Roychoudhury et al., 1995).

In view of these conversion factors, the teacher education curriculum needs to be a „gender and ESD responsive conversion agent“ itself. Such a curriculum would enable future teachers to „convert“ retrogressive gendered and unsustainable practices into capabilities for learners. In such a curriculum, there is need to pay attention to negative social conversion factors (patriarchal norms and other socio-cultural ills) and also negative environmental conversion factors (climate change and related ills) and engage them in a critical and transformative manner. There is also need to take advantage of the enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD, and factor them into the curriculum as shown in Figure 2.3.

In the same way that the capability approach evaluates policies according to their impact on people's capabilities (Robeynes, 2007), in this study I evaluated the SMTs teacher education

curriculum in terms of its impact on gender equality and sustainability in learning these disciplines (see Chapters Five and Six). The capability approach asks whether people are being healthy, and whether the means or resources necessary for this capability are present, such as clean water, access to doctors, protection from infections and diseases, and basic knowledge on health issues and so forth: similarly, in this study I interrogated whether future SMTs teachers have access to a high-quality and relevant education for them to contribute towards gender justice in SMTs and ESD as described in Chapters Five and Six. As illustrated in Figure 2.3, I found that analysis of the personal conversion factors, social conversion factors and environmental conversion factors allowed me to conceptualise content and purpose of the teacher education curriculum.

Sen's conception of the role of education which is to establish conditions that expand people's substantive freedoms to do things that they have reason to value (Elliot, 2007) dovetails well with the principles of ESD. As discussed in Chapter Two, ESD proposes that education should equip people with knowledge of and skills in sustainable development, making them more competent and confident for a healthy, productive life in harmony with nature and with concern for social values, gender equity and cultural diversity (UN, 2005). Hoffman and Bory-Adams (2005) added that ESD must be an education that aims to help people of all ages better understand the world in which they live, and better act on this understanding; it needs to address the complexity and interconnectedness of problems such as poverty, consumption, environmental degradation, climate change, health and population issues including HIV/AIDS, conflict, inequality and violation of human rights. ESD needs to address these topics not only by providing information, but also the abilities needed to understand and use this information, to establish agency and attitudes supporting behaviour that leads to sustainable development (UN, 2005; UNESCO, 2005b). In tandem with the demands of ESD, the capability approach covers all dimensions of human well-being. Development, well-being, and justice are regarded in a comprehensive and integrated manner, and considerable attention is paid to the links between material, mental and social well-being, or to the economic, environmental, social, political and cultural dimensions of life (Robeynes, 2007).

In line with this argument, I agree with Elliot (2007, pp.164-165) who examined the ideas of Aristotle and Dewey and related them to Sen's capability approach. He came to the following conclusions:

- Curriculum should be designed to expand capabilities and thereby extend the range of opportunities students have to choose a way of life they value and they have reason to value. This curriculum should be people-centred not content-centred.
- Curriculum frameworks should not restrict the set of capabilities given space for development, simply to those that are perceived to be instrumentally significant for economic progress at the societal level or income growth at the income level. In other words, human capital theory and concern to alleviate income deprivation should not be the exclusive drivers of curriculum reform.
- The process aspect of freedom implies that the curriculum should not only provide students with opportunities to expand their capabilities, but also to develop their capability for autonomous reasoning about which of the functions they are capable of achieving and which they have reason to choose (as ends and means) in the concrete situations they encounter or they are likely to encounter in life.
- Since the process aspect of freedom also relates to the freedom of thought at the level of developing specific capabilities, a curriculum for capability should make explicit the pedagogical implications of this for teachers, and their responsibility to foster „learning from experience“ through inquiry.

This would mean that, in a SMTs teacher education scenario, I draw the following conclusions: SMTs are a critical area of study which would enhance people’s capabilities (especially given the socio-ecological risk in Southern Africa) and gender responsive pedagogy can potentially enhance girls’ as well as boys’ functionings in these subjects. It therefore implies that, in their training, future science teachers need to be exposed to a curriculum that will develop their capability for autonomous reasoning about which of the functions they are capable of achieving and about which they have reason to choose (as ends and means) in the concrete situations they encounter or they are likely to encounter in life. In other words teachers, through their training, would be expected to acquire skills and attitudes to:

- nurture the potential in SMTs from each individual learner regardless of gender;
- detect and navigate through gender biases and stereotypes that normally act against girls in SMTs learning;

- identify and work on socio-cultural factors that impact negatively on girls' access of SMTs;
- be aware and accommodative of the experiences, learning interests and styles of both girls and boys in SMTs; and
- help young people to better understand the world in which they live and better act on this understanding and the need to address the complexity and interconnectedness of challenges such as poverty, unsustainable consumption patterns, environmental degradation, health, population issues HIV/AIDS, conflict and violation of human rights.

In the exploration phase of the study, I assessed whether SMTs teacher education curricula impart such skills and attitudes to future SMTs teachers. For this purpose I used Sen's aspects of capabilities; well-being achievement, well-being freedom, agency achievement and agency freedom (Sen, 1999; Unterhalter, 2005). Table 3.1 shows an adapted template for this purpose.

**Table 3.1** Capability template used to assess gender responsiveness and sustainability orientations in SMTs teacher education curriculum (Adapted from Unterhalter, 2003, p.118)

<b>Aspects of capabilities (for boys and girls)</b>	<b>Expectations on teacher education (what SMTs teacher education curriculum should engage with)</b>	<b>Questions for this study</b>
Well-being achievement	Conditions that should be in place to guarantee well-being access, retention and progress in SMTs for both girls and boys.	<p>-How does the SMTs teacher education curriculum prepare future teachers to guarantee physical and cognitive access of boys and girls in SMTs?</p> <p>-Are future teachers taught to check on gender stereotypes, socio-cultural constraints etc. as well as on the quality and relevance of SMTs e.g. in terms of socio-ecological risk responsiveness?</p> <p>-Does teacher education engage with literature on gender and science and science and social-ecological risk?</p>
Well-being freedom	Conditions necessary for learners (girls and boys) to do well in SMTs.	<p>-What knowledge, skills, attitudes and values are future SMTs teachers being exposed to in terms of gender and sustainability responsive pedagogies?</p> <p>-Does the SMTs teacher education curriculum engage with the following:</p> <ul style="list-style-type: none"> <li>• appropriate pedagogies, learning materials and assessments that account for gendered styles of learning,</li> <li>• gendered cultural issues,</li> <li>• learning environment that values and is appreciative of socio-ecological gendered experiences in SMTs?</li> </ul> <p>-Is SMTs teacher education curriculum critical of the gendered ontology/epistemology of SMTs [catering for gendered conversion processes]?</p>
Agency achievement	Support for success in (valuing and have reason to value) SMTs and SD content and practice.	<p>-Does SMTs teacher education engage with curriculum practices designed to raising the self-esteem of both girls and boys in SMTs so as to ensure equality in the disciplines?</p> <p>-Does SMTs teacher education curriculum seek to build agency in learners in view of socio-cultural and socio-ecological challenges facing communities?</p>
Agency freedom	Conditions to exercise agency and participate in SMT related sustainability practices.	<p>-Are future SMTs teachers exposed to ESD related pedagogies and methodologies that develop agency freedom such as: Reflexive accounts, critical reading and writing, problem-based learning, modeling good practice, fieldwork and outdoor learning.</p>

The above template was used as an analytical thread in this study. Put simply, I sought to gather insight on whether trainee teachers during their training are being equipped with knowledge, attitudes and skills to cater for the above capabilities for both girls and boys. Appendix 4.1 was designed as a simplified checklist of a set of capabilities. I did this by investigating whether the Teacher Education curriculum:

- contained gender stereotypic information in language, learning and teaching support materials that may act against females as they attempt to learn;
- was considerate to the perceived differences between boys and girls in relation to learning SMTs;
- paid special attention to the constraints faced by girls as they attempt to study SMTs and ability to take measures to correct these;
- was attentive to present and past societal practices that foster gender biases in SMTs learning.

In ESD and capability terminology, for that reason, the research questions for both the explorative and expansive phase of the study can be re-worded as follows:

- What capability set (opportunity and process freedoms) is provided for girls in SMTs teacher education curriculum?
- Which conversion processes are considered by the SMTs teacher education curriculum to establish the capability set for both genders in view of social and socio-ecological constraints?
- What capability set (opportunity freedom) is available for girls in SMTs in view of socio-ecological risk in a Southern Africa context?
- What conceptual artefacts can the study develop to support expansive learning for gender responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs as well as in response to increased socio-ecological risk in a Southern African context?

The template was also used to develop mediation tools in the expansive learning phase of the study (see Chapter 8).

### ***3.2.3 Critique of the capability approach***

According to Robeynes' (2000) critique of the capability approach can be categorised around the questions: Which functionings should we take into account? Is the capability approach too individualistic?

For the first question, Sen has been criticised for not proposing a list of relevant functionings. However, Sen has responded to those criticisms that selecting functionings will always be an “act of reasoning” (Robeynes, 2000, p.14). Clark (2005) also added that Sen does not subscribe to a fixed or definitive list of capabilities; instead he argues that the selection and weighting of capabilities depends on personal value judgments. Some critiques have further raised that the “act of reasoning” runs the risk of becoming the source of potential biases in the evaluative exercise (ibid.). In other words, the life world, values and social embedding of the researcher might influence which functionings will be included or not.

Is the capability approach too individualistic? This critique states that “any theory should regard individuals as part of their social environment, and hence agents should be recognised as socially embedded and connected to others and not as atomised individuals” (Robeynes, 2000, p.16). She further argued that this critique is most often found in writings or talks by social scientists or philosophers who in general argue that neoclassical economics or liberal egalitarianism is too individualistic (ibid.). Walker (2005, p.106) refuted the critique, pointing out that the “capability approach is ethically individualistic and neo-liberalism by contrast is ontologically individualistic.” She further explained that for the capability approach, the “focus on individual freedom and agency strengthens social life rather than fragments it, whereas the neo-liberal view grounded in ontological individualism is driven by selfish self-interest” (ibid.). Likewise the use of the capability approach in this study was aimed at evaluating and expanding the capability set for individual well-being of boys and girls in SMTs curriculum for the good of strengthening social life.

Another critique of the capability approach involves questioning whether the capability approach is not too difficult to apply or operationalise. Robeynes (2000) cited Robert Sugden (1993) who summarised this (perhaps widespread) critique as follows:

*Given the rich array of functionings that Sen takes to be relevant, given the extent of disagreement among reasonable people about the nature of the good life, and given the unresolved problem of how to values sets, it is natural to ask how far Sen's framework is operational. (p.21)*

Sen's (1992) argument on human diversity as a response to such a critique was illuminating in this study. In support of the necessity of an array of functionings, he argued that (ibid., p.xi)

*... human diversity is no secondary complication to be ignored or to be introduced later; it is a fundamental aspect of our interest in*

*equality...people will differ along a personal axis (e.g. gender, age, etc.); along intersecting external axes (wealth, climate, etc.) and along an individual axis which refers to differences in people's ability to convert resources into valued outcomes.*

It is in my attempt to research curriculum practices with such complexity of human diversity that I found this approach useful (see Figure 2.3).

### **3.3 FEMINIST STANDPOINT EPISTEMOLOGY**

Feminist epistemology arises out of the confluence of Marxism and postmodern deconstruction (Delanty, 2005). The notion of standpoint was developed from Marxism, but it was from postmodernism that a new critical edge was discovered with the notion of deconstruction (ibid.).

The Stanford Encyclopedia of Philosophy (2006) draws the following parallel between feminist epistemology and strands of Neo-Marxist materialism developed by Georg Lukács: “one's social position with respect to material labor is inversely related to one's epistemic position” (p.303). The point raised by Neo-Marxists is society is structured primarily along the lines of two classes: the working class (proletariat) and the capitalists (the bourgeoisie) who own the means of production. As the privileged class, the capitalists have a motivation to maintain the status quo, and this interest interferes in their ability to understand the exploitation of the working class upon which their capitalist privilege depends. The working class, however, as the socially underprivileged, can achieve a richer understanding of social relations; they not only have a motivation to understand the true nature of the exploitation to which they are subject (in order to be able to end to the exploitation), but their position offers the potential for a dual vision. Since they are subject to the rules of the capitalists who wield social power, the working class has an understanding of the capitalists' view of the world. But additionally, they have an experiential understanding of their own lives as the exploited. Thus, their position as socially underprivileged affords them the possibility of an epistemic privilege stemming from this dual vision.

Feminist standpoint theory draws on these ideas, but rests on a gendered division of labour rather than class divisions (ibid.). Sociologist Dorothy Smith argues for the epistemic advantage women sociologists have over male sociologists in their experience of a "bifurcated consciousness", caught as they are between the conceptual world of sociology

and the material world of their lives as women (1974, p.278 ). Nancy Hartsock's (1983) articulation of the theory argues that women's contributions to subsistence and childrearing result in a systematic difference of experience across the genders. Accordingly, the activities of women that place them in a socially underprivileged position can form the basis of a privileged epistemic standpoint, through which a deeper understanding of patriarchal institutions and ideologies can be reached (Hartsock, 1983). More recently, feminist standpoint theory has developed in response to feminist theorists' recognition that gender cannot be understood in isolation from other social categories. For example, Patricia Hill Collins has put forth the idea of a black women's standpoint, identifying specific epistemic resources in black women's experience that are important to the development of black feminist thought (Collins, 1990). Another vantage point of this is the epistemic resources associated with gendered social-ecological relations and practices in Southern African context as discussed in Chapter Two.

Feminist methodology can be defined as a concern with exploring the nature of social experience of women with a view to explaining the mechanism through which power operates in order to bring about the emancipation of women (Delanty, 2005). Feminist approaches are based on the central insight that:

- *social reality is a gender construction and the normative aim of social science should be both to deconstruct this and to point to an alternative;*
- *far from being objective, science in general is ideologically laden with male values.* (Delanty, 2005 p.123)

In general, feminist approaches argue that there is a gender bias in problem definition, interpretation and normative critique (Smith, 2006; Farganis, 2000). Delanty, (2005) saw standpoint epistemology going beyond this general claim in that it aims to develop a new methodological approach based on a new ontology and a radicalised epistemology. Feminists who adopt this standpoint position (Smith, 1987; Harding, 1991; Collins, 1990), argue that scientific knowledge is constrained by the social location of the scientist, and therefore the existence of the woman in social research leads to quite different kinds of experience which in turn require a different cognitive approach to that of mainstream science, as historically practised. Related to this, Daniels (2012, p.2), commenting on institutional culture and the patterns of social interaction within them, concluded that “the boundaries which shape researcher,s horizons often serve to severely constrain the research imagination”. This

resonates well with the need to consider conversion factors in issues of development as argued by the capabilities approach in the previous section.

It follows from the above that „situated knowledge“, that is the claim that knowledge derives from an ontological position, is a key idea in feminist epistemology. Smith (2006) elaborated that position is what needs to be critically examined since it is not occupying a fixed location, rather it is a matter of being able to see the complex web of social relations in terms of tensions, resistance, transformation. It ties social location very closely to epistemic position, arguing that social locations not only vary from an epistemological point of view, but that some social locations are more epistemically reliable than others (Campbell, 2004).

With this in mind Delanty (2005) reached the conclusion that a feminist standpoint approach is reflexive. Its reflexivity is characterised by its recognition of the social position of the researcher in social science; that it has an emancipatory agenda, shown by its will to deconstruct the existing male-centred constructions in order to realise new possibilities for women. However, as pointed out by Nancy Hartsock in Delanty (2005) the deconstruction moment in feminism differs very much from other postmodern thought, in that it is more constructivist rather than deconstructivist, it aims to transform women’s social experience by creating forms of knowledge that can liberate women from patriarchal social relations. For feminist epistemology, the object of study is also the subject; the knower and the known are the same, the reflexive relation is one of self-scrutiny and questioning one’s own role in the research process (Stanford Encyclopedia of Philosophy, 2006). This resonates with the cultural historical dialectics that exist between object and subject; as we work on the object, the object works back on the subject (see Section 1.8.3).

This reflexive research approach is not unlike that proposed by Janse van Rensburg (1995) for environmental education. Her key concern was to utilise education and research processes of empowerment and capacity building. The notion of empowerment in her case also underpinned calls for broader participation in research. This approach to research has an aim to address problems through research-in-action and thus has an explicit educative and developmental role (ibid.). Similarly in this study, I also adopted this reflexive approach to research with the hope to enhance the agential capacity of SMTs teacher educators towards gender and sustainability responsive curriculum practices (see Chapter Eight).

### ***3.3.1 Applicability to the study***

Feminist epistemology and philosophy of science studies the ways in which gender does and/or ought to influence our conceptions of knowledge, the knowing subject, and practices of inquiry and justification (Pressley, 2005). As highlighted in the above discussion, it identifies ways in which dominant conceptions and practices of knowledge attribution, acquisition, and justification systematically disadvantage women and other subordinated groups, and strives to reform these conceptions and practices so that they serve the interests of these groups (Smith, 2006).

With particular reference to SMTs, various practitioners of feminist epistemology and philosophy of science argue that dominant knowledge practices disadvantage women by (1) excluding them from inquiry, (2) denying them epistemic authority, (3) denigrating their "feminine" cognitive styles and modes of knowledge, (4) producing theories of women that represent them as inferior, deviant, or significant only in the ways they serve male interests, (5) producing theories of social phenomena that render women's activities and interests, or gendered power relations, invisible, and (6) producing knowledge (science and technology) that is not useful for people in subordinate positions, or that reinforces gender and other social hierarchies (Pressley, 2005).

Feminist epistemologists trace these failures to flawed conceptions of knowledge, knowers, objectivity, and scientific methodology and they offer diverse accounts of how to overcome these failures (Smith, 2006). Kelly and Roser in Roychoudhury (2004) suggest that science is masculine at the surface level, at the deeper epistemological level and in the nature of knowledge that is accepted as scientific.

At the surface level, which comprises the teaching-learning milieu, men comprise the majority of those who study, teach and practice science. For example, McCullough (2004) revealed that in the United States, women do well in education at a general level. They earn 57% of all bachelor's degrees and 44% of doctorates. Yet in the sciences the numbers drop dramatically particularly in physical sciences. Women obtain only 22% of physics bachelor's degrees. Teachers of physics also illustrate this gender discrepancy; females make only 29% of physics teachers at high school level (Neuschtz and McFarling, 2003). In college, women make up only 11% of assistant professors, 10% of associate professors and 5% of full professors of physics (Nelson and Rogers, 2004). In Zimbabwe, Mawere and Chikunda

(2006) discovered that in teacher education institutions, females constitute only 21.6% of lecturers in sciences.

Teachers and learning support materials are also blamed for promoting male scientists and downplaying the role played by female scientists. Wertheim (1995) pointed out that the sole female scientist that most people can name is Marie Curie, and yet there are so many other female scientists who have won Nobel prizes in science; these include Dorothy Crowfoot Hodgkin, Barbra McClinton and Getrude Elion. Girls therefore do not get the necessary exposure to both current and historical female role models that could provide encouragement and inspiration in the field of science.

Discussions on the nature of science look at how objective and how unbiased science knowledge is. Historically, „hard“ sciences such as chemistry and physics have been considered to be objective and unbiased. However, Schiebinger (1999) and others suggest that those who do the science might affect the science itself. McCullough (2004) added that lack of women in science has led to masculine theories and interpretations. She argued that male researchers have created a gendered situation where a non-gendered explanation might have sufficed. Cohn (1996) brought the example of the language surrounding the creation of bombs in the Second World War that was strikingly sexual: creators of the hydrogen and atomic bombs spoke of giving „birth“ to the bombs and the babies were of course male „Fat Man“ and „Little Boy“. All this shows how gender has unnecessarily infiltrated aspects of theoretically objective science.

African science curriculum specialists who have attempted to incorporate indigenous knowledge into school science are not spared the patriarchal values either. For example, Ndawi (1987) encouraged the use of traditional artefacts such as catapult, stone trap, bow and arrow to develop scientific concepts such as force, moments, velocity and kinetic energy in physics. While the idea of bringing in indigenous ways of knowing into school science is welcome and is useful to African students to link their lived experiences with school science, most artefacts used as teaching learning models are those normally used by males in society. It is likely that some girls would be seeing the artefact for the first time in science classes.

Socialisation both at home and in school also plays a role in hindering girls“ progress in science especially in most African societies that are patriarchal. Teachers who are central to the transformation of society in general, and the school system in particular, are a product of gender construction in any society. In most African communities, teachers, like their students,

are socialised in basically patriarchal structures that foster gender inequality economically, socially and culturally. Examples of gender inequality in most African societies include attitudes and practices that see women as basically inferior to men, without the right to ownership of the means of production and property as raised by Kalu (2005) in Chapter Two. These power dynamics make women more vulnerable to risk as reported by Shiva in Section 2.5. As discussed in the same section, adopting a gender approach to SMTs curriculum development, as proposed in this study, has the potential to improve the quality and relevance of education, as well as enhance the capability set (opportunity freedom) for females to respond to socio-ecological risks.

### ***3.3.2 Critique of the feminist epistemology on science***

Like any other theory/approach, feminist standpoint epistemology is not without critique. Nelson (1990), Walby (2001), and Goldman (2001) felt it was controversial to connect the epistemic perspective so closely to one's material and social location; the approach appears to posit chasms between knowers, suggesting knowers are unable to share knowledge across social locations. Versions of standpoint theory have also been critiqued for failing to adequately account for phenomenon such as internalised oppression, in which the perspective of the oppressed is damaged by the forces of oppression and is unreliable (Delanty, 2005). For example, feminists have argued that many women who blame themselves for their rapes have internalised “damaging false beliefs” about their responsibilities and the causes of their rapes, making it potentially problematic to consider their perspective epistemically advantageous or reliable (Delanty, 2005, p.45). This is similar to what Sen described as “adaptive preferences” (Section 3.2): preferences women frequently exhibit that have adjusted to or are constrained by their second-class status (Nussbaum, 2005, p.36).

Some versions of feminist standpoint theory also have had difficulty accounting for the coherence of a feminist standpoint while acknowledging that women are variously situated and do not experience oppression in the same way.

Because of these shortfalls in the approach I decided to use it supported by the broader feminist perspectives used to conceptualise key terms (see Section 1.7). Theory triangulation was also done to cater for the shortfalls of one theoretical approach. For instance, the use of the capabilities theory, activity theory and feminist approach, to assess the level of gender and sustainability responsiveness of SMTs teacher educators in SMTs teacher education,

gave more insights than I could have gained through the feminist approach by itself.

### 3.4 CULTURAL HISTORICAL ACTIVITY THEORY

*... activity theory is deeply contextual and oriented at understanding historically specific local practices, their objects, mediating artifacts, and social organization, ... activity theory is based on a dialectical theory of knowledge and thinking, focused on the creative potential in human cognition, ... activity theory is a developmental theory that seeks to explain and influence qualitative changes in human practices over time. (Foot, 2001, p.57)*

The epistemological theory that forms the backbone of this thesis is Cultural Historical Activity Theory (CHAT), especially the second and third generation CHAT. Gender and sustainability issues are contextually embedded in culture and history; these in turn influence our perception, thinking and practice. This study pays particular attention to the dialectics between knowledge, thinking, culture and practice with the ultimate goal of influencing changes in human practice as implied by Foot in the above quotation. Cultural Historical Activity Theory (CHAT) provides a way of understanding historically specific local practices, their objects, mediating artifacts, and social organisation and expanding, that is developing and influencing qualitative changes in human practices (Foot, 2001).

CHAT takes the object-oriented, artefact-mediated collective activity system as its unit of analysis, thus bridging the gulf between the individual subject and societal structure (Engeström, Miettinen and Punamaki, 1999). CHAT as a theory of learning and development is built on contradictions (see Section 3.4.3), which are a form of dialectics, as well as on reflexivity and agency (Engeström, 1987, 2008), and offers an explanation of learning through activity that helps to develop understandings of work practices (Sawchuk, 2009). Engeström developed CHAT based on the work of Vygotsky and his Russian colleagues Leont'ev and Luria (Daniels, 2001; Edwards, 2005; Warmington et al., 2005, Roth and Lee, 2007). CHAT was informed by the classic German philosophies of Kant and Hegel, Marx and Engels (Engeström and Miettinen, 1999; Quek and Alderson, 2002). From Marx and Hegel CHAT draws on dialectics, arguing that individual development cannot be separated from the social situation in which individuals exist (Engeström, 2001). In short, the origins of activity theory lie in Vygotsky's (1978, 1986) framework for analysing relationships between human actions and cultural artefacts in order to dispense with the

individual/social dualism and create a Marxist social psychology. Engeström (2001) described the advance represented by Vygotsky's activity theory:

*The insertion of cultural artifacts into human actions was revolutionary ... the individual could no longer be understood without his or her cultural means; and the society could no longer be understood without the agency of individuals who use and produce artifacts... (p.134)*

As illustrated by Murphy and Rodriguez-Manzanares (2008), one of the strengths or advantages of CHAT is that it offers a broad lens of inquiry that encompasses various aspects of the educational setting such as students' and teachers' backgrounds and perspectives, the whole institutional setting, and the evolution of the activity system over time. Mwanza (2002) added that CHAT is more of a framework than a theory from which various methods and theories for analysing human activity can be developed. The framework, he further explained, citing Nardi (1996), presents a collection of basic theoretical concepts to help understand the relationship between the human mind (consciousness) and activity (what people do).

Fundamental to CHAT is the idea that human capabilities develop when, in collaboration with others, people act upon their immediate surroundings (Blackler, Crump and McDonald, 2000). The incorporation of new knowledge and concepts into the individual happens first at the interface of the community and the individual through internalisation – inter-mental, and secondly within the individual, intra-mental (Daniels, 2001; Edwards, 2007). Discussing CHAT, Edwards (2007, p.259) made it clear that individuals and their society interact dialectically when she said “the way we see, think and act in our worlds are shaped by the cultures in which we are formed and in turn we shape those cultures by our actions”. This quality of CHAT signifies the incorporation of agency and reflexivity discussed in Section 1.8.

Related to the above, CHAT also sees learning as facilitated by the use of conceptual and material tools which help the learners to understand the object better. Again Edwards (2005, p.50) emphasised “learning is concerned with within-person changes, which modify the way in which we interpret and may act on our world ... and in turn change it by our actions”.

CHAT focuses on the structure of activities as historically constituted entities, with a pedagogical focus on bridging the gap between the historical state of an activity and the development stage of a person with respect to that activity (Wenger, 1998). Mukute and Lotz-Sisitka (2012) added that CHAT is an epistemological theory that posits that learning takes place through collective activities that are purposefully conducted around a common

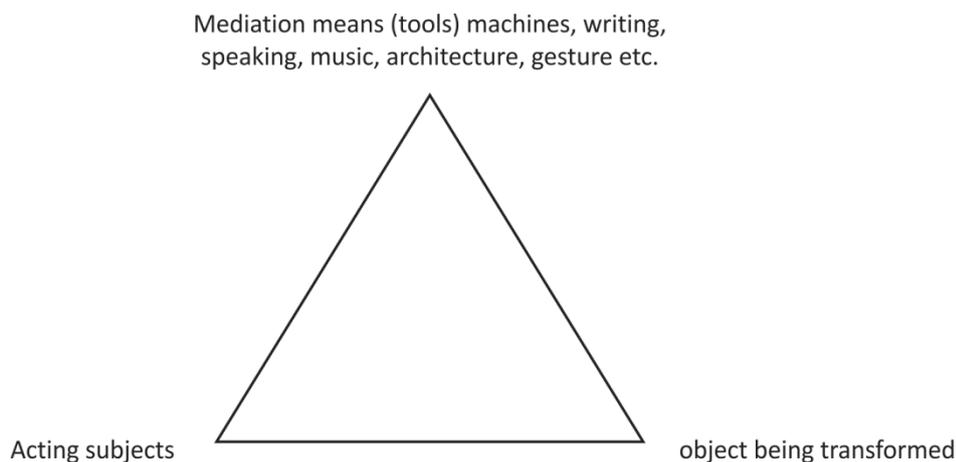
object, based on the proposition that learning is a social and cultural process that draws on historical achievements. It is for these reasons that I found the framework to be illuminating in this study with a curriculum transformation intention that required (re)conceptualisation of the object (curriculum practice), as it enabled a participatory approach to analysing tensions and construction of model solutions (see Chapters Seven and Eight).

### 3.4.1 Generations of CHAT

CHAT consists of three generations. Although this study made use of the second and third generations, it is important to discuss the first one as well because it provides the foundation for the other two.

#### 3.4.1.1 First generation of CHAT

The first generation of CHAT, which is attributed to Vygotsky and Leont'ev, consists of a basic Vygotskian mediation triad linking subjects, object and tools (Figure 3.1). Wells (2002, p.46) suggested that “agent-acting-with-mediational-means” is the basic unit describing human activity. The point is, whereas other species act directly upon the object of interest to them, humans on most occasions interpose a mediating artefact between themselves and the object of interest, thereby enabling them to act more effectively (ibid.).



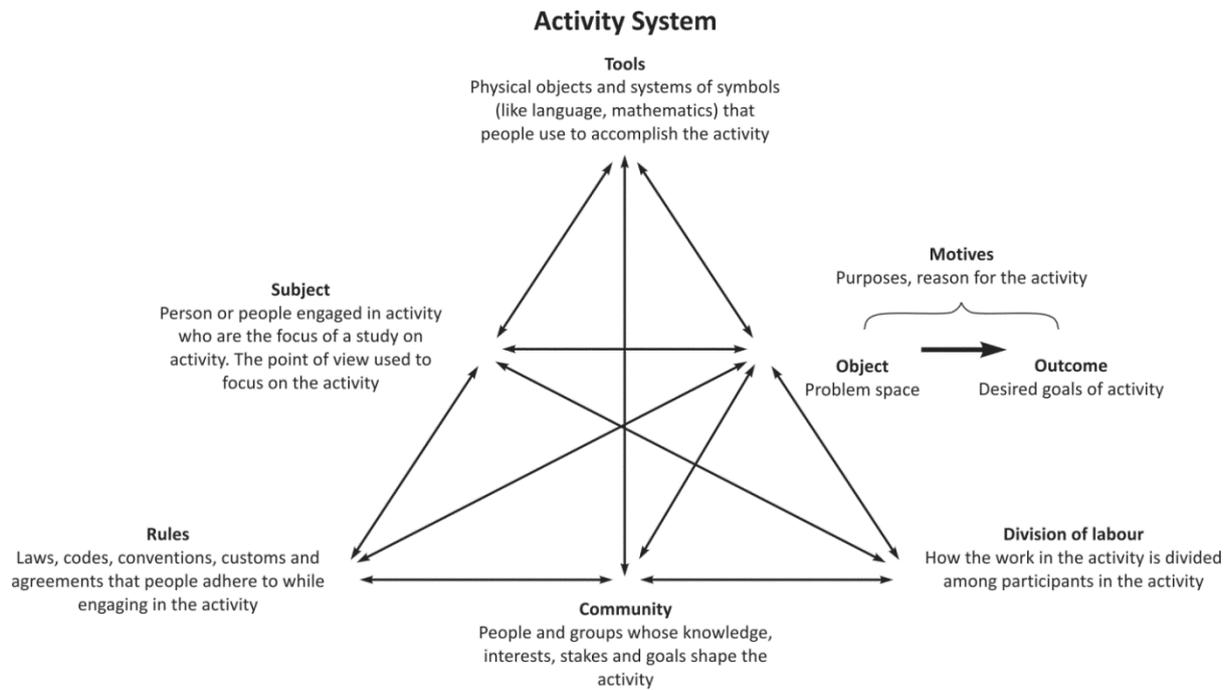
**Figure 3.1** Basic Mediation Triad (Engeström, 1987; Edwards, 2007)

Vygotsky concentrated on the symbolic mediation of culture, analysing the relationship between human action (the individual) and cultural artefacts (tools). His argument is that people learn from their culture and history by applying its conceptual and material tools to

transform the object (Edwards, 2005; 2007). One of the most important results of his work was the linking of the individual to the environment using tools for mediation, moving away from the tradition of treating people apart from their cultures.

#### *3.4.1.2 Second generation CHAT*

Engeström developed Vygotsky's work further, as shown in Figure 3.2 below. The top triangle is identical to Vygotsky's triangle in Figure 1. Engeström, however added the bottom triangle to include the rules, community and division of labour, socio-historical aspects of mediation that were omitted by Vygotsky (Engeström, 1999 in Yamagata-Lynch, 2003). Vygotsky's research was focused more on the semiotic process relation, while Engeström expanded this, locating it in everyday life i.e. situated activities. All the components of activity system, including the top triangle and the bottom socio-historical components, can mediate change not only for the object but for each other. In developing his model, Engeström suggested that (a) the relations between individuals and the object of their activity are mediated by concepts and technologies, (b) the relationships between the community and the overall object of its activity are mediated by its division of labour, and (c) the relations between individuals and the communities, of which they are part, are mediated by rules and procedures, which can be explicit or implicit (e.g. cultural „rules“ that govern gendered curriculum practices) (Blackler, et al., 2000). Daniels (2001) noted that the importance of second generation CHAT was that it brought interrelations between the individual and his/her community into focus. Figure 3.2 shows an activity system, as articulated in second generation CHAT.



**Figure 3.2** *Second generation CHAT*

### 3.4.1.2.1 Elements of the activity system

As shown in Figure 3.2 above, an activity system comprises a group of people pursuing a goal in a purposeful way (Peal and Wilson, 2001). Blackler et al. (2000, p.281) added that the “activity system comprises of an interrelated bricolage of material, mental, social and cultural resources for thought and action”. Table 3.1 below shows elements of an activity system and their relationship.

**Table 3.2** *Elements of the second generation CHAT* (Source: Engeström, 1999, 2002; Peal and Wilson, 2001; Wells, 2002; Puonti, 2004; Edwards, 2007)

<b>Element of activity system</b>	<b>Function/relationship with other components</b>
Object	Physical thing, idea or problem space being worked on (motive of activity including understanding of events, concept, principles, relationships etc). The „object“ is a central organising principle in activity theory. For Puonti (2004, p.34) the object is defined as „a project under construction“.
Subject(s)	Individual or group of people working on an object towards a common goal.
Outcome	Desired result of working on an object.
Tools	Conceptual and material, symbolic, external and internal artifacts for understanding or transforming the object. Tools carry the culture, history, skill knowledge, narratives, descriptions and explanations of the subjects. They are not conveniently handed to subjects, but are invented, purchased, discarded, and replaced in an activity system and can even be sources of disruptions.
Community	Group of people who share the same object.
Rules	Explicit and implicit regulations, norms and conventions that constrain actions and interactions within an activity system.
Division of labour	Horizontal and vertical allocation of responsibilities which mediates relationship between the community and the object.
Relational agency	Capacity to work with others to expand the object that one is working on by bringing to bear the sense-making of others and to draw on the resources they offer when responding to that sense making process.

Mwanza’s (2002, p.86) eight-step model that incorporates open-ended questions can further be used to interpret the various components of the activity system:

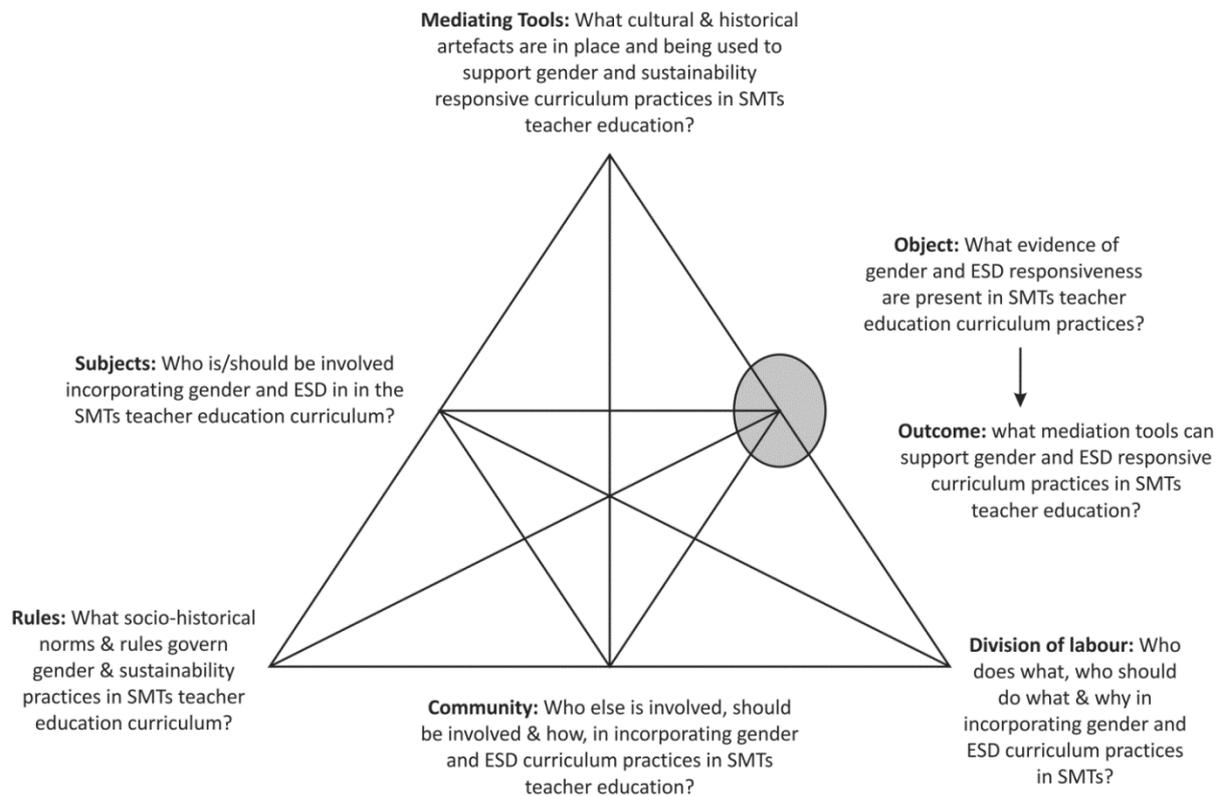
<b>Activity System component</b>	<b>Question to ask</b>
Activity	What sort of activity am I interested in?
Object-ive	Why is this activity taking place?
Subjects	Who is involved in carrying out this activity?
Tools	By what means are the subjects carrying out this activity?

Rules and regulations	Any cultural norms, rules and regulations governing the performance of this activity?
Division of labour	Who is responsible for what, when carrying out this activity and how are the roles organised?
Community	What is the environment in which activity is carried out?
Outcome	What is the desired outcome from this activity?

Figure 3.3 below shows the application of activity theory (second generation) to this research. The object of study is SMTs teacher education curriculum practices. As indicated by Wells (2002), the object can either be material or symbolic, although Cole (1996), cited by Wells (2002), pointed out that it is always both. In this study I emphasise this dual status of the object because of the following reasons raised by Wells (2002):

- Firstly the materiality of the object is critical in allowing it to become a focus of joint activity, something that can be sensually perceived, handled, and acted on.
- Secondly, it is the symbolic aspect of the object that allows it to participate in our (subjects) progressive attempts to increase our understanding of the phenomenon under investigation (curriculum practices in this case). To achieve an outcome, however, the two modes need to be combined (ibid.). In this case, I relied on Cornbleth's conception of curriculum (Section 2.9) and from it drew curriculum practices with material things, for example, syllabi, books, laboratory equipment, classroom interactions etc. For us to progressively understand practice, the material mode of understanding should be combined with the symbolic mode, which is imaginary, mental co-construction, meaning making of events and processes as they unfold in our daily work. This resonates well with the case study methodology (Section 4.2).

Applying the second generation CHAT enabled me to critically look at each element of the activity system with respect to gender and ESD responsiveness in the curriculum. To do this, I identified each component by posing questions as shown in Figure 3.3.



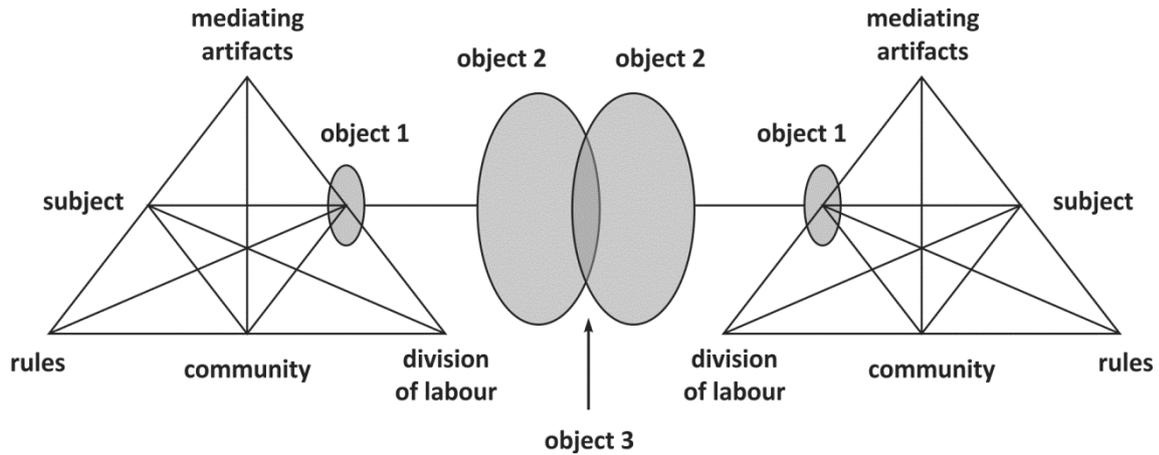
**Figure 3.3** Application of activity system to the teacher education activity system  
Adapted from Engestrom 1987,1999; Blackler et al., 2000

In this regard, the questions raised for each element supported an abductive analysis of the activity system, as further discussed in Section 4.7.2. Sections 5.2 and 6.2. report on the findings of this abductive analysis.

### 3.4.1.3 Third generation CHAT

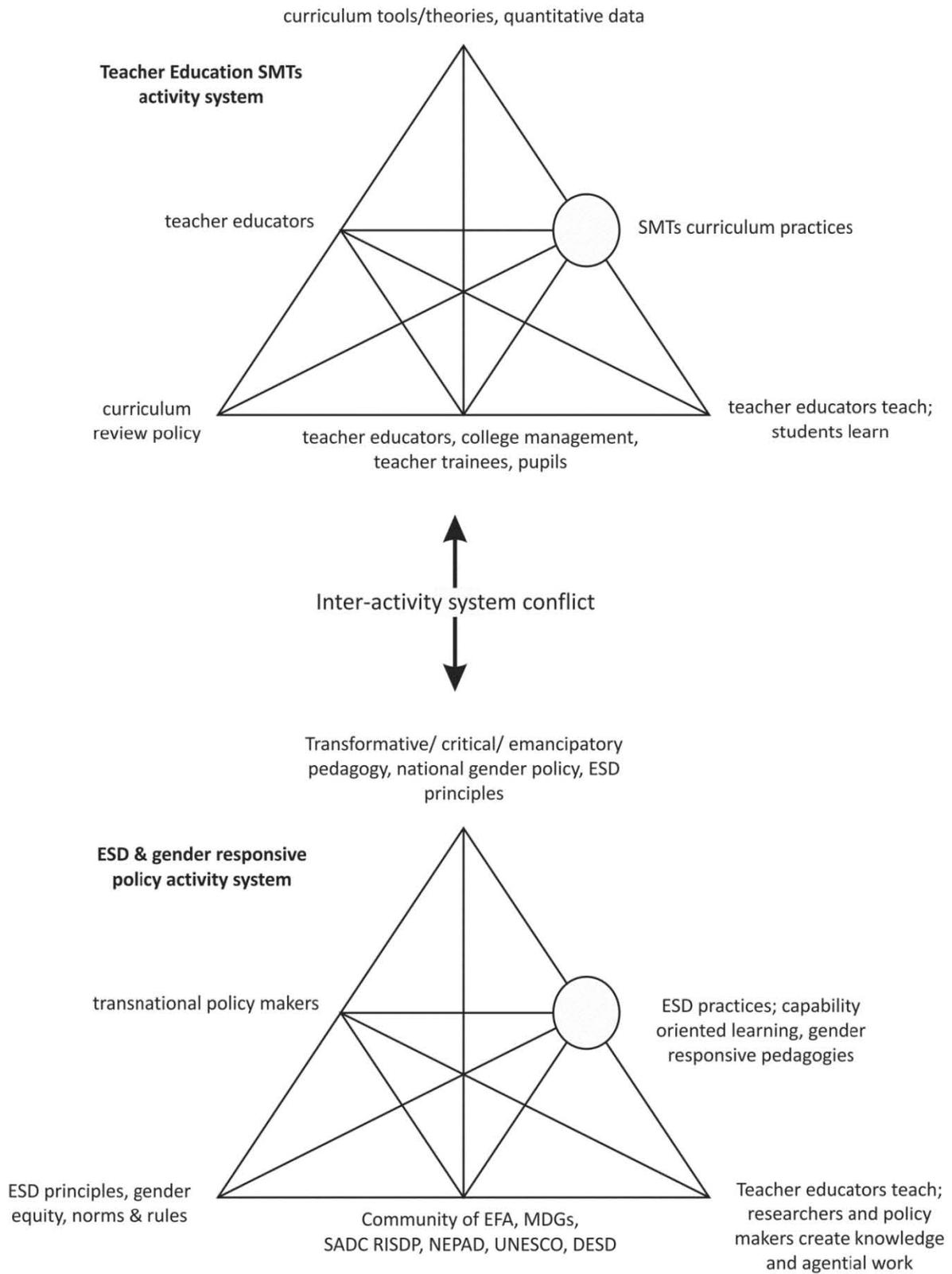
The third generation CHAT again developed by Engeström, exists when there is more than one activity system of the second generation and there is interaction between the activity systems. Figure 3.4 shows the minimal model for the third generation CHAT. The third generation CHAT outlined in Engeström (1999) takes joint activity or practice as the unit of analysis, rather than individual activity as shown in Figure 3.4. The oval representations of the object are used to indicate that object-orientated actions are “characterised by ambiguity, surprise, interpretation, sense making, and potential for change” (Engeström, 2001, p.134). The analysis is concerned with the process of social transformation and incorporates the structure of the social world, with particular emphasis upon the conflictual nature of social

practice (Warmington et al., 2005). Instability and contradictions are regarded as the motive force of change and development (Engeström, 1999; 2001) and the transitions and reorganisations within and between activity systems as part of evolution (Warmington et al., 2005). Third generation activity theory aims to develop conceptual tools to understand dialogues, multiple perspectives and networks of interacting activity systems (ibid.).



**Figure 3.4** Two interacting activity systems as minimal model for the third generation of activity theory (Source: Engeström, 2001, p. 136)

Figure 3.5 that follows illustrates the conflictual nature of curriculum practices between the current SMTs teacher education activity system and ESD driven activity system.



**Figure 3.5** Intra activity system disturbances conflicting with a bigger activity system

Applying third generation CHAT to the study meant contrasting the outcome of the analysis of each element in the current activity system with that of the more advanced ESD activity system as shown in Figure 3.3.

In more recent literature, the nature of the interaction seems to have shifted from the notion of a central activity system interacting with others to that of a number of activity systems that are in interaction and have a shared object (see Figure 3.6). Learning between such systems involves boundary crossing, a concept which is central to this study (see Section 3.4.2 and Chapter Eight).

### ***3.4.2 Unit(s) of analysis in CHAT***

CHAT's units of analysis were also applicable in this study in two ways; firstly as a tool of analysis for me the researcher and secondly, and very related, as a reflexive lens in change laboratory workshops to make the tacit implicit or as Engeström (1999) said "to make disturbances and innovations visible and analyzable to practitioners and researchers" (p.68). In support of this, Engeström (2008) argued that the unit of analysis is usually a conceptual idea strictly for the researchers. Arguing for the formative intervention methodology in research, based on the Vygotskian principle of double stimulation, he further encouraged the turning of the unit of analysis into an external auxiliary means, a mediating conceptual tool, for both the participating subjects and the researchers (ibid.). I used the triangular models for representing activity systems as I had observed them, and presented and explained them to the participants at an early phase of the intervention. Thereafter, we used them repeatedly to analyse and redesign various aspects of the participants' activity. In this way, the unit of analysis itself is offered as providing double stimulation for the participants (ibid.).

Engeström (2008) distinguished three generations in the evolution of the prime unit of analysis within cultural-historical activity theory. In the first generation (Section 3.4.1.1), based on Vygotsky's work, mediated action itself is the unit of analysis. With this in mind, using various methods (see Chapter Four), I interrogated at an atomic level, gender related issues in SMTs curriculum mediated action as a way of assessing the level of gender responsiveness of SMTs teacher educators. For example, this involved inferring whether an individual teacher educator takes cognisance of gendered complexities in the ontology and epistemology of SMTs in the whole mediation process (see Chapter Seven). My argument was that such a move would inculcate in trainee teachers, skills, knowledge, attitudes and

values to do so in their own practice. In other words the interrogation was to assess whether teacher education is fulfilling its gender conversion factor role as expected by national and international policies as discussed in Chapter Two.

Second generation CHAT (Section 3.4.1.2), based on Leont'ev's (1978, 1981) work, took the collective activity system as its molar unit of analysis. Likewise, I used strategies such as looking at institutional engagement with ESD and gender related policies, intra and inter departmental collaboration (boundary learning) as a way of gauging the extent to which SMTs teacher education curriculum practices support capabilities enhancement for female learners in SMTs in general and in view of socio-ecological risk in a southern African context in particular, within the teacher education curriculum activity systems in the two colleges (see Chapters Five and Six). With the complexity and the interrelatedness of the teacher education SMTs curriculum activity systems in the two teacher education institutions with other government and non-governmental institutions, the third generation unit of analysis became an important focus (Section 3.4.1.3). As discussed above, for third generation activity theory, there should be at least two activity systems with a partially shared object as minimal unit of analysis. In the BTTC case study for instance, the unit of analysis was the interaction between the teacher education activity system and various other institutions (activity systems) that share the common object of teacher education (see Section 5.2).

### ***3.4.3 Principles of Third Generation CHAT***

Summarising third generation CHAT, Engeström (1987), Blackler et al., (2000); Daniels (2007) and Queck and Alderson (2002) outlined the following as principles guiding third generation CHAT:

a) The first principle is that the prime unit of analysis is a collective, artefact-mediated and object-oriented activity system seen in its networked relation to other activity systems (Queck and Alderson (2002). Daniels (2002, 2007) added that goal-directed individual and group actions, as well as automatic operations, are relatively independent but subordinate units of analysis, and are eventually understandable only when interpreted against the background of entire activity systems.

The idea of object in CHAT requires a little more attention. It was Leont'ev who first worked on the idea of object-oriented activity, shifting the focus from Vygotsky's mediation tools to the object and its cultural construction. He proposed that "the main thing which distinguishes

one activity from another ... is the difference in the objects ... the object of an activity is its true motive.” (Edwards, 2007, p.7). The idea of object motive importantly recognises that our actions are elicited by our interpretations of the object and by the ways of engaging with the object that are possible in different sets of socially and historically situated practices (ibid.). An example of an object motive that Leont’ev used was that of traders in gem stones who work with gem stones very differently from, for example, how geologists do (ibid.).

Stetsenko (2005)’s work on Leont’ev’s notion of object drew out features of object-oriented action pertinent to this study. She noted the dialectics that exist between object and subject. As we work on the object, the object works back on us and impacts on our subjectivity and how we in turn approach the object (Edwards, 2007). In this study for example, through transactional relationship between subject (SMTs educators) and object (curriculum practices), by transforming the object through contesting gendered curriculum pedagogies, SMTs educators also transformed themselves. This transaction between subject and object in CHAT brings human subjectivity to the fore (ibid.) and therefore connects well with reflexivity and agency as well as with standpoint epistemology.

One may ask: what is this object? An object is a physical thing or idea being worked on. Supporting the object-subject dialectics, Kaptelinin (2005) added that the object of activity has a dual status; it is both a projection of human mind onto the objective world and a projection of the world onto the human mind. Employing the object of activity as a conceptual lens means anchoring and contextualising subjective phenomena in the objective world, and changes one’s perspective on both the mind and the world (ibid.).

Theorising on the complex and fluid nature of the object and its dialectics with the subject, Kaptelinin (2005) commented:

*Instead of being a collection of “mental processes,” the human mind emerges as biased, striving for meaning and value, suffering and rejoicing, failing and hoping, alive, real. On the other hand, the world is no longer just a collection of physical bodies, organizational structures, and so forth, but a place full of meaning and value, a place that can be comfortable or dangerous, restricting or supporting, beautiful or ugly, or (as it is often the case) all of these at the same time. (p.5)*

Through this quotation, Kaptelinin emphasised that from a research perspective, the concept of the object of activity is a promising analytical tool providing the possibility of understanding not only what people are doing, but also why they are doing it. He further

added: it (the object) can be considered a powerful sense-maker, both for subjects of activities and for researchers. In this study I took the cue from Kaptelinin's view. On the one hand, creating a concrete representation of the object of activity provides a basis for both rational and emotional dimensions of setting priorities and goals, commitments, planning, and coordination. On the other hand, the concept of the "object of activity" is employed as a useful conceptual tool helping to structure and interpret otherwise fragmented and confusing empirical data. As shown in Chapters Five, Six and Seven, identifying the object of activity and its development over time, served as a basis for reaching a deeper and more structured understanding of otherwise fragmented pieces of evidence. Kaptelinin and Miettinen (2005, p.5), however suggested that "the object of activity should be seen as a complex and contradictory assembly of entities embedded in economic, social and power relationships". Nardi (2005) employs the notion of the object of activity that address issues of power and passion. Such conceptualization made it possible to intellectualize gendered power relations inherent in curriculum issues as discussed under the feminist framework, and SMTs informed by ESD principles and values.

b) Activity systems are multi-voiced and are a nexus of many points of view, traditions and interests (Edwards, 2007). This is characterised by the division of labour, diverse histories of participants as well as of artefacts and rules. Supporting this, Engeström (2001) wrote:

*The division of labor in an activity creates different positions for participants, the participants carry their own diverse histories, and the activity system itself carries multiple layers and strands of history engraven in its artefacts, rules and conventions. (p.136)*

Engeström, (1987; 2000; 2001; 2007b) went on to add that the multi-voicedness is a source of trouble and a source of innovation as well, demanding actions of translation and negotiation. True to this study, the principle of multi-voicedness was very helpful given that I adopted a case study approach with a network of activity systems (see Section 4.2.4.1). The principle kept me alert and made it possible for the research participants and I to "follow the object" across organisational boundaries (Miettinen, 2009), as the unit of analysis changed from one activity system to a network of activity systems (see Section 4.2 and Chapter Eight).

c) The third principle is historicity; activity systems take shape and get transformed over time. History itself needs to be studied as local history of activity, objects, tools and theoretical ideas that have shaped the activity, its objects and outcomes as well as in terms of

the genealogy of conceptual tools that have shaped it over time (Engeström, 2001). Likewise in this study, there was need to look in each case study at the historical development of SMTs teacher education curriculum (object) as well as related tools such as national gender policies as well as ESD related policies. I also took cognisance of Engeström's view that such historical analysis needs "to be focused on units of manageable size", and he suggests that "if a collective activity system is taken as the unit, history becomes manageable" whilst at the same time moves „beyond the confines of individual biography“ (Avis, 2007, p.167).

d) The fourth principle is the central role of contradictions as a source of change and development in CHAT. These contradictions do not manifest themselves directly, but through disturbances, ruptures, problems, breakdowns, clashes and small unremarkable innovations in practitioners' everyday work actions (Engeström, 1999; 2001; Foot, 2001; Avis, 2007). They are not simply conflicts or problems, but are "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p.137). Contradictions between and within activity systems are potential sources of change and development. Engeström emphasised:

*When an activity system adopts a new element from the outside ... it often leads to an aggravated secondary contradiction where some old element ... collides with the new one. Such contradictions generate disturbances and conflicts, but also innovative attempts to change the activity. (2001, p.137)*

The central assertion of the theory is to translate the energy stemming from the tension-laden object into change efforts (Blackler et al., 2000). Activity theory sees contradiction as sources of development: "activities are virtually always in the process of working through contradictions" (Foot, 2001, p.54). Engeström and Miettinen (1999) emphasised a view of contradictions as "the motive force of change and development" (p.9). Engeström (2001) explained how contradictions can lead to innovation and transformation in an activity system; as the contradictions of an activity system are aggravated, some individual participants begin to question and deviate from its established norms. In some cases, this escalates into collaborative envisioning and a deliberate collective change effort. An expansive transformation is accomplished when the object and motive of the activity are conceptualised to embrace a radically wider horizon of possibilities than in the previous mode of the activity (ibid., p.137).

Engeström (1999), further added that research can trigger discussions about disturbances within and between activity systems and show how these are and might be responded to (ibid.). They generate “disturbances and conflicts, but also innovative attempts to change the activity” (Murphy and Rodriguez-Manzanares, 2008, p.442). In this study, after the exploration phase, I had to (in the expansive phase) engage with research participants to reflect on practice and research findings to make the tacit explicit and together worked on new curriculum practices oriented towards expanded functionings and capabilities of both girls and boys in SMTs.

Engeström (1987) also adopted the Batesonian term of „double bind“ to explain “a contradiction which uncompromisingly demands qualitatively new instruments for its resolution” (p.175). He further drew on the concept of zone of proximal development, defining it in terms of a double bind, a type of aggravated contradiction “potentially embedded in everyday actions” (in Miettinen, 2009, p.162). Taking a cue from this, Change Laboratory workshops were held in an atmosphere that made it possible to frame new forms of work (see Chapter Eight). Engeström (1999) put forward the following classes of contradictions:

- Primary contradictions that happen within elements of the activity system;
- Secondary contradictions that occur when there is tension between one element and another in the activity system;
- Tertiary contradictions that take place when the object of the central activity system clashes with that of a more advanced system; and
- Quaternary contradictions that transpire when the central activity system is at odds with any of its neighbouring activity systems.

An example of primary contradiction is that SMTs teacher educators were often aware and worried about gender imbalances in their disciplines but the majority could not connect this to gender biases in pedagogies or to socialisation both at home and at school (Kalu, 2005; FAWE, 2008). This lack of knowledge versus awareness within the subjects is an example of a primary contradiction. Another example of a primary contradiction in tools could be traditional content centered teaching methods/theories versus teaching methods that seek to enable critical thinking in view of current socio-ecological demands of society.

An example of secondary contradiction could be the discontinuity between SMTs teacher educators (subjects) who are concerned about gender inequality in SMTs but their curriculum

practices (object) are not deliberately designed to address the situation. Engeström (2005a) argued that primary contradiction evolves and takes the form of specific secondary contradictions. Taking the case of the secondary contradiction cited here, the reason why teacher educators fail to apply appropriate pedagogies is because they do not possess the knowledge and skills in the first place and this is a primary contradiction that leads to the clash between subject and object.

As mentioned above, tertiary contradictions emerge when the object of the central activity system clashes with that of a more advanced system. A policy practice gap could result in a tertiary contradiction. For example, if as national policy it is stipulated that gender and socio-ecological risk be incorporated in the curriculum and this is not done for one reason or the other, this then becomes contradiction between the two objects of the respective activity systems.

In Figure 3.4 I showed the ESD policy activity system as a more advanced activity system informing the possible expanded curriculum practices and contrasted it with the present object (current SMTs teacher education curriculum practices). The mediating tools in the ESD policy activity system are transformative, critical, emancipatory pedagogy, oriented to socio-ecological issues and risks and capability oriented learning etc. These are aligned with the critical educational research, the methodological theory informing this research as explained in Chapter Four. The subjects are transnational policy makers, and the community of the policy activity system is educational actors (including teacher educators) and the rules are constituted from national and transnational goals of the National Gender Policy, Education for All, and MDGs, particularly human rights discourses which have emphasised gender equity for many years. The proposed outcome of the ESD policy activity system is a curriculum which thrives on equality and opens capabilities to all.

Quaternary contradiction as pointed above transpires when the central activity system is at odds with any of its neighbouring activity systems. In this case I sought to find out for example in the BTTC case study whether the SMTs teacher education activity system was at odds with rule producing activity system (government producing gender responsive policies such as the NGP in Zimbabwe and National Gender Framework in SA); subject producing activity system; tool producing activity system, e.g. SADC-RISDP, educational theories and the culturally more advanced ESD activity system (see Chapter Five).

True to the Marxist origin of CHAT, Engeström acknowledged that the primary (level 1) contradiction of activities in capitalism is that between the use- and exchange-value of commodities (1999, 2001; Avis, 2007; 2009). He further conceded that in different activity systems, this fundamental tension appears in different forms (Avis, 2009). He wrote “this primary contradiction of activities within capitalism is that between the use and exchange value ... it pervades all elements of our activity system” (Engeström, 2001 in Daniels, 2007 p. 379). Critiques of CHAT and its associated methodology Developmental Work Research (DWR) point to avoidance in CHAT to address this primary contradiction, while focusing on resolving peripheral tensions and disturbances (Avis, 2009)(see Section 3.4.6).

e) The fifth principle proclaims the possibility of expansive transformations in activity systems. Engeström (2001) explained the principle: an expansive transformation is accomplished when the object and motive of the activity are reconceptualised to embrace a radically wider horizon of possibilities than in the previous mode of the activity. He further stresses:

*The object of expansive learning activity is the entire activity system in which the learners are engaged. Expansive learning activity produces culturally new patterns of activity. Expansive learning at work produces new forms of work activity. ...a crucial triggering action in the expansive learning process ... is the conflictual questioning of the existing standard practice. (Engeström, 2001, p.139 and p.151).*

Likewise, in this study, expansive learning in the two case studies emerged from a process in which participants were given the space to question current practices, ultimately moving beyond these to generate new conceptualisations and forms of practice. By so doing, as Engeström said, this expansive transformation was understood as a collective journey through the zone of proximal development (see Chapter Eight).

#### **3.4.4 Expansive learning: incorporation of praxis, reflexivity and agency**

*The challenge is to make the disturbances and innovations visible and analyzable to practitioners and researchers. (Engeström, 1999, p.68)*

The term „expansive learning“ refers to an approach that integrates the three dimensions of representing work: linear, socio-spatial and developmental (Engeström, 2005). As the above quotation highlights, expansive learning entails collaborative learning and seeks to address new and emerging problems, creating new knowledge and building institutional work

resilience. It builds on overcoming current contradictions in complex systems that involve objects, artifacts and perspectives (Engeström, 1999). Daniels, (2001, 2005; Edwards, 2005, 2007) added that expansive learning involves doing, reflecting and improving the practice, which essentially is praxis at one level, while at the same time it looks at how the everyday and scientific knowledge interact. For this I drew on Developmental Work Research as the primary methodological process in this research (see Section 4.2.3). As Senteni (2005) put it:

*... applying Developmental Work Research to curriculum transformation can serve as the basis of pedagogical approaches triggering changes requiring educational institutions to operate in a different way, based on concerted and continuous teamwork, according to new benchmarks of individual and collective performance. (ibid, p.4)*

In this particular study, Developmental Work Research enabled me to harness teamwork from SMTs teacher educators, use the capability approach and feminist standpoint epistemology as well as ESD principles to reflect on current curriculum practices and together focus on improving these as explained in Chapter Eight.

### **3.4.5 Boundary learning**

The main thrust and value of third generation CHAT, as represented in Figure 3.5 and functional to the networked activity systems described in Chapter Four, is when participants/actors belonging to the different activity systems are prepared to work together towards a shared object which they construct collectively. It is in this conceptualisation of third generation CHAT that the idea of boundary crossing gains significance. With the same idea, Roth and Lee (2007) emphasised that in the third generation of CHAT, boundaries, in the form of contradictions between activity systems (Figure 3.6), are seen as vital forces for change and development. A boundary can be seen as a socio-cultural difference leading to discontinuity in action or interaction (Akkerman and Bakker, 2011<sup>4</sup>). At the same time, boundaries simultaneously suggest a sameness and continuity in the sense that within discontinuity two or more sites are relevant to one another in a particular way (ibid.).

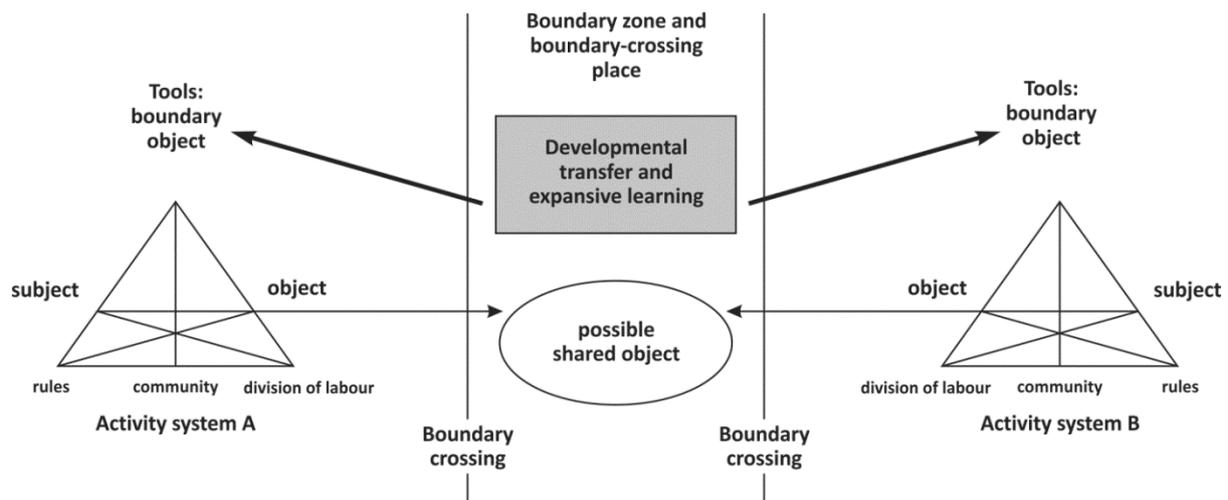
Akkerman and Van Eijck (2011, p.4) explained that boundaries between social practices are

*... not lines of distinction but ambiguous, in that they represent a neither/nor, as well as a both/and situation ... when people cross boundaries their position is one of belonging to multiple worlds, but also one of being a marginal stranger to each of these worlds*

---

<sup>4</sup> This paper is based on a review of 181 studies on boundary objects and boundary learning. A critical reading of this paper provided unique conceptual and analytical tools on boundary learning that were useful especially in the expansive learning phase (Chapter Eight) of the study.

Alsup (2006), cited by Akkerman and Bakker (2011), showed how student teachers can face such socio-cultural differences in values between a teacher education programme and a secondary school and that this can cause discontinuity in the sense that the student teachers experience role or perspective changes between sites as challenging. At the same time, sameness and continuity reside in the fact that both sites are concerned with pedagogy and with the learning process of the student teacher. In this case the object remains more or less familiar. Figure 3.6 is a schematic representation of boundary learning.



**Figure 3.6** Boundary learning between activity systems (Source: Engeström, 2004, p. 23)

Two concepts have been central in describing potential forms of continuity across sites: boundary crossing and boundary objects. Boundary crossing usually refers to a person's transitions and interactions across different sites (Suchman, 1994) and to facing "the challenge of negotiating and combining ingredients from different contexts to achieve hybrid situations" (Engeström et al., 1995, p.319). Star and Griesemer (1989) introduced the concept of boundary object to indicate how artefacts can fulfil a specific function in bridging intersecting practices (in Akkerman and Bakker, 2011). They went on to cite as examples of boundary objects, teacher portfolio as a means by which both the mentor and the school supervisor are able to track the development of the student. In describing boundary objects, Star and Griesemer (1989) in Akkerman and Bakker (2011) wrote:

*... boundary objects are those objects that both inhabit several intersecting worlds and satisfy the informational requirements of each of them... [They are] both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly*

*structured in common use, and become strongly structured in individual site use. (ibid., p.2)*

The interest in boundary learning in this study can be understood against the background of two developments in the social sciences. First, the interest in boundaries goes together with the study of larger units of analysis, as is with the two case studies described in Chapters Four and Five. I was inspired by Star and Griesemer (1989) who accentuated the need for ecological analysis that includes analysing the various institutions and different viewpoints of actors involved to understand how boundaries are encountered and crossed.

Likewise, in the case of this study, examination of boundary crossing required an analysis of all the loosely connected systems involved, true to the scope of analysis, and explicated the third generation of CHAT.

Second, as argued by Akkerman and Bakker (2011), studies on boundaries seem to represent a new fine-grained appreciation of diversity. Edwards and Fowler (2007)'s argument that the increasing interest in boundaries is a result of a growing attempt of social theory, influenced by postmodernism, poststructuralism, postcolonialism, and feminism, to focus on the marginal and the decentred as alternatives to discourses of power of the centre, was pertinent, bearing in mind the emancipatory interest of this study.

Akkerman and Bakker (2011), in their review of 182 studies on boundary crossing and boundary objects found four different types of learning at the boundaries which were pertinent to this study: identification, coordination, reflection and transformation. Applicable to this study, Akkerman and Bakker employed the term learning in a very broad sense, including new understandings, identity development, change of practices, and institutional development (ibid.).

Identification entails a questioning of the core identity of each of the intersecting sites. Pertinent to an expansive learning study, this questioning leads to renewed insight into what the diverse practices concern (ibid.). In their review of literature, Akkerman and Bakker, found two common processes of identification described in the studies: othering and legitimating coexistence. Othering is the dialogical process of defining one practice in light of another, delineating how it differs from the other practice (ibid.). Related to this, Bogenrieder and van Baalen (2007) described the underlying need for legitimating coexistence showing how people, when working simultaneously in different organisational groups, have to consider the interference between their multiple participations to be able to

pursue each one and be accepted in this multiple membership by others in the respective groups. These two terms were quite applicable in a multiple activity system, nested case study research domain like this one. For example, the terms helped in mapping out the activities of the department of teacher education in relation to the teacher education institution (see Chapters Five and Seven). Furthermore, the concepts became useful in Focus Group Discussions in analysing how individual actors from different organisations successfully define their differing organisational identities as well as their shared identities on a network level based on the shared object of SMTs teacher education curriculum practice. Of further interest to this study was the characterisation of the identification processes by Akkerman and Bakker (2011): that the boundaries between practices are encountered and reconstructed, without necessarily overcoming discontinuities, the learning potential resides in a renewed sense making of different practices and related identities. The sense making of practices proved to be an appropriate stage in Change Laboratory Workshops (see Chapter Eight).

Landa (2008) in Akkerman and Bakker (2011), pointed out that to manage this ambiguous position at the boundary, generally calls for “personal fortitude” (p.195). More specifically it requires people to have dialogues with the actors of different practices, but also to have inner dialogues between the different perspectives they are able to take on (Akkerman et al., 2006). As reported in Chapters Four, Six and Seven, focus group discussions in Change Laboratory Workshops through the Developmental Work Research methodology were designed in a way that allowed this to happen.

The next type of learning at the boundary is coordination. From literature, Akkerman and Bakker (2011) deduced various processes of coordination across boundaries: establishing a communicative connection, efforts of translation, increasing boundary permeability and routinisation. They further highlighted that this learning mechanism of boundary crossing takes a different form from identification in that the potential in the coordinative mechanism resides not in reconstructing but in overcoming the boundary, in the sense that continuity is established, facilitating future and effortless movement between different sites. Landa (2008) in Akkerman and Bakker (2011) looked for communicative connection between diverse practices or perspectives which can be established by instrumentalities (boundary objects) that are shared by multiple parties. In support Paterson (2007) described how an information structure (a designed tool) can allow exchange of relevant information across different communities of practice (activity systems), read differently by different actors. Roth and

McGinn (1998) in Akkerman and Bakker (2011) gave an example of how school grades as boundary objects mean different things in different sites: In schools, they are related to getting a good report card, graduating, and getting a diploma; in the admissions office of a university, the talk is about acceptance and probability of future success. Grades are the boundary objects that constitute the articulation between schools, colleges, and universities. In the same vein, the exploration phase looked at any stumbling blocks to communicative connection between institutions responsible for teacher education, interrogating for the absence or presence of boundary objects to facilitate articulation between sites. In the exploratory phase, efforts were made to construct mediation tools and structures to enable communication across boundary sites.

Second, coordination entails efforts of translation between the different worlds. Fisher and Atkinson-Grosjean (2002) described how the managers in industry liaison offices are charged with the role of translation, in their case, translation of research results into concrete commercial applications. Such translation work can also be accomplished by the use of boundary objects and strongly relates to finding a balance in the aforementioned ambiguity of boundaries (neither–nor and both–and) (Akkerman and Bakker, 2011). Similarly, in the BTTC case study for example, there was a gender focal person linking the ministry to teacher education institutions, presumably (translating) policy issues into curriculum practice. The person worked with boundary objects such as policies and other relevant curriculum documents. Specific items were designed for the exploration phase to infer on how such policies are translated into pedagogic practice. The same idea was followed up in the expansive learning phase bringing together teacher educators, Department of Teacher Education and ministry official to establish a communicative connection on how policy can be translated into curriculum practice.

Third, coordination entails enhancing boundary permeability (*ibid.*). Synonyms of permeability are penetrability, perviousness and absorbency. Boundaries can become permeable, so that one is not even aware of different practices simply because actions and interactions run smoothly without costs and problematic discontinuities. Shumate and Fulk, (2004) claimed that the permeability of boundaries can be enhanced by repeatedly crossing different practices. This leads to the fourth process of coordination across boundaries – the importance of routinisation, that is, finding procedures by means of which coordination becomes part of a daily routine. In this case, Change Laboratory Workshops were designed to make boundaries between activity systems more penetrable. Further to establishing a

communicative connection, Change Laboratory Workshops were also meant to reduce the power gradient inherent in hierarchical public offices.

Reflection is the other type of learning at the boundary. It is about learning to look differently at one practice by taking on the perspective of the other practice. It involves perspective making and perspective taking. Perspective making is making explicit one's understanding and knowledge of particular issue (Akkerman and Bakker, 2011). On the other hand, perspective taking is taking the other into account (Boland and Tenkasi in Akkerman and Bakker, 2011). In this study, Change Laboratory Workshops were designed to facilitate communication between different activity systems by making explicit the knowledge and assumptions mobilised in the interpretation of the object. Reflexive emphasis was on both perspective making and perspective taking. Boundary learning created opportunities for participants to look at oneself through the eyes of other worlds (ibid.). As argued by White, Hartel and Panipucci (2005), taking another perspective is a way to begin to see things in a different light. In this study, boundary objects such as policies, ideas and some mirror data from the exploratory phase were used for the boundary learning process. In the workshops, participants were involved in activities that were designed for perspective making and perspective taking (see Chapter Eight).

Transformation is the fourth learning mechanism described by Akkerman and Bakker (2011). Transformation leads to profound changes in practices, potentially even the creation of a new, in-between practice, sometimes called a boundary practice. More than in the other mechanisms, transformation involves real dialogue and collaboration between "flesh-and-blood partners" at either side of the boundary (Engeström, 1995, p. 333). In a study with a curriculum transformation agenda like this one, transformation was the basic motive in boundary-crossing change laboratories in which people from different activity systems were invited to meet to discuss and work on shared problems at the boundary. Transformation, according to the literature reviewed by Akkerman and Bakker, could happen in four possible ways: confrontation, shared problem space, hybridisation and crystallisation.

Confrontation entails encountering discontinuities that are not easily surpassed. In the context of this study, we had to confront for example, cultural patriarchal practices that often lead to discontinuities in SMTs curriculum, and seriously reconsider current curriculum practices and their interrelations with ESD expectations (see Section 2.1). My role as the researcher, was as Kerosuo (2001) advised, to act as a mirror confronting people with the problem they share.

A second process in intended and reported transformations is recognising a shared problem space, often in direct response to the confrontation. In the case of this study the shared problem space was lack of gender and sustainability responsive curriculum practices in SMTs teacher education curriculum. It was important therefore that research activities were motivated by and directed toward the problem space that binds the intersecting practices (different activity systems) together.

A third process in transformation is hybridisation. It entails emergence of a new cultural form or completely new practice that stands in between established practices. Hybridisation means that ingredients from different contexts are combined into something new and unfamiliar. This can take the shape of new tools or signs, such as the formation of a new concept (Engeström, 1995) or an analytical model (Postlethwaite, 2007).

A fourth process found in the descriptions of transformation is crystallisation. To crystallise is to give a definite, precise and usually permanent form. Crystallisation can occur by means of what Wenger (1998) called reification, that is, to “congeal this experience into „thingness“” (p.58). The reasoning, according to Akkerman and Bakker (2011), is that it is one thing to create something hybrid at the boundary but quite another to embed it in practice so that it has real consequences. Crystallisation also takes place by means of developing new routines or procedures that embody what has been created or learned. Gorodetsky and Barak (2008) described how the emergence of a community of student teachers, school teachers, and teacher educators represents a successful form of boundary crossing because the teachers started to enact new ideas in their own teaching practices. Akkerman and Bakker (2011) caution that, although the importance of crystallisation is emphasised in many of the studies pointing at transformation processes, their empirical findings suggest it is rarely realised. They conclude that this proves how hard it is to transform practices at the boundary, something that can often be explained by considering the distinct cultural history of practices. I met similar challenges in this study as discussed in Chapter Eight. It was fairly easy to articulate the other three transformation processes, but crystallisation seemed elusive.

In essence, CHAT as a methodology of this study, helped to:

- a. illuminate, that is get a deeper understanding of prevailing gendered curriculum practices in the SMTs teacher education curriculum activity systems. As suggested by Foot, (2005, p.55) “careful attention to emerging contradictions and an expanded conceptualization of Vygotsky’s (1978) notion of the “zone of proximal

development” enables the CHAT researcher to anticipate possible future transformations of an activity system.”

- b. historicise and trace the trajectories and development of curriculum practices with particular focus on the nexus of ESD, gender and SMTs in teacher education,
- c. stimulate contemporary learning; through identifying contradictions that allow for reflection on pedagogical practices that impede girls from participating fully in SMTs,
- d. deal with new and emerging challenges to influence curriculum re-orientation and the emergence of new curriculum practices through expansive learning oriented towards agency and capabilities development in view of socio-ecological risk. (Engeström, 1987, 1999; Blackler et al., 2000; Daniels, 2005; Edwards, 2005, 2007; Roth and Lee, 2007)

#### **3.4.6 Critique of CHAT**

Avis (2007) argued that the notion of contradiction used by Engeström in CHAT, whilst having a Marxist veneer, has much in common with conventional systems theory. He pointed out that Engeström’s developmental work research often appears to be accented towards an expansive learning that seeks to resolve peripheral rather than primary contradictions, thereby stopping short of a fully radicalised practice.

He pointed at Engeström’s conception of contradictions in the following quote (p.165):

*While the primary contradiction between the use value and exchange value of the object does not go away, it evolves and takes the form of specific secondary contradictions. The emergence, aggravation of these secondary contradictions may be regarded as a developmental cycle in the life of the activity system.*

Livingstone (2006, p.147) pointed out that “this shift of focus away from primary to secondary contradictions serves to reproduce the capitalist system and the basic objectives of Marxist inquiry are missed”. Avis (2009) further added that Engeström transformations are adaptive in the sense that they neither challenge nor disrupt the wider social relations within which the activity is set.

Through this critique, I was aware in this study that gender is a construction of the wider social structure; trying to address gender issues in the curriculum is only a small gesture towards gender equality in society.

Although CHAT appears to be a strong methodology that takes into account the complex nature of historically developed cultural mediating tools, it is still not very sensitive to complex power relationships between subjects and their influence on social interaction in the activity. Daniels (2010, p.379) talked of the invisible semiotic mediation which he described, citing Hasan (2002), as:

*... concerned with the ways in which unself-conscious everyday discourse mediates mental dispositions, tendencies to respond to situations in certain ways and how it puts in place beliefs about the world one lives in, including both about phenomena that are supposedly in nature and those that are said to be in our culture.*

Daniels and Warmington (2007) also argued that subject-subject and within subject relations are under-theorised in activity theory. It lacks a theoretical account of social relations and positioning (ibid.). Edwards and Daniels (2012) pointed out that the focus in CHAT is on the problem being worked on with the knowledge of subjects. They pointed out that there is need also to work on the knowledge in use. Daniels (2012) added that data collection (using activity theory) tends to focus on what is said. He cites Bernstein (1993) who noted that “extra-contextual structures of power and their discursive regulation are necessarily excluded from the analysis” (ibid., p.10). In view of this shortfall in CHAT, Daniels (2010, p.381) suggests that there is need to:

*analyse and codify the mediational structures as they deflect and direct attention of participants. In this sense I am advocating the development of cultural-historical analysis of the invisible or implicit mediational properties of institutional structures that themselves are transformed through the actions of those whose interactions are influenced by them.*

Working with different activity systems with structured power hierarchies and researching on gender issues which are embedded in relations of power, this critical analysis of the activity theory was helpful in this study. I also relied on Critical Discourse Analysis (see Sections 5.3 and 6.4) to support analysis of the invisible or implicit mediational properties that shape curriculum practices in SMTs teacher education in the two case studies.

### **3.5 CONCLUSION**

This chapter focused on discussing the theoretical framework for the study. It started by locating the three approaches used in the study to Critical Theory and relational ontology. It went on to describe each of the approaches and discusses how a particular approach is applicable to the study. The approaches were reviewed within the context of nexus of gender, science and ESD thereby linking the chapter to the discussion in Chapter Two. The chapter is linked to Chapter One in that it provides theoretical lenses used to respond to the research questions. The methodology that guided the study, discussed in Chapter Four, and the tools for generating and analysing data are conceived within the context of the theoretical approaches discussed here. Data presentation, interpretation and analyses reported in Chapters Five to Seven are also reflexively informed by the three approaches discussed in this chapter.

## **Chapter 4: METHODOLOGY and METHODS**

### **4.1 INTRODUCTION**

In this chapter I discuss how I engaged with research participants to generate and make use of data. In structuring the chapter I drew inspiration from Creswell's (2003, p.3) questions central to research design:

- What knowledge claims are being made by the researcher (including theoretical perspective)?
- What strategies of inquiry will inform the procedures?
- What methods of data collection and analysis will be used?

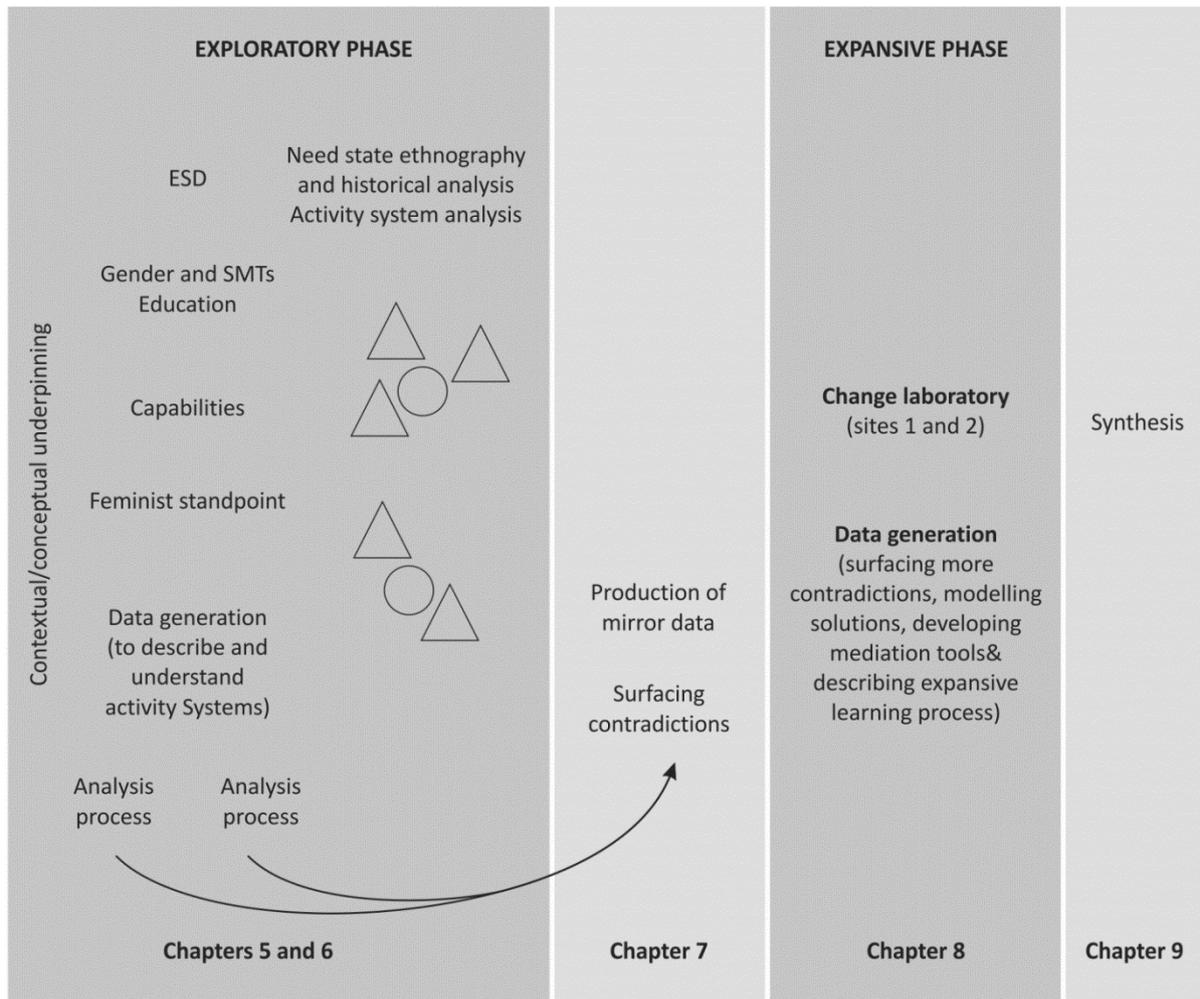
With the curriculum transformation interest in mind, guided by the Capability approach, Feminist theory and CHAT (see Chapter Three), this chapter shows how the research participants and I, as the researcher, reflexively worked together in understanding (exploring) and expanding gender responsive, ESD science teacher education curriculum practices.

The research journey was therefore a two-way encounter between two active agents, research participants and me, the researcher. In this sense I was an interventionist researcher hoping to enhance the agency of participants (SMTs teacher educators). The research was action oriented, working with teacher educators to reflect on their curriculum practices. In the initial stages of the research journey I set out to explore not individual behaviours but curriculum practices. Yamagata-Lynch (2003) noted that when conducting research with CHAT, examining individual behavior is only a gateway for the researcher into the activity of the subject; once the researcher identifies the activity, he or she needs to shift the focus of the examination to understanding the motive-goal-instrumental conditions rather than the observable individual behaviours and use that information to understand the collective meaning-making process.

Gender lenses supported by feminist theories and the capability approach in the context of ESD were used to assess the level of gender responsiveness in the curriculum practices of SMTs teacher educators as discussed in Chapters Two and Three. The two approaches were further used to gauge the degree to which the SMTs teacher education curriculum practices consider the functionings and capabilities of females in relation studying SMTs and to increased socio-ecological risk in a southern African context. As highlighted in Chapter

Three, CHAT epistemologically provided explanatory and intervention space to improve organisational (curriculum) practice through interpreting practice as activity and exploring the link between event and context (Blackler et al., 2000). In the exploratory phase, I used research methods such as document analysis, in-depth interviews (individual and group), focus group discussions and critical discourse analysis to generate and to make sense of data. This methodological triangulation enhanced the trustworthiness of the research as discussed in Section 4.5. Data generated in this phase formed part of the mirror data that was used together with literature based data in change laboratory workshops.

In the expansive learning phase CHAT provided the methodological framework of Developmental Work Research (DWR) (see Section 4.2.3). The expansive phase responded to the last question of the study: what conceptual artefacts can the study develop to support expansive learning for gender responsive science teacher education curriculum practices in general and in particular, curriculum practices that expand females' functionings and capabilities in response to increased socio-ecological risk in a Southern African context. As said above, change laboratory workshops were carried out for this expansive learning process (see Section 4.4.5). Figure 4.1 below shows the research design and the research process followed in this study.



**Figure 4.1** Research design and the research process

## 4.2 Methodological Framework

The choice of the research methodology, design and methods was influenced by the research goal (Section 1.4), the conceptual framework (Chapter Two) and the theoretical framework (Chapter Three). The research goal was informed by the context as described in Chapters One and Two.

### 4.2.1 Critical Theory in research

As mentioned earlier the study had an emancipatory intent as it was building agential capacity of SMTs teacher educators. This also implied curriculum transformation informed by critical theory. Giroux (1983) advised us to make education meaningful by making it critical in order for it to be emancipatory. The intention of the study with this critical contemplation was to go beyond mere understanding of situations and phenomenon as prescribed by naturalistic and interpretive approaches, to influence change. Critical theory is prescriptive and normative, entailing a view of what behaviour in a social democracy should

entail (Morrison, 1995 in Cohen, Manion and Morrison, 2000). In this enterprise critical theory identifies the „false“ or „fragmented“ consciousness (Eagleton, 1991 in Cohen, Manion and Morrison, 2010, p.26) that has brought an individual or social group to relative powerlessness or, indeed power, and it questions the legitimacy of this. It holds up to the light of legitimacy and equality issues of repression, voice, ideology, power, participation, representation, inclusion and interest (ibid.). Its intention is transformative: to transform society and individuals towards social democracy and social justice (ibid.).

In this respect, the purpose of critical educational research is intensely practical – to contribute towards a more just, egalitarian society in which individual and collective freedoms are practiced, and to eradicate the exercise and effects of illegitimate power (ibid.). This resonates well with the capability approach, and CHAT, theoretical approaches that inform this study (see Chapter Three). For critical theorists, researchers can no longer claim neutrality and ideological or political innocence (ibid.), a point that is explicit in feminist standpoint approaches, as indicated in Section 3.3. Cohen et al. (2010, p.27) added that critical theory and critical educational research have a substantive agenda, for example examining and interrogating the relationship between school and society, that is how schools perpetuate or reduce inequality; the social construction of knowledge and curricula, that is who defines worthwhile knowledge, what ideological interests this serves, and how this reproduces inequality in society; how power is produced and reproduced through education; whose interests are served through education and how legitimate these are (e.g. rich, white, middle class males rather than poor, black, females).

The research therefore was deliberately interventionist, reflecting the critical stance of both the feminist standpoint theory and the capability approach. The research was also participatory and action oriented as informed by CHAT and its associated DWR methodology (see Section 4.2.1). Habermas (1972) in Cohen et al. (2010, p.29), supported the twin intentions of critical research commenting that the emancipatory interest of critical theory subsumes naturalistic and interpretive approaches; it requires them, but goes beyond them, it is concerned with praxis-action that is informed by reflection with the aim to emancipate. It follows therefore that, not only does critical theory have its own research agenda, but also it has its own research methodologies, in particular ideological critique and action research (ibid.). The task of ideological critique is to uncover the vested interest at work which may become consciously or subliminally adopted as part of normalising cultural practice, revealing to participants how they may often paradoxically be acting to perpetuate an unjust

system (ibid.). Habermas (1972, p.230) suggested that ideology critique through reflective practice can be addressed in four stages:

- Stage 1: a description and interpretation of the existing situation, a hermeneutic exercise that identifies and attempts to make sense of the current situation.
- Stage 2: a penetration of the reasons that brought the existing situation to the form that it takes – the causes and purposes of a situation and an evaluation of their legitimacy, involving an analysis of interests and ideologies at work in a situation, their power and legitimacy both in micro and macro-sociological terms. Carr and Kemmis (1986) added that ideological critique here reveals to individual and groups how their views and practices might be ideological distortions that, in their effects, perpetuate a social order or situation that works against their democratic freedoms, interests and empowerment.
- Stage 3: an agenda for altering the situation – in order for moves to an egalitarian society to be furthered.
- Stage 4: an evaluation of the achievement of the situation in practice.

These four stages imply that ideological critique has both a reflexive, theoretical and a practical side to it. This resonates well with Developmental Work Research, the methodology that anchors the study as discussed in Section 4.2.3 below. Stages 1 and 2 involve similar processes to those of the need state ethnography and the historical analysis of the Developmental Work Research (Figure 4.2 below). Stages 3 and 4 resonate with modeling and implementing new solutions as encompassed in the practical side of Developmental Work Research through change laboratory workshops. The capability and feminist approaches as said above offered theoretical lenses for ideological critique and emancipation. Critical Discourse Analysis was also useful in this study, to historicise and, as pointed to in stage 2, to analyse interests and ideologies at work in a situation, their power and legitimacy both in micro and macro-sociological terms, and as underlying mechanisms that affect (promote or constrain) gender responsive and sustainability oriented curriculum practices in SMTs teacher education.

#### *4.2.1.1 Critique of Critical Theory in research*

Critical theory is however, not without critique. Morrison (1995) questioned the link between ideology critique and emancipation, and the assumption that a person or society can become emancipated simply through the exercise of ideology critique or action research.

Furthermore, claims have been made (under critical theory) that action research has powers to empower participants as researchers (e.g. Carr and Kemmis, 1986; Grundy, 1987). This is considered by some educational research critics to be over-optimistic, especially in a world in which power is often exercised through statutory mechanisms, where the reality of power within these structures seldom extends to teachers (Cohen et al., 2010). Bernstein's (1970) famous comment that "education cannot compensate for society" supports the point that teachers might exercise some power in schools but this has little effect on the working of society at large (p.32). In this research I took these critiques seriously and engaged in curriculum critique and transformation processes in the context of statutes that are already in existence. For example in the BTTC case study, the Zimbabwe National Gender Policy was the central state document used to empower SMTs teacher educators towards gender responsive curriculum practices. Likewise, with the UKZN case study, the state-drafted South Africa's National Gender Policy Framework's was also at centre of the research process. The curriculum transformation process was therefore limited to addressing a policy-practice gap, rather than initiating or challenging the policy, although the policy was also not uncritically viewed as revealed in Chapter Two. I tried however, not to "overclaim" transformational powers for the research process, choosing rather to report carefully what did happen as well as what did not, with respect to the transformational intent. It therefore follows that the empowerment process of teacher educators was agential as discussed in Section 1.7 entailing an ability to "coordinate one's actions with others and against others, to form collective projects, to persuade, to coerce, and to monitor the simultaneous effects of one's own and others' activities" (Sewell, 1992, p.21).

#### **4.2.3 Developmental Work Research (DWR)**

*Instead of just benign achievement of mastery, development should be viewed as partially destructive rejection of the old; instead of just individual transformation, development should be viewed as collective transformation; instead of just vertical movement across levels, development should be viewed as horizontal movement across borders.*  
(Engeström, 1999, in Warmington et al., 2005, p.2)

I used Developmental Work Research as the primary methodology for this research. DWR was developed in Finland at the centre of Cultural Historical Activity Theory as a form of applied activity theory (Senteni, 2005). Engeström (2001) proposed DWR as a methodology for supporting and developing expansive learning. As alluded to in the above quotation, the notion of expansive learning offers a framework for understanding forms of learning that do not adhere to standard models of "vertical mastery", in which a stable, defined body of

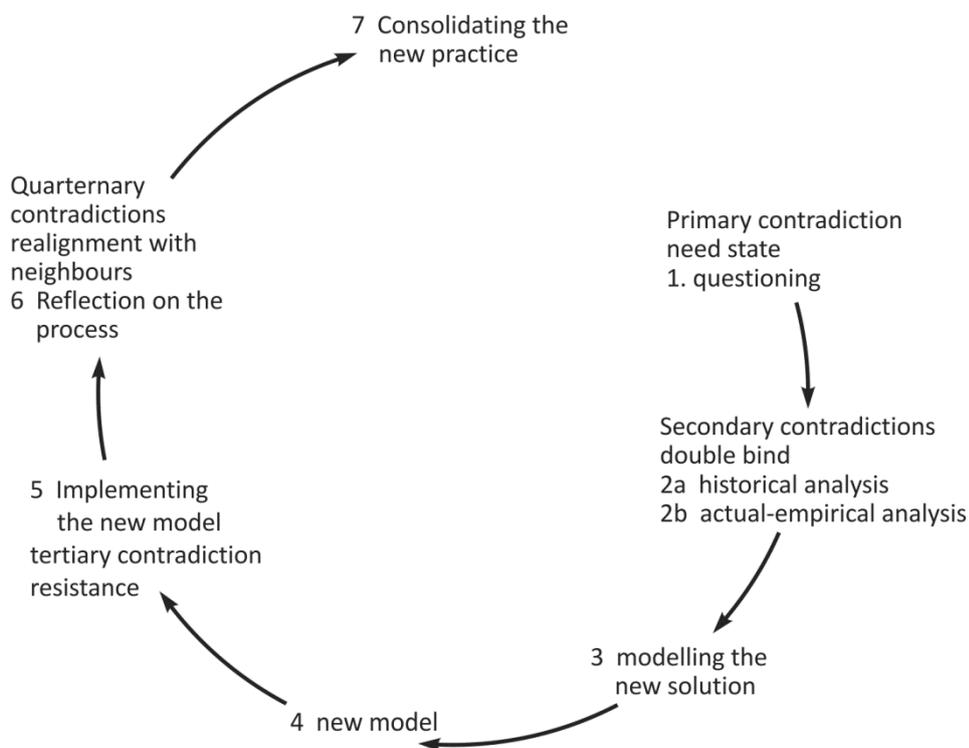
knowledge and skills is acquired by individuals or organisations that then ascend through levels of increasing competence (Warmington et al., 2005, p.3). Inherent in the above quote is Engeström's (2004, p.4) point that expansive learning is also "intertwined with horizontal or sideways movement across competing or complementary domains and activity systems". Thus horizontal, expansive learning comprises both "transferring and creating knowledge" (ibid.). The creation of knowledge occurs simultaneously with learning and these processes cannot be separated from each other "... knowledge is not about putting theory into practice but about the transmission and transformation of practices" (Puonti, 2004, pp. 52-53, cf. Turnbull and Beese, 2000). In this regard, I considered DWR's potential for embedding conceptual tools capable of expanding professionals' thinking and practice by confronting „everyday“ concepts with „scientific“ concepts, its potential to raise questions about the extent to which it is possible to develop intervention techniques in which researcher and participant relationships are dialogic and collaborative, and in which practitioners are able to co-construct expansive, transformative learning (Warmington et al., 2005, p.1). In this study, a typical example of collective transformation involving vertical movement across levels, as well as horizontal movement across borders, was experienced as discussed in Chapter Eight. Commenting on this in capability terms, Crocker (2008) saw this as agency; what human beings can do to achieve improvements, particularly through policy and political changes. He added that the agency aspect is concerned with the role of human agency for changing policy, social commitment, and norms for the achievement of states of well-being. Human beings can be agents of change through both individual action and collective action (ibid.). It is for this reason that Sen (2009) regarded agency as itself a valued functioning.

DWR has been developed as a framework for promoting new knowledge creation: a framework in which learning is conterminous with the creation of new forms of activity, in which activities are learned *as* they are created (Engeström, 1999; 2004). DWR employs the notion of radical exploration, which results in learning what is not yet there (Warmington et al., 2005). "Radical exploration is learning that which is not yet there. It is creation of new knowledge and new practices for a newly emerging activity, that is, learning embedded in and constitutive of a qualitative transformation of the entire activity system" (Engeström, 2004, p.4). He further added:

*In the approach advocated here, research aims at developmental re-mediation of work activities ... research makes visible and pushes forward the contradictions of the activity under scrutiny, challenging the actors to appropriate and use new conceptual tools to analyse and redesign their own*

*practice ...practitioners are invited to take part in analysing the disturbances of their activity. Practitioners are asked to perform essentially the same analysis, to appropriate and use the same conceptual tools as the researchers. (Engeström, 1999 in Warmington et al., 2005, p.16)*

In this particular study, DWR enabled me to be both a researcher and a participant, and in this case my role was mainly to facilitate SMTs teacher educators to reflect on and question their curriculum and their curriculum practices. Through DWR, I also assumed the role of an analyst, with a systemic view of ongoing activities in activity systems and reflected that to participants as mirror data. Throughout the process, I was guided by Engeström's (1999, 2001) notion of the expansive learning cycle, as beginning with the „germ cell“ of individuals questioning embedded workplace practices and progressing through stepwise transformations in collaborative practice into a new form of practice (Figure 4.2).



**Figure 4.2** Cycle of expansive learning (Source: Engeström, 2001)

Engeström (1987) described a need in terms of a recurring set of problems that are expressions of a historically formed, relatively persistent, critical internal contradiction of the activity in question. He also used the concept of „double bind“ to refer to “a social, societally essential dilemma that cannot be resolved through separate individual actions alone” (p.165). This dilemma, he explained, is expressed as a need state, a specific state of indeterminacy. Of particular important to this study is Engeström's advice that, although it (need state) is experienced and conceived individually, its solution calls for the collective articulation of a

solution, an expanded object and motive with adequate instrumentalities and in the process, both the activity and the individuals are transformed.

Building upon the principle of expansive, collective transformation, DWR promotes the questioning of contradictions in existing practice in order to germinate expansive learning or, as it is frequently termed, „radical exploration“. I saw this dovetailing well with the curriculum transformation intent of the study. The first phase in the methodological cycle is designated the “phenomenology and delineation of the activity system” (Engeström, 1987, p.334). The second phase is the analysis phase composed of three kinds of analysis (Miettinen, 2009): object historical, theory historical and actual empirical. True to this, in the Change Laboratory Workshops we analysed empirical data from the exploration phase and together with the participants did a historical analysis of the object and drew on theory produced on the object and came up with explanations (see Chapters Five, Six and Eight). The aim of the analysis was to make participants face the secondary contradictions, as Engeström (1987) puts it, “the analysis functions as a midwife for bringing about a double bind or at least a grasp of the double bind in the form of intense conceptual conflict” (p.335). An outcome of these analyses is a hypothetical picture of new forms of work. The hypothesis includes an instrumentality, a new solution to the contradictions of an activity system (Miettinen, 2009).

In DWR methodology Engeström’s concept of *boundary-crossing* (see Section 3.4.5) offers a potential means of conceptualising the ways in which collaboration between workers from different professional backgrounds might generate new professional practices. A boundary can be a socio-cultural difference leading to discontinuity in action or interaction (Akkerman and Bakker, 2011). They add that boundaries simultaneously suggest a sameness and discontinuity. I found this illuminating in the sense that although there are some cultural differences between the current SMTs teacher education curriculum (central activity system) and other surrounding activity systems, as well as with the advanced ESD informed curriculum activity system (higher activity system) that causes discontinuity (see Sections 4.2 and 5.1), at the same time, sameness and continuity reside in the fact that both activity systems are concerned with pedagogy and the learning progress of student teachers. The central focus in this study, guided by DWR was, therefore, surfacing and responding to challenges facing boundary crossing, constructing boundary objects, artefacts that facilitate boundary crossing by fulfilling a bridging function (Akkerman and Bakker, 2011).

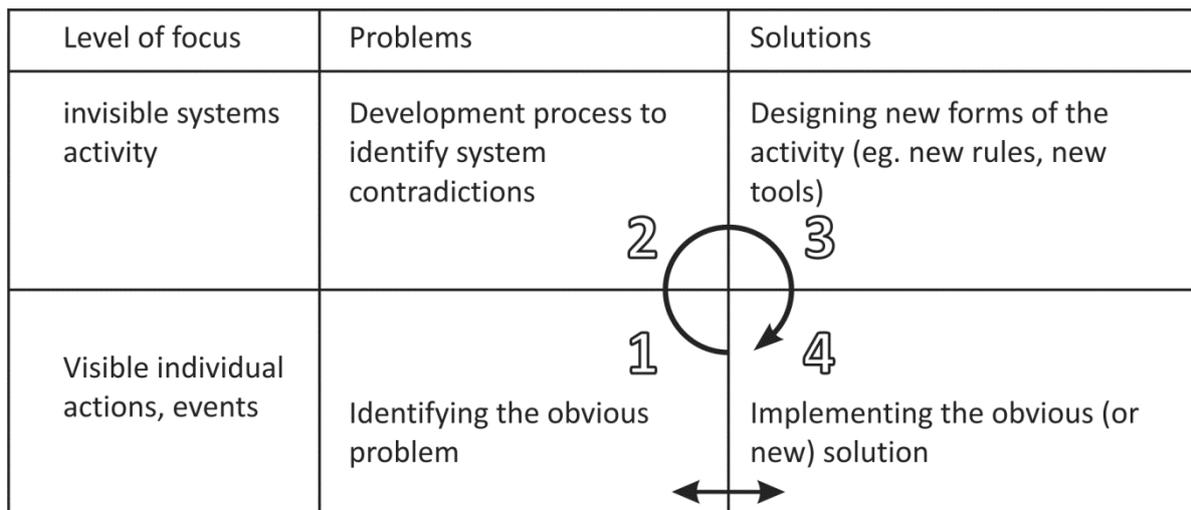
DWR methodology is organised around practitioner (participant) workshops, sometimes referred to as „boundary-crossing laboratories“ or „change laboratories“ (Warmington et al., 2005) (see Section 4.4.5).

The following steps were applied to DWR in this study (see Figure 4.2):

- i. Questioning and analysing: collaboratively drawing on research evidence to question existing practice/wisdom (Edwards, 2007; Leesa 2007).
- ii. Analysing the systemic and historical causes of such practices and bringing these analyses to bear in analysing current dynamics within and across services (Daniels, 2008). Work actions were represented in socio-spatial dimensions. Data from literature and the exploration phase was used as mirror data.
- iii. Modeling: involved construction of new ways of working or engaging with practice (ibid.). This meant engaging SMTs teacher educators in designing, representing and reflecting on new work actions with their associated artefacts.
- iv. Examining: experimenting with the new model to fully grasp its dynamics, potentials and limitations with the intention of re-organising to solve contradictions that may hinder the outcome of gender responsive curriculum practices.
- v. Implementing the new model: refers to working with the new model in real life situations and monitoring its impact.
- vi. Reflecting, consolidation and spreading new practice: involves monitoring and revising solutions in feedback sessions using videotaped data as well as actual documents and other actual documents from the newly designed practice as well as teaching others. This may also include codifying new rules, syllabi and policies.

In DWR, it is important to keep in mind that socio-cultural research takes place in activity settings, depicting individuals in their activity environments with a common goal. It is this shared goal that brings certain individuals together. As Engeström (2000) has pointed out, people only grasp the potential for innovation when their focus shifts from individual actions to the collective system of activity. However some researchers found this challenging, that is ways to represent this and make it visible, so that people can solve problems together and create new systems solutions (e.g. Seppänen, 2004; Hill et al., 2007). Hill et al. (2007) further discovered that, in the New Zealand workplace learning culture, people tended to resolve problems and manage change by connecting the “obvious” problem (see Figure 4.3, quadrant

1) to an immediately “obvious” solution to that problem (quadrant 4), without getting deeper into the contradictions and the underlying mechanisms (p.363). It is for such reasons that the model in Figure 4.3 was developed (Hill et al., 2007) to help people to move through a more robust problem identification process that accounts not only for visible problems (actions or events) but can also uncover the more invisible activities that may give rise to these problems. This process, which I also found very useful as a mediating tool in expansive learning, is represented as a circular movement through quadrants 1, 2, and 3 with the possibility that with this more comprehensive understanding, participants are able to design new forms of the activity, and these give rise to specific actions that can be implemented to provide new solutions (quadrant 4). I employed double stimulation during Change Laboratory workshops, with mirror data providing the first stimulus. I also used problem solving questions to push discussions from visible actions into invisible system activity (see Chapter Eight).



**Figure 4.3** Stepwise problem solving in CHAT (Hill et al., 2007, p.364)

Perfect as it may sound, DWR is not without critique as a research tool. In Section 3.4 I tried to pull together some of the challenges that one may encounter when using CHAT and DWR in interventionist studies. These are the same challenges that I kept an eye on, throughout the research journey.

#### 4.2.4 Case Study as a Research Methodology

*A case is a noun, a thing, an entity; it is seldom a verb, a principle, a functioning. Schools may be our cases – real things that are easy to visualise... Training modules may be our cases – amorphous and abstract, but still things, whereas „training“ is not. Nurses may be our cases; we usually do not define „nursing activities“ as the case. „Managing,“, „becoming effective,“, „giving birth,“ and „voting“ are examples of*

*functioning, not entities we are likely to identify as cases. For our cases, we may select ,managers, ,production sites, ,labour and delivery, or ,training sessions for voters. With these cases we find opportunities to examine functioning, but the functioning is not the case. (Stake, 2009 in Merriam, 2009, p.41)*

A case study is an in-depth description and analysis of a bounded system (Merriam, 2009). Yin (2008) defined case study in terms of the research process – “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (p.18). I found this to be an important deciding factor in using case-study methodology as it allows for an in-depth exploration of, for example, the cultural-patriarchal context and gendered curriculum practices in SMTs education (cultural context and curriculum practices boundaries which are not always clearly defined). Reflecting on Stake’s quotation above, my focus was on SMTs curriculum practice which is a functioning, not an entity. I had therefore to select SMTs teacher education activity systems as entities, that is cases to examine the functioning of curriculum practice. Using CHAT language, curriculum practice was therefore the object that was being worked on throughout the study.

Cresswell (2007, p.73) gave a more detailed definition of case-study methodology:

*... case study research is a qualitative approach in which the investigator explores a bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information (e.g. observations, interviews, audio-visual material, and documents and reports.*

Of particular importance to this study, which also resonates with CHAT, is the delimiting (bounded system, the case) characteristic of a case study, as the above quote suggests, a single entity, a unit around which there are boundaries (could be a unit of analysis in CHAT terms). Stake (2005, p.443) added that case study is less of a methodological choice than “a choice of what is to be studied”. Flyvbjerg (2006) concurred: good social science is problem driven and not methodology driven, in the sense that it employs methods for a particular problem.

The above characterisations bring out special features that define qualitative case studies all of which were pertinent to this study: particularistic, descriptive and heuristic. Particularistic means case studies focus on a particular situation, problem, event, programme, or phenomenon. According to Merriam (2009) this specificity of focus makes it an especially good design for practical problems – for questions, situations, or puzzling occurrences arising

from every day practice. It is for this reason that I used it to question gender related puzzling occurrences in science teacher education curriculum. Descriptive means that the end product of a case study is a rich, “thick” description of the phenomenon under study (ibid., p.43). Flyvbjerg (2006, p.238) calls it “telling the story in its diversity, allowing the story to unfold from the many-sided, complex, and sometimes conflicting stories that the actors in the case have told me”. For this reason case studies have been labelled holistic, lifelike, grounded, and explanatory (Merriam, 2009). Of interest to this study was the fact that such descriptions can be creative, using prose and literary techniques to convey researcher’s understanding of the case as articulated in the following chapters. Heuristic means that case studies illuminate the reader’s understanding of the phenomenon under study. In support of this, Stake (2007, p.3) in what he calls “naturalistic generalisation” argued that:

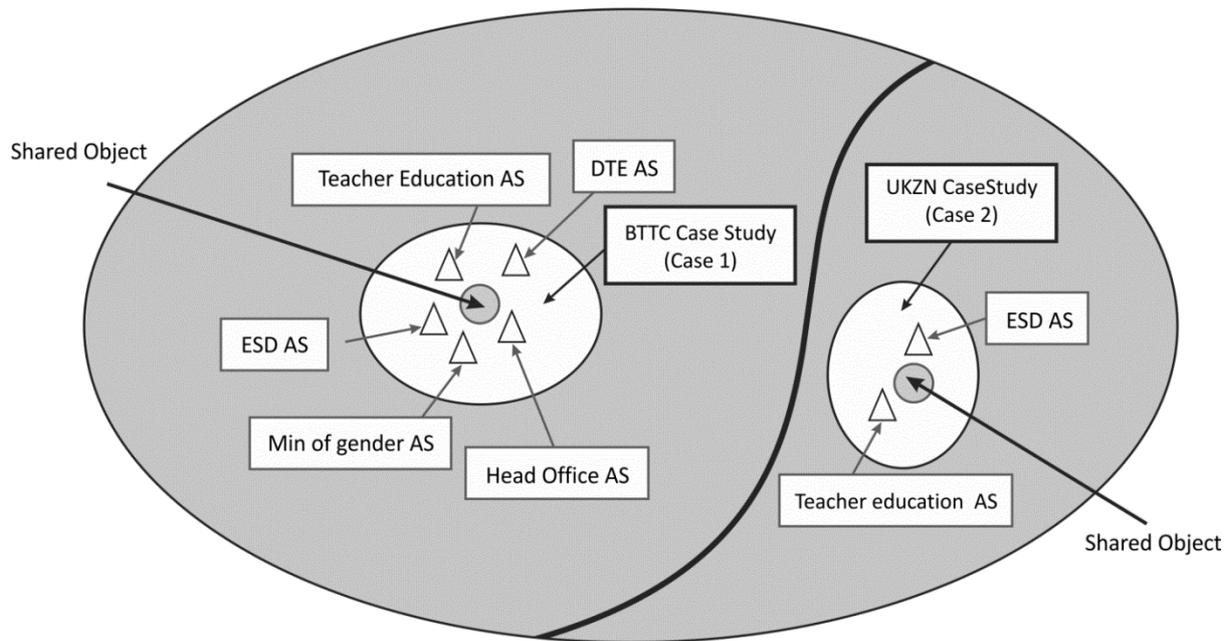
*a case study provides vicarious instances and episodes that merge with existing icons of experience ... sometimes an existing generalisation is reinforced; sometimes modified ... qualitative case study is valued for its ability to capture complex action, perception, and interpretation.*

Of interest to note is that heuristic in case study design hinges on trustworthiness of the research and it is used as such in this study (see Section 4.5).

A particular concern about the use of the case study is that it addresses the “what” question that addresses exploratory matters as well as the “why and how” that seek out the explanations (Yin, 2008, p.2). Missing, however is the “so what” question, the question that would address interventionist efforts. To address this, I drew inspiration from Habermas, (1972) in Cohen et al. (2000; 2010), who from a critical research perspective, saw the need to take advantage of exploration in case studies, but go beyond them, to praxis-action that is informed by reflection with the aim to emancipate. Alderman et al. (1980) cited by Lotz-Sisitka and Raven (2004) described case studies as a “step to action” (p.71). Furthermore Toma (2011) proposed that case study research can fit within the paradigm of participatory research. He argued that the participatory paradigm reflects more experiential reality and is grounded in practical knowledge, and consequently creates findings that prompt collaborative practical action. In a similar way, as Lotz-Sisitka and Raven argued (2004), my primary reason for using case-study methodology was to provide in-depth perspectives which could be directly interpreted and put to use, with an interest in the “action-based, contextually situated nature of case-study methodology” (p.71).

#### *4.2.4.1 Multisite Case Studies with related Activity Systems*

In this study a minimum of two networked activity systems constituted a case study (see Figure 4.4).



**Figure 4.4** Networked activity systems (cases) in a case study

As shown in Figure 4.4, the various activity systems are related cases within the case. The strength of examining learning situations using activity systems is that it does not only allow the analysis of collective action as a unit of analysis but also allows research to capture (a) the dynamic structure of the activity, (b) the historical development of the activity, and the multi-voiced nature in the formation of human activity (Engeström, 1993, 2007b; Yamagata-Lynch, 2003). In nested case studies with a network of activity systems, it is possible that the unit of analysis changes from one activity system (case) to a network of activity systems (networked cases), making it possible to “follow the object” across organisational boundaries (Miettinen, 2009). Such a methodological arrangement made it possible for me to analyse learning across horizontal and vertical boundaries as discussed in Chapter Eight.

### 4.3 RESEARCH PROCESS

#### 4.3.1 Choosing study sites

As discussed earlier, the intention of the study was to contribute, in a small way, towards a more just, egalitarian and sustainable society through curriculum transformation. I used a case study research design because the study sought to understand (explore) and influence transformation of curriculum practices (expand) in naturally occurring settings. The study was situated in the Southern Africa Development Community (SADC) region. I chose two cases: one in Zimbabwe and another South Africa. In both cases my focus was on SMTs

teacher education activity systems (and related activity systems), bearing in mind that all the SADC countries face more or less similar challenges in terms of gender equality in science disciplines as well as socio-ecological risk as discussed in Section 2.4.

The cases were chosen purposively and strategically. Studying in South Africa and being a Zimbabwean I had to select cases strategically that I could manage to visit regularly. The other criteria for case selection were that the teacher education should be offering a variety of science and technical subjects. Flyvbjerg (2006, p.230) called this information oriented selection, where “cases are selected on the basis of expectations about their information content”. In order to maximise the possibility of getting more information from a small sample and single institutions I had to look for a case with a large number of potential participants. I used two teacher education institutions, University of KwaZulu-Natal School of Education in South Africa and Belvedere Technical Teachers’ College in Zimbabwe. The population of the study included all the SMTs teacher educators in these two institutions. Sampling was guided by Engeström (2007a), who said participants in socio-cultural research are not sampled in anyway, but are determined by the activity setting; therefore in both sites, SMTs teacher educators were involved in the study. As highlighted in Section 3.4.2, the unit of analysis evolved. Analysis guided by the first generation CHAT (Section 3.4.1.1), based on Vygotsky’s work, mediated action (curriculum practice) in the central activity system was the unit of analysis. It was expanded through insight from second generation CHAT (Section 3.4.1.2), based on Leont’ev’s (1978, 1981) work, so that collective activity system became the molar unit of analysis. And in applying third generation CHAT analysis, the unit of analysis became the interaction between the teacher education activity system and various other institutions (activity systems) that share the common object of teacher education, (Section 3.4.1.3).

From this initial sampling and focus, I then followed the object as directed by the data generated. For example, in the BTTC case study, after discovering that teacher educators were not aware of the policy pronouncement on gender, I had to follow up with the policy/rule making activity system (Ministry of Gender) as well with the other tool/rule making activity systems (Department of Teacher Education and Ministry of Higher Education). The unit of analysis was evolving as discussed above. The UKZN case study had a different structure as everything was contained within the same institution.

#### ***4.3.2 Phases of the study***

Because of the nature of the objectives, the study was divided into two phases: exploration and expansion as shown in Figure 4.1.

#### *4.3.2.1 Exploration Phase*

The exploration phase responded to the first three objectives of the study:

- to assess the level of gender and sustainability responsiveness of SMTs teacher educators;
- to scrutinise underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices in SMTs teacher education;
- to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context.

In this phase, I used research methods such as document analysis, in-depth interviews and focus group interviews (see Section 4.4 below). This methodological triangulation enhanced the trustworthiness of the research as discussed in Section 4.5. Data generated in this phase formed part of the mirror data that was used together with literature based data in change laboratory workshops. Implementation of this phase involved preparation before the study, adjustments during the study and analysis and reflections during and at the end of the study.

Preparation involved careful crafting and pilot testing of research tools (in-depth and focus group interview guides). I also had to consider documents for analysis: which documents to look for, where they might be and what to look for in a particular document. Acquiring audio and video recording equipment and establishing contacts as well seeking for permission to conduct research (see Appendix 1), were also part of the preparation. Adjustments were made to the research tools according to the feedback from the pilot stage. As reported in Section 1.7, reflexivity was a mechanism that I applied. This helped me to adjust aspects of the research process. Fieldwork involved interviews and document analysis. All the interviews were audio recorded and later transcribed. The exploration phase also provided the context and historicity required for the expansive phase. It is through this that I managed to strengthen my position as an analyst and this gave me the opportunity to develop a systemic view of each case study and related activity systems.

#### *4.3.4.1 Expansive Learning Phases*

The expansive phase responds to the last objective of the study (to develop mediation tools that support expansive learning for gender and sustainability responsive teacher education curriculum practices). In this phase, I used Change Laboratory Workshops, guided by the

DWR design, along with focus group discussions (see Sections 4.4.4 and 4.4.5 respectively). Together with research participants, analysing and historicising contradictions were necessary to trace and explain curriculum disturbances, and cultural myths associated with gender issues in society in general and in curriculum in particular. The intention was to build agency in teacher educators, the ability to reflect on current practice, to work on tensions and disturbances to improve these, with the hope that such pedagogic practices would develop agentic practices in future teachers. In other words, the aim was to produce teachers with the capacity to provide opportunities (agency freedom) for both genders in SMTs. Chapter Eight reports fully on the Change Laboratory Workshops that took place in the study.

#### **4.4 RESEARCH METHODS**

*Whether in fieldwork or library work, the data collection is guided by questions, educated hunches, and emerging findings. Tracking down leads, being open to new insights, and being sensitive to data are the same whether the researcher is interviewing, observing or analysing documents. Since the researcher is the primary instrument for gathering data, he or she relies on skills and intuition to find and interpret data from documents. (Merriam, 2009, p.150)*

##### **4.4.1. Document analysis**

Documents carry the culture, history and context of practice. They are not dependent upon the whims of human beings whose cooperation is essential for collecting good data through interviews and observation (Merriam, 2009). Given that I was using CHAT and feminist approaches, two paradigms that are historical, cultural and context dependent, document analysis formed an important part of the data generation process. Documents that are ordinarily used as tools in teaching and learning and specific documents that provide curriculum guidelines as rules were targeted. Leads were also used during the research process to get more documents that could have information for the study. The documents that I used in the study include syllabi, course outlines, policies, notes, books, brochures, reports and mark lists. A full list of documents analysed for each case study is provided in Table 4.1 below. The following guidelines on using documentary material as data were useful to me in this study: finding relevant material, keeping an open mind when it comes to discovering useful documents, assessing the authenticity and accuracy of located documents as part of the research (ibid.).

**Table 4.1** List of documents analysed in the two case studies

Case Study	Titles of Documents
Belvedere Technical Teachers' College	<ol style="list-style-type: none"> <li>1. Science Methodology course</li> <li>2. Mathematics diploma in Education Programme Booklet</li> <li>3. Technical and Vocational Education Pedagogics syllabus</li> <li>4. Mathematics Post „A“Level syllabus</li> <li>5. Science Post „A“Level syllabus</li> <li>6. Students' research projects</li> <li>7. Strategy of Education for Sustainable Development in Sub-Saharan Africa: UNESCO (2006a)</li> <li>8. Strategy of Education for Sustainable Development in Zimbabwe: Ministry of Education, Sport and Culture (2006)</li> <li>9. Zimbabwe National Gender Policy (2004)</li> <li>10. 2010 MDGs country report for Zimbabwe</li> <li>11. Steep Guide to Resource Materials (2006)</li> <li>12. Environmental Education in Action in Secondary Teacher Training in Zimbabwe (2004)</li> <li>13. Zimbabwe Education for All country report (UN, 2010)</li> <li>14. Economic Commission for Africa (2010)</li> <li>15. SADC Protocol on Gender Equality (2008)</li> <li>16. Beijing Platform for Action country report</li> <li>17. SADC RISDP report</li> <li>18. UNESCO 2011 ESD expert review report</li> <li>19. UNESCO 2012 ESD expert review report</li> </ol>
University of Kwazulu-Natal	<ol style="list-style-type: none"> <li>1. Biological Sciences for Educators: Syllabus</li> <li>2. Biological Sciences for Educators: Assessment Project</li> <li>3. Physical Sciences for Educators</li> <li>4. Agricultural Sciences Teaching: Syllabus</li> <li>5. Agricultural Sciences Teaching: Student Project</li> <li>6. South Africa's National Gender Policy Framework</li> <li>7. 2010 MDGs country report for South Africa</li> <li>8. The South Africa Education for All country report (UN, 2010)</li> <li>9. Economic Commission for Africa (2010)</li> <li>10. SADC Protocol on Gender Equality (2008)</li> <li>11. National Curriculum Statement Grades 10-12 Physical Sciences</li> <li>12. SADC RISDP report</li> <li>13. UNESCO 2011 ESD expert review report</li> <li>14. UNESCO 2012 ESD expert review report</li> <li>15. SADC Protocol on Gender Equality (2008)</li> <li>16. Beijing Platform for Action country report</li> <li>17. Strategy of Education for Sustainable Development in Sub-Saharan Africa (UNESCO, 2006a)</li> </ol>

For the analysis of data obtained from documents I was guided by Merriam (2009) who argued that data from documents can be used in the same manner as data from interviews or observations. The data can furnish descriptive information; verify emerging hypotheses, advance new categories, offer historical understanding and developments.

I also used researcher generated documents. These are documents prepared by the researcher or for the researcher by participants after the study has begun (ibid.). These include a diary or a log of activities by a participant during the course of the investigation or even photographs taken during the research process. A good example is a diary and minutes of proceedings that was developed by one UKZN participant detailing a relevant curriculum review process that was taking place in a department during the time of research (Document 1-3 in Table 4.1). Quantitative and qualitative data that I compiled for use in either subsequent interviews or as mirror data in Change Laboratory Workshops also fall in this category.

Considering that I used the ESD policy activity system as a more advanced system informing expanded curriculum practices (Chapter Two), it follows that I needed to be conversant with this policy and other related documents. I therefore used relevant documents for this purpose as shown in Table 4.1. I also used relevant documents on science teacher education curriculum: syllabi and syllabi review policies, relevant science education policies, books, records of enrolment, assessment profiles and reports, learning support materials, articles and other pedagogical and administrative documents that I deemed relevant to the research. As reflected in the above quotation, I obtained some of the documents through tracking down leads, being open to new insights, and being sensitive to data coming in. One of the advantages of document analysis is its unobtrusive and non-reactive nature; one can infer issues of gender as they apply to science teaching and learning with minimum human reaction. Documents further assisted me to assess the extent to which science education current curricula consider the functionings and capabilities of females in relation to increased socio-ecological risk. Access to these documents was negotiated prior and during the course of the study.

#### 4.4.2 Individual Interviews

DeMarrais (2004) defined an interview as a process in which a researcher and a participant engage in a conversation focused on questions related to a research study. Patton (2002) added that the researcher wants to find out what is “in someone else’s mind” (p.341).

*We interview people to find out from them those things that we cannot directly observe ... we cannot observe feelings, thoughts and intentions, we cannot observe behaviours that took place at some previous point in time ... We cannot observe how people have organised the world and the meanings they attach to what goes on in the world. We have to ask about things. The purpose of interviewing, then, is to allow us to enter into the other person’s perspective.*  
(p. 340-341)

I found the attributes in this quote important to this study as I wanted to understand cultural beliefs (habitus), feelings, meanings and thoughts that influence curriculum organisation and curriculum practice of SMTs teacher educators. Working with CHAT, I also had to conduct interviews to develop an understanding of the historical perspective and the activity systems. Interviews are categorised philosophically in line with the research orientation. Roulston (2007) came up with six conceptions of interviewing, each lodged in a different theoretical framework:

- Neo-positivist interviews are those in which the researcher upholds a neutral stance to minimise bias, skilfully asks good questions, generates quality data and produces valid findings.
- In romantic conceptions of interviewing, which largely draw from phenomenology, feminist research and psychosocial research, the researcher makes no claim to being objective, analyses reveals subjectivities and strive to generate the kind of conversation that is intimate and self-revealing.
- Constructivist interviewing focuses on how interview data are constructed through such tools as discourse analysis, narrative analysis and conversation analysis.
- Postmodern interviewing, congruent with postmodern theory, does not aim to come up with a single perception of self but various non-unitary performances of selves.
- Transformative interviewing is based on a critical philosophical orientation in which issues of power, privilege and oppression are made visible.
- De-colonising interviewing is based on critical philosophical orientation but aims at restorative justice of indigenous people.

The transformative interview was the most appropriate to this study since it is consistent with the methodological paradigm of the study (see Section 4.2). Some aspects of Romantic conceptions of interviewing also played a role in shaping the interview process especially for the exploration phase. The idea was to reveal subjectivities and to generate the kind of conversation that is intimate and self-revealing, information that formed part of the mirror data in Change Laboratory Workshops. However, as a standpoint researcher, I did not claim to be objective. Constructivist interviewing was also evident in focus group interviews through conversation analysis as discussed in Section 4.4.3.

Interviews are also categorised by structure. The continuum varies from highly structured, semi-structured to unstructured. I used semi-structured in-depth individual interviews to generate most of the data for the exploratory phase of the research. In semi-structured interviews, all questions are asked flexibly, without any predetermined wording or order and there is usually specific data required from all respondents (Merriam, 2009). The flexibility of semi-structured interviewing allowed me to obtain relevant information related to the research interest from different participants. This format also allowed me to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic. Bloor and Wood (2006) supported in-depth interviewing (semi-structure interviewing) saying the process sacrifices reliability in pursuit of validity, meaning that such interviews give prominence to accessing fully the social meaning at the expense of repeatability, an account that I found reasonable for this study.

In designing the in-depth interview guide I followed the advice of Patton (2002) who classified types of questions that stimulate responses from interviewees as well as probe for deeper insights on a topic:

- Experience and behaviour questions – to discover what a participant does or did in his/her curriculum practice.
- Opinion and values questions – here I was interested in individual beliefs or opinions, what participants thought about related issues, bearing in mind that gender issues are value laden and highly culturally dependent.
- Feelings questions – to gain access to the affective dimension of human life.
- Knowledge questions – to elicit a participant’s actual factual knowledge about a situation, for example the prescriptions of particular policies e.g. national gender policy or MDGs on teacher education.

I also used some techniques to ensure rigour and depth, such as asking open-ended questions, probing, immediately cross-checking on important information and audio recording the interview as shown in Appendix 4.1. As a standpoint researcher, I also used some leading questions to “uncover the vested interest at work which may become consciously or subliminally adopted as part of normalising cultural practice, revealing to participants how they may often paradoxically be acting to perpetuate an unjust system” (Cohen et al., 2010, p.29).

As shown in Appendix 4.1, the interview guide was also constructed with CHAT in mind. The idea was to use the aspects of the activity system to make sense of the practices in the activity system as later discussed in Chapters Five and Six

#### *4.4.2.1 Generating data with individual interviews*

Within the Belvedere Technical Teachers’ College (BTTC) case study, there were four activity systems (see Section 4.2.2.1). These are the teacher education institution itself (BTTC, the central activity system); Department of Teacher Education (tool/rule making activity system); Ministry of Higher Education (rule and subject producing activity system); and Ministries of Gender and Environment (tool producing activity system).

For BTTC I had a total of six in-depth individual interviews: four with the management, comprising of three lecturers in charge of Sciences, Mathematics and Technical subjects and the head of the department. I had planned to interview a lecturer in each section, but I ended up with only two. For the four managers, lecturers in charge and head of department, sampling was purposive, and they were all males. The intention was to understand policy implementation and curriculum development aspects of gender issues in SMTs, as well as the curriculum response to socio-ecological risk. Sampling for the three lecturers was largely stratified to accommodate one from each learning area. It was also convenient in the sense that I had to speak to those who were available and willing. I managed only two interviews instead of three largely due to time and work commitments. Table 4.2 shows the details of the interviewees.

For the Ministry of Higher Education, usually referred to as head office, I interviewed the deputy director and a UNESCO desk official, all in the section of teacher training. Both were male. Sampling was purposive; I was advised to interview these two officials after I requested permission to do this study from the ministry. The UNESCO desk is a ministerial entry point for UNESCO related material. For the Department of Teacher Education, I

interviewed two lecturers, both females. Again I was directed to them because they were the ones driving the gender, environment and sustainability agenda in the unit. For the Ministry of Gender, I interviewed the deputy director who further referred me to a gender focal person in the Ministry of Higher Education.

**Table 4.2** Interviewee details in the BTTC case study

Interviewee	Gender	Designation	Years of experience	Date of interview
BInt1	M	LIC	18	01/08/2010
BInt2	M	LIC	14	02/08/2010
BInt3	M	LIC	17	03/08/2010
BInt4	M	HOD	18	02/08/2010
BInt5	F	Lecturer	9	03/08/2010
BInt6	F	Lecturer	9	01/08/2010
DTIn1	F	Lecturer	13	02/12/2010
DTIn2	F	Chairperson	15	02/12/2010
HOInt1	M	Deputy Director	27	06/12/2010
HOInt2	M	UND	15	06/12/2010
HOInt3	F	GFP	12	23/06/2011

Key: LIC - Lecturer in charge; UND - UNESCO Desk (official); GFP - gender focal person

With UKZN I held a total of six individual in-depth interviews, one in each discipline of SMTs education that is, mathematics, chemistry, life sciences, educational development and physics and one with the head of the teacher education school. Sampling was stratified in the sense that I wanted representation of all the sub-disciplines. Availability also played a big role as participants chose whether or not to participate in the study. Educational development was not within the immediate focus of the study but had to be included it as it is within this discipline that social issues such as gender and environmental education are taught; hence it contributed to the construction of the ESD activity system as shown in Chapter Six. All the interviewees who agreed to take part in the study were females.

**Table 4.3** Interviewee details in the UKZN case study

Interviewee	sex	Designation	Years of experience	Date of interview
UInt1	F	Section head	19	07/12/2010
UInt2	F	Section head	18	07/12/2010
UInt3	F	Lecturer	13	08/12/2010
UInt4	F	Section head	15	08/12/2010
UInt5	F	Lecturer	16	08/12/2010
UInt6	F	HOS	17	06/09/2011

#### ***4.4.3 Generating Data with Group Interviews***

I also used focus group interviews to generate data for the exploration phase of the study.

Krueger (2008) defined „focus group“ as a carefully planned discussion designed to obtain perceptions in a permissive, non-threatening environment, on a topic with a group of people who have the knowledge of the topic. Merriam (2009) added that since the data obtained from a focus group is socially constructed within the interaction of the group, a constructivist perspective underlies this data collection procedure. This constructivist notion feeds into the following insights on focus group interviews reported by Cohen et al., (2000), Struwig and Stead (2001), Patton (2002) and Merriam (2009) which I found very helpful in this study:

- In focus groups, participants challenge and extend each other’s ideas and introduce new ideas into the discussion. Deepening and broadened contestations provided me with fertile ground to surface tensions and contradictions that I used later in Change Laboratory Workshops.
- Focus groups generate a wider range of responses than individual interviews. This resonates well with the principle of „multi-voiced“ in CHAT and also assisted me in broadening the scope of individual interviews.
- Focus groups bring together people with varied opinions or representatives of different collectives. I used the technique to break the subject/departmental divide that characterises most tertiary institutions. Through this I was able to establish some history and a wider cultural context of gender issues in SMTs and as well as make sense of different opinions on gender issues pertaining to socio-ecological risk.

I also employed the following techniques proposed by Cohen et al., (2000) and Struwig and Stead (2001) to facilitate the smooth progression of interviews: skilful chairing; starting with more general and less threatening questions; listening and showing an interest in what is being said; encouraging a wide range of opinions; assisting participants to explore their ideas further; avoiding belittling participants; tactfully redirecting questions when people become repetitive or stray from the topic.

All in all I held four focus group interviews, three for the BTTC case study and one for the UKZN case study. Two of the BTTC case study focus groups were at the education institution. The first one was with science and maths teacher educators and the second was

with Technical subjects teacher educators. I separated the two for convenience and availability reasons. It was difficult to bring the two groups together because the timetable did not permit this. Also, working with two groups allowed for more manageable numbers. The first focus group had 12 and the second 18 people. I later held another focus group interview with Department of Teacher Education with nine people. Each group interview took more than two and half hours and everything was audio recorded. Transcripts were later sent back for member checking. With the UKZN case study I had one focus group interview with seven people. Initially I had planned two, but I only managed to do one, partly because the case study is less heterogeneous than I thought and logistically it was so difficult to bring teacher educators together. I compensated for not having the second focus group interview by making sure the individual interviews were detailed and Change Laboratory Workshops added further data.

#### ***4.4.4 Focus group discussions***

Unlike in a focus group interview, in focus group discussions participants interact with each other rather than with the interviewer, so that the views of the participants can emerge. Cohen et al. (2010) defined focus groups as contrived settings bringing together a specifically chosen sector of the population to discuss a given theme or topic leading to data and outcomes. I worked with focus group discussions and change laboratory workshops discussed below. Focus group discussions were useful in the following ways: (a) it was possible to orient to a particular field of focus. For example with the BTTC case study it was possible to have representatives of different activity systems discuss challenges and opportunities for navigating across both horizontal and vertical boundaries (see Chapter Eight). With the UKZN case study, focus group discussions were very useful in the historical analysis of causes of the rigid compartmentalisation of departments. (b) Developing themes, topic and schedules for subsequent use in the research cycle. For instance, ideas that came out of focus group discussions were used as ideas and tools in Change Laboratory workshops. (c) Developing model solutions, focus group discussions were very instrumental in producing strong conceptual resources for practitioners to use when engaging in the new practices.

#### ***4.4.5 Change laboratory workshops (Boundary crossing laboratories)***

Change laboratories are tools for transforming work, used by researchers within the broad theoretical and methodological framework of Developmental Work Research (Engeström,

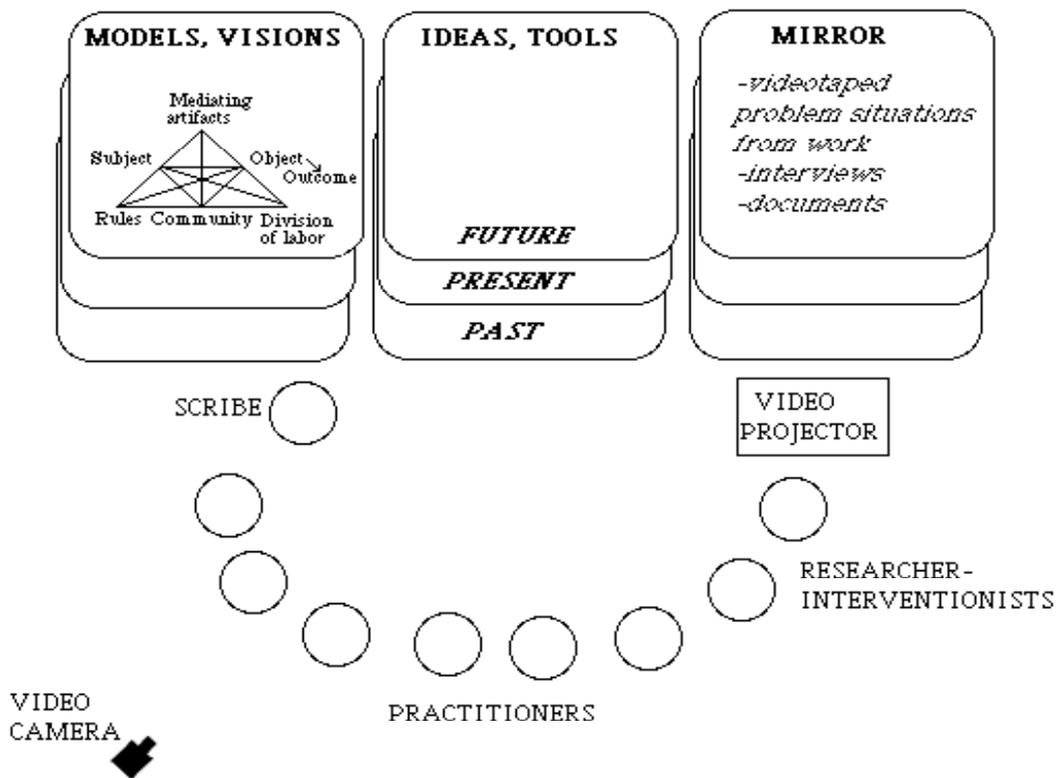
Lompscher, and Ruckriem, 2005 in Sannino, 2008). The approach is a method of intervention, developed in Finland by Engeström and his colleagues since the 1980s, based on Vygotsky's method of double simulation (Engeström, 2007a; Daniels, 2008; Sannino, 2008). Change laboratory is a participatory approach which implements the cycles of expansive learning. The objective is to engage practitioners in reflective cycles of deconstruction, reconstruction, trial and readjustment, revealing the needs and possibilities for development in an activity by jointly constructing the zone of proximal development of this activity (Senteni, 2005). Sannino (2008) added that the central idea behind the Change Laboratory is that educational and work practices can develop through collective, cognitive, and material reconceptualisation of the object of activity.

In designing the workshop sequence, I drew upon key elements of Engeström's (2004) conception of Developmental Work Research:

- employing activity theory as the analytical framework shared by researchers and practitioners, informed by Vygotsky's cultural historical method of analysis of the formation of conceptual and material tools in use (i.e. how wider societal practices are embedded within thinking and practice);
- facilitating practitioners' reflective systemic analysis, as a vehicle for examining and promoting change in professional thinking, practices and organisational cultures;
- promoting systemic change by focusing systemic analysis upon (a) collective learning challenges facing practitioners and organisations in the drive towards multiagency working (b) the surfacing of contradictions in past and present practice that might point towards new forms of professional practice (future objects); and
- producing strong conceptual resources for practitioners to use when engaging in new practices demanded by changes in policy (using the workshop sequence to confront professionals' „everyday“ concepts of practice with „scientific“ concepts derived from activity theory analysis, thereby generating a process of remediation and the creation of tools appropriate to emergent forms of practice).

#### 4.4.5.1 Structure and administration of Change Laboratories

In embarking on the Change Laboratory, I was clear of the need to initiate cycles of discussions in which participants, with the help of artefacts, reconceptualise the object of their work and create new meaning. For this, I had to rely on a three sets of „surfaces“ for representing the work activity (see Figure 4.5 below).



**Figure 4.5** Workshop layout

Figure 4.5 depicts the workshop layout and the dynamics through which researchers and practitioners „share“ the same conceptual tools in the process of analysing, repositioning and redesigning practice. (Daniels, 2008, p.133; Sannino, 2008, p.237).

*Mirror surface:* Work in the Change Laboratory typically starts with examples gained from the exploratory phase, in this case obtained through interviews, focus group interviews, and document analysis as explained in previous sections. Data generated was used as mirror data, designed to mirror particularly present problems, situations and disturbances, as well as novel innovative solutions (Daniels, 2008; Sannino, 2008).

*Model and Vision* is another „surface“, reserved for theoretical tools and conceptual analysis (Daniels, 2008). These are used for elaborating conceptual models of the activity under

scrutiny to analyse inner contradictions. Engeström's triangular model (see Chapter Two) was used to analyse systemic and interconnections of the teacher education activity system as an educational and work activity system. The model and vision surface provides an opportunity for double/dual stimulation, a process in which participants face and work out contradictions of their own practice (Sannino, 2008). Engeström, (2007) in Daniels (2008) emphasised "systemic roots of specific but recurring problems and disturbances are traced and conceptualized as inner contradictions of the activity system" (p.134). In using the activity system model, I figured that Engeström's triangular model is a general model of an activity system, from which more specific models can be developed. Throughout the expansive learning phase, I was also mindful of the five principles of activity theory as discussed in Section 3.4.3.

*Ideas and tools* is the third „surface“ used in change laboratory workshops. It is used as an intermediate "empty" stage between the experiential mirror and the theoretically structured model and allows for capturing of ideas and representations in progress (Sannino, 2008 p.237). Change laboratories were carried out for each case study as explained in Chapter Eight.

Observation was the main data gathering tool that I used in expansive learning processes. Information gathered fed into and shaped subsequent sessions of each workshop. Proceedings were captured by video which I re-played, transcribing significant aspects for analysis.

#### **4.4.6 Critical Discourse Analysis**

Critical Discourse Analysis (CDA) was used in this study to historicise emerging tensions and contradictions. It is a tool that helped me to respond to the question "What are the underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices in SMTs teacher education?"

On the surface, it may seem that CHAT, as a research approach, does not offer tools for historicising contradictions. However, being a socio-cultural approach, it draws on the Vygotskian tradition of conceiving language as both a cultural and a psychological tool. Most socio-cultural researchers treat communication, thinking and learning as related processes which are shaped by culture. For example Mercer (2004) pointed out that the nature of human activity is that knowledge is shared, and people jointly construct understandings of shared

experience. Communicative events, he added, are shaped by cultural and historical factors. Thinking, learning and development cannot be understood without taking account of the intrinsically social and communicative nature of human life. Daniels (2012) argued “Talk shapes and is shaped by thought; Talk is situated, Institutions shape talk and talk shapes institutions”. It is such thinking that inspired me to use CDA to probe underlying mechanisms in gender, ESD and SMTs teacher education curriculum. I now briefly describe the historical development of CDA and explain how I used this analytical tool in the study.

Some of the tenets of CDA can be traced to critical theory and the Frankfurt School. The strong focus on language and discourse, however, can be traced to critical linguistics emerging mostly from the UK and Australia at the end of the 1970s (van Dijk, 2001). CDA enables access to the ontological and epistemological assumptions behind a project, a statement, or method of research. In other words, discourse analysis can reveal the hidden motivations behind a text or behind a particular method of research used to interpret that text (Griffin, 2007) thereby helping to surface discontinuities, disturbances, tensions and contradictions. It is precisely for this reason that I used CDA more as an additional or extended data generating tool rather than as a tool for final data analysis, as it is commonly used. Being a two-phased study, data obtained from the first phase, was interpreted in more depth through CDA, and findings from this analysis and the activity system analysis were later used as mirror data in the expansive learning phase.

Discourse analysis is concerned with the investigation of language as it actually used, it is a method for examining all sorts of sign systems such as visual and behavioural ones, not only verbal systems (Griffin, 2007). Discourse analysis thus assumes from the outset that language is not a neutral tool for transmitting a message, but rather that all communicative events, whether these are reports, interviews or arguments constitute a particular way of talking about and understanding the world or an aspect of the world (van Dijk, 2001; Griffin, 2007). In support of this and citing the Truth and Reconciliation Report of 1998, Janks (2001) added that: “language, discourse and rhetoric does things: it constructs social categories, it gives orders, it persuades us, it justifies, explains, gives reasons, excludes ... it constructs reality ... it moves people against people” (p.3).

It is implicit in this claim that language in its many and varied forms, is a central element of ideology and power, and it can shape how people act in terms of the norms, values, standards

of groups that provide us with identities, for example, racial, ethnic, national, gendered. It is also clear from this analysis that language is a form of historical and culturally constructed social action and that the discourse we encounter plays a role in constructing our multiple identities (ibid.).

CDA is fundamentally interested in analysing opaque as well as transparent structural relationships of dominance, discrimination, power and control as manifested in language (Martin and Wodak, 2003). In addition CDA is concerned with the ways in which the power relations produced by discourse are maintained and/or challenged through texts and the practices that affect their production, reception and dissemination (Janks, 2001). As Foucault (1978) saw it, discourse can be an instrument and an effect of power, but also a hindrance, a stumbling block, a point of resistance and a starting point for an opposing strategy. He added that discourse transmits and produces power; it also undermines and exposes it, renders it fragile and makes it possible to thwart it. In accordance with the goals of this study, I used CDA, employing feminist and capability lenses to describe, interpret, analyse and critique curriculum practices as written in texts and spoken words to reveal gender biases, discrimination, blindness and so forth, and how these are initiated, maintained, reproduced, challenged and transformed. The purpose was to make these practices more explicit and open for examination – the intention was to surface contradictions between the current teacher education curriculum practices and the expectations of the more advanced ESD activity system. Furthermore, I anticipated that CDA would make tensions and contradictions visible and analysable in expansive learning change laboratory workshops.

It is also worth noting that methodologically CDA is an integrated research method which mobilises diverse sources and multiple analytical methods to achieve its end (Griffin, 2007). Likewise in this study CDA relied on data generated through a range of research processes, from desk-based textual analysis e.g. document analysis to field based interviews.

#### ***4.4.6.1 Critical Discourse Analysis as research methodology***

Questions relevant here are: why use CDA in this research? What is it? What does it offer for this project in particular?

Fairclough (2008, p.42) defined discourse as “just a particular form of social practice” in the centre of which power and ideology mutually influence and interact with one another. Wodak defined the subject of CDA as follows:

*Critical Discourse Analysis centres on authentic everyday communication in institutional, media, political or other locations rather than on sample sentences or sample texts constructed in linguists` minds. [CDA] regards both written and spoken `discourse` as a form of social practice. It assumes a dialectical relationship between particular discursive acts and the situations, institutions and social structures in which they are embedded: the situational, institutional and social contexts shape and affect discourse, and, in turn, discourses influence social and political reality. In other words, discourse constitutes social practice and is at the same time constituted by it. (in Matrikelnr, 2006, p.4)*

Wodak (1999) further added that the aim of CDA is to unmask ideologically permeated and often obscured structures of power, political control, and dominance, as well as strategies of discriminatory inclusion and exclusion in language in use (ibid.). Van Dijk (1993) pointed out that critical discourse scholars want to make a more specific contribution, namely to get more insight into the crucial role of discourse in the reproduction of dominance and inequality. Janks (1997) defined the CDA`s paradigm: “Where analysis seeks to understand how discourse is implicated in relations of power it is called Critical Discourse Analysis” (p.26).

This way of conducting an analysis is called critical, as Fairclough (2001) confirmed: it is not only critical in the sense that it seeks to discern connections between language and other elements in social life which are often opaque, but mainly because it is committed to progressive social change. CDA “has an emancipatory „knowledge interest”” (Fairclough, 2001, p.29).

Features of CDA as discussed here are critical to this study: firstly, understanding discourse as a form of social practice and secondly, its emancipatory agenda. These attributes resonate well with the explorative and expansive agendas of the study. CDA as used in this study sought to inform the curriculum transformation process first, exploring which structures, strategies or other properties of text, talk, verbal interaction or communicative events play a role in curriculum practice.

In the second instance, use of CDA for the expansive learning phase was motivated by Fairclough (2008) who argued that the adequacy criteria of CDA are not merely observational, descriptive or even explanatory; ultimately, its success is measured by its effectiveness and relevance, that is, by its contribution to change. In support of this and in line with the principles of CHAT and the capability approach, Van Dijk (1993) advised that

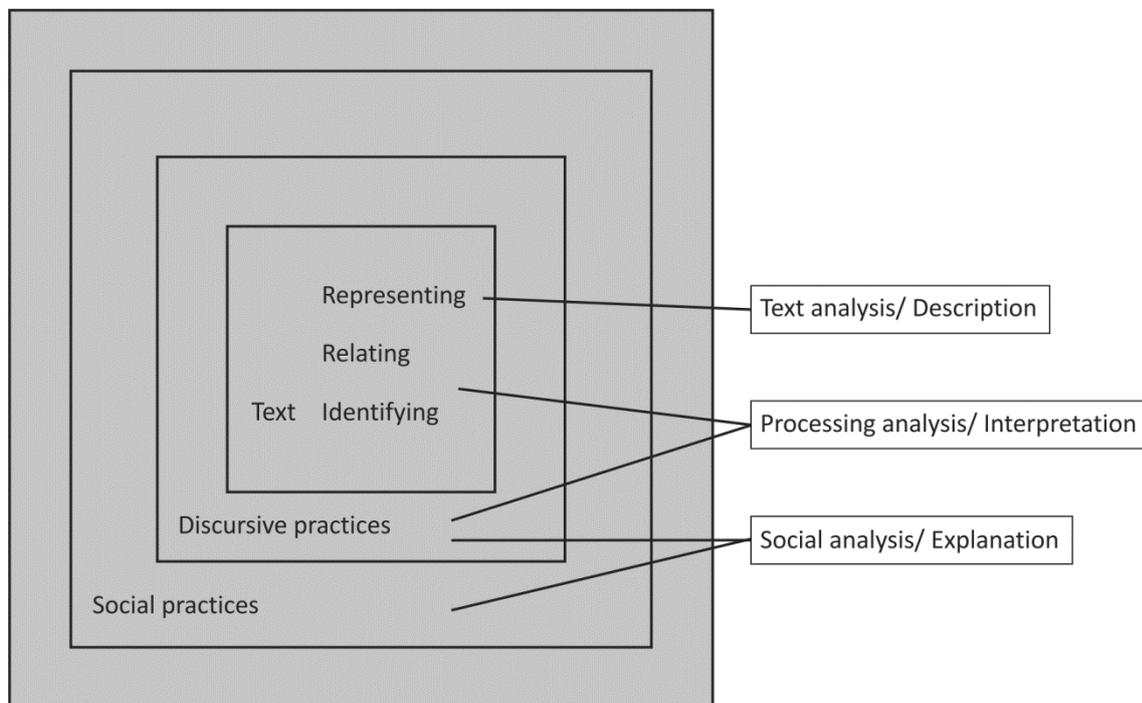
CDA critique should not be ad hoc, individual or incidental, but general, structural and focused on groups, while involving power relations between groups. He added, in this sense, critical discourse scholars should also be social and political scientists, as well as social critics and activists, in other words, “CDA is unabashedly normative: any critique by definition presupposes an applied ethics” (p.253).

Discourse Analysis is basically the analysis of language in context (Gee, 2005; Matrikelnr, 2006). Context ultimately means the very shape, meaning, and effect of the social world – the various social roles people play, the socially and culturally situated identities they take on, the social and cultural and historically shaped activities they engage in, as well as the material, cognitive, social, cultural, and political effects of these” (ibid.). What this implies is language has a two-fold function: reflecting and creating context. Horvath (2010) added that, not only the language use is affected by its groundedness within certain frames of cultural or social practice, but also the use of language influences and shapes the social and cultural context it finds itself in. It can be concluded that discursive practices are partially constitutive of social structures, in the same way as social structures partially determine discursive practices (ibid.). In working with CDA in a curriculum set-up, I had to recognise the two directions, exploring the tension between these two sides of language use, the socially shaped and the socially constitutive.

The concept of context in CDA goes beyond mere analysis of written text to also take in consideration of different sets of data from discursive practices like posters and brochures, psychological factors and motives of speakers, their environment (Matrikelnr, 2006). By so doing, critical discourse analysts always try to make “the reciprocal relationship between discursive action and political and institutional practices” transparent by using a methodologically pluralistic approach (historical, socio-political and linguistic perspectives) (ibid., p.5).

The socio-historical approach of CDA complemented the broader situational analysis describing the activity systems using CHAT’s concept of activity system and its interactions. As in CHAT, context is not separated from activity, or from texts, which are seen as tools for the mediation of activity (Russell, 2001). In Fairclough’s three dimensional model for CDA (Figure 4.6), context has to do with analysing of the processes of production and reception of a discourse fragment. Fairclough referred to the “situational context (questions about time

and place) and the intertextual context (looking for additional texts/information about or from producers and their product) as central for the process of interpretation” (in Janks, 1997, p.37). CHAT analysis of situational context would add rules, dimension of labour, community to this analysis, with reference to the socio-cultural and historical formations.



**Figure 4.6** Fairclough’s dimension of discourse and discourse analysis  
Source: Matrikelnr (2006, p.6)

Using Fairclough’s model as a research tool there is need to first explain the model itself. The model shows three interrelated dimensions of discourse represented as boxes nesting one inside the other (Janks, 1987). The first dimension represents the discourse fragment, i.e. the object of analysis (including verbal, visual, written verbal and other visual texts). The second dimension can be described as the aspect of context, or even the place where struggles over power relations in discourse happen, or, as Janks (1997) put it, the dimension where “the processes by which the object is produced and received (writing/speaking/designing and reading/listening/viewing) by human subjects” (p. 26). Finally, the third dimension of discourse could be described as ‘power behind discourse’ or as social practices, because it constitute “the socio-historical conditions that govern these processes of production and reception” (ibid.). Analogy can be drawn here with the prime units of analysis within cultural-historical activity theory.

Janks (1997), Matrikelnr (2006), Fairclough (2008) and Horvath (2010) concurred that for each dimension a different type of analysis needs to be conducted: for the first dimension „text analysis“ or description, for the second dimension „processing analysis“ or interpretation, and for the third dimension it is „social analysis“ or explanation. Janks (1997) and Matrikelnr (2006) further advised that all dimensions are interdependent and therefore it does not matter with which kind of analysis one begins; they are “mutually explanatory” (Matrikelnr, 2006, p.27). Likewise, in CHAT the three units of analysis are not mutually exclusive. As Engeström (2008) argued, the mediated action of the 1st generation may be recognised as the tip of the iceberg in the 2nd and 3rd generation models. More importantly, a mature view of the unit of analysis may actually require multiple levels, as was already forcefully pointed out by Leont’ev (1978). In this case, while I may want to focus on, say, a discourse fragment as the prime unit of a study, this unit only gains explanatory power if visible transitions and boundaries between the discourse fragment and the actions it generates on the one hand, and between the activity system and the field of interconnected activity systems in which it is located, on the other hand.

Each of the analysis processes are reflected in Table 4.4 below that synchronises dimension, its characteristics, object of analysis and related type of analysis.

**Table 4.4** *Elements of CDA*

<b>Dimension</b>	<b>Characteristics</b>	<b>Object of analysis</b>	<b>Type of analysis</b>
First dimension: Text/discourse fragment	Representations, relations, identities	Verbal, transcription of spoken, written, symbol, grammar, semantics, cohesion – organisation of ideas. - particular presentation, ideational function, ideological - particular constructs (writer of reader identity) - particular construction of relationship between writer and reader (formal, close etc.)	Text analysis and description. Intertextual analysis (descriptive)
Second dimension: context dimension; discourse practice	Struggles of power relations in discourse. Straddles society/ culture and discourse/text division	Discourse practice; production and consumption of discourse). Intertextual traces of discourse practice in text, snatches of other texts (manifest and constitutive).	Processing and interpretation analysis. Interaction in (writing/speaking/desig ning and reading/ listening/viewing). Intertextual analysis (interpretive)
Third dimension: socio-cultural practices	Economic, political, socio-cultural ecological contexts	Power behind discourse. Socio-historical conditions	Socio-cultural analysis. Context explanation

*4.4.6.2 Critique of Critical Discourse analysis as a research method*

CDA by its nature is heavily influenced by structuralist and post-structuralist perspectives. As a reflexive researcher, I needed to be mindful of the possible pitfalls of this theoretical perspective in research. An overarching critique labelled against major representatives of structuralism and post-structuralism (Bourdieu and Foucault respectively) is their tendency to reduce the significance of human agency to the reproduction of structures (Harrington, 2005). Archer (2000, p.2) further argued against this tendency of “dissolv[ing] the human being into discursive structures and human kind into disembodied textualism”. Her argument is that the self is not just discursively constituted as portrayed by both structuralists and post-structuralists, a perspective often reflected in CDA work. Here Archer is arguing for human agency, a concept that I found very useful both in expansive learning and in curriculum transformation. As noted above, I used CDA specifically to analyse opaque as well as transparent structural relationships of dominance, discrimination, power and control as

manifested in language, but I took full cognisance of human beings' abilities to be reflexive, exercise agency in change processes, through using this as mirror data in the expansive learning phase. As understood by Archer (2007), reflexivity enables people to consider themselves in relation to their social contexts and vice versa, enabling them to evaluate their situations and determine their concerns and actions (see Section 1.8.2). From this cue, I was able to observe reflexivity in the expansive learning processes.

#### **4.5 ENSURING DATA QUALITY (TRUSTWORTHINESS) (VALIDITY)**

In qualitative work, the standards of validity, reliability, generalisability and objectivity are broadly termed trustworthiness (Toma, 2011). Lincoln and Guba cited in Toma (2011) and in Shenton (2004) suggest that qualitative researchers establish the trustworthiness of their findings by demonstrating that they are:

- credible (in preference to internal validity);
- transferable (in preference to external validity/generalisability);
- dependable (in preference to reliability);
- conformability (in preference to objectivity).

In this study, I worked with these four standards in ensuring trustworthiness. I explain below how I tried to adhere to each of these standards.

Credibility is established if participants agree with the constructions and interpretations of the researcher, that is, the description of the case is accurate based on the understanding of those studied (Toma, 2011). Marshall and Rossman (2011) further clarified that reporting processes and interactions within the boundaries of the cases with sufficient depth satisfies the credibility standard. Stressing that human beings are the primary instrument of data collection and analysis in qualitative research, Merriam (2009) urged researchers to ask themselves the following questions to ensure credibility: How congruent are the findings with reality?, Do the findings capture what is really there?, Are investigators measuring what they think they are measuring?

In this study I used triangulation, member checking, adequate engagement in data collection, reflexivity, and peer examination as strategies to ensure credibility. Merriam (2009) cited Denzin (1978) who proposed four types of triangulation, three of which I found useful in this

study: the use of multiple methods, multiple sources of data, multiple investigators and multiple theories to confirm emerging findings. With regard to multiple methods of data generation, I used interviews (individual and group), document analysis, focus group discussions and workshops (see Section 4.4). I was able to verify what was found in interview data with data in documents for example.

Triangulation using multiple sources of data meant comparing and cross-checking interview data collected from people with different perspectives and from follow-up interviews with the same people. For example I carried out in-depth interviews with teacher educators at BTTC, Department of Teacher Education lecturers, as well as with representatives from the Ministry of Higher Education with one goal in mind: to gauge the extent to which the science teacher education curriculum practices consider gender issues and the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context. Shenton (2004) supported this form of triangulation pointing out that individual viewpoints and experiences can be verified against others and, ultimately, a rich picture of attitudes, needs, or behaviour of those under scrutiny may be constructed, based on the contributions of a range of people. Inspired by Shenton (*ibid.*, p.65), “whilst focus group and individual interviews suffer from some methodological shortcomings since they are interviews of a kind, their distinct characteristics also result in individual strength”, I used individual interviews to verify what had come from group interviews.

Theoretical triangulation saw me using multiple theories to shed light on emerging findings. I tried to bring credibility through the use of different theoretical lenses relevant to the complexity of my research questions prior to the study (see Chapters Two and Three) as well as showing a coherent set of findings (emerging) linked with theory as shown in Chapter Seven and Eight.

Member checks or respondent validation (Merriam, 2009) was another credibility strategy that I used. I found this strategy very important, as argued by Maxwell (2005) “this is the single most important way of ruling out the possibility of misinterpreting the meaning of what participants say and do and the perspective they have on what is going on, as well as being an important way of identifying your own biases and misunderstanding of what you observed” (p. 111). I solicited feedback on emerging findings from some of the interviewees. I used various means to do this including emails and follow-up face to face formal and semi-

formal interviews for this process. My prolonged stay in the field (over a year) and persistent contact with research participants made this feasible.

Adequate engagement in data collection was reasonably useful as a credibility strategy. Throughout, I tried to be as close as I could be, to obtain in-depth insight information on participants' understanding of the phenomenon under study. The indicator here was saturation of emerging findings especially in the exploration phase. As time went on I began to identify similar findings as I tried to generate more data.

Patton (2002) argued that credibility hinges partially on the integrity of the researcher. Reflexivity or researcher's position is a credibility strategy that is also related to the integrity of the qualitative researcher (Merriam, 2009). It involves the process of reflecting critically on the self as researcher, „the human as instrument“ (ibid., p. 219). As an investigator I needed to be in control of my biases, dispositions and assumptions regarding the research to be undertaken (see Chapter One). Working within critical theory, with emancipatory frameworks; feminist standpoint, capability and CHAT, I could not claim neutrality nor ideological or political innocence (see Section 1.7.1). As Maxwell (2005) argued, being explicit about this, as reflected in Chapter One, will help the reader to understand how my values and expectations (as a researcher) influenced the conduct and conclusion of the study. Without this, it was impossible to be reflexive.

Peer review, also called peer examination, is another strategy that I used for credibility purposes. I made use of presentation opportunities in PhD seminars and other forums such as the International Society for Cultural Activity Research PhD summer school which I attended to get ongoing critical feedback on the study. I also asked a critical friend to go through the script and responded to supervisory feedback.

Transferability is concerned with the extent to which the findings of one study can be applied to other situations. Lincoln and Guba (1985) suggested that with the notion of transferability, the burden of proof lies less with the original investigator than with the person seeking to make an application elsewhere. Nevertheless, the investigator needs to provide sufficient descriptive data, to make transferability possible. In this case I used the activity system framework and descriptions (Chapters Five and Six) to heuristically illuminate the reader's understanding of the phenomenon under study and to capture complex action, perception, and interpretations in such activity systems. I also depended on the use of thick descriptions of

settings, participants as well as detailed description of findings, drawing on quotes from interviews, field notes and documents (Chapters Five and Six).

Dependability is another standard I took note of in ensuring research rigour and trustworthiness. Dependability as it applies to qualitative research can be ensured by the following attributes (Toma, 2011) that I attended to throughout the research journey: (a) a study design that is congruent with research questions (see Sections 4.2 and 4.2.3); an explicit explanation of the status and roles of the researcher within the site as summarised in Section 9.8; (b) findings showing parallelism across data sources as shown in Chapters Five and Six; (c) specifying basic theoretical constructs and analytical frameworks (see Chapters Two and Three); (d) collecting data across a full range of settings as discussed in Section 4.4; and (e) peer reviewing.

Conformability is concerned with ensuring as far as possible that the work's findings are the result of the experiences and ideas of the participants, rather than the characteristics and preferences of the researcher (Shenton, 2004). To adhere to conformability I used triangulation to reduce the effect of my own bias as a researcher. Admission of my own standpoint as researcher (discussed above) was also used in this sense. I further tried to critique the methods and theories that I used seeking to respond to their shortcomings and potential effects as far as possible. To guarantee conformability and dependability I also ensured an audit trail of the data sources and analysis process which are included in Table 4.6.

#### **4.6 ETHICAL CONSIDERATIONS**

In keeping with the principle of good research, I observed ethics that included: seeking prior informed consent, obtaining access and acceptance, avoiding emotional harm and deception of respondents through misrepresentation, ensuring privacy and anonymity of respondents and confidentiality of information.

Cohen, Manion and Morrison (2010) defined informed consent as the procedures in which individuals choose whether to participate in an investigation after being informed of the facts that would be likely to influence their decisions. This definition involves four elements that were key in my research journey: competence, voluntarism, full information and comprehension. Competence implies that reasonable, mature individuals will make correct decisions when they are given the relevant information. Working with teacher educators I had

no problem with this element. Voluntarism entails applying the principle of informed consent and thus ensuring that participants freely choose to take part (or not) in the research (ibid.). Full information implies that the participant is fully informed. It is often practically impossible to fully inform the participants about everything (ibid.). However I made sure that the would-be participants were aware of the major steps in the research process such as the goal, the methodology, dissemination of information, and the right to withdraw, through the process explained below.

Obtaining access and acceptance is another ethical parameter that I followed. The first stage was gaining official permission to undertake my research in the two institutions. For the BTTC case study I wrote to the principal of the college and for UKZN I wrote to the head of the school (see Appendices 1 and 2). In both cases I was referred in writing to relevant section heads. Knowing that my study was going to take a prolonged time and involving a variety and complex activities like Change Laboratory Workshops, focus group discussions and interviews, I had to prepare an outline in writing of the precise nature and scope of the research. The next step was to make actual contact with the then would-be participants. After identifying significant figures I formally wrote to them requesting their participation in my research. In the formal letter I tried by every means possible to adhere to the principle of honesty in research. I also outlined the whole plan of the study as shown in Figure 4.1. By so doing I was fulfilling the principles of informed consent, obtaining access and acceptance and to some extent that of avoiding emotional harm, the latter being an ethical concern that I attended to throughout the research process.

Cohen et al. (2000) listed some ethical considerations that I also found useful: all participants will be offered the opportunity to remain anonymous; and all information should be treated with strictest confidence. To abide by these principles, I made sure that information revealed by participants did not in any way reveal their identity. To achieve this, I used codes to attach to the information given, as shown in Chapters Five and Six. This guaranteed the participants' privacy. Other techniques that I put in place to guarantee confidentiality include deletion of identifiers e.g. names, addresses, departmental stamps etc. Crude report categories were also useful in this case, that is general information rather than specific. For example I used Science Lecturer rather than Chemistry Lecturer. Throughout the study, I did not see the need to use betrayal and deception.

Table 4.5 provides a summary of data generating methods used at different stages of the research process.

**Table 4.5** *Data generating methods*

Case Study	Exploration Phase Interviews (in-depth and group), documents	Expansive Phase: Focus group discussions, observation of learning processes in change laboratory workshop	
		Change laboratory workshop	Extended field contact
B TTC	Individual interviews (see Table 4.2) Four focus group interviews Document analysis (Table 4.1)	Three change laboratories with several sessions (Table 8.1) Focus group discussions in change laboratory workshops	Workshop to developing mediation tools
UKZN	Individual interviews (see Table 4.3) 1 focus group interview Document analysis (Table 4.1)	Developmental work research meetings Focus group discussions in change laboratory workshops	Use of a critical friend

#### 4.7 DATA ANALYSIS

*A qualitative design is emergent, the researcher usually does not know ahead of time every person that might be interviewed, all the questions that might be asked, or where to look next unless data are analysed as they are being collected ... the process of data generation and analysis is recursive and dynamic.* (Merriam, 2009, p.169)

Data analysis is the process of making sense of the data, and this involves consolidating, reducing and interpreting what people have said and what the researcher has seen and read (Merriam, 2009).

As illustrated in the above quotation I simultaneously analysed data as I generated it. Simultaneous data generation and analysis occurred both in and out of the field. However analysis became more intensive in between the two phases of the research, and once all the data were in, that is, at the end of the study as shown in the research design diagram in Figure 4.1. Some of Bogdan and Biklen’s (2007) suggestions, discussed below, were very helpful in analysing data.

- Developing analytical questions: Going into the field I was always conscious of which of the research goals would be addressed and with what information. For example for

the first research goal (to assess the level of gender responsiveness of SMTs teacher educators), I raised the analytical questions in the capability checklist (see Appendix 4.2).

- Developing analytical questions using the capability checklist (Appendix 4.2) also enabled me to think through the theoretical landscape of the research (see Section 4.7.2).
- Planning data collection sessions according to what was found in previous sessions. This forced me to review field notes and memos and generally to pursue specific leads in subsequent data collection sessions. Exploring literature whilst in the field was also another technique that was helpful for data analysis. Going through substantive literature assisted in verifying, shedding perspectives on and sharpening hunches, working hypotheses and educated guesses, adding rigour to the analysis.

Intensive data analysis is usually preceded by data organisation and management. To facilitate analysis, I coded all the interviews that were held. Interviews that were held for the BTTC case study had a code of B and those of UKZN had a U. For example the first interview for BTTC was **Bint1** while **Bfg1** stood for focus group 1 for the same case study (see Table 4.6). Individual participation in change laboratory sessions was coded with a B for BTTC and U for the UKZN case studies. For example B1 will be individual participant one in the BTTC case study and HO and D for Head Office and Department of Teacher Education respectively.

**Table 4.6** Data Index

<b>Method</b>	<b>BTTC</b>	<b>UKZN</b>
In-depth interviews	Bint 1-Bint 6 (see Table 4.2)	Uint-uint6 (see Table 4.3)
Focus group interviews	Bfgint	
Change laboratory	BFG-central activity system	UFG1and UFG2
Focus group discussions	DFG-rule/tool making focus group HOFG-rule/tool making focus group	

#### **4.7.1 Category Construction in Data Analysis**

The next step was category construction which also involved some coding of data. A category is a theme, a pattern or an answer to a research question (Merriam, 2009). For example, as I read the first interview transcript or field notes, I made notations next to bits of

data that had the potential for answering my research questions. This form of coding is often called open coding (ibid.), because at this point I was still very open to anything possible. Segment 4.1 below is an example of how I engaged with open coding on evaluating the level of gender responsiveness of SMTs teacher educators.

#### Segment 4.1 Example of category construction in data analysis

**Researcher:** *Now let us talk about the possible push-out factors for girls from science. Why do you think girls become less and less interested in sciences as they continue with their education?*

**BInt1:** *-they believe that science is for boys/is difficult*      **girls self-belief**  
*-they put less and less effort in science as they proceed in high school education*      **lack effort**

*-girls are socialised to do easier stuff*      **societal effects**  
*-some look up to men to look after them in life - they are capable/able but they put less effort - at F3 (G10) they have acquired a gender identity and they want to be recognised as such by male counterparts - implication.. is unfeminine to be good in sciences. Some even start love relationships*      **negative gender identity**

**Researcher:** *What is your opinion on the impact of patriarchal socialisation as a push-out factor?*

**BInt1:** *-learners should be able to draw the line between culture and academic aspects, “when we are in class it’s about learning, nothing to do with behaviour at home”*      **girls themselves**

**BInt1;** *-opportunities towards education for all are there, the fault is theirs (girls) not the system.*      **assumes a level field**

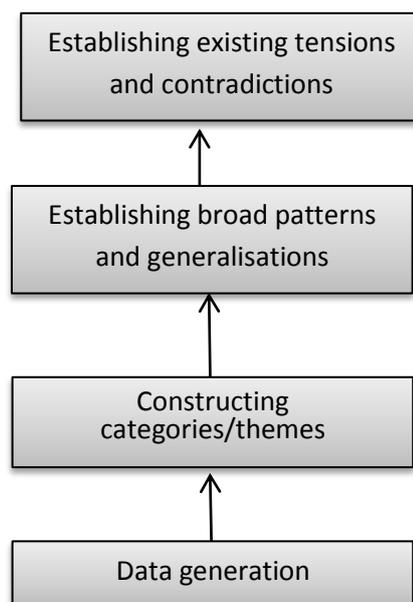
**BInt1;** *-teacher education institutions should bring this issue (impact of patriarchal socialisation) to the trainee teachers, make them aware of gender stereotypes... this should be in our methods syllabus and for now we don’t talk about cultural issues in science education*      **not taught to trainee teachers**

After open coding I went on to do what Corbin and Strauss (2007) called axial coding or analytical coding (in Merriam, 2009). This coding goes beyond descriptive coding; it is coding that comes from interpretation and reflection of meaning (ibid.). This involves grouping notes and comments that seem to go together. For example, in segment 4.1 above I grouped **girls’ self-belief, lack of effort, negative gender identity** into one category: **girls at fault** (blaming the victim). This became a theme or category into which subsequent items were sorted. I went on to establish other categories that I used to assess the level of gender responsiveness of SMTs teacher educators. I did this with data deriving from various methods and sources. Along the way as more and more data was produced I was sorting into

established categories; Marshall and Rossman (2006) visualised categories as “buckets or baskets into which segments of text are placed” (p.159). Merriam (2009) raised some criteria for category construction that I found useful. Categories should be:

- Responsive to the purpose of the research: in this sense all the categories that I came up with were answering the research question in one way or the other.
- Exhaustive, though not simple and straightforward: I tried to come up with categories that captured all the data.
- Mutually exclusive: I tried to make sure that a unit of data fitted into only one category.

Category construction followed an inductive process: I used bits and pieces of information from interviews, discussions and documents to build towards concepts, hypotheses and theories. Figure 4.7 below shows the inductive logic used in this qualitative study.



*Figure 4.7 Inductive logic process used in the study*

#### **4.7.2 Thinking of theory in data analysis**

The analysis process described above is largely inductive, that is analysis that lets data speak for itself. My next level of analysis was abductive, which involves the use of theoretical lenses to make sense of data. In a broader sense, abductive analysis can be seen as an overall term for all forms of interpretation made from a pattern or system of classification (Danermark et al., 2002). They added “here we interpret and redescribe the different components/aspects from different hypothetical conceptual frameworks and theories about structures and relations” (ibid., p.150). Abductive analysis is “theoretically guided redescrptions” of data (ibid.). Abductive analysis in this study was informed by the three theoretical approaches discussed in Chapter Three, as well as by the ESD framework. For example, using feminist lenses, I was able to identify that blaming girls for their low involvement in science is a sign of gender blindness in the SMTs teacher educator’s practice.

Danermark et al., (2002, p.95) pointed out that:

*... when we apply abductive inference in social science and interpret a phenomenon in the light of a frame of interpretation (rule), the frame of interpretation constitutes one of several possible frames and the interpretation of the phenomenon one of several possible interpretations.*

In this case, I was able to use a capability lens applied to analysis of the same example above to infer that gender blindness in the curriculum would mean that the curriculum does not cater for the capabilities of females, and that teacher education curricula are not operating as gender conversion agents as described in Section 3.2.2. Table 3.1 in the same section raises some capability related questions that were helpful in the analysis as reported in Chapters Five and Six.

Abductive reasoning, using CHAT, was employed to explore elements of activity systems as discussed in Section 3.4.1. (Figure 3.3) as well as in surfacing tensions and contradictions and during expansive learning as discussed in Chapters Seven and Eight. I had to do this from the category level. For example there is contradiction in the statement *opportunities towards education for all are there; the fault is theirs (girls) not the system*. Such a contradiction and many more became the focus of expansive learning in change laboratory workshops (see Sections 4.4.5 and 5.) I also used the sensitising concepts of agency, reflexivity and dialectics (Section 1.8) as theoretical lenses in abductive analysis. Table 4.6 is a summary of data analysis processes.

**Table 4.7** Summary of data analysis processes

Type of analysis	Mode of inference	Research question addressed
Interviews and document analysis	Inductive analysis Initial categories from field work interviews and documents  Abductive using feminist, capabilities and ESD	What is the level of gender and sustainability responsiveness of SMTs teacher educators? What capability set (opportunity freedom) is available for girls and boys in SMTs in general and in view of socio-ecological risk in a Southern Africa context? (Chapters Five and Six)
Activity system analysis in each case study	Abductive using CHAT	What is the level of gender and sustainability responsiveness of SMTs teacher educators? (Chapters Five and Six)
Analysis of contradictions	Abductive using CHAT Historical analysis Critical Discourse Analysis	What are the underlying mechanisms that affect (promote or constraint) gender and sustainability responsive curriculum practices in SMTs teacher education? (Chapter Seven)
Analysis of change laboratory workshops	Abductive using CHAT, Boundary learning processes, Zone of Proximal Development Critical reading of Akkerman and Bakker (2011)	What expansive learning can the study develop to support gender and sustainability responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context? (Chapter Eight)
Analysis of agency in expansive learning processes	Abduction informed by an ESD framework, CHAT Feminist theory on science and capability.	What mediation tools can the study develop to support gender and sustainability responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context? (Chapter Eight)
Implications and recommendations	Abductive based on the research outcomes for each case study and what could be done. Abductive based on ESD framework, CHAT, capabilities and feminist perspectives	Overview(Chapter Nine)

## 4.8 CONCLUSION

This chapter communicates how the study was put together by outlining the methodological framework of Developmental Work Research and placing the study within a critical research framework. The chapter discussed the case study approach and explained the nature of each case study in terms of the activity systems. Data generating and analysis methods in the two phases of the study were also outlined. The chapter is central to the study in that it shows how methods were used for generating data to respond to the research goals in Chapter One and how the analysis of data was approached. These methods are informed by the literature reviewed in Chapters Two and Three. The chapter informs and guides presentation, analysis of data and expansive learning process as reported in Chapters Five to Eight.

## **Chapter 5: EXPLORING CAPABILITIES, SUSTAINABILITY AND GENDER JUSTICE IN SMTs TEACHER EDUCATION CURRICULUM: BTTC CASE STUDY**

### **5.1 INTRODUCTION**

This chapter reports on the exploration phase of the study. It addresses the first two objectives of the study in the Belvedere Technical Teachers' College (BTTC) case study:

- to assess the level of gender and sustainability responsiveness of SMTs teacher educators,
- to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context.

To respond to these two objectives, I made use of the data generated from the field using in-depth individual and group interviews, document analysis and focus group discussions as described in Section 4.4. In responding to these objectives, I sought to appraise the SMTs teacher education curriculum as a „potential conversion agent“ as discussed in Section 2.8.2. Through use of critical discourse analysis, the chapter also scrutinises underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in the case study. In other words, the purpose of the chapter is to report on the need state analysis of the DWR design (Section 4.2.1).

The analysis is situated within a brief description of activity systems making up the BTTC case study. Following this, data is presented using thick descriptions. My aim here was to present data, followed by speculative inferences, where I posit some possible explanations for the situation, identify some key elements and to some extent some causal explanations as well. These are discussed more systematically later in the thesis (Chapters Seven and Eight). As described by Cohen et al. (2010), it was a process of setting up working hypotheses that feed into and are reflexively reviewed by theory (as discussed in Section 4.7.2).

Critical discourse analysis helped me to condense findings and excavate sources of tension and contradiction in the activity systems. In this case, my intention was to go beyond description of existing situations and to examine some possible reasons for the situation as revealed in the data. This reflects Carspecken's view (1996), in Cohen et al. (2010), which suggests that critical ethnography, to which critical discourse can contribute, provide preliminary reconstructive analyses. He asserted that what distinguishes this stage as

“reconstructive” is that cultural themes, social and system factors that are not usually articulated by the participants themselves are, in fact, reconstructed and articulated, making the “undiscursive into discursive” (p.188). Grootenboer and Ballantyne (2010) argued that teachers (in this case teacher educators) through their practice, teach more than just subject knowledge and skills; they also communicate their values, beliefs and emotional responses to the subject they teach. In a CHAT sense, CDA resonates with the principle of historicity as discussed in Section 3.4.3. As proposed by Engeström (2001), the history of the activity system needs to be studied as local history of activity, objects, tools and theoretical ideas that have shaped the activity, its objects and outcomes, as well as in terms of the genealogy of conceptual tools that have shaped it over time. CDA helped me to reveal some of these genealogies and local histories.

## **5.2 ACTIVITY SYSTEMS IN THE CASE STUDY**

Activity systems are presented for each of the two case studies. Activity systems were developed by Engeström as a viable root model of human activity (Yamagata-Lynch, 2003) (Section 3.4). An activity system comprises of a group of people pursuing a goal in a purposeful way (Peal and Wilson, 2001). Blackler et al. (2000) added that the activity system comprises of an interrelated *bricolage* of material, mental, social and cultural resources for thought and action.

The purpose of identifying activity systems and presenting them as part of preliminary research results was to use activity systems as rich descriptive tools in highlighting the historical interpersonal interactions between researcher and participants and among participants in the research journey. The rich description has positive implications for the trustworthiness of the study as discussed in Section 4.5. As alluded to in Section 4.2.7, it is through interpretation of work practices that I came up with activity systems and it is further interpretation of these activity systems in relation to work practices led to deeper insights about practices in an organisation and further clarification of the activity system itself. It is fair though to highlight that the activity systems that I worked with in both case studies are naturally well defined entities as they are well established institutions. I did, however, need to establish the studies’ boundaries, to clearly demarcate a case for study as a bounded system in accordance with the case study methodology (Section 4.2.2). Bearing in mind that the two case studies have a network of activity systems (see Section 4.2.4.1), the unit of analysis progressed from one activity system (central activity system) to networks of activity systems

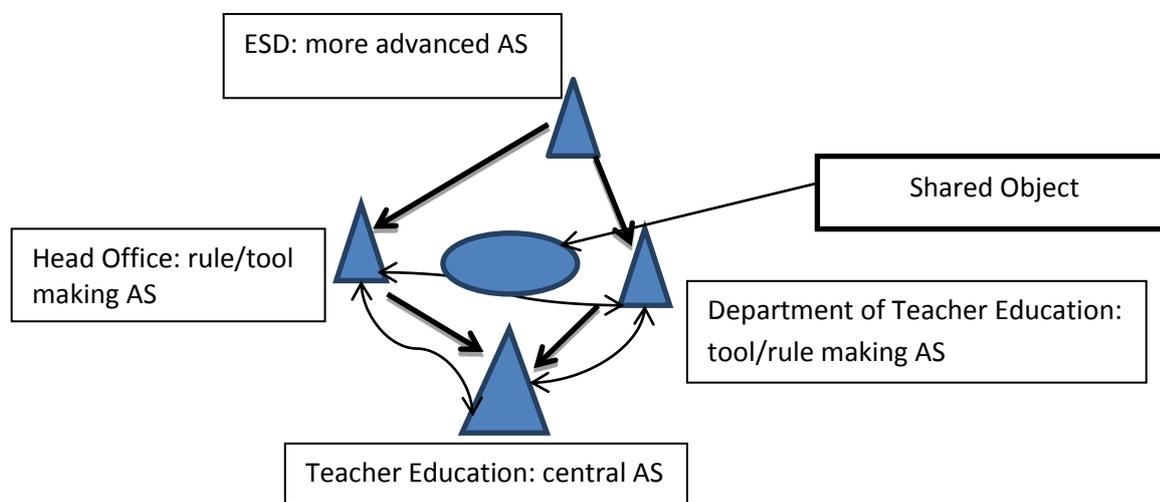
and to following the object (curriculum practice) across boundaries as shown in Chapter Eight.

### ***5.2.1 Activity Systems in the BTTC Case Study***

As discussed in Section 4.2, in the BTTC case study I worked with four interacting activity systems namely the teacher education institution itself (as the central activity system), Department of Teacher Education (as the rule and tool making activity system) and the Ministry of Higher Education, also known as Head Office (as another rule and tool making activity system) and finally, the ESD activity system (as the more advanced activity system). Initially the ministries of higher and tertiary education and that of gender appeared to be two separate activity systems. However, it emerged in the exploration phase that a gender focal person is assigned to each ministry from the Ministry of Gender. This led to the collapse of the two ministries into one activity system. Figure 5.1 shows the various activity systems for the BTTC case study. Primarily people in these activity systems are brought together in a curriculum activity with the intention of producing SMTs secondary school teachers.

The administrative structure of teacher's colleges in Zimbabwe is set in a way that lecturers in charge are the front line managers who oversee the day to day running of the curriculum business in their disciplines. For example, a lecturer in charge of sciences supervises all the lecturers teaching Physics, Chemistry and Biology. The duty of the lecturer in charge is to oversee curriculum development, implementation and assessment. The lecturers in charge report to the Head of Department, who in turn reports to the vice principal of the college. The lecturers in charge and the heads of department sit in the college academic board which is the supreme board of the college that oversees all curriculum matters of the college.

**Figure 5.1** *Networked Activity Systems for the BTTC case study*



**Key:**     $\longrightarrow$  Supposed to feed into                       $\longleftrightarrow$  Supposed to interact

### 5.2.1.1 *Teacher Education Activity System (Central Activity System)*

Belvedere Technical Teachers' College was founded in 1982 as one of the newest teacher training colleges in the newly established independent state of Zimbabwe. The college was established for training teachers in the much neglected area of technical subjects (Teaching Profession, 2011). Today the college is still producing secondary school teachers for a broad range of technical subjects namely building technology, mechanical engineering, agriculture, technical graphics and wood technology, clothing and textiles technology, tourism and hospitality management and information technology. This is in addition to training teachers in Mathematics and traditional Sciences (Physics, Chemistry and Biology). For the technical subjects, trainees are holders of either a National Certificate or a National Diploma in their respective disciplines from various polytechnic and vocational colleges across the country. They are expected to participate in a 20-month education course. For Mathematics and Science, trainees will have passed either advanced (form 6) or ordinary level (form 4) Mathematics and Science. They study both education and specific content courses at college. Advanced levels involve a course of two years while the post ordinary level will do a three-

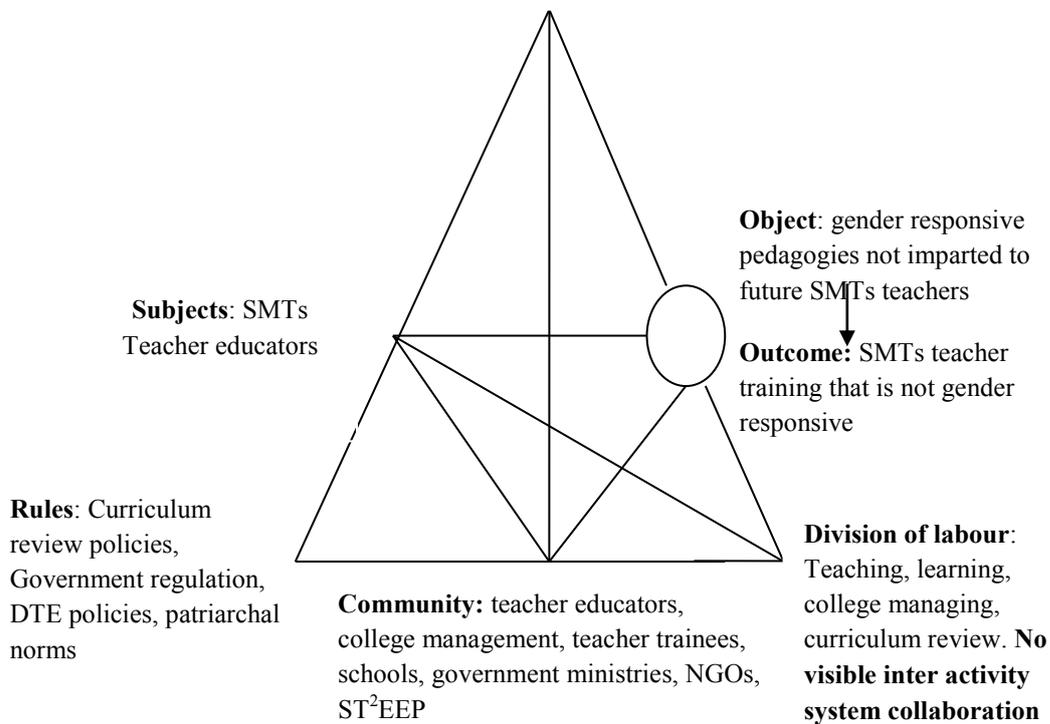
year course. At the end of their training everyone is awarded a National Teaching Diploma in his/her respective discipline.

Such a curriculum was appealing to this study that had interest in exploring and expanding gender and sustainability responsive pedagogies in traditionally gendered and technicist disciplines such as those offered at this college. It was therefore the central activity system of study in this case study. Figure 5.2 shows the activity system. The description for the elements of the activity system was established after preliminary results reported in Section 5.3. Table 5.1 is descriptive summary of the elements of the SMTs teacher education activity system before expansive learning.

**Table 5.1** Description of the elements of the SMTs teacher education activity system before expansive learning

<b>Element of the Activity System</b>	<b>Description from preliminary data</b>
Tools/artefacts	No institutional designed tools or mechanism to engage with gender issues in SMTs. No visible engagement with gender and related policies. No engagement with research in gender and SMTs education. Environmental education incorporated in a gender blind manner.
Object	Gender not an object of curriculum practice. Ecological issues incorporated into the curriculum in a gender neutral manner. No coordinated curriculum practices towards gender responsive pedagogies, despite being aware of the need to do so. No consideration of gender related personal and social conversion factors (contradiction between subject and object and between object of this activity system with that of the ESD activity system)
subjects	Aware of gender inequalities in enrolment, individual conceptions of push out factors, most do not incorporate gender issues in curriculum besides mentioning in isolated incidences, lack of mediating tools for gender responsive curriculum practices (primary contradiction within the subjects)
Rules	Patriarchal norms; instrumentalist view of SMTs; exam driven curriculum. No engagement with gender related policies.
Community	No evidence for intra college or inter-institutional efforts towards gender responsive curriculum practices.

**Mediating Artefacts:** Curriculum tools, subject content & pedagogical content knowledge, language, syllabus, gender disaggregated data, environmental education integrated knowledge. **Absent: no institutional designed tools to mediate gender responsive pedagogies**



*Figure 5.2 BTTC Teacher Education Activity System*

### 5.2.1.2 Department of Teacher Education Activity System

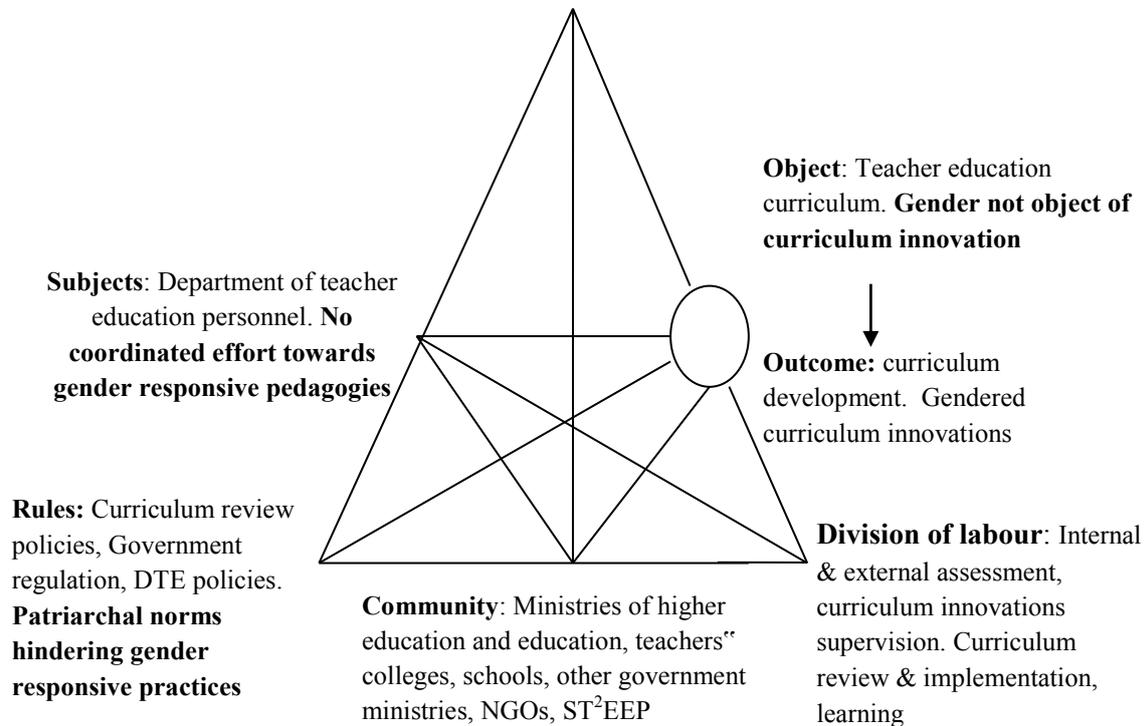
The Department of Teacher Education is a department in the faculty of education at the University of Zimbabwe. The University of Zimbabwe has traditionally monitored the quality of higher education in the country, approves syllabi for polytechnics and teachers' colleges through its multiple roles concerning education, research, supervision, and extension courses throughout the country. It is through this association that the Department of Teacher Education was conceived, starting as the Institute of Education and becoming Associate College Centre in the 1950s, till today when it is part of the state devolution and university statutes.

The sole responsibility for the Department of Teacher Education is monitoring teacher education programmes in teacher's colleges. The Department of Teacher Education board is made up of lecturers in the department who also teach University of Zimbabwe degree programmes and coordinate colleges in the scheme of association described above. Both

ministries of education (Ministry of Education and Culture and Ministry of Higher Education) are partners in this scheme of association. The association functions through two boards, chaired by the Department of Teacher Education: the board of examiners and the board of studies. The first one ratifies teachers' college results and the latter formulates and monitors policy implementation by the department and the colleges.

The Department of Teacher Education has the mandate to encourage individual colleges to initiate new programmes, introduce new subjects and assists colleges to devolve into degree offering institutions. It also has the mandate for short and long term staff development programmes for teacher training college personnel. The activity system of the Department of Teacher Education, as constructed with the information emerging from preliminary data, is shown in Figure 5.4. It emerged that the department has the knowledge of gender inequality, the ministerial mandate to drive curriculum and well-laid structures for execution of curriculum initiatives, but it is held back by factors such as rigid patriarchal ideology. For this reason, there is tension within the subjects; some are keen for gender responsive curriculum innovations while the majority (males) are reluctant to develop these (see Section 5.4). Figure 5.3 summarises the elements of this activity system.

**Mediating Artefacts:** Teacher Education assessment tools, ministerial policies, research evidence, gender disaggregated data, curriculum expertise. **No coordinated tools to mediate gender responsive pedagogies in teacher education.**



*Figure 5.3 Department of Teacher Education (rule/tool producing) Activity System*

### 5.2.1.3 Higher Education Activity System

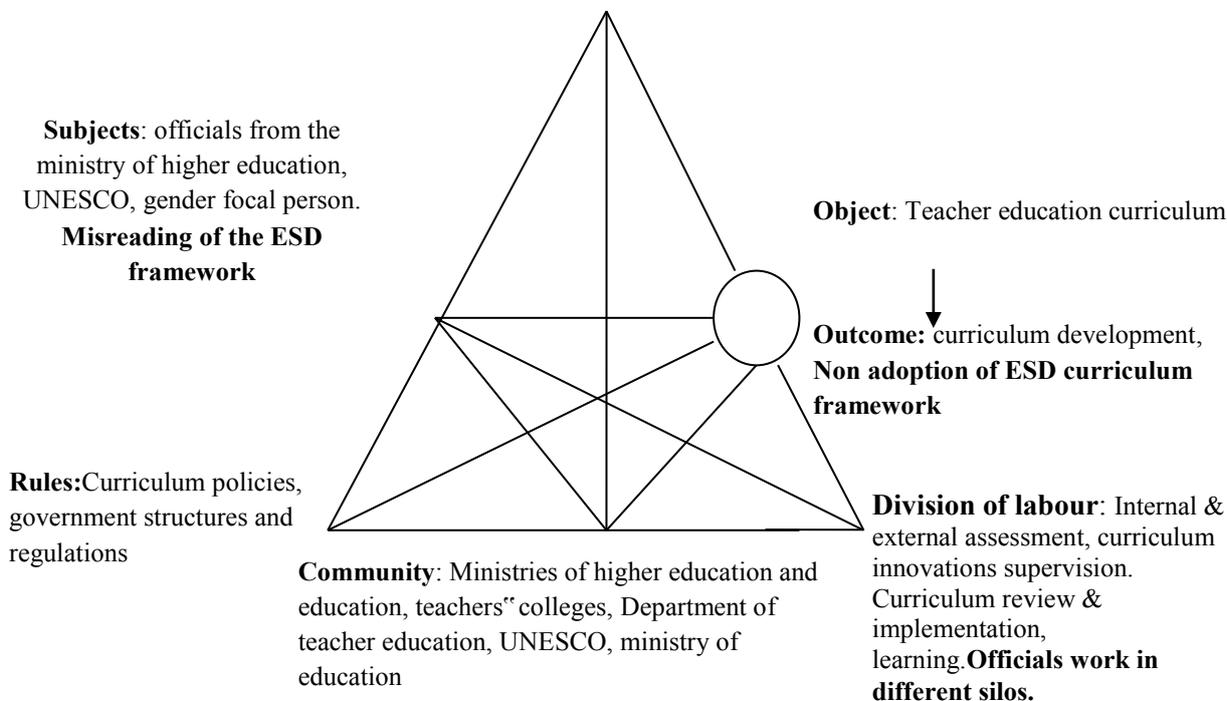
The government of Zimbabwe plays a major role in higher education in the country by influencing policy, funding, establishing programmes, and determining curricula, especially in agricultural, teachers', and polytechnic colleges, which are operated through the government's administrative structure, spearheaded by the Ministry of Higher Education (Teaching profession, 2011). In general, the Ministry of Higher Education administers teachers' colleges in the country. Teachers' colleges follow the standard administrative structure of government; they have an academic board, which is called the Associate College Centre academic board. This board comprises all college principals, representatives from the Ministry of Higher Education's Teacher Education section, and department of teacher education representatives. The board is charged with the responsibility of monitoring all academic programmes in the colleges. The second body is the college administration (CA),

which is the administrative organ of the college; it includes the principal, the registrar, and the deputy and assistant registrars. The final group is the College Board of Studies Committee (CBSC), which is chaired by the college principal and is responsible for monitoring academic programmes as well as overall administration. Senior administrators of the college join the principal on the board.

The teacher education wing under this ministry, headed by a Director of Teacher Education has as some of the responsibilities: contributes to curriculum development; draws from cabinet and other government departments; links regional and international directives with teacher education curriculum. The director is therefore the link person responsible for interpreting both international and national policies on behalf of teacher education. S/he attends high profile meetings with cabinet. The UNESCO desk is also part of the Higher Education directorate.

Another dimension was also added to this activity system, that of the gender focal person. The Ministry of Gender appoints a gender focal person to every ministry whose mandate is to spearhead gender mainstreaming in that specific ministry. Initially I had thought of having the ministry of gender as a separate activity system but because of this arrangement, the gender focal person in the ministry of higher education became one of the subjects of the higher education activity system. Figure 5.4 is the activity system constructed after preliminary results of the exploration phase in Sections 5.3 and 5.4. As with the Department of Education activity system, it emerged from data analysis that there are no institutional tools for mediating gender responsive pedagogies in teacher education. There is also misunderstanding of the ESD framework. These critical issues result in primary contradiction within the subjects. This contradiction causes a secondary contradiction between the subject and other elements of the activity system. The final result is a clash of the object of this activity system with that of the ESD activity system (see Chapter Seven).

**Mediating Artefacts:** Cabinet Policies on Teacher Education, Gender policies, MDGs, UNESCO & ESD policies, national reports, research evidence, gender disaggregated data, **no institutionalise tools to mediate ESD and gender issues in teacher education.**



*Figure 5.4 Higher Education (rule/tool producing) Activity System*

*Table 5.2 Description of the elements of the two rule and tool making activity systems in the BTTC case study before expansive learning*

Element of the Activity System	Description from preliminary data	
	Higher Education	Department of Teacher Education
Tools/artefacts	Traditional ministerial direct and command tools (ministerial policies, research evidence, gender disaggregated data, curriculum expertise). No visible tools to mediate gender and sustainability responsive curriculum development in SMTs teacher education. No visible engagement with gender and ESD related policies. Visible misreading of the ESD framework.	Traditional Teacher Education tools of association with teachers' colleges (ministerial policies, research evidence, gender disaggregated data, curriculum expertise, curriculum assessment tools). No visible tools to mediate gender and sustainability responsive curriculum development in SMTs teacher education. Lagging behind teachers' colleges in designing tools to incorporate sustainability in the curriculum.

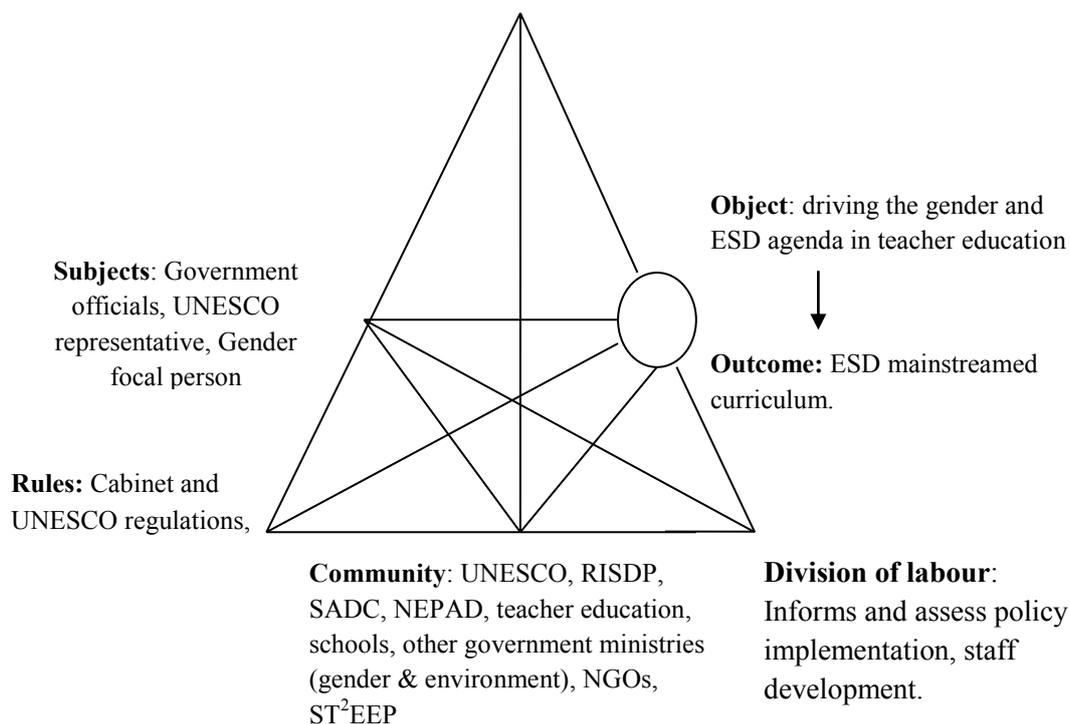
Object	Gender and ecological issues not part of the curriculum development agenda. No visible practices towards directing/leading teacher education to incorporate gender and sustainability issues into curriculum. No structures to translate policy into curriculum practice (contradiction between the object of this activity system and that of the ESD activity system). Non engagement with personal, social and environmental conversion factors in the curriculum.	Gender issues not part of the object of curriculum development. Some officials reluctant to incorporate gender issues into the teacher education curriculum. Teacher's colleges ahead in terms of incorporating ecological issues into the curriculum because of the Secondary Teacher Training Environmental Education Programme that was implemented at the college level leaving out the tool making activity system. Contradiction between the object of this activity system with that of the ESD activity system. No evidence of engagement with social and environmental conversion factors in curriculum development.
Subjects	Aware of gender inequalities in enrolment. Lack mediating tools to coordinate gender and sustainability responsive curriculum practices in SMTs. Misreading of the ESD framework as another cross cutting issue to overload the curriculum (primary contradiction within the subjects)	Aware of gender inequalities in enrolment and retention in SMTs. Some officials aware of the need to incorporate gender into the teacher education curriculum. Lack institutional coordination to come up with mediating tools to direct gender and sustainability responsive curriculum practices in SMTs. Primary contradiction within the subjects, leading to secondary contradiction between subject and object.
Rules	Exam driven curriculum, non-engagement with gender related policies, patriarchal norms, instrumentalist view of education, instrumentalist implementation of MDGs and EFA related policies.	Exam driven curriculum, non-engagement with gender related policies, patriarchal norms, instrumentalist view of education.
Community/Division of labour	Different units working in silos. e.g. gender focal person does not liaise with DTE personnel in curriculum efforts.	Gender issue seen as the responsibility of female officials of the department.

#### 5.2.1.4 ESD Activity System

Section 2.2.2 gives a detailed account of the rationale for having the ESD as a culturally more advanced activity system in this study. As explained in this section, ESD's four thrusts or areas of emphasis and its objectives provided the study with a blueprint to draw from in both the exploration and expansive phases of research. In addition to that, the ESD framework offers processes, which refer to engagement opportunities, pedagogical approaches or teaching and learning styles adopted to implement ESD in different levels and settings of

education and in other informal and social learning scenarios. This provided tools to interrogate issues of quality and relevance of teaching and learning in SMTs teacher education curriculum. ESD also anchored international efforts such as re-orienting curriculum development towards the Millennium Development Goals and provides scope to incorporate ESD into education reform efforts. In this regard the ESD in a CHAT context, brings together a framework that can be used to critically look at issues of social justice in education and also provides guidelines for curriculum transformation with a capability orientation, as outlined in Chapter Three. As shown in figure 5.5, the ESD activity system provides tools, rules and a community that helped in both the exploration and expansive phases of this study.

**Mediating Artefacts:** MDGs, UNESCO, EFA, Beijing Platform for Action, ESD & DESD documents, national reports and gender policies, research evidence, gender disaggregated data, curriculum expertise, and gender mainstreaming techniques



*Figure 5.5 ESD: Culturally More Advanced Activity System*

### **5.3 ASSESSING THE LEVEL OF GENDER AND ESD POLICY RESPONSIVENESS IN SMTs TEACHER EDUCATORS IN THE BTTC CASE STUDY**

Gender responsiveness involves responding to gender issues in ways that eradicate the bias and discrimination seeking to ensure equality and equity. It goes beyond gender awareness and gender sensitivity. This section focuses on assessing the extent to which the teacher education curriculum plays its gender conversion factor role. As discussed in Section 2.8.2, for curriculum to be a „conversion agent“ it should be able to „convert“ retrogressive gendered practices into capabilities and functionings for learners. In such a curriculum, there is need to pay attention to negative social-ecological conversion factors (patriarchal norms and other socio-ecological-cultural ills) and engage them in a critical and transformative manner. There is also need to take advantage of the enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD and factor them into the curriculum.

In order for me to assess the level of gender responsiveness of SMTs teacher educators, I used the tools discussed in Chapter Four to generate data. The emerging data was categorised along the following themes/categories:

- Knowledge /perceptions on push out factors for girls from SMTs;
- Role that teacher education can play to improve the participation of females in SMTs;
- Level of engagement with gender, ESD and curriculum transformation related policies; and
- SMTs curriculum as capability enhancing in view of socio-ecological risk.

I use these themes to do a need state analysis of the activity system in accordance with the Developmental Work Research Design (see Section 4.2.3). As discussed in Section 4.7, in category construction I followed an inductive process using bits and pieces of information to build towards themes. I then used abductive analysis to make sense of data. I used as key tools in this analysis, the capability table (3.1) Section 3.2.2 and the CHAT component posing questions as shown in Figure 3.3. From these I constructed an interview analysis tool (see Appendix 4.1). A checklist, assessing aspects of capabilities (well-being achievement, wellbeing freedom, agency achievement and agency freedom) was designed to guide both focus group interviews and document analysis (see Appendix 4.2).

It is also necessary to remind the reader that as a standpoint researcher (see Section 4.2), I did not claim to be objective in designing my interview guide. In this regard, and as highlighted in this section I found transformative interview techniques appropriate. Some of the questions were designed to focus respondents on particular gender issues in SMTs. For that reason I saw it worthwhile in certain situations to sensitise respondents ahead of the question on research based issues pertaining to gender, ESD and SMTs education. In other circumstances such interview technique may be deemed biased or self-fulfilling. However, the idea was to reveal subjectivities and to generate the kind of conversation that is intimate and self-revealing on specific issues related to the topic, rather than departing from a neutral position.

### ***5.3.1 Knowledge of push out factors for girls from SMTs***

In order to assess the level of gender responsiveness of SMTs teacher educators, there was a need to check on their knowledge of push-out factors for girls from SMTs. Although the focus of the study was on curriculum practices, assessing knowledge was a gateway to understanding practice. As Green (2009) said, practice is in itself a form of action knowledge, also called practical sense, practical logic or practical knowledge, characterised by phenomena such as agency, knowledge, language, ethics, power and science (see Section 1.7.15). The idea was to interrogate teacher educators' knowledge of socio-curricula conditions that may infringe on girls' agency freedom (opportunity freedom) and agency achievement in SMTs.

As reported in Section 4.4.2.1 there were six interviewees in the central activity system. Data became more and more saturated. Interviewees were giving the same information in different words. For this reason, for analysis I used the information from the lecturers in charge more as they are the ones who play a leading role in curriculum development.

The findings reveal that all the teacher educators were familiar with gender disparities in SMTs education. Each one of them was able to articulate some experiences that showed awareness of gender inequality in terms of enrolment, retention and progression of girls and boys in SMTs from secondary level of education and beyond as highlighted in the following extracts. One would say teacher educators in the activity system had some basic level of gender sensitivity, meaning that they had ability to perceive existing gender inequalities as it applies to gender disaggregated data, especially when it comes to enrolment and retention.

In probing further, it came out strongly that some teacher educators apportion the blame to the girls (blaming the victim) (see extract 1 below) for their failure to participate in SMTs.

## Extract 1

**Researcher:** *Now let us talk about the possible push-out factors for girls from science. Why do you think girls become less and less interested in sciences as they continue with their education?*

### Participants (several interviewees)

**Bint1:** *They (girls) believe that science is for boys/is difficult, they put less and less effort in science as they proceed in high school education, some even start love relationships.*

**Bint5:** *Girls are socialised to do easier stuff, some look up to men to look after them in life.*

**Bint3:** *Girls are capable/able but they put less effort at a certain level in their studies. Information Technology is lifelong learning it depends on the character of the person -females not willing to continue learning.*

**Bint2** *At F3 (G10) they have acquired a gender identity and they want to be recognised as such by male counterparts – implication ... it is unfeminine to be good in physics for example.*

Focus group interviews also showed that there were some teacher educators who thought that girls are to blame for their lack of interest in science.

### Extract 2: Bfgint 1 and 2

- *girls perceive them (science and maths) as a male domain*
- *they are normally weak in maths and they do not seem to like to put effort*
- *they (girls) are less forthcoming in discussions and in practical activities*
- *they are shy and at times they withdraw to their little circles*
- *I don't know why more boys than girls opt for physics probably it's a perception that girls have that physics is a male domain*
- *males are more creative, more forthcoming, and adventurous*

There were different opinions however concerning the diminishing of girls' interest in sciences as they progress with education. Some teacher educators thought teachers are partly to blame as shown in extracts 3 and 4.

### Extract 3: part of Bfgint 1 and 2

- *this perception (that girls are not good in sciences) I think is propagated by teachers themselves,*
- *lack of motivation by teachers*

- *teachers propagate stereotypes*
- *society looks down upon females*
- *females do not do well in science, not that they are „dull“but probably due to socialisation*

One interviewee coded **BInt4** had a slightly different opinion stating:

*Gender parity in mathematics improving but slowly ... it looks like females are now willing to take up maths. There is lack of motivation (girls) by their teachers ... teaching approaches favour male learners mostly. Probably because of tradition teachers are biased towards males. Girls lack the confidence to take up the challenge ... this could be because they look down upon themselves due to stereotypes that act against them (girls) for example gender stereotypic statements such as „maths dzinoda varume chaivo“ [mathematics is for real men].*

However, these teacher educators could not articulate any curriculum strategy that is in place to prepare would-be SMTs teachers towards gender responsive pedagogy. This showed tension between subjects' awareness of gender issues and their curriculum practice.

Follow-up questions on the category of knowledge of push-out factors for girls from SMTs, were designed to assess teacher educators' engagement with mediation tools or cultural norms and values (rules) that may impact on gender and SMTs learning as shown in examples under extract 5. Five of the six in-depth interviewees could not link cultural gender inequality inherent in patriarchy (retrogressive conversion factors) to SMTs learning and teaching. In the interviews and focus group discussions, teacher educators acknowledged having witnessed, especially during their high school teaching attributes, such as boys being more assertive and more forceful in getting teachers' attention while the girls tended more toward compliance and conformity; boys taunting and harassing girls so as to deter them from active participation in sciences especially in practical activities that they (boys) deemed male oriented. Surprisingly, as shown in extract 2 below, teacher educators could not attribute such gendered pedagogical behaviours to patriarchal power socialisation and gender-role expectations inherent in most African communities, even though there is an abundance of reports on this in literature (e.g. O'Connor, 2000; Prasad, 2004; Kalu, 2005; FAWE, 2005; Rwodzi, 2006; Clegg, 2007).

### **Extract 5**

**Researcher:** *Traditionally in our African homes, girls are expected to be obedient, submissive, passive ... how do you see this affecting learning and what possibly can be done to equip a trainee teacher to handle such cultural issues?*

**Bint1-** *Learners should be able to draw the line between culture and academic aspects, when we are in class it's about learning, nothing to do with behaviour at home.*

*Opportunities towards education for all are there, the fault is theirs (girls) not the system.*

**Bint3-** *Teacher education institutions should bring this issue (impact of patriarchal socialisation) to the trainee teachers, make them aware of gender stereotypes ... this should be in our methods syllabus and for now we don't talk about cultural issues in science education.*

The ontology and epistemology of school science was also raised with participants to assess the level of gender responsiveness of SMTs teacher educators. The idea was to assess whether SMTs teacher educators prepare their trainee teachers to be aware of and equip them to respond to the experiences, learning interests and styles of both girls and boys in SMTs.

Although analysis of documents revealed that two syllabi mentioned gender in their aims: *the course aims to develop students who make constructive contributions to contemporary issues such as gender and use of a second language...* (Science Methodology Course, n.p. and Technical and Vocational Education Pedagogics syllabus, p.9). Further analysis of other documents (student research projects, assignments, assessment papers, and other syllabi) did not reveal any evidence of engaging with the gendered nature of SMTs.

Evidence gathered in interviews show that all teacher educators involved in the research have had some experiences of different ways that boys and girls would prefer to learn. They are however not translating this into their own curriculum practice as none were able to come up with clear cut curriculum practices to ensure that trainee teachers get exposure in this regard. Extract 6 highlights some of the opinions expressed in interviews.

### **Extract 6**

**Researcher:** *Do you think girls and boys may have different preferred learning styles?*

**Bint3** - *yes ... there are girls who prefer to work with boys - (these are clever girls) - they have confidence ... may want to show the boys that they know just like them.*

- *there are girls who prefer to work in a group of girls only – the average and the weak ones.*

*- on the other hand boys whether weak, average or gifted can work with anyone they don't care much. When they make mistakes they are not very worried ... life goes on, it's an attitude thing.*

**Bint3** *- well probably yes ... what I have seen is that the examples talk more about males and appeal more to boys than to girls ... obviously I know that examples on women experiences will appeal more to girls. Unfortunately most examples in text books make reference to males and their socially ascribed gender roles.*

*- we hope to improve, as we work towards a new syllabus, on equipping our trainee teachers to be able to pick and engage with such issues in text books.*

**Bfgint 2** *- girls prefer laid down instructions e.g. in an experiment (they follow them faster than the boys)*

*- boys comfortable with experiments in which only a mathematical relationship/principle is given*

*- we don't have a college policy on gender but there was a workshop on gender responsive pedagogy so it's difficult to put this across to trainees*

*- girls can perform well in physics when learning as girls only*

*- boys tend to push them away... they (boys) display an impression that physics is their domain*

### **5.3.2 Role that teacher education can play to improve the participation of females in SMTs**

In this section I report on whether SMTs teacher educators are aware of the role that they can play in teacher education to improve the participation of females in sciences. Nussbaum (2004) argued that institutions have power beyond that of individuals and further reasons that the responsibility for promoting human capabilities is institutional. My intention in this section was to explore the mediating tools for gender responsive pedagogy in the SMTs teacher education curriculum.

As reported in the extracts above, SMTs teacher educators had some sense of gender disparities and they were to some extent agreeable that something should be done. But none could articulate any gender responsive strategies and how these could be brought into the curriculum. Interview Bint 3 was specific: "this should be in our teaching methods syllabus and for now we don't talk much about cultural issues in science education".

As is apparent in extract 7 below, teacher educators gave disjointed, individual, abrupt responses on the role that they play or could play as teacher education institution in equipping future teachers accordingly. This echoes the „victim blame“ opinion of most teacher educators

revealed in the extracts above. It also showed that teacher educators do not give attention to, or are blind to other constraints facing girls in SMTs such as patriarchal norms at the deeper epistemological level and in the nature of knowledge that is accepted as scientific (see Section 3.3.1). SMTs teacher educators appear to lack tools/artefacts and institutional cultures to equip future teachers with knowledge, attitudes and skills on gender. This meant that there is little if any at all that is tangible as capability set for girls in SMTs teacher education curriculum.

### **Extract 7**

**Researcher:** *What curriculum efforts are there/are you putting in your practice to impart gender responsive skills, knowledge, and attitudes to future SMTs teachers?*

**Bint1** *- The education lacks to the girl child that we are all the same there is nothing like subjects for boys and some for girls [sic].  
-Teachers don't convey such messages to girls, I sensitise my own trainee teachers towards this ...*

**Bint6** *Last week I spoke about it, giving a lived example of ... 8 out of 10 who did well in a test were females.*

**Bint3** *We always try to make a reference to the low involvement of females in math. Teacher Education should try by all means in their practice to motivate girls to join math/sciences. We always point it out that they (trainee teachers) should try as much as possible to motivate our girl child out there to join maths/science.*

Focus group interview questions required participants to identify tools that they were working with so as to equip future SMTs teachers with knowledge and skills to deal with gender issues in their own teaching. The report (Bfg2) below showed that there was no college policy on gender responsive pedagogies, and that teacher educators were not aware of any national policy to assist them in this regard.

**BFG2:** *No college policy in gender responsive pedagogy. There should be some national policy to find mechanisms to promote girls' access into sciences, find a way to incentivise girls to participate in sciences e.g. bursaries for tertiary education however they should enter tertiary with the same score with boys ... lower entry points tend to attract prejudicial attitudes.*

A capabilities checklist (Appendix 4.2) was used to design in interview questions to assess whether SMTs teacher education engages with aspects of capabilities (well-being achievement, well-being freedom, agency achievement and agency freedom – see Table 3.1, Section 3.2.2). The checklist was looking for specific curriculum evidence such as a document, a lecture session or any piece of information that shows that teacher educators are dedicated to such aspects. Extract 8 summarises the input of teacher educators from various in-depth interviews.

**Extract 8: Checklist for curriculum evidence to show that SMTs teacher education engages with the following capability aspects**

Capability aspect	Evidence indicators
Analyse sexist bias/gender stereotypes in resources, content and language.	We talk about it when opportunity arises, we do not have specific lectures or activities for this. <b>Bint3</b> Well yes whenever there is need but in most case science content is factual so yah we teach facts. <b>Bint6</b>
Examine content, teaching methods and classroom dynamics that encompass girls’ and boys’ interest, experiences and learning styles.	As I said science content is very factual and is given, does not have much room for interest. <b>Bint6</b> I always worry about examples in books that appeal more to males and are sometimes foreign to girls. I try to look for examples that both boys and girls are familiar with, but looks like many favour boys. <b>Bint4</b>
De-emphasise sex-role stereotyping that hinders girls’ progress in science.	When we teach science we teach science, and I do not see sex stereotyping there. <b>Bint1</b> As I said before there is need for teachers to know this but at the moment we are not doing much. <b>Bint4</b>
Draw the attention of boys and girls to the presence and contributions of women in science and mathematics.	Unfortunately the books that we have mostly talk about male scientists and few females, e.g. the Marie Curries <b>Bint3</b>
Alert future teachers to be on the lookout for boys/girls who want to dominate classroom proceedings to the detriment of others.	I discuss about it especially after teaching practice lesson observation if there was evidence of such. <b>Bint5</b> I think there should be a college policy to guide us to all these curriculum needs but at the moment we do not have. <b>Bint4</b>
Ensure that future teachers are able to deal with counter cultural practices that may impact negatively on girls’/boys’ pursuance of sciences.	As I said learners should be able to draw the line between culture and academic aspects, “when we are in class it’s about learning, nothing to do with behaviour at home”. <b>Bint1</b>
Expose future teachers to various ways to help empower girls and raise their self-esteem in sciences.	We need to play a big role here to educate our girl child that there is no science for girls or for boys ... that they (girls) are like any other student, unfortunately we are not doing much as a department in this regard. <b>Bint1</b> We always try to encourage girls out there to study Mathematics, we talk about it in our lectures, so yes I can say awareness raising is there. <b>Bint4</b>
Assist future teachers to add relevance and quality to science by drawing	The syllabus is given in schools; there is little room for teachers to come up with their own things. <b>Bint4</b>

attention to socio-ecological issues.	Education should be seen to be solving societal problems otherwise it will be meaningless. Unfortunately there is very little flexibility in content and teaching methods because the education is examination driven and there is a lot to cover. <b>Bint3</b>
---------------------------------------	---

Extract 8 shows that teacher educators talk about these capability aspects in science learning, when opportunity arises in their lectures, but none of them could raise or highlight lessons or a series of lessons set aside for such aspects. A review of documents such as course outlines, lecture notes, students' research portfolios and assessment materials did not reveal anything different. There was minimum institutional commitment to address gender inequality through curriculum.

SMTs teacher educators' engagement with gender and ESD related policies was assessed in both in-depth and focus group interviews using a checklist shown in Appendix 4.3. It emerged that none had ever heard of the National Gender Policy or the SADC Regional Indicative Strategic Development Plan. All of them had heard about the Education for All, MDGs and the Beijing Platform for Action but they had never used them as tools or rules to support their curriculum practices. They all reported that they had worked with ESD policies through the Secondary Teacher Training Environmental Education Programme. From the above information I was able to construct the teacher education activity system as shown in Figure 5.1.

Inputs from the Department of Teacher Education and Ministry of Higher Education were also vital to give a full picture of gender responsiveness in the whole teacher education system in Zimbabwe. As discussed above, these two activity systems play an important role in tool, subject and rule making and they are active members of the community in the teacher education activity system. It therefore implies that they are key members in the working of the central object, which is the teacher education curriculum. Extract 9 shows that the interviewee was more articulate about gender issues in SMTs in general and was also aware of some gender dynamics in SMTs e.g. stereotypes, bias in people and literature, in language and at home. Surprisingly, as shown in extract 10, there was very little that the Department of Teacher Education was doing to address such gender issues in the teacher education system. As further articulated in evidence 10 below, there are gender based tensions in the Department of Teacher Education itself. This is problematic and affects curriculum

innovations. Although there are affirmative considerations at enrolment, once in the programme no gender considerations, or exposure to knowledge about gender in SMTs for trainee teachers, is provided.

### Extract 9

**Researcher:** *What is your opinion on gender complexities in SMTs in general and teacher education in particular?*

**DTint1** *We really send girls away from sciences [narrates her own experiences as a trainee teacher which was full of gender stereotypes]. Stereotypes, the taken for granted gender biases, tradition of sciences ... mostly males, literature in general seem to underplay the role of females in sciences. Gender issues start with us mothers ... sometimes we don't allow girls to check even a fuse. We need to start as early as pre-school to have gender responsive literature. There is a need to change the way we run schools. Streaming and labelling give the picture that other subjects are harder than others.*

**DTint2** *Need for role models and lots of them, literature that talks about women scientists as well. Girls downplay themselves as individuals. Physics has always been viewed as difficult by both boys and girls ... more so by the girls who are stereotyped to be weaker. Physics has always been delivered as if it is divorced from humans.*

### Extract 10

**Researcher:** *Now as an institution responsible for teacher education, how do you translate these concerns into curriculum practice?*

**DTint1** *It is only now that we are trying to bring the social element into it [teacher training]. Teaching methods courses are supposed to assist the student teachers to make them realise that learners have different ways of learning ... vary your examples e.g. talking about physics in the kitchen ... as long as we talk about weapons and space in physics most girls are left out.*

**Researcher:** *Is this happening now in your education courses?*

**DTEint2** *There is however TRENDS<sup>5</sup> in SMTs that deals with inequalities, abuse, rape, Sexually Transmitted Infections within a school set-up. This is one area in which we hear the stories of teachers and how they tried to cater for the girl child within a school set-up. Most teachers confess that they don't go beyond imparting the subject content, they are incapable of dealing with other social issues, and they normally refer needy learners to guidance and counselling*

---

<sup>5</sup> A module that deals with cross-cutting issues in education.

*teachers. I always tell them you don't teach your subjects but you teach people, so don't be too narrow, talk about social issues as well.*

**Researcher:** *Do you have actual focus on gender issues such as developing skills in trainee teachers to be able to check on gender stereotypic information in language, learning and teaching support materials, and paying special attention to the constraints faced by girls as they attempt to study and/or take measures to correct these?*

**DTint1** *Gender issues are always explosive and involve a lot of emotions. It is a challenge really because it talks about norms that may go against cultural and religious beliefs, patriarchy still rules and we have too much of it. In the whole department of science and maths of 13 we are only two females, it is seen as a department of males and this brings a challenge to advance gender issues into the curriculum, maybe the male members do not want to talk about gender issues in their curriculum because they think they will be shooting themselves in the foot. We usually have debates in the faculty sometimes they make other people uncomfortable but those willing to learn always learn.*

**DTint2** *Each time a gender issue is raised it is referred to the two us [female lecturers] and we are called Beijing [from the Women Beijing conference of 1994]. So gender issues are associated with female lecturers and most males do not want to be involved in that.*

**Researcher:** *Do the outcome of such debates feed into teacher education curriculum?*

**DTEint2** *To some extent yes; we came up with some gender considerations at enrolment, girls enter with two or three points lower than their male counterparts.*

**Researcher:** *Do you in any way engage with gender related policies such as the national gender policy in your relations with teacher education curriculum, if so how?*

**DTFG1:** *Haven't heard of such a document, haven't seen it. I heard about it but I have never used it. What space does it have in training teachers?*

My conclusion here was that although the research participants from the Department of Teacher Education are a little more knowledgeable about gender issues in SMTs, this knowledge is not being translated into curriculum practice except through giving examples here and there and giving consideration to females during enrolment. It was evident that there is no coordinated intervention from this tool making activity system. There was no substantive evidence of engagement with gender related policies in their tool and rule producing activities. This on its own is a contradiction as discussed in Chapter Seven.

Gender considerations are only included at enrolment level; once in the programme there are no formally structured gender considerations nor is there exposure to knowledge about gender in SMTs for trainee teachers. With this research evidence I was able to construct the Department of Teacher Education Activity System as shown in Figure 5.3.

As emerged from the interviews, some Department of Teacher Education officials are knowledgeable of what they should do to address the gender issues in teacher education curriculum, but this is not being translated into practice because of inherent patriarchal norms.

### ***5.3.3 Level of engagement with gender and ESD related policies***

As discussed in Section 2.2 ESD, in this study, was used as culturally advanced and esteemed activity system. As shown in Figure 5.5 ESD as an activity system has, as its community, institutions such as government ministries (especially ministries of education), political groupings such as SADC RISDP, NEPAD, UNESCO and national governments themselves. ESD as an activity system relies on international directives, for example, the MDGs, Education For All, the international implementation scheme and sub-regional and national strategies, DESD, and the Beijing Declaration of Action for mediating artefacts and rules (see Chapter Two). National policies such as the Zimbabwe National Gender Policy are also employed as tools within the ESD framework. It follows therefore that curriculum development ought to mirror the expectations of the ESD framework if the assumption is that national policy systems are engaged with these more globally constituted discourses. With unsustainable issues such as gender inequality in education and socio-ecological risk facing the livelihoods of people, especially women in the SADC countries, and in Zimbabwe specifically, it could be expected that education in general, more so teacher education would contribute in addressing these issues.

A checklist was used to assess the level of teacher educators' engagement with policies (see Appendix 4.3). All the teacher educators in the two focus group interviews confessed that they were not aware of the existence of any of the policies listed in the checklist; neither were they aware of any policy that could assist them to engage with gender issues in their curriculum practice. To probe the use of policy further, I followed this up in in-depth interviews. Extract 11 below shows that teacher educators; in this case those who are in administration, were not using any specific policy to guide their practice.

### Extract 11

**Researcher:** *What efforts do you put in place to ensure education for all in SMTs as prescribed by Education for All policy for example?*

**Bint2:** *There is equal opportunity to study SMTs for all the children (both sexes); we don't actually see any tangible barrier to deny girls equal access to SMTs.*

**Bint3:** *Well I think we need to draft some kind of a national policy to guide us on how to incorporate gender issues in the curriculum.*

**Researcher:** *Have you tried using the National Gender Policy?*

**Bint3:** *No I haven't heard of that one. If it is there surely someone should inform us of the existence of the policy and it is reasonable for policy makers to come up with some implementing programme*

**Bint1:** *I do not know what they mean about Education for All in that policy but I know opportunities for education for all are there but the girl child is not exploiting them.*

**Researcher:** *Is it the fault of the girl child or the system?*

**Bint1:** *It is the fault of the girl child not the system. Well there are some girls who are disadvantaged by society, when parents prefer sending the boy to school when resources are limited, but those in school have the same opportunities with boys; I do not see any need of special treatment.*

#### **5.3.4 SMTs Curriculum as capability enhancing for females in view of socio-ecological risk**

To understand whether SMTs teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context (as per the two case studies), I designed simple open-ended questions such as: *As we teach science do we keep in mind the socio-ecological risks and their gendered nature?*

Judging by the responses analysed within this theme, considerable SMTs curriculum development was initiated through the Secondary Teacher Training Environmental Education Programme<sup>6</sup> (ST<sup>2</sup>EETP). All the teacher educators were very conversant with how they engage with environmental issues in their curriculum practice. It emanated however that, such curriculum efforts were implemented in a gender neutral manner. Being gender neutral is tantamount to being gender blind (see Section 1.7.7). What this means is that teacher

---

<sup>6</sup>A programme to integrate Environmental Education into the Secondary Teacher Training curriculum.

educators were under the impression that socio-ecological issues are gender neutral themselves, that is they impact on men and women in the same manner. Extract 12 below shows this:

### **Extract 12**

**Researcher:** *As we teach science do we take socio-ecological risks and their gendered nature into consideration?*

**Bint3** *We have incorporated Environmental Education into the curriculum through ST<sup>2</sup>EEP to make sure when they go out there they can make pupils aware of the issues of climate change etc.... No gender aspect here.*

**Bint1:** *Recently we had a workshop incorporating ESD into the curriculum ... over the years we have working with ST<sup>2</sup>EEP incorporating Environmental Education into the curriculum. We haven't looked at it with a gender eye.*

**Bint4:** *ESD issues, climate change, drought etc., well-articulated in syllabus reviews because of ST<sup>2</sup>EEP and Environmental Education ... Information Technology is meant to solve problems and it requires a certain level of education. Now females who suffer more from climate change are less educated and have lesser chances of accessing Information Technology and related technology. This is the situation in reality but as for now we haven't put the gender aspect into it.*

**Bint2:** *We were given the task to work within the ESD framework and we are always having workshops. We would appreciate to have that done with gender as well. As for now there is no link between the two.*

After this analysis, I followed up with the Secondary Teacher Training Environmental Education Programme activity system, to check whether there were any efforts to genderise the curriculum transformation that was embarked on in the four-year period of the project (2003-2006) and beyond. Most of the information was obtained through document analysis. All the documents used made reference to socio-ecological challenges like land degradation, pollution, biodiversity loss, poverty and many more. None of these challenges were, however, analysed using gender lenses. Gender does not appear in any of the curriculum guidelines of the programme. The assumption was that these socio-ecological ills affect men and women in the same way. It meant therefore that the curriculum programme was constituted in a gender blind manner.

Over the years, feminist commentators have demonstrated that policy or programme conception and implementation that purports to be gender neutral, actually express the partial and interested perspectives of dominant social groups and perpetuate gender inequality

inadvertently (Dieltiens et al, 2009). Syed and Ali (2005) further argue that it is important to study the nature of social relations beneath the visible nature of the problem. In this way, curriculum reform would be more effective in addressing environmental issues as well as articulating with other factors of social injustice, and the ESD framework as discussed in Chapter Two offers room for this.

The ministry of Higher Education including the gender focal person also contributed to the findings on the role that teacher education can play in order for it to be a potential gender/ESD conversion agent. Extract 13, from an interview with a senior person in the ministry, shows the position of this activity system in relation to the whole gender/ESD discourse.

### **Extract 13**

**Researcher:** *As curriculum drivers how do you make sure that emerging issues e.g. climate change, gender issues are incorporated into the curriculum and whom do you work with?*

**HOInt1:** *UNESCO gives directions, frameworks, guidelines then we try to implement and cabinet makes final decisions. When public opinion is there you can't resist it. Everyone knows that there is climate change, droughts etc.... any good lecturer would use things like this in a social studies lesson or science or mathematics.*

**Researcher:** *But how do you cascade the relevant knowledge down to teachers" colleges, say from UNESCO?*

**HOInt1:** *If there is money/funding we run workshops. Usually we hold our own workshops with principals of teachers" colleges. Also important meetings we have with the department of teacher education usually at the end of each exam mostly in line with assessment and everything else.*

**Researcher:** *As Head Office do you have the mandate to check on assessment and give input e.g. querying why ESD is not well reflected in assessment items or gender issues into the curriculum?*

**HOInt1:** *That is if we agree at all ... at the moment we still have to put ESD in our curriculum. As with gender we look at that not because it's ESD but because there should be gender equity and equality that is why we have a Ministry of Gender that should make sure that the NGP is implemented. Millennium Development Goals, yes we are working with them but to call them ESD is a mistake. For example we have been working with HIV/AIDS very seriously but we haven't been calling it ESD.*

**Researcher:** *Why would you not put the MDGs and HIV/AIDS under ESD?*

**HOInt1:** *Because we have been working with these over the years and now to reclassify them would confuse people and the structures that are in place. There are so many of these cross-cutting issues and the curriculum is overloaded already.*

**Researcher:** *Concerning the low participation of females in SMTs?*

**HOInt1:** *Very true, as a country we have seen this and we would like very much to correct it. The policy of having a pass in “O” level mathematics as an entry requirement into any primary teacher training college was done with the idea that if all teachers are confident in mathematics then children are not short changed. Our lecturers, most of them seem to be aware of such challenges, they should now transmit these things to their students so that gender equality in these disciplines is achieved. Some think we have had a lot of these cross-cutting issues and we get people confused.*

This extract shows clearly that there is an assumption that teacher educators should be able to interpret socio-ecological risk and incorporate this into their curriculum: “Everyone knows that there is climate change, droughts etc. ... any good lecturer would use things like this in a social studies lesson or science or mathematics”. There is also a visible misreading or misunderstanding of what ESD is, evidenced in the statement: “Millennium Development Goals, yes we are working with them but to call them ESD is a mistake”. Yet ESD as a framework is designed to foster increased quality and relevance of teaching and learning and to help countries make progress towards, and attain the Millennium Development Goals. This shows a tension within the system and between this activity system and the ESD activity system as discussed in Section 7.2 as well as being an object of the expansive learning as reported in Chapter Eight.

The gender focal person also raised some issues that needed attention if the teacher education SMTs curriculum was to transform into a gender/ESD conversion agent. Extract 14 below attests to this.

#### **Extract 14**

**Researcher:** *As a gender focal point how do you make sure that gender issues are incorporated into the SMTs curriculum, and whom do you work with?*

**HOInt2:** *There are so many colleges for one person, fourteen of them in the country and I am all by myself. [Meaning she is responsible for all the 14 teacher training colleges in the country in terms of incorporating gender in the curriculum]. We have come up with an institutional gender focal person on a voluntary basis. Unfortunately these are mostly from languages and social sciences. I think it could be better if these people come from SMTs. Their mandate is to raise gender awareness in their institutions, some have even managed to influence*

*drafting of a gender policy for the college. It is difficult for them too, they also have their jobs to do like any other lecturer.*

**Researcher:** *What exactly is their mandate and how far do you think they can go to transform curriculum practices?*

**HOInt2:** *Very little, remember they are lecturers who are experts in their own areas most of which are non-sciences, where we do not have much gender problems. I have tried to go round running workshops on gender responsive pedagogies.*

**Researcher:** *As we do all this, do you take into consideration socio-ecological risks and their gendered nature?*

**HOInt2:** *In most cases we will talk about what is gender, gender and sex roles, just to show participants that gender is a social construct that can be deconstructed. Yes we have gone into how environmental issues like drought affect men and women differently, how girls' education can be disturbed by the HIV/AIDs pandemic because of the nurturing roles associated with females, but we haven't gone into the actual engagement with teaching and learning of specific subjects ... its general gender awareness.*

**Researcher:** *Do you think your efforts can have an impact on more girls enrolling for SMTs as hinted at in the National Gender Policy?*

**HOInt2:** *Umm, I am not sure, as I said we haven't specifically looked into the subjects.*

What is clear from this extract is that the mandate of the gender focal person is to raise gender awareness in institutions of teacher education. Gender awareness is an important step but does not guarantee gender responsiveness in practice. One can be aware, this does not necessarily result in corrective measures. This contradicts the intentions of ESD, the National Gender Policy and the Millennium Development Goals (see Chapter Two and Section 7.2).

#### **5.4 CRITICAL DISCOURSE ANALYSIS**

In this section, I report on the Critical Discourse Analysis (CDA) findings used to supplement the inductive analysis presented in Sections 5.2 and 5.3. My intention was to respond to the research question: *What are the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs teacher education?*

As highlighted in Chapter Three, gender issues are contextually embedded in culture and history; these in turn influence our perception, thinking and practice as discussed in Chapters Two, Three and Four. CDA provided analytical tools to scrutinise the dialectics between knowledge, thinking, culture and practice with the ultimate goal of influencing changes in

human practice. As highlighted in Chapter Four, CDA is an integrated research method which mobilises diverse sources and multiple analytical methods to achieve its end (Griffin, 2007). In this study CDA relied on data generated through document analysis and in-depth interviews focusing on a range of research processes, from desk-based textual analysis to field based interviews. With interviews, CDA was applied to the spoken word as recorded by the researcher during interviews and then transcribed. Griffin (2007) and Jonathan (2006) argued that this two stage process interviewing, followed by the analysis of transcribed material, not only integrates fieldwork and desk-based work but also indicates the way in which CDA is achieved through a serial process of interpretive steps based on the selection of what to ask, whom to ask, how to record the data, what to focus on in analysis and how to articulate that analysis. As Griffin (2007, p. 8) puts it, “this refuses the notion of this research method as a unitary fixed grid to be imposed on a given text but rather frames it as a dynamic, situated, dialogic, flexible and provisional process”. Such attributes are pertinent for trustworthiness and rigour of a research method.

#### ***5.4.1 Making sense of data with Critical Discourse Analysis***

As discussed above and in Chapter Four, I used a multi-disciplinary approach anchored by Fairclough’s three dimensional model of discourse analysis (Figure 4.6) supported by feminist and capability approaches. As highlighted in the introduction, CDA was used to summarise findings linked to the first two goals of the research that is: to assess the level of gender responsiveness of SMTs teacher educators, as well as to gauge the extent to which the SMTs teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context. The CDA responded most especially to the research question: What are the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practises in SMTs education? Bearing in mind the curriculum transformative agenda of the study, that was to be done through expansive learning, CDA also surfaced tensions and contradictions that were later on used in Change Laboratory workshops.

The discourse fragments which were analysed are excerpts from interviews (spoken and transcribed) and extracts from documents. Although I analysed the three dimensions of discourse with a different focus, I however, kept in mind that they are interdependent as highlighted by Matrikelnr (2006).

#### 5.4.1.1 Critical Discourse Analysis on spoken language.

A CDA process used the themes established in Section 5.3. This section concentrated on data obtained through in-depth interviews (spoken and then transcribed), most of the information was obtained through verbal interviews. In doing CDA on spoken language I was inspired by Daniels (2012) who argued that institutions shape talk and talk shapes institutions. As said before, after discovering data saturation, I concentrated on the information coming from the management team that is lecturers in charge and the Head of Department as they are the ones who drive curriculum development. The first theme looked at SMTs teacher educators' opinions on the „push-out“ factors for girls from SMTs.

**Discourse fragment 1:** Responses to the question: *Why do you think girls become less and less interested in sciences as they continue with their education?*

#### **Participants (several interviewees)**

**Bint1:** *They [girls] believe that science is for boys/is difficult, they put less and less effort in science as they proceed in high school education, some even start love relationships.*

**Bint5:** *Girls are socialised to do easier stuff, some look up to men to look after them in life...*

**Bint3:** *Girls are capable/able but they put less effort at a certain level in their studies. Information Technology is lifelong learning it depends on the character of the person ... females not willing to continue learning...*

**Bint2:** *At F3 (G10) they have acquired a gender identity and they want to be recognised as such by male counterparts ... implication ... it is unfeminine to be good in physics for example. Opportunities towards education for all are there, the fault is theirs (girls) not the system. Some even start love relationships...*

Using the first dimension of CDA to analyse this discourse, the discourse fragments came from experienced male SMTs teacher educators with a long history of teaching at the secondary level of education as well. They were all raised in a typical Zimbabwean patriarchal culture as discussed in Section 1.7.16. Three of them were lecturers in charge who drive policy and play supervisory roles in their respective departments; they are in middle management in teacher education, a position that is key to curriculum design, innovation, implementation and development.

To interpret this data, I drew on Fairclough's (2008) three functions of linguistic analysis: representation, relations and identities. The representation function (ideational function)

looks at particular representations and re-contextualisations of social practice (Sheyholislami, 2008). In this case, girls are represented as “weak, putting less effort, used to get things done for them”, therefore “the fault is theirs”. The sentence “girls are socialised to do easier stuff” in the above extract is ideationally loaded.

Identities are particular constructions of writer and reader identities, and reflect status and role aspects of identity or individual and personality aspects of identity highlighted in the text (ibid.). All the sentences in Text 1 articulate that girls are not motivated to do science. In fact, the discourse fragments portray girls as lazy and unmotivated, a group of people who look forward to be looked after in life. The socially constructed feminine identity is also stereotyped to be anti-science. By relationship, Fairclough (2001) means a particular construction of the relationship between producer of text and the one referred to in the text (as for instance, close or distant, formal or informal). Although not explicit in the text, one is tempted to deduce that such statements are uttered by teacher educators who do not maintain a close curriculum relationship with female learners. They have lower expectations of them and the relationship is likely to be cold. Lower teacher expectations are detrimental to girls, as observed by Kalu (2005) in Nigeria, who found that in SMTs, there is a relationship between lower teacher expectations for female performance, and a negative self-image of female students (Section 2.4). By extrapolation, the vicious cycle is likely to be perpetuated, if teachers show lower expectations of female students, female students perform less or quit SMTs outright. It would be prudent then to question the conditions in SMTs teacher education in terms of the capability set (opportunity freedom) for girls (see Chapters Seven and Eight).

According to Fairclough (1995) linguistic analysis is also concerned with presenting as well as absencing. Conspicuously absent in this text are other push-out factors for girls from SMTs as reported in literature. The only aspect that is presented as causal for girls’ avoidance of sciences is their identity. This would mean that lecturers in charge do not know of other push-out factors such as the masculine ontology and epistemology of SMTs and patriarchal socio-cultural constraints that may impede girls from learning SMTs as discussed in Section 2.4. There is no clear answer to the capability reframed research question (see Chapter Three) “what capability set (opportunity freedom) is provided for girls in SMTs teacher education curriculum?” As shown by the data above, teacher educators did not articulate the social conversion factors that may prevent girls from flourishing in SMTs. It is evident that

curriculum practices of SMTs teacher educators were hindered by gender blindness, even in cases where other aspects of ESD, such as those promoted in the Secondary Teacher Training Environmental Education Programme are found. By so doing, trainee teachers are likely to graduate from college without the necessary attitude, values, knowledge and skills to tackle gender issues in their careers and teaching practices. This evidence shows contradictions between the object of the teacher education activity system and that of the ESD activity system, a situation which expansive learning focuses on, as reported in Chapter Eight.

The second dimension relates to discourse practice. It looks at context at the micro level. It raises questions on power relations, merging voices and relies on intertextual analysis, looking at ways in which the text straddles society (Fairclough, 1995). Analysis of the discourse fragment in this case clearly shows some intertextual traces or snatches of patriarchal ideology. This is shown by the undervaluing of women's and girls' work. This is despite overwhelming research evidence showing that women work more than men in patriarchal societies (Kabeer, 1994), and that from an early age girls are socialised to do reproductive, productive and community work (see Section 1.7.17). This opinion emanates from patriarchal societies that only value productive work that is paid for in the capitalist world. The statement "at F3 (G10) they have acquired a gender identity and they want to be recognised as such by male counterparts..." is again ideologically loaded. Implicit is the fact that girls acquire their value, worth, identity etc. through the eyes of males. This greatly underrates their personhood, individual identity and agential powers. Fraser calls this misrecognition, "the manner in which individuals or groups are marginalized, degraded or oppressed by social and cultural practices" (cited in Dieltiens et al., 2009, p.367).

The last piece of the discourse fragment "some even start love relationships" could be linked to gender role stereotypes found in most patriarchal societies that view reproductive roles (marriage and motherhood) as primary for any woman (Moser, 1993). Discourse properties like these are, as van Dijk (1993) said, geared towards the production or activation of an episodic mental model confirming negative attitudes about the powerlessness, of girls in sciences, amongst others. Once established, he elaborates, such negative social (curriculum) representations may in turn be used in the formation of models that monitor discriminatory acts. This formation of general attitudes, consisting of general opinions such as "girls are less motivated to do science", are acquired more or less directly by generalised statements in

discourse (ibid.), as shown in discourse extracts. Van Dijk's argument, to which I subscribe, is that such social representations of a particular group sustain inequality.

Another piece of the discourse fragment "opportunities towards education for all are there, the fault is theirs (girls) not the system" is also ideologically laden. From an intertextual analysis, one can read functionalist, instrumentalist views of gender equality in education shaped with a patriarchal parlance. Gender equality is seen in a narrow sense that includes physical access: the belief that once girls and boys are exposed to the same curriculum, taught by the same teacher, read the same book, there is equality. Unfortunately this has a long history. After the pronouncements of Education For All, Dakar and the MDGs, most governments and non-governmental organisations provided resources for girls to go to school, as a way of fulfilling the UN call for education as a basic human right (see Section 2.6.2). This assumption overlooked the existing gendered social relations in school bureaucracies and in the societies of which they are part, as discussed in Chapter Two. Adequate learning and teaching linked to the prevailing curriculum does not necessarily address the intensity and force with which views about gender inequality are held. Nor does it overcome the consequences of a long history of gender inequality (Brighouse and Unterhalter, 2002). Lotz-Sisitka (2008), citing the EFA Global Monitoring Report and field-based data, added that physical access on its own to education, does not necessarily lead to epistemological access to knowledge or to relevant education being offered.

Sen's conversion factors also become useful for interpretation here (see Section 3.2). Equality of resources in a curriculum sense falls short because it fails to take account of the fact that girls and boys differ in their abilities to convert these resources (books, teachers, scientific knowledge etc.) into capabilities and actual functionings, partly due to patriarchal social environmental factors around SMTs learning (such as the masculine ontology and epistemology of SMTs, gendered pedagogies and socio-cultural gendered constraints).

Van Dijk (1993) also noted denial and legitimation as „strategies“ used to maintain dominance and inequality. For example the phrase "opportunities towards education for all are there" is a good example of a case in which a teacher educator is denying that there is anything more the system can do. As discussed above, the denial hinges on a functionalist tenet that the curriculum offers both boys and girls equal access to curriculum resources. Justification and legitimation are read in: "the fault is theirs (girls), not the system; they are

capable/able but they put less effort". Implicit in this discourse is the system (curriculum) is just and the fault is theirs (the „girls“).

Drawing on the second and third dimensions of Fairclough's CDA model, I saw it appropriate to make reference to concepts of ideology and hegemony. This enables the analyst as Fairclough (2001) says, to dig into linguistic material and examine it "from the inner core to the outer range" (p.30) in order to investigate any signs of hegemony and/or ideological changes. He noted that ideologies are brought to discourse "not as explicit elements of text, but as background assumptions" (p.71). He added that "hegemony is not only dominance, but also a process of negotiation out of which emerges a consensus meaning" (ibid., p.76). As a force, hegemony is diverse, never stable but in constant change and may also question the given ideologies (Fairclough, 2008). Moreover, he adds, it is a process which in the end may lead to either production or reproduction, and maybe to reconstruction of fixed entities or to a further establishment of already existing ideologies. Discourse fragment two below is a typical example of the power struggle between constraining ideologies.

**Discourse fragment 2:** Responding to: *T*raditionally in our African homes, girls are expected to be obedient, submissive, passive ... personality attributes that may not be in accordance with active participation as required in science learning; how do you see this affecting learning and what possibly can be done to equip a trainee teacher to handle such cultural issues?

### Several participants

**Bint1:** ...learners should be able to draw the line between culture and academic aspects ... when we are in class it's about learning, nothing to do with behaviour at home.

**Bint3:** yes ... there are girls who prefer to work with boys- (clever girls)-they have confidence ... may want to show the boys that they know just like them. There are girls who prefer to work in a group of girls only – the average and the weak ones. On the other hand boys whether weak, average or gifted can work with anyone they don't care much. When they make mistakes they are not very worried ... life goes on attitude.

**Bint4** ... males are more creative, more forthcoming, and adventurous ...

Critically analysing the fragment, and looking into context at a macro level, with gender lenses as framed in Chapters One and Two, I could see two ideologies at play in SMT teacher education in this context. Girls are expected to cross the boundary between the patriarchal ideologies which value female submission, while at the same time operate differently in a science learning domain where success is measured by levels of participation. They are expected to negotiate the boundary crossing by themselves, as reflected in the fragment “learners should be able to draw the line between culture and academic aspects, when we are in class it’s about learning, nothing to do with behaviour at home”. This epitomises how ideology is brought into discourse, not as an explicit element of text but as „common sense“ or that which is taken for granted in socio-cultural and socio-historical practice within the activity system. According to van Dijk (1993)’s socio-cognition, implicit in this text is an articulation of the „us versus them“ dimensions (Sheyholislami, 2010). For this teacher educator, being male, looking at issues from a position of power, it is „common sense“ for girls to see that they should behave differently in the different environments of school and home. It is for him beyond any doubt and so he does not see any need to prepare future teachers to facilitate girls’ abilities to cross ideological borders, or see a need for himself to cross such ideological borders. Given this hegemony, it was not surprising, therefore, that there were no visible conversion processes that were taken into account in the SMTs teacher education curriculum to establish the capability set for girls in view of socio-cultural constraints and socio-ecological risks. I concluded that teacher educators in this activity system are often inadvertently, due to their own social habitus, (see Section 1.7.15) perpetuating gender inequality in SMTs by extending gender blind curriculum practices to future teachers.

The second half of fragment two: “yes ... there are girls who prefer to work with boys- (clever girls) – they have confidence ... may want to show the boys that they know just like them”, shows patriarchal ideology at play. Again using one of van Dijk’s principles of making explicit the presupposed and the implied (1993), those girls who are deemed to be clever are seen as confident enough to work with boys. Doing an intertextual analysis, I could link this to the Shona (vernacular) expression „*murume pachake*“ (she is a real man), a phrase commonly used to describe women who have made it in life, or young girls who do well in school, competing with boys. The underlying cultural assumption is that society does not

expect its female folk to be as good as men; this has also clearly permeated curriculum thought and practice.

The fragment also shows how girls and boys are seen differently in society in general and in school in particular "... on the other hand, boys whether weak, average or gifted, can work with anyone, they don't care much. When they make mistakes they are not very worried ... they have a „life goes on“ attitude". Taken together with the previous statement, this shows a typical example of the many semantic „content“ statements that entail negative evaluations of one group and positive evaluations about the other (ibid.). In this case, the discourse producer(s)'s lexical style, that is choice of words, imply negative evaluations of girls and positive positioning of boys in science learning. Van Dijk (1993, p.263) further argued that if such "polarised" models are consistent with negative attitudes or ideologies, they may be used to sustain existing attitudes or form new negative attitudes thereby reproducing and perpetuating, as in this case, curriculum gender inequality. He (van Dijk, ibid.) further confirmed what I discovered in this case study, that discourse producers tend to emphasise that this „is always like that“, and that the circumstances do not allow alternative interpretations of the „deviant“ actions of them (girls).

It can be deduced that boys, in this case context are given intellectual free range, more so than girls in general as deduced from the text "males are more creative, more forthcoming, and adventurous". Such an assumption can inform practice that greatly reduces anxiety levels in boys, hence giving them more conducive space for learning; it does the opposite for girls. Several authors have reported that girls have restricted space, compared to boys in laboratories or in classrooms which dampens their opportunities for expressing their creativity or full potential (see Kalu, 2005; Chetcuti, 2009; Chikunda, 2010; Christidou, 2011; Chetcuti and Kioko, 2012) (see Section 2.4). Such an assumption is also unfounded as many girls perform as well as boys in sciences, when provided with equitable learning contexts (Chetcuti and Kioko, 2012).

As discussed in Chapters One and Three, agency forms a central part of this study bearing in mind its curriculum transformation interest. Agency looks at what human beings can do to achieve improvements, particularly through policy and practice. This relates to the second and third themes raised in Section 5.3: „Role that teacher education can/is play(ing) to improve the participation of females in SMTs“ and „level of engagement with gender and ESD related policies“. The critical discourse analysis revealed what teacher educators are

doing to improve gender equality and ESD in SMTs education. It examined efforts made, policies worked with to instil in future teachers“ relevant skills, knowledge, norms and values to tackle gender issues in their own practices. As supported by Fakuda-Parr (2003) and Crocker (2008), an interest in agency is concerned with the role of human agency for changing policy, social commitment, and norms as well as human rights. Human beings can be agents of change through both individual action and collective action (ibid.). It is for this reason that Sen (2009) regarded agency as itself a valued functioning. In this regard, I sought to understand the agency of teacher educators in view of the underrepresentation of girls in SMTs. I used CDA to examine capability rephrased questions such as: “what capability set (opportunity freedom) is provided for girls in SMTs teacher education curriculum?”; “which conversion processes are considered by the SMTs teacher education curriculum to establish the capability set for both sexes in view of socio-cultural constraints and socio-ecological risk”? Discourse fragment3 below adds further perspective.

**Discourse fragment 3:** Responding to: *What role can teacher education play to improve female participation in sciences? What efforts are you putting in place to ameliorate the situation/alert/impart knowledge, skills and attitudes to future teachers?*

**Bint1:** *The education lacks to the girl child that we are all the same there is nothing like subjects for boys and some for girls [sic]. Teachers don“t convey such messages to girls.*

**Bint6:** *I sensitise my own trainee teachers towards this... last week I spoke about it giving a lived example of ... 8 out of 10 who did well in a test were females.*

**BFG2:** *...no college policy in gender responsive pedagogy, there should be some national policy to find mechanisms to promote girls“ access into sciences.*

As discussed above, it is obvious from the surface meaning of this discourse fragment that teacher educators are not aware of the existence of policies that can assist them in bringing about gender responsive pedagogies into their curriculum practices. This shows a policy practice gap which raises tensions in SMTs teacher education in this case study. A critical analysis of the text fragment however, provides deeper insight. Fairclough“s (2001) notion of member“s resources was quite helpful in this case. He viewed member“s resources as ideologies e.g. assumptions of culture, social relationships and social identities which are

constituted by power relations but at the same time either reproduce or change these power relations by participating in the social process of struggle.

The text fragment: “the education lacks to the girl child that we are all the same there is nothing like subjects for boys and some for girls”, may look sincere but it is also manipulative. The discourse producer dismisses the patriarchal ideological barrier that girls face and assumes that if every teacher repeatedly tells girls and boys that “we are all the same there is nothing like subjects for boys and some for girls”, then there is gender equality. Additional cues “teachers don’t convey such messages to girls” confirm the belief that what is needed is simply conveying the message. The producer appears to lack understanding of deeper cultural issues that impact on the ontology and epistemology of SMTs education.

Features of member resources related to social relationships and social identities are also implicit in the fragment: “I sensitise my own trainee teachers towards this...there is no college policy in gender responsive pedagogy; there should be some national policy to find mechanisms to promote girls’ access into sciences”.

Teacher educators may be seen as being responsible for the problem of gender inequality, but this discourse fragment reveals a deeper structural problem related to a lack of appropriate policy guidance to assist them to implement the necessary curriculum initiatives. The text “I sensitise my own trainee teachers towards this” implies „I am doing my level best in the given circumstances“. The discourse shows that SMTs teacher education practice is constituted by power relations between those who decide on the curriculum and those who implement what is decided. Such power relations not only have the potential to perpetuate the status quo, but also to weaken, if not eliminate agential identities of individuals. The conclusion from this text analysis is that there was no concrete capability sets (opportunity freedoms) provided for girls in SMTs teacher education curriculum other than those they could access in the normalised gender insensitive curriculum. The SMTs teacher education curriculum operates in a gender neutral manner, a situation that will make the practice gendered. By not addressing the patriarchal hegemony embedded in SMTs, it is perpetuating gender blind curriculum practices. In CHAT terms, this is constituted by a tension between two or more activity systems, the central activity system and the tool and rule making activity systems (see Section 5.2).

CDA was further extended to the theme: SMTs curriculum as capability enhancing for females in view of socio-ecological risk. The intention was to elaborate responses to the research question: “What capability set (opportunity freedom) is available for girls in SMTs in view of socio-ecological risk in a Southern Africa context?” Discourse fragment four below offers a mixture of gender blind and gender-lite<sup>7</sup> perceptions of socio-ecological risk.

#### **Discourse fragment 4:**

**Bint3:** *Not sure ... when we teach science we just teach science. We have incorporated EE into the curriculum through ST<sup>2</sup>EEP to make sure when they go out there they can make pupils aware of the issues of climate change etc. We haven't looked at it with a gender eye.*

**Bint1:** *Drought is drought and it does not discriminate males and females, no gender aspect here.*

**Bint4:** *gender and ESD... IT (information technology) is meant to solve problems and it requires a certain level of education. Now females who suffer more from climate change are less educated and have lesser chances of accessing IT and related technology.*

The gender blind conception separates ecological issues from the social justice concerns. The fragment “drought is drought and it does not discriminate males and females” shows blindness in the way environmental concerns interact with social justice issues such as gender inequality. The assertion “when we teach science we just teach science”, has scientism connotations, which reflects a view that is divorced from social sense making.

The gender-lite conception acknowledges the need to look at both social and ecological issues as expressed in “... females who suffer more from climate change are less educated and have lesser chances of accessing IT and related technology”. However because of the way curriculum is structured, ecological concerns are treated separately from social justice issues.

---

<sup>7</sup> Dieltiens et al. (2009, p. 365) defined „gender-lite“ “as acknowledging some gender discrimination and the need to identify particular conditions of girls, but this often took essentialised forms that stopped short of addressing underlying power structures that disadvantaged girls and women”.

Although the Department of Teacher Education was a different activity system, I thought a critical discourse analysis of the obtained data could add value to the argument above.

Discourse fragment five shows the responses given by the department participants in interviews. The participants were reflecting on the challenges that they face in including the gender agenda in the SMTs teacher education curriculum.

### **Discourse fragment 5:**

**DTint1:** *Gender issues are always explosive and involve a lot of emotions and certain individuals may become offended. It is a challenge really because it talks about norms that may go against cultural and religious beliefs ... patriarchy still rules and we have too much of it ... in the whole department of Science and Maths of 13 we are only two females, it is seen as a department of males.*

**DTint2:** *Each time a gender issue is raised it is referred to the two us [female lecturers]... males do not want to be involved in that.*

Applying Fairclough's model to the first dimension of text analysis or description, the fragment came from two women in the Department of Teacher Education, an activity system that is responsible for making rules and tools for teacher education. They both have vast experience in teaching sciences at high school, teacher education and university levels. The texts reflect power relation struggles in discourse. In interpreting the fragment: "gender issues are always explosive and involve a lot of emotions..." one can deduce that perhaps there are some individuals within the organisation who support the idea of change and others who want to maintain the status quo. The statement "It is a challenge really because it talks about norms that may go against cultural and religious beliefs, patriarchy still rules and we have too much of it", confirms the power behind the discourse, which is patriarchy. The text also lays bare social practices, and the socio-historical conditions that govern the processes of curriculum production at Department of Teacher Education level. It could be deduced that the reason why the Department of Teacher Education has not yet included gender issues into teacher education is partly because of the patriarchal ideology that is strong enough to affect even supervisors of teacher educators.

Furthermore much can be seen in the statement "in the whole department of science and maths education of 13 we are only two females, it is seen as a department of males ... other departments are gender balanced" and "... gender issues ... are referred to the two us males do not want to be involved in that". Firstly, the discourse producer is saying it is difficult for the two of them to include gender matters in the curriculum. My own experience as a

researcher endorses this. When I was negotiating access, each time after giving the title and goals of the research, I was quickly referred to the two women, who later became participants in the study. This occurred with four individuals in the department and this indicated that all gender matters were seen as the concern of the women. Secondly and related to the first point, is the concern that two females is too few in number for the task and that they are not able to do enough to act as role models for girls. Lastly, one can also detect a defeatist orientation: if gender cannot be included in the curriculum pedagogically, then at least young women should have some individuals to emulate. Pessimistic sentiments were confirmed by statements such as “we are talking about 40-50 year olds doing post graduate courses, to change them is difficult” (DTEint1).

The picture outlined here is that the Department of Teacher Education is not integrating a gender responsive agenda into the teacher education curriculum, as it is expected to do as an activity system that oversees curriculum development in teacher education. It is also evident that despite all capabilities to do so, like knowledge of gender inequality, the ministerial mandate to drive curriculum and well laid structures for execution of curriculum initiatives, the Department of Teacher Education is held back by factors such as rigid patriarchal ideology. This affects agential powers of individuals. By so doing, the Department of Teacher Education is contributing towards a SMTs teacher education curriculum in which the capability set (opportunity freedom) for girls is not fully accommodated.

Pierre Bourdieu’s (1990) concepts of habitus, field and doxa can be used here to offer a supplementary explanation on the status of gender and socio-ecological justice in SMTs teacher education curriculum. Habitus for Bourdieu was a set of dispositions inculcated in each of us by the conditioning that follows from our social environment (Elder-Vass, 2007). Bourdieu argued that dispositions that make up the habitus do not operate in a rule-like fashion; rather each disposition provides a generative capacity, a transposable potential to react in a certain style (ibid.). Bourdieu defines habitus as:

*... systems of durable, transposable dispositions, structured structures predisposed to function as structuring structures, that is, as principles which generate and organise practices and representations that can be objectively adapted to their outcomes without presupposing a conscious aiming at ends or an express of mastery of the operations necessary in order to attain them. (1990, p.53)*

Thus, as seen in most discourse fragments in this chapter, the habitus produced by patriarchal social conditioning, tends to encourage SMTs teacher educators and the Department of Teacher Education participants to behave in their curriculum practices in ways that reproduce or perpetuate gender inequality in sciences. Reacting to Rational Action Theory (Rational Choice Theory), Bourdieu argued that “social agents do not continuously calculate according to explicit and economic criteria, rather, they (social agents) operate according to an explicit practical logic ... a practical sense ... and bodily dispositions, they act according to their feel of the game” (ibid., p.83). The “feel” is, roughly, habitus, and the “game” is the field (Thorpe, 2009, p.494). The discourse fragments have shown power struggles that characterise the SMTs teacher education field (game). Bourdieu (2000) claimed fields are constructed according to underlying *nomos*; fundamental principles of vision and division, and that “agents subscribe to a particular field not by way of explicit contract, but by their practical acknowledgement of the stakes, implicit in their very playing of the game” (ibid., p.169).

Some discourse fragments highlighted above such as “girls believe that science is for boys/is difficult; girls are socialised to do easier stuff; some (girls) look up to men to look after them in life” show in some SMTs teacher educators what Bourdieu referred to as „doxa“: fundamental, deep-founded unthought beliefs, taken as self-evident, universal and they inform their actions and thoughts in their field (curriculum practice) (ibid.; Thorpe, 2009). Bourdieu further adds that „doxa“ tends to favour the particular social arrangement of the field, thus privileging the dominant and their position of dominance as self-evident and universally favourable (ibid.). Likewise SMT teacher education in the case study remains largely male dominated and the agents (teacher educators) somehow accept this as legitimate and habitually perpetuate/reproduce the status quo.

Bourdieu’s theory, although very useful here in offering an explanatory account, has been criticised for being too deterministic and leaving little room for agency (Birkett, 2011) and for neglecting the role of consciousness in the formation of the habitus (Elder-Vass, 2007). In criticising Bourdieu, Archer (2007) provided an account of identity and identity emergence that recognised that people are not only determined or produced by structures; people have agency. She went on to argue that the emergence of personal and social identity (cognitive and affective) takes place through continuous internal conversations, the capacity to deliberate reflexively about commitment and concerns. Reflexivity, she added, enables

persons “to consider themselves in relation to their (social) contexts and vice versa. Her argument is that such deliberations, enable people to evaluate their situations and determine concerns and future actions” (Birkett, 2011, p.3). In this study, I drew on Archer’s theoretical arguments to strengthen reflexivity among SMTs teacher educators in Change Laboratory workshops (see Chapter Eight), using processes to support them to scrutinise their practices further as it relates to establishing the capability set for girls in SMTs in general, and in particular, in view of socio-ecological risk in a southern African context. Chapter Seven therefore surfaces contradictions that were used in a CHAT change laboratory framework in a bid to expand the object of teacher education curriculum in terms of socio-ecological justice as discussed in Chapter Two.

## **5.5 CONCLUSION**

The chapter sought to analyse SMTs teacher education as a potential gender conversion agent in the BTTC case study context. This was done through probing the level of gender responsiveness of SMTs teacher educators in their interacting activity systems, and reporting on the manner in which the science teacher education curriculum practices considered the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context. Results show that teacher educators in the BTTC case study are aware of gender inequalities in SMTs as they pertain to parity. However there was no evidence of systematic engagement with gender issues in the curriculum, thereby limiting the agential potential of future teachers to engage with gendered and social-ecological issues in their own curriculum practices. Environmental issues were incorporated into the curriculum but in a gender blind manner. While this is a positive step towards ESD, it cannot in its current form contribute much towards social-ecological justice, as this will not contextualise the source of injustice embedded in cultural practices as discussed in Chapters One and Two. Critical discourse analysis was used as a methodological tool to develop a deeper understanding of the underlying mechanisms that constrain the uptake of gender issues in the SMTs teacher education curriculum in the case context. This was also resonant with the principle of historicising tensions and contradictions in preparation for expansive learning as is discussed in Chapter Eight.

## **Chapter 6: EXPLORING CAPABILITIES, SUSTAINABILITY AND GENDER JUSTICE IN SMTs TEACHER EDUCATION CURRICULUM: UKZN CASE STUDY**

### **6.1 INTRODUCTION**

This chapter reports on the exploration phase of the UKZN case study. As with the BTTC case study in Chapter Five, this chapter addresses the first two objectives of the study in the UKZN case study:

- to assess the level of gender responsiveness of SMTs teacher educators; and
- to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context.

The chapter starts with a brief description of activity systems making up the UKZN case study. This is followed by a presentation of data using thick descriptions accompanied by inferences. As with the previous chapter, I made use of data generated from the field using in-depth individual and group interviews, and document analysis.

Critical discourse analysis CDA was undertaken to condense findings as well as to excavate sources of tensions and contradictions in activity systems. The idea was to go beyond description of existing situations and gain deeper insight of the situations.

### **6.2 ACTIVITY SYSTEMS IN THE UKZN CASE STUDY**

The UKZN School of Education developed out of the merger between the university and the Edgewood College of Education. The college was established as a white and ladies only seminary in 1966 (Vietzen, 2010) moving from one primary school to the other in the vicinity. It finally moved to its permanent premises at Pinetown in 1970 (Tebbutt, 2010), which is today the home of the Faculty of Education. The college was initiated by the Natal Education Department as an English-speaking teachers' training college "to prove to the National Part Government (largely made up Afrikaners) that Natal (English speaking province) was not lagging behind" (ibid., p.12). In 1991 Edgewood College opened her residences to Black African students by admitting 12 with over 600 White students (Buthelezi, 2010). Over the years Edgewood was able to offer degree programmes, with formal curriculum approval by the Faculty of Arts of the University of Natal (Hemson, 2010). Like the country itself, the history of the college has anecdotes of tensions around race,

ethnicity and sexism. Despite this however the college grew to be one of the most renowned teacher education institutions in the country (Mwamwenda, 2010). There were also tensions of a curriculum nature from the merger with the university, which were of a particular interest to this study. Jarvis (2010, p.88) summed it up:

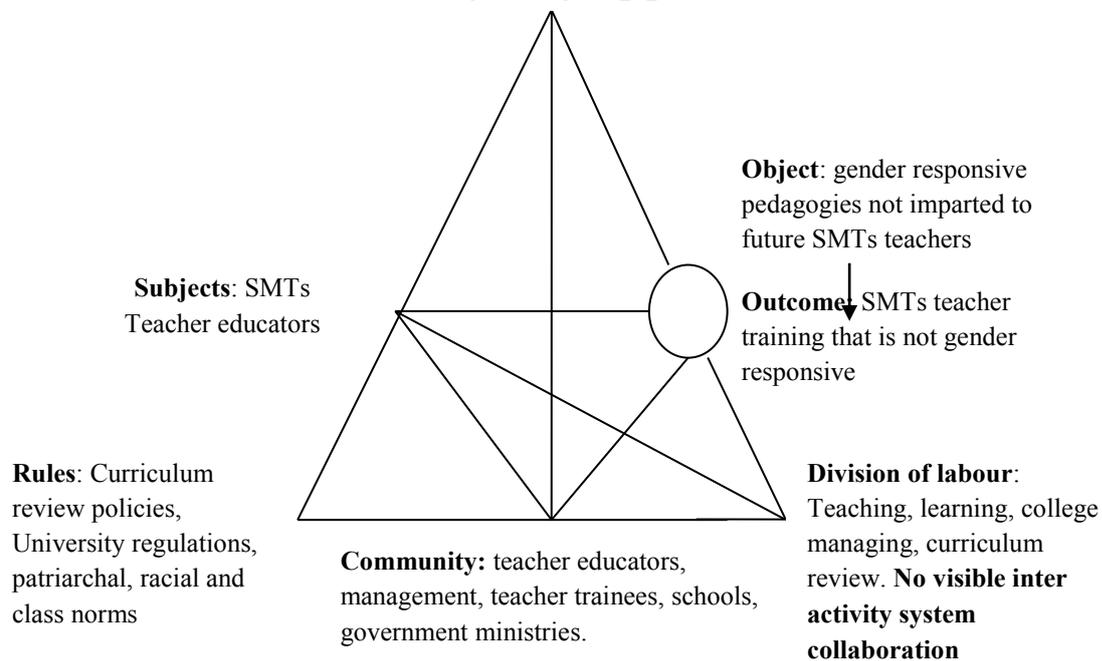
*The Faculty of Education in the University of KwaZulu-Natal is preoccupied with research and the production of knowledge. The good, solid, old fashioned teaching that students so desperately need is regarded as being secondary of importance ... teaching is left, often, to large numbers of contract staff who are forced into crowd control tactics ... permanent staff members, meanwhile clamour to avoid being labelled unproductive by doing whatever they can to get something published in approved journals. And all of this within a climate of advancing managerialism and a preoccupation with productivity units and performance management.*

As discussed in Section 4.2, the UKZN case study had two activity systems namely the teacher education institution itself, and the ESD activity system as the more advanced activity system. It emerged from the preliminary data analysis, reported in the following section (6.3) that these two activity systems are both represented at the institution. As described in Section 6.2.2, the South African education system in general has incorporated ESD objectives and principles across its learning levels. Some of the teacher educators' curriculum practices in this case study are grounded in the ESD framework. I coded this group as the „ESD driven activity system“. The other group are teacher educators who are finding it difficult to work within the ESD framework as illustrated in Section 6.3. I coded this group „Non-ESD driven activity system“. I admit at this point that it is unusual to identify an activity system by what it does not do rather by what it does. However in this case it was a case of naming one activity system as opposite to the other.

### **6.2.1 Teacher Education Activity System**

Figure 6.1 shows one activity system in the UKZN case study. Preliminary data in Section 6.3 shows that this activity system is not driven by ESD principles. Table 6.1 provides further explanation of the elements of this activity system.

**Mediating Artefacts:** Curriculum tools, subject content and pedagogical content knowledge, language, syllabus, gender disaggregated data, environmental education integrated knowledge. **Absent: no institutional designed tools to mediate gender responsive pedagogies**



**Figure 6.1** *Non-ESD UKZN Teacher Education Activity Systems*

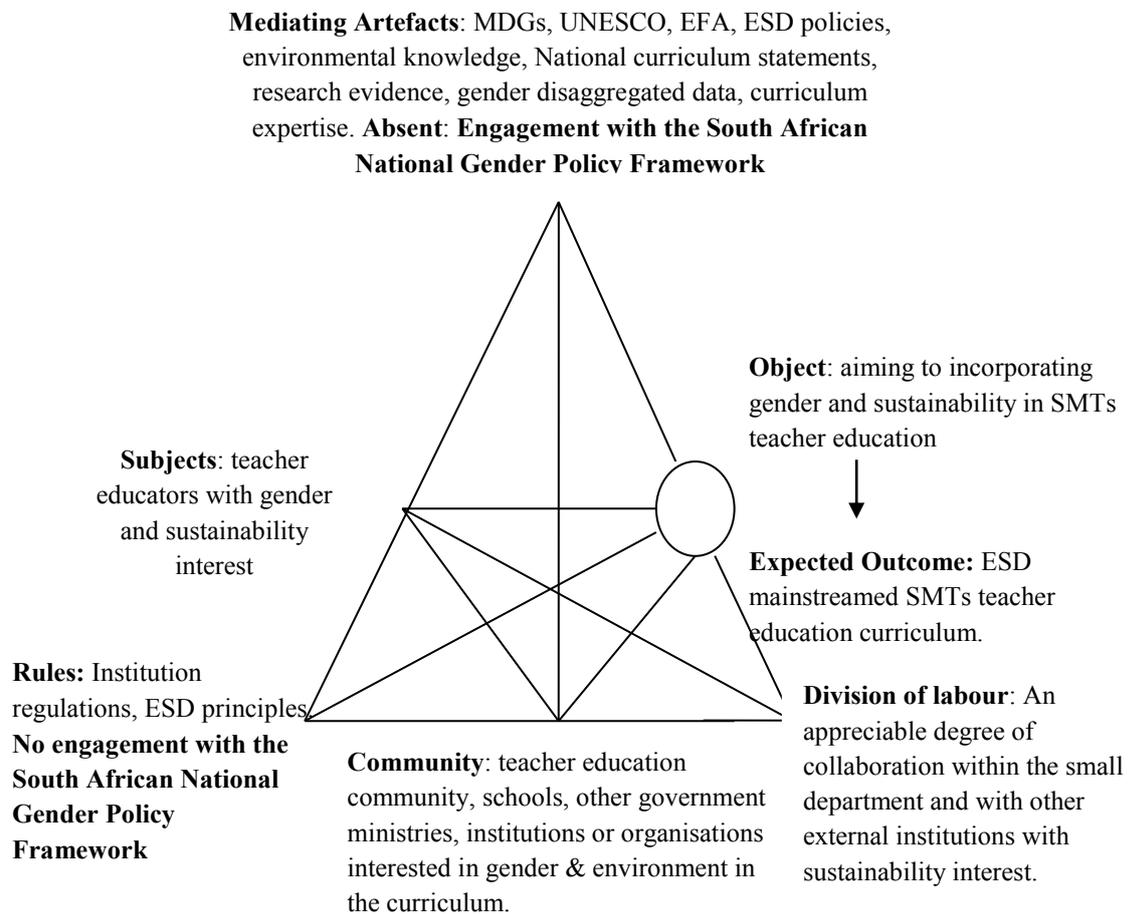
### 6.2.2 ESD Activity System

As discussed in Chapter Two, the study sought to explore the realisation of ESD principles which are expressed in the objectives of the Decade of Education for Sustainable Development, especially those related to gender, SMTs and sustainability. The ESD objectives provide lenses for the study to look into issues of quality and relevance of the SMTs teacher education curriculum. ESD in a capabilities and feminist context brought together a framework that I used to critically look at issues of gender and sustainability in education, and also provides guidelines for curriculum transformation with a CHAT orientation, as outlined in Chapter Three.

One unique feature of this case study is the level of incorporation of ESD objectives and principles in the South African education system in general. The National Curriculum Statement draws from the constitution of the country which is underpinned by the values of “human dignity, the achievement of equality and advancement of human rights and freedoms” (South Africa National Gender Policy Framework, n.d., p.3) and expects all schools and teachers to ensure that the relationship between a healthy environment, social

justice, inclusivity and human rights are incorporated into the curriculum at all levels (Department of Education, 2002). Lotz-Sisitka (2011) further highlighted that key principles of ESD (environment, society and economy; see also Section 1.7.13) have been incorporated into the National Curriculum Statements at all levels of the South African Education system. For instance, learning outcome 3 for Physical Sciences curriculum statements for schools in the Further Education and Training band (grades 9-12) expects learners to be able to identify and critically evaluate scientific knowledge claims and the impact of this knowledge on the quality of socio-economic, environmental and human development. The associated assessment standards are: (a) evaluate the impact of science on human development: research case studies and present moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications, (b) evaluate the impact of science on the environment and sustainable development: evaluate the impact of scientific and technological research and indicate the contribution to the management, utilization and development of resources to ensure sustainability continentally and globally (Kelder et al., 2007, p.v). Implied in this curriculum statement is the issue of quality and relevance of science as it is taught in schools. As pointed out by Shumba et al. (2008), quality and relevance of education (science) will lie in its ability to address the socio-ecological concerns faced by communities. This in a way also has the potential to attract young people to sciences, more so girls, as most studies argue that girls are less attracted by science because it seems dry and irrelevant to their everyday life (as discussed in Section 2.4). I argue that curriculum outcomes such as this one require teachers to be able to engage with all the conversion factors that affect SMTs learning as explained in Sections 2.8.2 and 3.2.2. It would seem important that for teachers to be able to handle curriculum outcomes such as the one above, they need to, especially during their formative stages, be exposed to ESD pedagogical learning innovations (see Section 2.2.2) such as learning to ask critical questions; learning to clarify one's own values; learning to envision more positive and sustainable futures; learning to think systemically; learning to respond through applied learning; and, learning to explore the dialectic between tradition and innovation (UNESCO, 2011). Such pedagogic artefacts have the potential to enable future teachers to handle socio-ecological issues in their own practice. The task in this chapter was therefore to explore how the teacher education curriculum prepares future teachers to handle such ESD informed curriculum outcomes.

Figure 6.2 shows the ESD driven activity system of the UKZN case study that was constructed with preliminary data presented in section 6.3. Table 6.1 provides supplementary explanation to the two diagrammatic representations of activity systems of this case study.



*Figure 6.2 ESD; Culturally More Advanced Activity System in the UKZN case*

**Table 6.1** Description of the elements of the two activity systems within the UKZN case study before expansive learning

Element of the Activity System	Description from preliminary data	
	Non ESD driven activity system	ESD driven activity system
Tools/artefacts	No visible engagement with gender and ESD related policies.	Visible engagement with gender and ecological issues in curriculum tools.
Object	Gender and ecological issues not part of the curriculum. No visible curriculum practices towards gender and sustainability responsive pedagogies, despite being aware of the need to do so. (Contradiction between subject and object; and between object of this activity system with that of the ESD activity system). Non engagement with personal, social and environmental conversion factors in the curriculum.	Gender and ecological issues part of the curriculum object. Nexus between gender in SMTs and socio-ecological risk weak. Socio-ecological risks approached in a gender neutral manner. Curriculum practices geared to build gender and sustainability related agency in SMTs teachers.
Subjects	Aware of gender inequalities in enrolment, individual conceptions of push out factors, most do not incorporate gender issues in curriculum besides mentioning in isolated incidences, lack mediating tools for gender responsive curriculum practices. (primary contradiction within the subjects)	Aware of gender inequalities in SMTs, to some extent respond to the inequalities in curriculum practice. Engage with research on gender, SMTs and ESD.
Rules	Exam driven curriculum. Non engagement with gender related policies, patriarchal norms. (contradiction with the subjects).	Engage with ESD related policies (MDGs and EFA). No evidence of engagement with National Gender Policy Framework. Also ruled by institutional culture and norms.
Community/Division of labour	No evidence of intra departmental efforts towards gender responsive curriculum practices. Teacher educators work in silos.	Some evidence of intra departmental collaboration. Recommending for an institutionalised gender and ESD responsive syllabi review. Visible elements of collaboration within departments and with other institutions interested in gender and environmental issues.

### 6.3 ASSESSING THE LEVEL OF GENDER RESPONSIVENESS IN SMTs TEACHER EDUCATORS IN THE UKZN CASE STUDY

This section reports on the need state analysis of the teacher education activity system. The focus was on assessing the extent to which the teacher education curriculum plays its „conversion agent“ role as discussed in Section 2.8.2. As with the previous case study, a

curriculum can potentially become a „conversion agent“ if it engages with negative social-ecological conversion factors (patriarchal norms and other socio-ecological-cultural ills) and takes advantage of the enabling social conversion factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD and factors them into pedagogic practices.

As discussed in the previous case study, the emerging data to assess the level of gender responsiveness of SMTs teacher educators was categorised using the following themes/categories:

- Knowledge of push-out factors for girls from SMTs;
- Perception of the role that teacher education can play to improve the participation of females in SMTs;
- Level of engagement with gender and ESD related policies; and
- SMTs curriculum as capability enhancing for females in view of socio-ecological risk.

As with the previous case study most of the data was generated through interviews. As highlighted in section 5.3 as an interviewer influenced by critical theory, using transformative interview techniques I did not claim to be objective in designing my interview guide. I saw it worthwhile in certain situations to sensitise respondents ahead of the question on research based issues pertaining to gender, ESD and SMTs education. In other circumstances such interview technique may be deemed biased or self-fulfilling. However, the idea was to reveal subjectivities and to generate the kind of conversation that is intimate and self-revealing on specific issues related to the topic, rather than departing from a neutral position.

### ***6.3.1 Knowledge of push-out factors for girls from SMTs***

As a point of departure, I considered the experience of teacher educators as it pertains to gender enrolment of learners in SMTs. For all of them, a clear pattern of more boys than girls enrolling more in physical sciences and mathematics was reported. A similar gendered enrolment pattern was also reported for the teacher training level as shown in extract 1 below:

#### **Extract 1**

**Researcher:** *what is your experience on enrolment of males and females in SMTs?*

**UInt1:** *For those who are to teach up to grade 9 (General Education and Training phase) you see more of females, for Further Education Training phase you tend to see more males, that is very traditional; high score the men rock up.*

**BInt5:** *In biology the enrolment is normally 50-50, of late boys are showing interest in biology, whether it is interest or they don't make it in Physical Sciences, their traditional domain, I am not sure.*

**BInt2:** *In Physics majority are male, on average 33% females over the years, generally less than that.*

With these understandings in place, the subsequent interview items were designed to solicit further information on their knowledge of push-out factors for girls from SMTs in order to infer more about pedagogic practices. The findings revealed that although teacher educators in this case study were familiar with gender disparities in SMTs education, they were however unable to account for such inequality as Extract 2 below illustrates. One could say teacher educators in the sample had basic levels of gender sensitivity, meaning that they had the ability to see existing gender inequalities related to enrolment and retention. The majority was not able to link gender inequality to socio-cultural and curriculum issues as established in various studies (Section 2.4). One interviewee (UInt2) showed a sound level of gender awareness with the ability to identify problems arising from gender discrimination and to some extent was able to link these to patriarchy, as well as to the ontology and epistemology of SMTs as is taught in school.

## **Extract 2**

**Researcher:** *Now let us talk about the possible push-out factors for girls from SMTs. Why do you think girls become less and less interested in sciences as they continue with their education?*

**UInt1:** *It's a cultural aspect; in those cultures the more caring aspects are associated with females. It's different from France for example where more females teach maths, it's an exception so far. It's only a cultural thing.*

**UInt3:** *I don't know, probably socialisation, when they are by themselves, girls do all the things very well. Whether it is their choice or boys cow them out, I don't know.*

**UInt5:** *Boys are always dominating and they definitely learn more in such circumstances. But it may sound contradictory that very often girls perform better, looking at averages, than boys. I think it's because girls like Biology*

*whereas boys take it as a last option after failing to get into Physical Sciences. They may not be strong in Biology; they only dominate in group work.*

**UInt6:** *Umm it's a difficult one. Probably gender perception, it's probably an issue of the girls who come through ... I have Indian and African girls, I suspect for some of them it's not an easy choice. I haven't specifically asked or interrogated.*

**UInt2:** *The access of girls to science in general and to cognitive aspect in particular in my view can be problematic because of the design of science and its philosophical underpinnings. The people who have designed it in my view have done so in a way that is cognitively accessible in general to the male mind.*

### **6.3.2 Role that teacher education can play to improve the participation of females in SMTs**

In this section I report on whether SMTs teacher educators at UKZN are aware of the role that they can play as teacher educators to improve the participation of females in sciences. All this was done to assess the level of gender responsiveness of SMTs teacher educators in the activity system. From the findings shown in Extract 3 below, it looks like there is a fair level of gender awareness among SMTs teacher educators at UKZN. However, the awareness did not seem to influence the curriculum practices of the teacher educators interviewed, except for interviewee UInt2. Teacher educators cited various reasons for not translating the gender knowledge they have into curriculum practices as shown in the same extract. Because of this, teacher educators in this case study could not be said to be gender responsive in their curriculum practices.

#### **Extract 3**

**Researcher:** *What curriculum efforts are in place/are you putting in your practice to impart gender responsive skills, knowledge, and attitudes to future SMTs teachers?*

**UInt1:** *Education is our best way of changing things; we know that this thing of producing ourselves out of problems doesn't work.*

**Researcher:** *Do you see it as a problem to have fewer and fewer females in SMTs as we go up the educational hierarchy?*

**UInt1:** *I think it's going to balance itself up ... look at Europe it is almost 60% females of those in higher education are now females ... if you give an opportunity they (females) will take it up. So I think in the next generation or two it will level out.*

**Researcher:** *Are we giving them opportunity now? Surely in Europe there were some interventions for years.*

**UInt1:** *Ummm I don't know, I think you can try to make initiatives but values, practices, change over a long period of time. There is a cultural limitation, constraints, gender division of labour and roles in some cultures. So if the home situation is more equal, when women start to say I am not doing all the laundry, you do your part, then things can change. The more we start making a fuss about it ... the less we make a fuss about it. So I haven't focused so much in the gender aspects. Based on my experience, we can't look at gender isolated from class and race. I can easily reach out to my Zulu female students but it's a bit difficult to access some Zulu males probably because I am a female lecturer. I think for me it's not gender that is the biggest problem its class ... among the students who are struggling the most are those from poor background and they tend to be Africans, it's not just racial but the school background. Once I get in touch with the men, some of them say "you know at first I did not trust you because you are woman professor" so the problem is to reach them in terms of different competing value systems.*

**Researcher:** *That is where my question is, do you put those strategies into the curriculum for future teachers to acquire the relevant knowledge, values, attitudes and skills or it's your own initiative?*

**UInt1:** *My own initiative, I can't change the curriculum. It is very narrow, only a course ... I must teach pedagogical content knowledge. I can't teach all the other staff, what I do is to try and get the background of the learner (trainee teacher). But adults have already acquired values ... a lot of cases where racial issues come up e.g. a belief that a white lecturer doesn't want you to know because of the past experience in apartheid*

**Researcher:** *Do you think it is worthwhile to teach future teachers to analyse text books and Learning Support Materials of the values that lead to gender stereotypes for example?*

**UInt1:** *I am not saying it's not worthwhile but there are so many things to worry about, I would rather have someone clean up the books of all the sexist, racial and class language. It's not something that I will give a huge emphasis on, given the kind of teacher we have, the situation we sit with, where its class and access to knowledge that is the biggest problem. Our teachers when they come into our programme are so weak generally, so we can't do everything, we need to concentrate on content. We are forced to let them go to schools with half the calculus we want them to have.*

**Researcher:** *Do you agree that background and cultural practices can be a stumbling block to learning and they impact differently on boys and girls?*

**UInt1:** *Yah [yes] but there are other things that are bigger stumbling blocks – race and class. We spend about a third of our time talking about how to reach out to different learners. So we talk about gender issues in examples very briefly,*

*e.g. girls with more chores at home and boys have more time. We hardly bring in the cultural component in teaching maths because of time; I must admit even at post grad level we don't do it enough.*

**Researcher:** *What role do you play as teacher educators to improve female participation in sciences?*

**UInt4:** *I think for me the strongest prospect is that I am a female, so I am a role model. I encourage the girls to participate equally with boys. So I don't think I privilege one over the other. In fact sometimes I joke about it. I do emphasise that girls and boys are equal in class. In the content module I do encourage future teachers to be critical about books particularly when we go out for practice teaching.*

**Researcher:** *As you do your teaching practice observation, do you see your trainee teachers taking care of preferred learning styles of both girls and boys?*

**UInt4:** *Observation in teaching practice: In group work you see girls taking a back role, being secretaries. I have also noticed that most students do engage with girls and boys alike. But I did not see much of innovative and creative teaching methods.*

**Researcher:** *Do you have any provision for such gender issues in your curriculum?*

**Int4:** *It's very difficult, but I do point at it in post lesson observation discussions. I don't really teach on such things at college, there are lots of things you know.*

**Researcher:** *How do you prepare our future teachers to handle societal aspects of physics?*

**UInt4:** *That is very important, if you look at our curriculum Learning Outcome 3, it is all about socio-ecological issues. Obviously environment, sustainability and gender are issues in Physics in education. So in learning about how a power station works, we need to learn about its socio-ecological impact as well.*

**Researcher:** *What is your comment on the statement that physics is a factual, value free, non- negotiable science and that it deals with phenomenon and not with people, culture free, masculine, and male centric and exclusive*

**UInt4:** *I think my students would probably agree to all that. Well the masculine, male centric and exclusive part of it; the fact that I am a woman teaching it will sort of ease that. Yaah [yes] but if you ask them whom do they recognize as big physicist they will think of males, the Newtons but unfortunately a lot of the women who did contribute will go unmentioned. I think it's a societal thing that women were expected to be wives and mothers and that was their defining role. Some in the field did not live long in the field to be remembered. It's a pity we don't concentrate on all this in our teaching and then stereotypes are perpetuated.*

**Researcher:** *Why then don't you incorporate such socio-cultural issues in your curriculum?*

**UInt4:** *There is just too much stuff to cover. Our students require the basic Physics when they come here so have a lot of content to cover before we look at other issues. These other issues are important yes, but I think content is much more important.*

The information given here came from section heads of Mathematics and Physics, two disciplines that are very unpopular with young people, especially girls. From the information given by the two interviewees, I was able to conclude that there was no curriculum coordination towards gender responsive practices at least in these two departments, despite the visible gender disparities raised by the interviewees. This shows primary contradiction within the subjects, which comes out as a secondary contradiction between the subject and the object (see Chapter Seven) when considered in relation to the objectives of the study.

There was a cohort of teacher educators in the same case study who presented a higher level of gender awareness as shown in Extract 4 below. They were able to identify problems arising from gender discrimination and link them to patriarchy. They also displayed some evidence of gender responsiveness in practice and were highly motivated to work towards a gender responsive curriculum.

After seeing this huge disparity among SMTs teacher educators in the case study context, I decided to strengthen the tools that I was using to check whether there was any intra faculty or inter departmental learning on crosscutting issues such as gender and environment. This I did with the aim of surfacing tensions and contradictions that were later used in change laboratory workshops. The tools also helped in establishing the boundaries that needed to be crossed as well as possible boundary objects to be used in expansive learning as discussed in Chapter Eight.

As displayed in the same extract, the two testified that there was no inter or intra faculty collaboration on gender or socio-ecological issues in SMTs education.

#### **Extract 4**

**Researcher:** *What role then do you think teacher education should play in this matter?  
[improving female participation in sciences]*

**UInt2:** *My area of interest is gender and science education. By excluding gender from science education we are perpetuating gender inequality. The access of girls to science in general and to cognitive aspect in particular in my view can be problematic because of the design of science and its philosophical underpinnings. The people who have designed it in my view have done so in a way that is cognitively accessible in general to the male mind. So I think that gender issues need to be taken into account as integral part of the modules not added superficially. There should also be some work that looks at the way girls think and the activities that girls do well and how science education can be delivered to women. By keeping silent we are actually perpetuating gender inequality. And there is absolute need to incorporate gender in Physical Sciences, because that is the area in which girls and women are really alienated in many ways and at several levels right from primary school to tertiary.*

**Researcher:** *Is this thinking widespread in the faculty? Any collaboration on this with colleagues?*

**UInt2:** *No collaboration and not widespread either. When I asked for such issues to be incorporated in the curriculum, I was told they are catered for in the honours and students can take them in the masters. I have been busy trying to bring in issues of social justice into my own modules, I never thought of talking to colleagues. I don't know how it will be received by other colleagues. I wouldn't want to see it peripheral but central, to talk about it, and to engage with it in a meaningful way.*

**Researcher:** *What role do you think teacher education can play here? [improving female participation in sciences]*

**UInt5:** *In a small way, in the methods module we look at how a teacher should be on the lookout and be able to deal with dominant learners, not only with gender but other aspects as well.*

**Researcher:** *Any cross faculty collaboration on this and how you put such issues into the curriculum?*

**UInt5:** *I have to say no unfortunately, no collaboration at all, not since we became part of the university, the only time we come together is when we talk about our researches not our teaching.*

**Researcher:** *What is it that was brought by the merging of the college and university that is stopping that collaboration that you use to have?*

**UInt5:** *Well looks like in a university people work in their different silos and there is more emphasis on research publication for individual growth, promotion ... very little attention is given to how best can we produce a good teacher as we used to do before.*

### ***6.3.3 Level of engagement with gender and ESD related policies/ SMTs Curriculum as capability enhancing for females in view of socio-ecological risk***

As with previous case study, ESD was in this case study used as a culturally advanced and esteemed activity system. South Africa and Zimbabwe are in the same SADC regional block so they draw from the same socio-political institutions such as RISDP, NEPAD and other socio-economic organisations that may in one way or the other influence education in general and teacher education in particular. ESD as an activity system is explained in Sections 2.2.2 and 5.3.3. With particular reference to this case study Section 6.2.2 highlights ESD with the context of the education system of South Africa.

In this section I report on the findings related at the level of engagement of SMTs teacher educators with gender and ESD related policies. The purpose as said before was to further explore on the level of gender responsiveness of SMTs teacher educators and to gauge the extent to which science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context.

It became evident in this case study that all teacher educators have a sound knowledge of socio-ecological risks as in climate change and the associated effects as shown in extract 5. It was also apparent that some individual teacher educators interviewed (two out of six) were conversant with ESD related policies and engage with them in their curriculum practices. To the contrary, the majority of teacher educators did not know of such policies. It also emerged that those attempting to respond to socio-ecological risk in their curriculum innovations, are doing so in a gender blind manner. As discussed before, issues of inter or intra departmental learning were further explored, in a bid to establish boundaries that could be crossed in expansive learning workshops.

#### **Extract 5**

**Researcher:** *As we teach science do we keep in mind the socio-ecological risks and their gendered nature?*

**UInt1:** *I did my PhD in mathematical modeling of environmental problems but I don't touch it at all in class not at all, nothing, not at all. It is too far away, the best way you can do that is differential equations, you can look at graphs, tendencies, but it all forms outside standard math.*

**Researcher:** *Surely one can teach graphs using environmental facts.*

**UInt1:** *Yes I know of maths literacy books that deal with that. My experience is that it confuses the learners, the prerequisite knowledge required is too high, and most math teachers will end up with misconceptions. They confuse ozone layer and carbon dioxide, even the simplest thing is confused. We need scientific content knowledge and the mathematical content knowledge to come together and we are not there yet. It can be easier with science teachers.*

**UInt 5:** *There is also an attitude problem coming from trainee teachers, e.g. why do you want to limit my consumption when you have a house and a car of your own. It becomes very political and most of the time we have stayed away from this and focus on other issues. So I haven't taken the time and put that into the curriculum, probably I will be the only one in the Math group doing it.*

**Researcher:** *Do you in any way engage with gender related policies such as the South Africa's National Gender Policy in your curriculum, if so how?*

**UInt1:** *No, not at all, as I said before, for me issues of class and race are more important at this moment in time in South Africa.*

**Researcher:** *Do you cover environmental issues in physics and physics education?*

**UInt4:** *The only probable is that we mention or talk about is energy because we do energy in mechanics and in Natural Science we look at renewable and non-renewable energy sources. In electricity we may touch on it again. In the nuclear physics module we look at the environmental impact as well. But it's more indirect like that because we have a very content heavy and short time to cover it. So I don't address these issues as I would want because of time and our students are very weak, they battle with content so we spend most of the time on basics. So I try and mention the environment. In assessment we have had problems with external moderators/examiners who did not like applied physics (environmental component in physics) in a physics paper. Our external moderators come from pure physics, so there is a bit of tension there. I think their perception is that physics is about the content, facts, theories but not as they go into technology or environment. It's also compounded by the fact that usually our moderators are not from education. I think anyone in science education will be a little bit broader.*

**Researcher:** *Any intra faculty and inter faculty collaboration in view of such challenges?*

**UInt4:** *I haven't looked for the space to share with our physicists (our external examiners), but it is important that if people from pure physics are to work with teachers they need to know the context, the type of student, the context in which they will work.*

**Researcher:** *Are there any gender related you may think of when teaching environmental issues in physics?*

**UInt4:** *I haven't noticed something I can really classify as a gender issue. Maybe female students don't complain. I hope future teachers are leaving college with the relevant knowledge, skill, values and attitudes, to help the girl child in high school. I have no idea how these teachers will conduct themselves in the classroom and this is a concern to me.*

**Researcher:** *Do you in any way engage with gender and ESD related policies such as South Africa's National Gender Policy, MDGs, EFA and many others in your curriculum?*

**UInt4:** *I am not sure about those, I haven't come across them.*

**Researcher:** *As we teach science do we keep in mind socio-ecological risks and their gendered nature?*

**UFGI1** *When we were a teacher's college it was compulsory for every student to do environmental literacy.  
We looked at teaching the environment across the curriculum. That has fallen by the way side the university doesn't see that as an important aspect. We are fighting for its re-introduction but it hasn't happened...  
The way I see it is environmental literacy is as good as computer literacy, but unfortunately people don't see it that way. Those in arts and culture for example don't see environmental literacy as part of their job.  
They don't see how HIV/AIDS; social justice become part of the same thing...  
Personally I also feel that environmental justice is part of social justice...  
Everyone in biology is for the idea and geography probably...  
We have already written a motivation for this...  
Well curriculum review is due next year; we will try to push for it, whether it will be acceptable or not is something else...*

**Researcher:** *Environmental issues are not gender neutral. Do you engage with the gendered nature of these?*

**UInt5:** *Aah I must be honest I haven't really focused on gender issues in environmental issues. We look at it in general but not in terms of socio-ecological risk as affecting people differently. We are however trying to write a paper on the plight of women concerning water and other basic provisions*

**Researcher:** *Is there any collaboration in dealing with environmental issues at college level?*

**UInt2:** *Yes, we have an environmental committee and some of my colleagues involve students in getting things going in the environmental club. Mostly its Life Sciences and technology lecturers.*

**Researcher:** *Do you have some environmental learning in your Life Sciences?*

**UInt2:** *Yes I do that very much. I teach nutrition and that is one area I can bring in environmental issues. Students develop sustainable food gardens, using indigenous plants and permaculture methods. I also take them to some field trips to horticulture projects, botanical gardens and medicine kitchen garden projects. All this is done in the form of a research, to strengthen scientific research. So its science through education not education through science. The principles of what could have gone wrong, why did things not happen the way anticipated and testing hypothesis along the way through gardening. But at the end whether the garden is successful or not is not the biggest issue, the issue is how they engage with it in a meaningful way.*

**UInt5:** *We used [as a college before merging with the university] to teach the environment across the curriculum. That has fallen by the side way, the university doesn't see that as an important aspect. On a different note, sometimes our environmental passion is met with resistance based on political conceptions. One day I asked students to pick up litter from a common space. They refused and told me to do it. I did pick the litter. Later on I had the deputy dean complaining why I had asked students to pick up litter. The whole issue was unnecessarily politicized. Being white the thinking was I was trying to show off, send blacks to do cleaning jobs etc. Furthermore there was connotation that its only whites who enjoy clean recreational facilities.*

**Researcher:** *Any inter/intra faculty collaboration in such innovative curriculum practices?*

**UInt2:** *No, no, I don't. It's something that I could explore. People do work in isolation here. I felt it and I can't deny that. Of course I get outside support like a horticulturalist coming to run a workshop on propagation etc. I was stunned when 80% of my students told me that they have never planted anything in their lives. These are 19-20 year olds. So they really enjoy these Friday afternoons. In terms of working with the community, I bring my expertise from the community. I was also thinking of changing my approach to food gardening and take it into the community, like what a colleague of mine is doing with what she calls service learning. I would want to learn from her. Time is another constraint, we see our students for 90mins. We have been asking for 3hr slots once a week for such activities. Teaching practice time is also very inadequate (only 4 weeks), they can't meaningfully do their garden in schools in that shorts space of time.*

**Researcher:** *Does the institution have an environmental policy and who drives it?*

**UInt2:** *Yes I believe they do have a policy, but I am not sure who drives it. I adopted the concepts of environmental sustainability, responsible sexuality, access in terms of gender and social justice issues, incorporating all these into my modules but I don't know who drives them at a bigger level.*

**Researcher:** *Socio-ecological risks are gendered e.g. climate change, poverty, drought affect men and women differently. Do you bring that gender component in your curriculum?*

**UInt2:** *Ummm well it does come in, unknowingly it comes in. What I do is that I teach back sessions when they present their research. When they gather information on nutritional disease for example, the pictures of women and children being affected more than men, I then draw their attention to this particular vulnerable group. I will then try to bring the link between poverty and this vulnerable group.*

**Researcher:** *How do you, in any way engage with gender and ESD related policies such as the South Africa's National Gender Policy, MDGs, Agenda 21, EFA and many others in your curriculum?*

**UInt2:** *We refer to the UNESCO document and I have been involved in writing a UNESCO document. People have different views about ESD for me it "snot only about learning environmental issues. It does include the way you teach it. They should learn how to take action and how to see it in their own environment. These are the two things that go together. Sustainability too should be action oriented. So youngsters should develop some critical thinking and problem solving skills. We have an environmental forum with other people from maths and one from geography and another from social justice. The problem with our curriculum is we don't have enough time to really engage with issues, we only touch on them.*

As in Chapter 5, a capabilities checklist (Appendix 4.2) was used in interviews to assess whether SMTs teacher education engages with aspects of capabilities (well-being achievement, well-being freedom, agency achievement and agency freedom) see Table 3.1, Section 3.2.2). The checklist was looking for specific curriculum evidence such as a document, a lecture session or any piece of information that shows that teacher educators are dedicated to such aspects. Table 6.2 summarises the input of teacher educators from various interviews.

**Table 6.2** *Capabilities checklist in the UKZN case study*

<b>Capability aspect</b>	<b>Evidence indicators</b>
Analyse sexist bias/gender stereotypes in resources, content and language	I am not saying it is not worthwhile but there are so many things to worry about, I would rather have someone clean up the books of all the sexist, racial and class language. <b>(Uint1)</b> I haven't seen anything that is really gender ... in the content module I do encourage future teachers to be critical about books particularly when we go out for practice teaching. <b>(Uint4)</b>
Examine content, teaching methods and classroom dynamics that encompass girls' and boys' interest, experiences and learning styles	We hardly bring in the cultural component in teaching maths because of time; I must admit even at post grad level we don't do it enough. <b>(Uint1)</b>
De-emphasise sex-role stereotyping that hinder girls'	I haven't specifically asked ... there are cultural limitations, you can try to make initiatives but values, practices, change over a

progress in science	long period of time. <b>(Uint6)</b> It is not something that I will give a huge emphasis on, given the kind of teacher we have, the situation we sit with, where its class and access to knowledge that is the biggest problem. <b>(Uint1)</b>
Draw the attention of boys and girls to the presence and contributions of women in science and mathematics	I think my students would probably agree that physics is factual, objective, and non-negotiable. And that it deals with phenomenon and not with people, culture free, masculine, and male centric and exclusive. <b>(Uint6)</b>
Alert future teachers to be on the watch out for boys/girls who want to dominate classroom proceedings to the detriment of others	In a small way, in the methods module we look at how a teacher should be on the lookout and be able to deal with dominant learners, not only with gender but other aspects as well. <b>(Uint3)</b>
Ensure that future teachers are able to deal with counter cultural practices that may impact negatively on girls"/boys" pursuance of sciences	By neglecting the social aspects of science, we are marginalizing and make it inaccessible to people who need it the most. <b>(Uint5)</b>
Expose future teacher to various ways to help empower girls and raise their self-esteem in sciences	I draw their attention to a particular vulnerable group. I will then try to bring the link for example between poverty and this vulnerable group. <b>(Uint1)</b>
Assist future teachers to add relevance and quality to science by drawing attention to socio-ecological issues	Environmental issues are too far away from maths education, trainee teachers struggle with basic mathematical concepts; this leaves no room to bring in application. <b>(Uint1)</b> Over the years we in biology we have advanced our teaching in environmental learning. You have to find an environmental issue and teach in a way that learners engage with it ... active learning, in other words... I must be honest I haven't really focused on gender issues in environmental issues. <b>(Uint2)</b>
Develop critical thinking	I always ask three questions: why; under what conditions as well make them guess the answer to get the intuition and then reflect on that ... I am a pragmatist and I believe constructivism work to a certain extent. <b>(Uint1)</b> I also teach critical thinking by making learners argue for and against environmental issues. For example the use of nuclear energy. <b>(Uint2)</b> People have different views about ESD for me it's not only about learning environmental issues ... it does include the way you teach it ... you have to find an environmental issue and teach in a way that learners engage with it ... active learning, in other words. <b>(Uint 5)</b>

The capability checklist shows that teacher educators in this activity system were approaching issues of gender and sustainability in different ways. Some had a strong feeling that given the context in which they are practicing, there is no room for engaging with socio-ecological issues. Others think these should part of the curriculum. It became evident that there is no coordinated, institutional framework to guide SMTs teacher educators towards

gender and sustainability responsive curriculum practices. The division also showed two distinct activity systems in the case study, one that is ESD driven and the other that was not, a situation that I thought would be interesting for the expansive phase of the study.

Supplementary data from analysis of curriculum documents (syllabi and students research projects) (see Table 4.1) using a tool in Appendix 3.3 did not show any evidence of an institutionalised approach towards gender and sustainability responsiveness in the SMTs teacher education curriculum.

#### 6.4 CRITICAL DISCOURSE ANALYSIS

As was the case in the BTTC case study reported on in Chapter Five, CDA was undertaken here for the UKZN case study to supplement the analysis above. CDA responded to the research question: *What are the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs teacher education?* Referring to the capability framework (Figure 2.3) CDA was carried out to unearth causal mechanisms that constrain teacher education from fulfilling its ESD conversion agent role. Furthermore CDA resonates with Developmental Work Research; analysing the systemic and historical causes of practice and bringing these analyses to bear in analysing current dynamics within and across services (Daniels, 2008). Aligned with the curriculum transformative interest of the study, CDA also helped to surface tensions and contradictions (see Chapter Seven) that were later used in Change Laboratory workshops in Chapter Eight.

Information used for CDA was obtained through interviews and document analysis. The following excerpts were taken from interview transcripts in which research participants were responding to: *Why do you think girls become less and less interested in sciences as they continue with their education?*

**UInt1:** *For Further Education Training phase you tend to see more males, that is very traditional; high score the men rock up. It's a cultural aspect; in those cultures the more caring aspects are associated with females. It's only a cultural thing.*

**UInt6:** *I haven't specifically asked or interrogated. I have Indian and African girls, I suspect for some of them it's not an easy choice.*

Drawing on Fairclough's CDA tool (Figure 4.6) I could report that the identities of the participants were white females, teaching mathematics education and physics education. They both had extensive experience in teacher education, and were raised and educated in apartheid South Africa.

By relationship, Fairclough (1995) means a particular construction of the relationship between producer of text and the one referred to in the text (as for instance, close or distant, formal or informal). There is evidence of a cultural remoteness in the discourse e.g.

*It's a cultural aspect; in those cultures that ... It's only a cultural thing (UInt1)  
I have Indian and African girls, I suspect for some of them it's not an easy choice.  
(UInt6)*

Two aspects can be inferred from the discourse fragment. The first is the detachment of discourse producers (teacher educators) from those referred to in discourse (trainee teachers). The second is implied in “it is cultural...in those cultures...”, meaning being a cultural issue, a culture that is foreign to us, as teacher educators we may have very little control or none at all over that. Analysing this critically one could deduce that teacher educators are uneasy about cultural issues and hence distanced it from their impact on formal learning. In this context, I would argue that, if cultural issues are not engaged with, then gender issues in SMTs teacher education curriculum will not be addressed.

CDA enables us to ask the question: what is the power behind this discourse/social practices? As Janks (1997) asked: what are the socio-historical conditions that govern these processes of production and reception of this discourse? In answering such questions, we dig deeper into underlying mechanisms that impact on curriculum practices. As such, there is a visible cultural gap between the teacher educators and their trainees. There is an element of „them“ and „us“ and a strong pointer to „their culture“ (African/Indian) that appears to be constraining these teacher educators to engage with gender issues in their curriculum practice. Teacher educators seemed to be emphasising that „their“ culture is always like that, and we (white teacher educators, with a different culture) are not used to that, and that the teacher education curriculum circumstances do not allow alternative interpretations (ways of looking at it) of the „deviant“ cultural practices of „theirs“. Such reasoning is partly valid, as it is widely reported that African patriarchal culture is highly gendered and associated norms and values constrain the establishing of the necessary opportunity freedoms for girls to learn SMTs as reported earlier in this study (Chikunda, 2010; Rwodzi, 2006; Kalu, 2005).

Be that as it may, in terms of teacher education there are tensions and contradictions that can be identified in the same statements that may directly or indirectly entail negative evaluations of „their culture“. There are signs of giving up in statements: “the more we start making a fuss about it ... the less we make a fuss about it; So I haven't focused so much on the gender

aspects; I think it's going to balance itself up ... so I think in the next generation or two it will level out" (UInt1). Leaving „things“ to balance themselves out contradicts the South Africa's National Gender Policy Framework, as well as other regional and international directives such as SADC RISDP, Education For All, MDGs and many more that are aligned to the ESD framework.

An intertextual analysis led me to the South Africa's National Gender Policy, which makes note of the need for a fundamental review of what has come to be accepted as „business as usual“ (p.iii). In this case, the policy points at the challenge in South Africa to shape the broad transformation project in a way which acknowledges the centrality and compatibility of the transformation of gender relations to the broader institutional change process. The UKZN SMTs teacher education curriculum, by not being gender responsive, contradicts the South Africa's Beijing+5 Report, which described science and technology as fundamental components of development, transforming patterns of production, contributing to the creation of jobs and new ways of working, and promoting the establishment of a knowledge-based society (United Nations, 2000) as discussed in Section 2.2. The report went on to advise that given the large number of women in the workforce, South Africa must devise mechanisms for engaging women with science and technology in order to enhance their productivity and thus increase the quality of national production. One would expect tertiary education, especially teacher training, to be proactive in this endeavour.

I interrogated further to establish underlying mechanisms that hinder or promote gender responsive curriculum practices in SMTs teacher education, for equipping future teachers with skills, knowledge, values and attitudes to establish opportunity freedoms for girls in SMTs. As discussed in the previous section, the interrogating question was: “What curriculum efforts are there/are you putting in your practice to impart gender responsive skills, knowledge, and attitudes to future SMTs teachers?” Through textual analysis one can easily identify contradictions in “Education is our best way of changing things; we know that this thing of producing ourselves out of problems doesn't work” vis-a-vis “I think it's going to balance itself, the more we start making a fuss about it... the less we make a fuss about it” (UInt1). Such contradicting statements confirm that there is no tangible, institutional, curriculum effort towards gender responsiveness in practice. There was no provision for a capability set (opportunity freedom) being made available for girls in such teacher education curriculum practices.

Both the process and social analyses of the discourse fragment below show a teacher educator (UInt1) identifying class and race as the real worrisome ideological problems impacting on education. She, however, tacitly made reference to gender as well. This is evident in the statement: “I can easily reach out to my Zulu female students but it’s a bit difficult to access some Zulu males probably because I am a female lecturer”. She goes on to say: “I think for me it’s not gender that is the biggest problem its class ... among the students who are struggling, the most are those from poor background and they tend to be Africans, it’s not just racial but the school background as well”. Obvious in this fragment, as in the one before, is the fact that the teacher educator does not deal with gender issues in her practice. She thinks it is not a real challenge for SMTs learning. Her foregrounding of race and class issues can be interpreted in two ways. Firstly, it is this foregrounding that results in gender issues being placed into a less important category. In the second place, her worries are not baseless. A socio-historical analysis can assist us to trace the race issues from the apartheid days of South Africa. The class issue is also paramount given that South Africa is the most unequal society in the world, with the widest gap between the rich and the poor (Gadra Education, 2012). It is understandable therefore that the power struggles that show up in the curriculum are mostly related to race and class. Likewise, it becomes comprehensible that these social categories outshine other social ills that impact on the curriculum even though these are related. As alluded to in the fragment, class and race issues manifest themselves in the curriculum in several ways ranging from teacher educators struggling to access learners to learners themselves struggling to access curriculum knowledge. The teacher educator is left with no choice other than to sacrifice other socio-ecological issues that impact negatively on curriculum practice, such as gender as shown by the following data extracts:

*I am not saying it’s not worthwhile but there are so many things to worry about, I would rather have someone clean up the books of the entire sexist, racial and class language; our teachers when they come into our programme are so weak generally, so we can’t do everything, we need to concentrate on content. (UInt1). We are forced to let them go to schools with half the content we want them to have (UInt6).*

Through intertextual analysis of this discourse, it is possible to reveal functionalist, instrumentalist views of gender equality in education. “I would rather have someone clean up the books of all the sexist, racial and class language” reflects a view of gender equality in a narrow sense, that is physical access; there is a belief that once curriculum materials are cleared of sexist language, then there is gender equality, meaning both girls and boys can

equally access them. The same misjudgment is visible in the way most countries designed gender related initiatives within the frameworks of Education for All, Beijing Platform for Action and MDGs as discussed in Section 2.8.2. Most initiatives overlooked the existing gendered social relations in school bureaucracies and in the societies of which they are part, to achieve gender equality in education (Unterhalter, 2007; Brighouse and Unterhalter, 2002). Learning and teaching material cleaned of sexist language will not fully challenge societal gendered power structures and social relations in institutions that may limit girls' capabilities to do what they want to do or to be what they want to be.

Further interrogations brought out more insights in the underlying mechanisms that inhibit gender responsive curriculum practices in SMTs teacher education curriculum. For instance, sentiments like: "I can't change the curriculum ... I can't teach all the other stuff" (UInt1). Evident in this discourse fragment is not only the sense of a rigid curriculum, but one that is overloaded as well. There is power behind the discourse, or behind curriculum design illustrated by "I can't change the curriculum". Intertextual analysis either points at the rigidity of the system or a practitioner who is stuck in scientism as the only epistemological option for interpreting SMTs. The second one is more appealing than the first because tertiary institutions are not meant to operate with rigid curriculum parameters; there is always room for flexibility (although this may not necessarily be the case). Furthermore, it did not look like there was need to change the content of the curriculum but to adapt or adopt some learner and context centred pedagogic strategies like those offered by the ESD process (see Chapter Two). All this was followed up in change laboratory workshops in Chapter Eight, which provided more insight into the situation.

The level of teacher educator engagement with gender and ESD related policies, was also subjected to CDA scrutiny. The idea was to further explore the research objective: *To what extent do SMTs teacher educators engage with gender policies related to SMTs education as a way of enhancing capability set (opportunity freedom) for girls in teacher education training? And To what extent are science teacher education curriculum practices supportive of capabilities enhancement for female learners in view of socio-ecological risk in a Southern African context?* The aim was to infer whether SMTs teacher educators engage with such policies as way of equipping future teachers with relevant knowledge, attitudes, values and norms related to gender and sciences as well as the socio-ecological risk and its gendered nature.

Responding to the question: *Do you in any way engage with environmental issues in your teaching of Mathematics and/or Mathematics education?*

Response: *I don't touch it at all in class, not at all, nothing not at all* (UInt1).

This was said by a professor of mathematics education, who did a PhD in mathematical modeling of environmental problems, yet she does not factor such an aspect into her curriculum practice. Her reason was that: “environmental issues confuse the learners, the prerequisite knowledge required is too high, and most math teachers will end up with misconceptions ... they confuse ozone layer and carbon dioxide, even the simplest thing is confused” (UInt1).

Both interviews and document analysis revealed no evidence of engaging with any related policy. In a CDA sense there was need here to scrutinise the socio-historical conditions that govern such processes of production and reception of the curriculum as highlighted in the above discourse fragment. Firstly, the teacher educator’s reasons of poor subject knowledge on the part of student teachers and teachers in general in South Africa, is well documented, for example, Bloch, 2009; Van der Berg, 2008; Taylor, 2011; Pendlebury, 2008 and many more. The evidence is damning, for instance Van der Berg (2008) reported that in 2008, the average score of Grades 1-3 teachers who wrote a maths test pitched for Grades 1-4, was 40%. It seems logical that, given such a scenario, teacher educators will use their discretion and maximise what this teacher educator called „mathematical content knowledge“. The implication is that teaching mathematics in a traditional way is important, a curriculum practice that barely considers the socio-ecological significance of mathematics and science. I had to get additional information on this in accordance with the principle of intertextual analysis (looking for additional texts/information about or from producers and their product) as central for the process of interpretation (Janks, 1997, p.37). Documented information in course outlines and students’ assessment work further confirms the absence of the socio-ecological aspects of maths and science.

The question of engaging with environmental concerns in teacher education also has a socio-political side as shown in the following discourse fragment:

*There is also an attitude problem coming from trainee teachers, e.g. some ask why do you want to limit my consumption when you have a house and a car of your own. It*

*becomes very political and most of the time we have stayed away from this and focus on other issues. (UInt1)*

Another teacher educator added her story: one day she asked learners (trainee teachers) to pick up litter from the foyer and around the building. They resisted and later on she learnt that the learners had interpreted that being white, she was instructing black people to pick up rubbish. Some even commented that whites safeguard the environment a lot because they are the ones who afford/enjoy most recreational facilities in the country.

These are examples in this case study where class and race issues manifest themselves in the curriculum resulting in an antagonistic situation where teacher educators struggle to access learners. The teacher educator is left with no choice other than to put aside engagement with important socio-ecological issues that impact negatively on curriculum practice, such as gender and environmental concerns. Consequentially learners themselves are short-changed on curriculum knowledge. Due to this, curriculum practices fail to fulfil the objectives of ESD as informed by the MDGs (specifically MDG 7), SADC RISDP, the South Africa's National Gender Policy and many more.

Physics teacher educators also echoed some sentiments for lightly treating environmental issues in their practice: "... so I don't address these issues (socio-ecological issues) as I would want because of time and our students are very weak, they battle with content so we spend most of the time on basics ..." (BInt2).

The teacher educator went on to add:

**BInt2:** *In assessment we have had problems with external moderators/examiners who did not like applied physics (socio-ecological aspects) in a physics papers, ... I think their perception is that physics is about the content, facts, theories but not as they go into technology or environment.*

Analysing this discourse I drew from Horvath (2010), who saw language as reflecting and creating context. Pertinent issues arising from this discourse reflect the context of practice. It is clear that socio-ecological issues are given a peripheral position in Physics and Mathematics because of two interrelated reasons namely: weak students and content heavy curriculum. The third reason of external examiners, who are „anti-applied“ physics, also impacts negatively on sustainability responsive curriculum practices. Whatever the reason, it was clear that teacher educators going through this course were not being offered the

opportunity to interact with ESD learning processes as expected by the curriculum statement referred to in Section 6.2.2.

The issue of external examiners who have the perception “that physics is about the content, facts, theories but not as they go into technology or environment”, was an example of how discursive practices are constitutive of social structures, in the same way as the social structures determine discursive practices as claimed by Horvath (2010). Daniels (2012, n.p.) argued that “different institutional modalities may be described in terms of the relationship between the relations of power and control, which gives rise to distinctive discursive artefacts”. The power behind discourse or behind curriculum practices here is that of external examiners. An intertextual analysis enabled tracing this thinking of external examiners to the values of scientism: the belief that science is authoritarian, non-humanistic, objective, purely rational and empirical, universal, impersonal, socially sterile and unencumbered by human bias, dogma or cultural values (Aikenhead, 2002). Sadly, educators who believe in the values of scientism tend to ignore other forces such as students’ and teachers’ home background and patriarchy and the whole socio-ecological context that influence science knowledge (Brickhouse and Gaskel, both in Aikenhead, 2002).

Such pedagogic practice does not have much potential for the learning processes expected in ESD as described above, resulting in a clash between teacher education activity system and the higher ESD activity system. As shown in Sections 6.3.2 and 6.3.3, none of the teacher educators engaged with the gendered nature of socio-ecological risk. CDA helped to probe the underlying mechanisms that constrained this. The focus here was on those teacher educators who had shown some signs of engaging with environmental issues in their curriculum; it seemed inappropriate to ask whether one engages with the gendered aspects of socio-ecological risk when one does not engage with the latter in the first place. The following discourse fragments from such teacher educators were selected for CDA to this effect.

**UInt5**      *Aah I must be honest I haven't really focused on gender issues in environmental issues.*

**UInt4:**      *I haven't noticed something I can really classify as a gender issue. Maybe female students don't complain.*

**UInt3**      *We look at it in general but not in terms of socio-ecological risk as affecting people differently particularly vulnerable groups. I will then try to bring the link between poverty and this vulnerable group.*

One can read much into the discourse fragments above. Bourdieu's concepts of field and habitus can be helpful here for the intertextual analysis. The habitus of teacher educators (acquired schemes of dispositions, perceptions and appreciations, including tests, which orient our practices and give them meaning), which operate at an unconscious level is even or compatible with the patriarchal field. This is a field that contains and enforces gendered rules, values and norms. For Bourdieu, as long as the habitus is aligned to the field, there are no tensions hence no conscious reflexivity (Thorpe, 2009). The implication here is that the teacher educators in question have not yet seen anything wrong (i.e. gender issues) because they are operating in a patriarchal society (field); their habitus is gender blind. For the same reason, female students are not likely to complain either. As Bourdieu claimed, women are „condemned“ to participate in symbolic violence of gender blindness and compelled to adhere to structures and agents of domination (Thorpe, 2009, p.502). Chambers (2005) adds that when there is fit between habitus and field, the habitus tends to be reinforced rather than challenged. Sen's concept of “adaptive preferences”; the fact that women frequently exhibit preferences that have adjusted to their second-class status (Nussbaum, 2005, p.36) can also be applicable here.

It was the task of the expansive learning phase of this study, through change laboratory workshops, to do as Bourdieu said: rise with teacher educators to the moments of disalignment and tension between habitus and field, to increased reflexive awareness (Thorpe, 2009).

As reported in this study there were different sets of teacher educators in this case study: one group were engaging with gender issues in their curriculum practice. The same group also engaged with ESD related policies to a considerable extent. The other group was apathetic to both.

## **6.5 CONCLUSION**

This chapter is located in the explorative phase of the study. It discusses findings related to the explorative research questions. The chapter started by working with second generation CHAT to describe and represent the activity systems that were dealt with in the UKZN case study. Two activity systems were constructed. The chapter then reported, analysed and

developed interpretations on the data obtained through interviews and document analysis. The findings revealed that all the teacher educators are familiar with gender disparities in SMTs education as it relates to enrolment and retention. One would say that the majority of teacher educators in the sample had some basic levels of gender sensitivity, meaning that they had the ability to perceive existing gender inequalities as it applies only to gender disaggregated data especially when it comes to enrolment and retention. Not all of the SMTs teacher educators could show evidence of responding to gender issues in their curriculum practice. Using the capability lenses, I reached the conclusion that the SMTs teacher educators in the group, who were not engaging with gender issues, did not equip future SMTs teachers with skill, knowledge, values and attitudes for them to be able to provide opportunity freedom, or capabilities for girls in SMTs in their own curriculum practice beyond providing mainstream SMTs knowledge. By not paying attention to negative conversion factors (patriarchal norms and other socio-ecological ills), and not adequately engaging with enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender, the teacher education as it was at this stage, could not be classified as a fully-fledged conversion agent.

There was, in this case study also a category of SMTs teacher educators with appreciable levels of gender awareness. They showed evidence of going beyond mere ability to perceive existing gender inequalities, to articulate socio-cultural mechanisms that constrain gender equality in SMTs education. Sadly though these SMTs educators are struggling to be gender responsive in their curriculum practices. Their efforts to bring socio-ecological issues into their curriculum are done in gender blind manner. CDA was used in this chapter to unearth constraining structural mechanisms for gender responsive curriculum practices. Some of the constraints are of a socio-political nature, such as cultural differences between students and teacher educators, as well other related binaries such as race and class. Other constraints are seemingly of a curriculum nature, such as a rigid content-heavy curriculum, coupled with students who came into the system with inadequate content knowledge.

This chapter is linked to the first four chapters of the study. It connects to Chapter One through responding to some of the research questions raised in that chapter. It relies on the conceptual location of the study and the theoretical frameworks discussed in Chapters Two and Three respectively. The chapter reports on data generated and analysed through the methods described in Chapter Four. The chapter connects to Chapter Seven by responding to

the research question: *What are the current gender pedagogical tensions in SMTs teacher education curriculum practices?* Chapter 7 further discusses some contradictions in the case study in preparation for expansive learning discussed in Chapter Eight.

## Chapter 7: SURFACING CONTRADICTIONS IN THE TWO CASE STUDIES

### 7.1 INTRODUCTION

Engeström (2001) stated that contradictions are a “guiding principle of empirical research”. He elaborated:

*... the central role of contradictions as sources of change and development. Contradictions are not the same as problems or conflicts. Contradictions are historically accumulating structural tensions within and between activity systems ... Contradictions generate disturbances and conflicts, but also innovate attempts to change the activity. (p.137)*

This chapter unearths contradictions in and between the different activity systems in the two case studies. Chapters Five and Six reported some of the findings of the exploration phase for each case study. In this chapter the focus is on surfacing contradictions from the data reported in each case study. The chapter is located within the contradictory layer of Engeström’s (2008) three layers of agentive talk for human action as explained in Section 1.8.1. The chapter responds to the research question: *What are the current gender and ESD curriculum tensions in SMTs teacher education curriculum practices?* By so doing, the chapter interrogates causal mechanisms that constrain the teacher education curriculum from being an ESD conversion agent as anticipated (see Section 2.2). In line with viewing “contradictions as sources of change and development” as pointed out in the above quotation, the chapter prepares the ground for the expansive learning towards curriculum transformation for social justice (Chapter Eight).

The contradictions discussed in this chapter are largely based on information that was generated during the exploratory phase of the study, which used interviews (in-depth and focus group) as the main data gathering methods and augmented by document analysis (see Chapters Four, Five and Six). Information synthesised through Critical Discourse Analysis also helped to trace the root of some contradictions, as they are “historically accumulating structural tensions within and between activity systems”, as highlighted by Engeström (ibid.) in the above quotation (see Chapters Five and Six). For each case study, I tried to surface and categorise emerging contradictions according to primary, secondary, tertiary and quaternary as explained in Section 3.4.3. For easy reading of the chapter and to avoid too much backward referencing, I quoted the same data in Chapters Five and Six where relevant.

As explained in Chapters Five and Six, the two case studies had different structural arrangements. The institutions in the BTTC case study were the Ministries of Higher Education and Gender and the Department of Teacher Education, which are directly involved in teacher education. These were the activity systems as highlighted in Chapter Five. In this case study, the study surfaced contradictions within each activity system as well as between and among activity systems. In the UKZN case study, because teacher education is largely the responsibility of the university, there were no inter-institutional structures involved. The two activity systems that emerged as explained in Section 6.2 were both in one institution. For that reason, the contradictions that were surfaced were within one institution as shown in Section 7.3. There was no intention to compare the two but to get an indepth understanding of each.

In line with the Developmental Work Research, the methodological framework anchoring expansive learning, it is worth pointing out that primary contradictions are connected to the first phase of the cycle (need state) and secondary contradictions to the second phase (double bind), (see Figure 4.2, Section 4.2.3). As Miettinen (2009) said, the other latter types of contradictions may be regarded as developmental forms of the primary contradiction. Engeström (2005a) wrote that primary contradiction “evolves and takes the form of specific secondary contradictions as the activity system interacts with other activity systems” (p.181).

In surfacing contradictions it was also prudent to bear in mind that contradictions do not manifest themselves directly, but through disturbances, ruptures, problems, breakdowns, clashes and small unremarkable innovations in practitioners’ everyday work actions (Engeström, 1999; 2001; Foot, 2001; Avis, 2007). It means therefore that any manifestation of such attributes is an indication of underlying contradictions.

## **7.2 CONTRADICTIONS IN THE BTTC CASE STUDY**

As explained above in the BTTC case study, contradictions were surfaced from three activity systems: the teacher education activity system (central activity system), the Higher Education/ Ministry of Gender activity system (tool and rule making activity system) (see Section 5.2.1.3) and the Department of Teacher Education activity system (another tool and rule making activity system) (see Section 5.2.1.2). I decided to present the two ministries (Higher Education and Gender) as one activity system because the Ministry of Gender assigns a gender focal person in

every ministry who spearheads gender related matters in particular ministry. As highlighted in Chapter Five, the ESD activity system was viewed as a culturally more advanced activity system and contradictions are surfaced between it and the activity systems in the network.

### **7.2.1 Contradictions in the teacher education activity system**

As said above, Belvedere Technical Teachers' College (the teacher education activity system) was the central activity system in this case study (see Section 5.2.1.1). In this section I surfaced primary and secondary contradictions within this activity system. In order to facilitate expansive learning I reflected as much as possible on mediated action as the unit of analysis to surface contradictions related to gender and ESD issues in SMTs teacher education curriculum practice.

#### *7.2.1.1. Primary contradictions*

Engeström (1987) defined primary contradictions as those that occur when activity participants encounter more than one value system attached to an element within an activity that brings about conflict. One of the lead questions that I used to surface contradictions was: *Why do you think girls become less and less interested in sciences as they continue with their education?* As revealed in Chapter Five, most teacher educators showed some understanding of gender inequality, but they could not articulate the causes of it and instead blamed girls for their failure to pursue sciences (blaming the victim).

**Bint6:** *Girls perceive them (science and maths) as a male domain.*

**Bint2:** *I don't know why more boys than girls opt for physics ... probably it's a perception that girls have that physics is a male domain.*

**Bint4:** *... looks like females are now willing to take up maths ... girls lack the confidence to take up the challenge ... this could be because they look down upon themselves due to stereotypes that act against them (girls) for example gender stereotypic statements such as „maths dzinoda varume chaivo“ (maths requires real men).*

**Bint3:** *Information Technology is lifelong learning it depends on the character of the person ... females not willing to continue learning.*

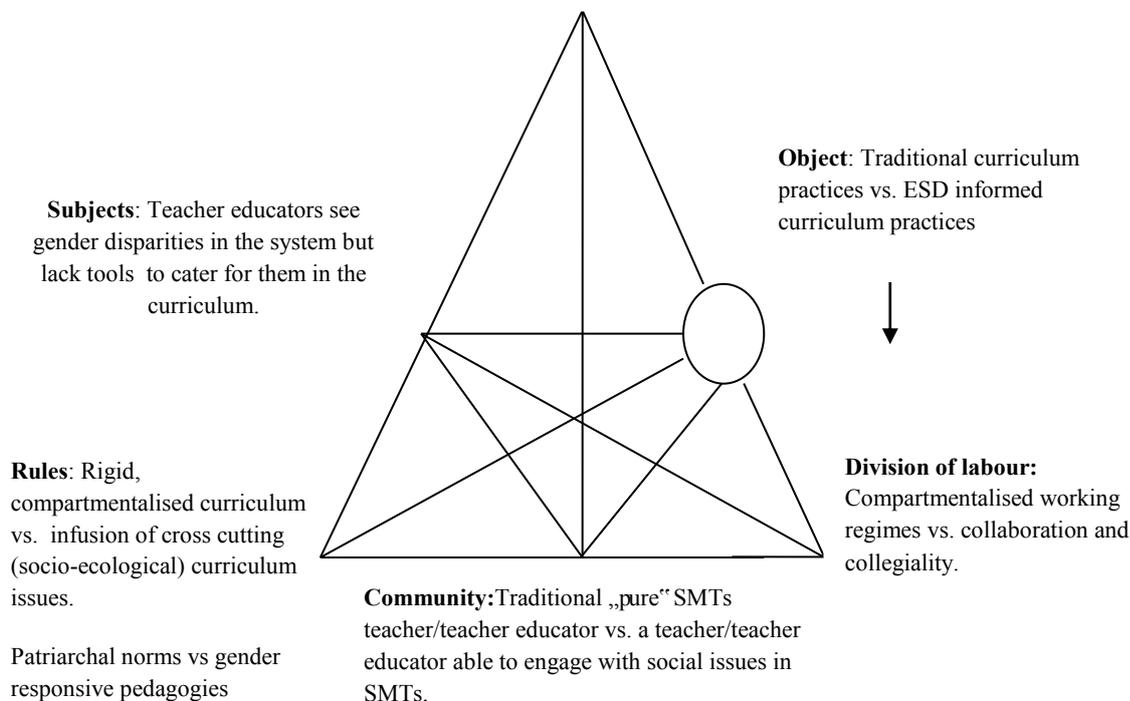
Such statements reveal a primary contradiction within the subject in that although teacher educators could see gender disparities in terms of enrolment and retention, they did not possess the required tools and analytical lenses to undertake a deeper analysis of the causes of such gender disparities and the implications for girls studying SMTs, nor did they have capacity for working against these in their practice. Interpretation on the information obtained in the capability checklist (Extract 8) in Chapter Five, gives more examples of primary contradictions within the subjects as shown in Table 7.1.

**Table 7.1** Primary contradictions within the subject in the central activity system

<b>Capability aspect</b>	<b>Evidence indicators</b>	<b>Primary Contradiction</b>
Analyse sexist bias/gender stereotypes in resources, content and language	<i>Well yes whenever there is need but in most case science content is factual so yah we teach facts.</i> (Bint6)	Within the subject, lack of conceptual tools to make the factual content relevant to socio-ecological concerns of society
Examine content, teaching methods and classroom dynamics that encompass girls' and boys' interest, experiences and learning styles	<i>As I said science content is very factual and is given, does not have much room for interest.</i> (Bint6)	Within the object subject. Lack of learner centred pedagogies, even when content is given.
De-emphasise sex-role stereotyping that hinder girls' progress in science	<i>When we teach science we teach science, and I do not see sex stereotyping there.</i> (Bint1)	Gender blindness within the subject. Lack of conceptual tools for gender responsive pedagogies
Draw the attention of boys and girls to the presence and contributions of women in science and mathematics	<i>Unfortunately the books that we have mostly talk about male scientists and few females, the Marie Curies.</i> (Bint3)	Subject relies on materials given. This could show lack of innovation and creativity on the part of the subject
Alert future teachers to be on the watch out for boys/girls who want to dominate classroom proceedings to the detriment of others	<i>I think there should be a college policy to guide us to all these curriculum needs but at the moment we do not have.</i> (Bint4)	Within the subject, lack of conceptual tools for gender responsive pedagogy
Ensure that future teachers are able to deal with counter cultural practices that may impact negatively on girls'/boys' pursuance of sciences	<i>As I said learners should be able to draw the line between culture and academic aspects; when we are in class it's about learning, nothing to do with behaviour at home.</i> (Bint1)	Gender blindness within the subject. Lack of conceptual tools for gender responsive pedagogies
Expose future teacher to various ways to help empower girls and raise their self-esteem in sciences	<i>We need to play a big role here to educate our girl child that there is no science for girls or for boys.</i> (Bint1) <i>We always try to encourage girls out there to study Mathematics; we talk about it in our lectures, so yes I can say awareness raising is there.</i> (Bint4)	Gender blindness on the part of the subject. Does not see the ontology and epistemology of science as a factor. Stereotypically thinks girls are to blame for their failures in SMTs
Assist future teachers to add relevance and quality to science by drawing attention to socio-ecological issues	<i>The syllabus is given in schools; there is little room for teachers to come up with their own things.</i> (Bint4)	Subject lacks tools to engage with for example ESD informed pedagogies to „deliver“ the given content

Various other primary contradictions emerged within the elements of the activity system as shown in Figure 7.1 below.

**Tools:** Traditional teaching methods/theories vs. teaching methods that seek to address current socio-ecological demands of society



**Figure 7.1** Primary contradictions in the teacher education activity system

### Contradictions within the tools

The study analysed both conceptual and material tools that could support curriculum practices that are responsive to gender and ESD SMTs teacher education. Evidence presented in Chapter Five shows no visible engagement with gender related policies and no engagement with research in gender and SMTs education in the activity system. Document analysis (students assessment project, syllabi, see Table 4.1 in Section 4.4.1) revealed that there were no institutionally designed tools or mechanisms to engage with gender issues in SMTs, nor was there any evidence of engaging with ESD related pedagogies. SMTs teacher education curriculum practices were based on the traditional instrumentalist view of science. There were curriculum supporting materials for incorporating environmental education into the teacher education curriculum that were designed with the support of the Secondary Teacher Training Environmental Education provided. However, as discussed in Section 5.3.4, these tools were gender blind. Contradictions within the subjects, described above, testify that most

teacher educators lack conceptual tools for gender and ESD responsive pedagogies in their practice. All this results in traditional teaching methods/theories contradicting with teaching methods that seek to address current social justice and socio-ecological demands of society.

### **Contradictions within rules**

The study also looked at the explicit and implicit regulations, norms and conventions (Engeström, 1999, 2001) that promote or constrain gender and ESD responsive curriculum practices in the central activity system. There were written down rules in this activity system such as curriculum review policies, government regulations, examination driven curriculum and Department of Teacher Education policies. Such rules had their impact as far as gender and ESD are concerned. For instance the teacher educators in the extract below expressed that they did not see much room for teachers to incorporate gender and ESD issues into the curriculum because of rigid curriculum regulations.

**Bint4:** *The syllabus is given in schools; there is little room for teachers to come up with their own things.*

**Bint6:** *Well yes ... but in most cases science content is factual so ... we teach facts.*

There were invisible semiotic mediation properties (Daniels, 2010) that hindered gender and ESD responsive curriculum practices in the activity system. It emerged from the critical discourse analysis (Section 5.4.1.1) that patriarchal social conditioning with the related habitus and doxa tends to obstruct SMTs teacher educators' viewing of other reasons that may push girls out of sciences apart from their gender identity. The extract below from a focus group interview shows this:

### **Bfgint 1 and 2**

- *girls perceive them (science and maths) as a male domain*
- *they are normally weak in maths and they do not seem to like to put effort*
- *they (girls) are less forthcoming in discussions and in practical activities*
- *they are shy and at times they withdraw to their little circles*
- *I don't know why more boys than girls opt for physics; probably it's a perception that girls have that physics is a male domain*
- *males are more creative, more forthcoming, and adventurous*

Teacher educators' identity construction of girls as "weak", "putting less effort", "shy", "used to getting things done for them" emanate from patriarchal perceptions of women and, in this case, influenced their curriculum practices.

Instrumentalist views of science and scientism on the part of teacher educators were also identified as having regulatory properties shaping curriculum practices. The utterances below are examples that show that some teacher educators saw science as divorced from social issues.

**Bint6** *As I said science content is very factual and is given, there is not much room for interest (meaning science is taught as it is and the teacher can hardly consider learners' interests).*

**Bint1** *When we teach science we teach science and I do not see sex stereotyping there.*

Teacher educators' non-engagement with gender and ESD related policies also results in regulatory properties that affect gender and ESD responsive curriculum practices. According to Eisner (1985, p.97) "ignorance is not simply a neutral void, it has important effects on the kinds of options one is able to consider, the alternatives that one can examine, and the perspectives from which one can view a situation or a problem". Similarly, in this case, the lack of knowledge of policy requirements related to curriculum, leads SMTs teachers to fail to implement gender responsive curriculum practices in a gendered context.

### **Contradictions within the object**

Analysis of SMTs teacher education curriculum practices using the data obtained through interviews revealed that gender responsive pedagogies were not an object of curriculum practice and that ecological issues were incorporated into the curriculum in a gender blind manner (see Section 5.2.1.1). This was in contradiction with the aims of some syllabus documents as shown in Section 5.3.1: "the course aims to develop students who make constructive contributions to contemporary issues such as gender and use of a second language". More discussion on this contradiction is provided under secondary contradictions in the following section.

## **Division of labour**

There was no visible intra activity system collaboration with respect to gender in SMTs.

### *7.2.1.2 Secondary contradictions*

As explained in Section 3.4.3, secondary contradictions emanate from the tension between two elements of the activity system. As Engeström (2005b) said, primary contradiction evolves and takes the form of specific secondary contradictions. He explained that secondary contradictions occur when activity participants encounter a new element of an activity, and the process for assimilating the new element into the activity brings about conflict (Engeström, 1987). In this case, teacher educators' low level of gender awareness (primary contradiction within the subject), as discussed above, led to them failing to impart gender responsive pedagogies in their curriculum practice. There are also some tensions between other elements of the activity system that finally manifest as a contradiction between subject and object. For example, tension between the syllabus documents (material tools), mentioned above, that point to the need of incorporating gender issues in the curriculum, and lack of subject's conceptual tools to translate this into curriculum practices, eventually manifest as failure by the subject to practice gender responsive pedagogies. Tensions within the rules discussed above e.g. patriarchal norms will lead to the same effect of the subject failing to implement gender responsive pedagogies (contradiction between subject and object).

Further evidence from data analysis with the help of a critical discourse analytical lens seemed to point at patriarchal socialisation of teacher educators (as a rule) as a major contributing factor to their gendered curriculum practices. As discussed above, tacit primary contradictions could be surfaced, that is tension emanating from the teacher educator failing to observe gendered practices in the curriculum because of their own patriarchal socialisation. As Engeström (2001) said, as cited in the opening quotation: "contradictions are historically accumulating structural tensions within and between activity systems". Some teacher educators seem to be heavily influenced by their own patriarchal values in their curriculum practices. For instance when asked how they equip future teachers to engage with traditional cultural issues such as girls are expected to be obedient, submissive, passive – personality attributes that may not be in accordance with active participation as required in SMTs learning, some responded:

**Bint1:** *Learners should be able to draw the line between culture and academic aspects, when we are in class it's about learning, nothing to do with behaviour at home.*

**Bint5:** *Opportunities towards education for all are there; the fault is theirs (girls) not the system.*

**Bint1:** *Yes ... there are girls who prefer to work with boys (these are **clever girls**) - they have confidence ... may want to show the boys that they know just like them ... there are girls who prefer to work in a group of girls only – **the average and the weak ones**. On the other hand boys, whether weak, average or gifted can work with anyone, they don't care much. When they make mistakes they are not very worried ... life goes on, it's an attitude thing.*

Such statements are a typical example of how culture can „obstruct“ people from seeing gender issues in their practice; in fact they act gender blindly unknowingly, hence fail to develop the necessary tools essential for gender responsive curriculum practices. This is a typical example of a primary contradiction evolving into secondary contradiction. It became apparent that there is tension between reproducing/maintaining vs. transformation largely due to patriarchal socialisation that results in an attitude that is indifferent to addressing gender issues in the curriculum. Kalu (2005) observed this and pointed out that in most African communities, teachers who are central to the transformation of society in general and the school system in particular, are a product of gender constructs in society. Teachers and students alike are socialised in basically patriarchal structures that foster gender inequality, economically, socially and culturally. She gave examples of gender inequality in most African societies that include attitudes and practices that see women as basically inferior to men, without the right to ownership of the means of production and property. Women are also expected to be subservient to men, leave decision making to the men, are taught not to speak out in public, not to be outspoken especially against men and generally to accept the injustices meted out on them by the system without a fight (Kalu, 2005). Elder-Vass (2010) used Bourdieu's concept of habitus to explain this; habitus is a product of history which is both a product of, and produces, individual and collective practices, predisposes the participant to act, think and behave in particular ways as discussed in Section 1.7.16. In terms of curriculum practices, the teacher educator's habitus (subject) clashes with gender responsive curriculum practices (object), resulting in a secondary contradiction between subject and object. This is a secondary contradiction at a microscopic individual level. However, if the teacher education curriculum practice (the object) is not gender responsive at an institutional level, as seen here, it then clashes with the ESD (higher esteemed activity system) driven gender responsive curriculum practice; this culminates in a tertiary

contradiction between the object of the central activity system and that of the ESD activity system as explained in Section 7.2.2.

It also emerged that even though some teacher educators (subjects) showed a slightly higher level of gender awareness in SMTs education as shown in Section 5.3, they however failed to articulate curriculum responses (object) that they use to address such issues. The following is an example of such a secondary contradiction.

**Bint4:** *This perception [that girls aren't good in SMTs] I think is propagated by teachers themselves, teachers propagate stereotypes, society looks down upon females.*

**Bint3:** *Males are more creative, more forthcoming, and adventurous – females are not, probably due to socialization ... not that they are dull ...*

The same individuals went on to reveal uncoordinated efforts that they bring into their curriculum practices as a way of trying to impart gender responsive pedagogic skills, values and attitudes to trainee teachers. They said:

**Bint4:** *I sensitise my own trainee teachers towards this ... we always try to make reference to the low involvement of females in math, Teacher Education should try by all means in their practice to motivate girls to join math/sciences.*

**Bint3:** *We always point it out that they (trainee teachers) should try as much as possible to motivate our girl child out there to join maths/science ... find a way to incentivise girls to participate in sciences e.g. bursaries for tertiary education. Teacher education institutions should bring this issue (impact of patriarchal socialisation) to the trainee teachers, make them aware of gender stereotypes ... this should be in our methods syllabus but for now we don't talk about cultural issues in science education.*

It is clear from this evidence that although the teacher educators concerned possess an appreciable degree of gender awareness, they are however not translating this awareness into curriculum practice leading into a contradiction between subject and object.

In this study I also had to surface contradictions related to the research question *to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context*. The lead question related to this was: *As we teach SMTs do we keep in mind socio-ecological risks and their gendered nature?*

Some responses were:

**Bint1:** *Not sure ... when we teach science we just teach science, we have incorporated Environmental Education into the curriculum ... No gender aspect here ... We haven't looked at it with a gender eye.*

**Bint4:** *gender and ESD ... Information Technology is meant to solve problems and it requires a certain level of education. Now females who suffer more from climate change are less educated and have lesser chances of accessing IT and related technolog. This is the situation in reality but as for now we haven't put the gender aspect into it.*

At face value the contradiction manifesting here may look as simple as a primary within the subjects, the teacher educator failing to envision the connection between SMTs, gender and capability enhancement in view of socio-ecological risk. Nonetheless, such a contradiction further reveals itself as a clash between tools and the object, teacher educators lacking relevant curriculum conceptual tools to engage with the nexus of science learning, gender and socio-ecological risk. Historicising the source of the contradiction through Critical Discourse Analysis reveals SMTs pedagogical ideologies that are shaped by scientism (as reported in Section 2.4). For instance one can feel the remnants of scientism in the statement: “when we teach science we just teach science”. Scientism as a curriculum ideology has dominated pedagogy for years and it clashes with ESD curriculum expectations, showing secondary contradiction evolving into a tertiary contradiction as discussed in Section 7.2.2.

### **7.2.2 Contradictions within, between and among activity systems**

As discussed in Section 5.2.1, the case study had a network of activity systems. The unit of analysis therefore progressed to the third generation of CHAT, in which the object (curriculum practice) of the central activity system had to be analysed in a network of other activity systems. The object had to be followed across boundaries. In order to surface contradictions at this level, I interrogated the institutional engagement with policies that are within the ESD and transformative education framework. In fact the idea was to interrogate why the central activity system is largely ignorant of gender and ESD related issues when there are policies in the system that could have provided a framework to have these socio-ecological issues incorporated into the SMTs teacher education curriculum. In capability terms, the idea was to unearth mechanisms that constrain teacher educators from paying attention to enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD as a way of countering negative

social conversion factors (patriarchal norms and other socio-cultural ills) and engage them in a critical and transformative manner in their curriculum practice.

The entry point for this analysis was to understand the subjects (teacher educators) engagement with national gender and ESD policies. The principal question was: *Do you in any way engage with gender related policies such as the national gender policy in your relations with teacher education curriculum, if so how?* All the teacher educators indicated that they have no idea of such a document and hence there is no college policy on gender responsive pedagogy derived from it (see Section 5.3.3). As a result, even initiatives to incorporate ESD in the curriculum were executed in a gender blind manner (see Section 5.3.3). It became apparent at this point that cultural tools and artefacts provided for by policies like the National Gender Policy are not permeating into the SMTs teacher education curriculum as intended, resulting in a clash between the object of the central activity system and that of a higher activity system. At this point, the unit of analysis changed from one activity system to a network of activity systems. It also helped me make sense of the notion of “following the object” across organisational boundaries (Miettinen, 2009, p.166). In this case, the idea was to interrogate what systems are in place to make policy frameworks translatable into curriculum practices. In preparation for expansive learning, the focus was to surface contradictions, which, as mentioned by Engeström (2001) are deep seated structural tensions.

As highlighted by Engeström (2008), three successive units are not mutually exclusive; the mediated action of the first generation maybe recognised as the tip of the iceberg in the second and third generation models. I took his advice that while one may want to focus, say, on an activity system as the prime unit of a study, this unit only gains explanatory power if one makes visible transitions across boundaries between the activity system and the actions it generates on the one hand, and between the activity system and the field of interconnected activity systems in which it is located on the other hand (ibid.). It meant therefore that I had to follow the object (curriculum practice) and its relationship to the two tool and rule making activity systems: the Department of Teacher Education and the Ministries of Higher Education and Ministry of Gender (the latter two are conflated into one as they are represented by a gender focal person) (see Section 5.2.1).

### 7.2.2.1 Contradictions involving the Department of Teacher Education activity system

Preliminary results reported in Chapter Five (Section 5.4) indicate the Department of Teacher Education is not ensuring that the gender responsive agenda is integrated into the teacher education curriculum as it is expected to do as an activity system that oversees curriculum development in teacher education (rule and tool making activity system). Interview excerpts from the two interviewees show that there are structural tensions within the Department of Teacher Education activity system itself as reported in Section 5.3. First the two female interviewees narrated their gender concerns in the curriculum to the point that one could judge them to be gender aware:

**DTint1:** *Physics has always been delivered as if it's divorced from humans. Methodology (science education) courses is to assist the students to make them realise that learners have different ways of learning ... vary your examples e.g. talking about physics in the kitchen ... as long as we talk about weapons, space most girls are left out.*

To the contrary they went on to lament:

**DTint1:** *Gender issues are always explosive and involve lot emotions ... it is a challenge really because it talks about norms that may go against cultural and religious beliefs.*

**DTint2** *It is not easy, each time we talk of gender issues ... we are referred to as Beijing and everything is left to us. I really point out this with my students but I am not sure how widespread this is in the department ... probably male lecturers don't talk about gender issue at all because you will be shooting yourself in the foot.*

Judging from this and the Critical Discourse Analysis reported in Chapter Five, I could surface contradictions within the Department of Teacher Education community itself and the division of labour. It was clear from the data that anything to do with gender was relegated the responsibility of two female teacher educators. It appeared thus that gender issues are treated as a peripheral concern left to the two female educators. The underlying mechanism and historical explanation for this is, as raised by the Critical Discourse Analysis reported on in Section 5.4 is patriarchy, both as a culture and as an ideology that permeates curriculum practice. In short, only two (females) of the 13 officials in Department of Teacher Education were quite knowledgeable about gender issues and were willing to incorporate these into the teacher education curriculum. However, curriculum development in this regard was not happening simply because most of the teacher educators did not see this as really worthwhile.

This was due to the tensions within and between subjects. The majority of subjects lack the required tools, leading the primary contradiction to evolve into a secondary contradiction (clash between subject and object) or as it were, tension between the intended and the actual outcomes. The final result was therefore a clash between the object of this activity system and that of the higher activity system (ESD). By the same token, this tool and rule making activity system failed to provide the much needed curriculum tools and/or rules to the teacher education activity system resulting in another clash of activity systems. This obviously brings about a quaternary contradiction.

It became obvious to me as an interventionist researcher that the Department of Teacher Education activity system is not playing its agential role in this regard to equip and constantly replenish the teacher education curriculum with necessary tools for it to execute its gender conversion agent role. I therefore saw the need for expansive learning at two levels (see Chapter Eight): firstly at the institutional level that is the Department of Teacher Education activity system itself, to assist with horizontal boundary crossing within the activity system; secondly, expansive learning was necessary for vertical boundary crossing between Department of Teacher Education and Ministry activity systems and then with the teacher education central activity system.

The next task was to examine contradictions associated with the integration of ESD in teacher education. This was in response to one of the research goals: *to gauge the extent to which the SMTs teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context.* The contradictions that emerged once again were to do with subjects lacking appropriate tools, as confirmed by this data:

**DTint1:** *Not everyone in Department of Teacher Education understands sustainability. Lecturers in teacher colleges are actually more knowledgeable because of Secondary Teacher Training Environmental Education Programme that was implemented straight into teacher education leaving most of our staff members out.*

**DTint2:** *As a university we are now trying through Mainstreaming Sustainability in African Universities and Department of Teacher Education is involved. Universities are not well connected in terms of sustainability issues. As for the gender aspect of it I think you have seen that we are not yet there.*

It was also surprising to learn that the curriculum development initiative to infuse Environmental Learning through the Secondary Teacher Training Environmental Education Programme had actually left out most of the staff members of the Department of Teacher Education, a higher activity system that is mandated to oversee and monitor such curriculum developments. This left some of the Department of Teacher Education subjects with lack of knowledge (tools) for curriculum transformation in this respect. Lack of tools (knowledge) is a primary contradiction within the subject. As discussed earlier, this contradiction evolves into a secondary contradiction that is the subjects failing to incorporate ESD issues into their curriculum practices (object). This clash between subject and object is a secondary contradiction.

What emerged from this analysis is that the tool making activity system (Department of Teacher Education) is not taking it as its object to produce curriculum tools to support gender and ESD responsive curriculum practices in the central activity system. This leads to tension between the objects of the two activity systems, (tertiary contradiction). Figure 5.3 in Section 5.2.1.2 highlighted the primary contradictions in this activity system. Table 7.1 below summarises secondary and tertiary contradictions that evolved from these primary contradictions as discussed in this section.

**Table 7.1** Summary of secondary contradictions in the Department of Teacher Education activity system

<b>Secondary Contradiction</b>	<b>Obstacle (cultural-historical context)</b>	<b>Tertiary Contradiction</b>
Between rules and subjects	Patriarchal values vs. incorporating gender issues in curriculum	Between objects (Department of Teacher Education gender blind curriculum development vs. ESD curriculum practices).
Between division of labour and objects	All gender related issues relegated to the two female staff members vs. major curriculum transformation of incorporating gender issues in SMTs teacher education	Between object (Department of Teacher Education gender blind curriculum development vs. tools for gender responsive practices in teacher education).
Between subject and object	Lack of gender related curriculum tools vs. the need to come up with such tools for teacher education curriculum development	Between object (Department of Teacher Education gender blind curriculum development vs. tools for gender responsive curriculum practices in teacher education).
Between tools and object	Most DTE staff not conversant with ESD vs. the need for DTE to play a supervisory (tool/rule making) role to the TE activity system	Between object (Department of Teacher Education ESD blind curriculum development vs. tools for ESD responsive curriculum practices in teacher education).

### *7.2.2.2 Contradictions within the Ministry of Higher Education activity system*

As mentioned in Section 5.2.1.3, the Ministries of Gender and that of Higher and Tertiary education are two separate ministries that were considered as one rule making activity system in this study. The rationale for this is that the Ministry of Gender appoints a gender focal person to each government department in a particular ministry to represent its interests. It is for this reason that my research participants in the Ministry of Higher and Tertiary Education included the gender focal person as shown in Figure 5.4.

Tensions and contradictions involving the Higher Education activity system can be seen in the data extract 13 in Section 5.3. Firstly, the assumption that teacher educators should be able to interpret socio-ecological risk and come up with relevant knowledge and curriculum practices “...everyone knows that there is climate change, droughts etc...any good lecturer would use things like this in a social studies lesson or science or mathematics” (HOInt1) negates the mandate of the office of contributing to teacher education curriculum development. Earlier in the interview, the interviewee, a very senior official in the ministry had described the ministerial mandate as a “curriculum driver” that draws from cabinet and other government departments as well as feeding this into teacher education curriculum development (see Section 5.2.1.3). This shows contradiction within the subjects or within the whole institution, and a failure to come up with tools and structures to steer the curriculum towards socio-ecological justice. Furthermore, the assumption sharply contradicted the situation on the ground that all teacher educators were not aware of the existence of any policy that can guide them to incorporate gender into the curriculum as shown in extract 13. One interviewee raised that “if the policy is there, surely someone should inform us of the existence of such a policy or the need to incorporate emerging issues into the curriculum and it is reasonable for policy makers to come up with some implementing programme” (Bint3). This was a sign of a tertiary contradiction, a clash between the object of this tool/rule making activity system and that of the teacher education activity system. As in the case with the Department of Teacher Education, the clash emerges in that the tool making activity system is not taking it as its object to provide the teacher education activity system with the required tools that are needed to make their curriculum practices (object) gender and ESD responsive.

The gender focal person who operates under the same ministry also confirmed the lack of collegiality in the ministry. She concurs that she runs her own workshops: “there are so many colleges for one person, fourteen of them in the country and I am all by myself” (HOInt2). A primary contradiction within the division of labour is visible here. The

implication is that the gender into teacher education agenda is not happening fast enough because the workload is too much for one person. This contradiction evolves into a tertiary contradiction in that the tool making activity system fails to provide teacher education with the necessary tools for incorporating gender issues in the curriculum. The clash is between the division of labour of the tool making activity system and the tools element of the teacher education activity system (see Figure 7.1).

The gender focal person also confirmed that most of the workshops that she runs are aimed at simply raising gender awareness and not curriculum transformation. This is evidence of a tertiary contradiction between the object of this activity system and the ESD activity system, in that the object(ive) of the latter goes beyond awareness raising to reorienting existing educational programmes to address sustainability as discussed in Section 2.2.2.

The gender focal person also showed that most of those who volunteered to be institutional gender focal persons are not from science disciplines: “Unfortunately these are mostly from languages and social sciences. I think it could be better if these people come from SMTs” (HOInt2). Although this is a worthwhile starting point, the arrangement however is not in accordance with the targets of the Zimbabwe National Gender Policy that specify the need to eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology as discussed in Section 2.7.1. This is once more a tertiary contradiction between the object of this activity system and that of the ESD activity system as the National Gender Policy is one of the elements that make up the latter (see Figure 5.5).

There is also misreading of the ESD framework by the ministry, as shown in the statement “we look at gender not because it’s ESD but because there should be gender equity and equality” (HOInt1). He goes on to add: “Millennium Development Goals yes we working with them but to call them ESD is a mistake ... for example we have been working with HIV/AIDS very seriously but we haven’t been calling it ESD”. This information shows that the ministry is interpreting ESD as another cross cutting issue that needs to be incorporated into the curriculum. He supports this by saying: “... some think we have had a lot of these cross-cutting issues and we get people confused”. Such a „mistaken identity“ of the ESD discourse creates a potential clash between the tools of the ESD framework and the object of the Ministry of Higher Education activity system, in that all the conceptual tools offered by the ESD to improve the quality and relevance of teaching and learning are not seen as tools

but as additional work. The ESD framework objective (to help countries make progress towards, and attain the MDGs through ESD efforts) is not taken advantage of by the ministry. These were the issues that were brought up for discussion in the expansive learning phase (see Section 8.2.4.2).

### **7.3 CONTRADICTIONS IN THE UKZN CASE STUDY**

As explained in the introduction of this chapter, in this case study the two activity system that emerged as explained in Section 6.2 were both contained in one institution. It follows therefore that that I had to surface contradictions within this same institution, unlike in the previous case. This section firstly surfaces contradictions that are in line with SMTs teacher education in general. It responds to the research question: *what are the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs teacher education?* It then surfaces contradictions related to gender, SMTs teacher education and socio-ecological risk, responding to the research question: *to what extent do the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context?*

#### **7.3.1 Contradictions concerning gender and SMTs in general**

The UKZN case study had two activity systems, namely the teacher education institution itself, and the higher and esteemed ESD activity system as reported in Chapter Six (Figures 6.1 and 6.2).

In view of gender responsive curriculum practices and as discussed in Chapter Six, teacher educators in this case study could be grouped in three categories. The first category with very few individuals comprised of teacher educators who confessed utter ignorance to gender responsive pedagogies beyond being able to see gender disaggregated data that is the number of females and males in enrolment. Interview extracts such as the one below on their perception of push out factors for girls from SMTs confirms:

**UInt3:** *I don't know, probably socialisation, when they are by themselves, (girls) do all the things very well. Whether it is their choice or boys cow them out, I don't know... I think it's a cultural thing.*

In such statements teacher educators concerned do not only show their sensitivity to gender disparities in enrolment, they also reveal a lack of required tools and analytical lenses to undertake deeper analysis and develop understanding of the causes of such disparities and the implications they have for girls studying SMTs. This is a typical example of a primary contradiction within the subject. The contradiction however manifests itself as a clash between the two elements of the activity system, the subject and the object. This is in the sense that teacher educators (subjects) were unable to address gender issues in their curriculum practices (object), thereby rendering the teacher education curriculum ineffective as a gender conversion agent. This obviously will bring about a tertiary contradiction, in the form of a further clash between the object of the teacher education activity system and that of the esteemed ESD activity system.

Another source of disturbance evidenced here is the tendency by teacher educators to detach themselves from what they call cultural issues. It is implied here in “it is cultural thing ... I don’t know, probably socialisation” (UInt1). As highlighted in Section 6.4 through the Critical Discourse Analysis, the implication here is that gender issues are embedded in people’s culture and curriculum has very little room to initiate changes. This could be superficially viewed as a secondary contradiction resulting from the clash between the subject and community. However, closer analysis could reveal this as a primary contradiction in the sense that teacher educators lack pedagogic tools to engage with cultural issues in their curriculum practice. Nonetheless, whichever way one looks at it, the fact remains that curriculum practice is affected by gender blindness causing a clash between the object of the teacher education activity system and that of the ESD activity system. In the capability sense, this perceived cultural constriction negatively impacts on agency opportunities (freedom) of teacher educators and simultaneously on the agency outcomes (achievements) of future SMTs teacher educators. As outlined by Sen, individual agency (freedom) depends on social arrangements:

*the freedom of agency that we individually have is inescapably qualified and constrained by the social, political and economic opportunities that are available to us. There is a deep complementarity between individual agency and social arrangements. It is important to give simultaneous recognition to the centrality of individual freedom and to the force of social influences on the extent and reach of individual freedom. To counter the problems we face, we have to see individual freedom as a social commitment. (Sen, 1999, pp.xi-xii).*

What does this mean for curriculum transformation? It would follow that curriculum development, particularly in SMTs teacher education, pedagogic practice should aim at agentic development in future teachers; to produce teachers with the capacity to provide opportunities (agency freedom) for both sexes in SMTs. As argued in Chapter Two, such curriculum practice can potentially contribute towards agency achievement of both sexes in sciences. One would expect a teacher education curriculum that engages with the social arrangements that constrain girls from participating in SMTs at the same level with boys. In their formative stages as teachers, they should be exposed to those social opportunities (e.g. progressive policies) and social norms that expand or diminish agency freedom of girls in SMTs.

The second category of teacher educators in this activity system could be categorised in the middle: aware of gender disparities and conscious of the need to engage with them in their curriculum practice. However, this group had other disputes that influenced a failure to address gender issues in their curriculum practice as reported in Chapter Six. One such concern is the poor subject content knowledge of trainee teachers. The following interview extracts represents an argument that was put forward by the majority of teacher educators across the SMTs band in this case context.

**UInt1:** *Our student teachers when they come into our programme are so weak generally, so we can't do everything, we need to concentrate on content. We are forced to let them go to schools with half the calculus we want them to have.*

**UInt3:** *Umm it's a difficult one, probably gender perception, it's probably an issue of the girls who come through ... I haven't specifically asked or interrogated.*

A contradiction arises as a result of the difficulties teacher educators experienced in finding a suitable compromise between pure content coverage and engaging with socio-cultural issues in curriculum. This arguably, can be interpreted as lack of adequate curriculum tools on the part of the subjects to engage with socio-cultural issues within the context they are working in. Lack of tools is a primary contradiction within the subject. This contradiction evolves and manifests itself in deep seated tensions between the subject and the object (secondary contradictions) in that the subjects fail to be gender responsive in their curriculum practice. There is also another secondary contradiction between the subject and the community (student teachers). Because of the lack of adequate curriculum tools, the subjects do not impart gender responsive knowledge, skills, attitudes and values to future teachers.

Another concern raised by teacher educators as causal to non-engagement with gender issues in their pedagogy is the issue of race and class. The following extracts from interviewees highlight this:

**UInt1:** *Yah but there are other things that are bigger stumbling blocks- race and class ... we spend about a third of our time talking about how to reach out to different learners, so we talk about gender issues in examples very briefly, e.g. girls with more chores at home and boys have more time.*

**UInt2:** *Basing on my experience, we can't look at gender isolated from class and race, think for me it's not gender that is the biggest problem its class ... among the students who are struggling the most are those from poor background and they tend to be Africans, it's not just racial but the school background.*

**UInt3:** *I have Indian and African girls, I suspect for some of them it's not an easy choice*

As with the previous category, Sen's argument, when related to the quote above can be used to explain how social arrangements, in this case (weak content knowledge in trainee teachers as well as racial issues) restrain individual agency, which in this case relates to freedom to integrate gender responsive pedagogies. The result is curriculum practices that still do not consider gender relations in SMTs teacher education.

In CHAT generally, contradictions are always viewed as springboards for growth. In this regard Dick and Williams (2004) singled out what they termed „invisible“ or „undiscussable“ contradictions as the most difficult contradictions to use as springboards for growth (p.11). They explained an invisible contradiction as one that is so much part of the team's everyday life that the members do not even recognise it as a difficulty. Invisible contradictions include anything that is „taken for granted“, and especially cover cultural assumptions about how things are done and how relationships are managed (ibid.). On the other hand they describe undiscussable contradictions as those that nobody ever talks about because they are embarrassing, uncomfortable or culturally difficult to confront. They went on to give gender and racial issues in teams, or offensive personal habits of politically powerful programme stakeholders, as examples of undiscussable contradictions. Nobody is willing to talk about them openly, but they may be seriously impeding progress towards the goal (ibid.).

While no one may freely talk about them as argued here, Daniels (2010) believed that such contradictions (or institutional structures) are cultural historical products (artefacts) and have mediation properties:

*different social structures give rise to different modalities of language that have specialised mediational properties. They have arisen, have been shaped by, the social, cultural and historical circumstances in which interpersonal exchanges arise and they in turn shape the thoughts and feelings, the identities and aspirations for action of those engaged in interpersonal exchange in those contexts. Hence the relations of power and control, which regulate social interchange, give rise to specialised principles of communication. These mediate social relations. (p.380)*

I saw this conceptualisation of contradictions as relevant in this case study. Issues of race and class in South Africa are often treated as „invisible“ or „undiscussable“ in the new democratic dispensation. However, they still mediate social relations through regulating power relations, shaping thoughts, feelings, identities and aspirations for action of people. As highlighted in the interview extract above, teacher educators spend time and effort strategising how to reach out to students of different races and cultures and for that reason very little time is dedicated to gender or socio-ecological issues, or the interface between these and these also become „invisible“.

Dick and Williams (2004) again provided inspiration: they suggested that surfacing invisible or undiscussable contradictions and stimulating a developmental dialogue around them is the most potentially valuable service that an Activity Theory based research intervention can provide. The Critical Discourse Analysis reported on in Section 6.4 offered a socio-historical analysis tracing race issues from the apartheid days. In this sense the past is still interacting with the present. As pointed out in the same extract the fact that “among the students who are struggling the most are those from poor background and they tend to be Africans” (UInt2), is not coincidental but is the result of a system that was purposively crafted for separate development, constructing one race as superior.

With this legacy, the teacher education system, like most systems in South Africa faces numerous challenges related to race and class. In this specific context, disturbances manifest through teacher educators (who are mostly white) struggling to access black student teachers. One teacher educator stated that a foreign doctoral student once confided in her that some South African black students were telling him to be on the lookout because they believe that a

white person will never want a black person to have knowledge and so they are always suspicious of their white lecturers/supervisors. Another interviewee added: “once I get in touch with them, some of them say „you know at first I did not trust you because you are white“ so the problem is to reach them in terms of different competing value systems” (UInt2).

There is an „invisible“ impasse on one hand and on the other, poor school background supported by the poor quality education still rampant in black schools partly due to the apartheid legacy. The students therefore struggle to access curriculum knowledge, creating a clash between community and the object (secondary contradiction). Teacher educators consequently report having no choice other than to waive social issues that have the potential to improve the relevance and quality of education, such as engaging with gender and socio-ecological risk. The resultant effect is a gender blindness and a purportedly gender neutral curriculum object clashing with the ESD curriculum object (tertiary contradiction). The cause is limited freedom of agency of SMTs teacher educators, their individual agency as evidenced here being constrained by the social, cultural, historical political and economic arrangement around their practice.

Some teacher educators in this category could be classified as indifferent; they are aware of gender issues in SMTs curriculum but they are apathetic about these. The data extract below shows statements from different teacher educators expressing either their unconcerned attitudes or halfhearted attempts to deal with gender issues in the curriculum.

**UInt1:** *Education is our best way of changing things; we know that this thing of producing ourselves out of problems doesn't work ... but the more we start making a fuss about it ... the less we make a fuss about it ... I think it's going to balance itself up ...*

**UInt3:** *I think for me the strongest prospect is that I am a female, so I am a role model; I encourage the girls to participate equally with boys. So I don't think I privilege one over the other... in fact sometimes I joke about it. I do emphasise that girls and boys are equal in class.*

There is a sense of gender neutrality implicit in this discourse; the claim that one is indifferent to issues of gender, as he/she has no ultimate gender practice (Section 1.6.6). Such a claim assumes that all people are affected by programmes (or policies) or learning and learning situations in the same way. It is premised on the belief that all people are already equal, therefore treating all people the same way is fair as underscored by “I don't think I

privilege one over the other and the more we start making a fuss about it ... the less we make a fuss about it” (UInt2).

Such statements show a primary contradiction within the subject; perhaps lack of knowledge by the subject concerning the impact of gender issues in the SMTs curriculum and/or lack of tools to deal with them in their curriculum practice. As highlighted in 6.4 “leaving „things” to balance themselves out” (UInt1), contradicts with the school curriculum statement that calls for learners to be able to identify and critically evaluate scientific claims and the impact of this knowledge on the quality of socio-economic conditions (Brooks et al., 2006). The question is, if teachers are not exposed to such critical evaluations themselves during their formative years, what guarantee is there that they will be able to inculcate such values to their pupils? The South African curriculum statement reflects the need for critical thinking and draws national, regional and international bodies such as South Africa's National Gender Policy Framework, Southern African Development Community, Education for All, MDGs and ESD. One would therefore expect that SMTs teachers should be exposed to similar critical thinking in their formative years, so as to be able to handle this in their own pedagogical practice. Failure by the teacher education system to prepare them in this regard therefore is a tertiary contradiction, a clash between objects of the teacher education activity system and that which is informed by ESD. Figure 6.1 in Chapter Six highlights some of the major primary contradictions in this case study. Table 7.3 summarises secondary and tertiary contradictions in the case study.

### ***7.3.2 Contradictions concerning gender, SMTs and socio-ecological risk***

As discussed in Sections 2.6.2 and 6.2 ESD tenets are well enshrined in all the learning areas of the South African formal school curriculum. Learning outcome 3 in physical sciences is a typical example: “learners to be able identify and critically evaluate scientific knowledge claims and the impact of this knowledge on the quality of socio-economic, environmental and human development”. The outcome expects learners especially at secondary school level to be able to discuss or argue issues relevant to the impact of science on the environment and the sustainability of resources, as well as evaluate the impact of scientific research on management, utilisation and development of resources to ensure sustainability (Brookset al., 2006, p.3; Kelder et al., 2007). Sustainability as discussed in Chapter Two (Sections 2.2.1; 2.2.2. and 2.6) has interrelated components: the biophysical, economic and the social. This learning outcome creates a curriculum practice expectation requiring teachers to support

learners to interrogate the interplay of science and technological development, ecological sustainability and social issues such as social justice and equity. It follows therefore that teacher education institutions should prepare future teachers for such a task. Lotz-Sisitka (2011) further highlighted that key principles of ESD (environment, society and economy; see also Section 1.7.13) have been incorporated into the National Curriculum Statements at all levels of South African Education system as discussed in Section 6.2.2.

It is with this background that contradictions were surfaced in this case study. The section responds to the research goal: *to what extent do science teacher educators consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context?* The surfacing of contradictions also enabled a response to the research question: *What are the underlying mechanisms that affect (promote or constrain) gender responsive curriculum practices in SMTs teacher education?*

Responses to the following probing question provided useful insight to this issue: “*Do you in any way engage with environmental issues in your teaching of ... (discipline)?*” Data extracts below share some of the teacher educators’ explanations of their lack of or low uptake of environmental issues in their curriculum.

**UInt1:** *I don't touch it at all in class not at all, nothing not at all, it is too far away from standard math, my experience is that it (environmental issues) confuse the learners, the prerequisite knowledge required is too high, and most math teachers will end up with misconceptions ... we need scientific content knowledge and the mathematical content knowledge to come together and we are not there yet.*

**UInt3** *I don't address these issues as I would want because of time and our students are very weak, they battle with content so we spend most of the time on basics. In assessment we have had problems with moderators/examiners who did not like applied physics (environmental component in physics) in a physics paper.*

This shows a secondary contradiction between the subject and object. It was evident in interviews that teacher educators (subjects) were quite aware of the curriculum requirement (object) but they were not doing it for a number of reasons. As with the previous issue of gender in SMTs, reasons cited were: weak students, content heavy curriculum, limited contact time and external examiners who did not want for example applied physics questions in examinations. A careful analysis of this secondary contradiction provides insight into other contradictions. For instance one can infer from the utterance: “I don’t touch it at all in class not at all, it is too far away from standard math, we need mathematical content knowledge and we are not there yet” that teacher educators are advocating for pure mathematical

knowledge out of context. This can be linked to a view of SMTs teaching by the subject, reflecting on instrumentalist methodological stance representing a primary contradiction in the activity system.

Structural tensions were also raised as being causal to the non-engagement with environmental issues in the curriculum. Most teacher educators reported that since the college became part of the university there has not been much emphasis on environmental issues:

**UFG11:** *When we were a teacher's college it was compulsory for every student to do environmental literacy,*

**UInt3** *We looked at teaching the environment across the curriculum. That has fallen by the way side; the university doesn't see that as an important aspect. We are fighting for its re-introduction but it hasn't happened.*

Further probing indicated that much emphasis in the university is now on research for personal promotion and most of the interfaculty collaboration is focused on that as reported on in Chapter Six. These are some of the invisible semiotic mediation properties (Daniels, 2010) that hindered ESD responsive curriculum practices in the activity system.

Cultural detachment also emerged from in the Critical Discourse Analysis which brought its own contradictions. As discussed in Section 6.4 data extracts such as: "It's a cultural aspect; in those cultures the more caring aspects are associated with females ... I have Indian and African girls, I suspect for some of them it's not an easy choice" (UInt3) implies that teacher educators distance themselves from the culture of trainee teachers and subsequently from the larger student culture in South Africa that they are preparing teachers for. This cultural detachment contradicts the principle of cultural engagement fortified by ESD policies and emphasised by the national curriculum statements. Table 7.3 gives a summary of related contradictions in this case study.

**Table 7.3** Summary of secondary contradictions in the UKZN case study

<b>Secondary contradiction</b>	<b>Cultural-historical context</b>	<b>Tertiary contradiction</b>
Between rules and subjects	Patriarchal, racial, class and cultural detachment restrictions vs incorporating gender and socio-ecological issues in curriculum.	Between objects of the two activity systems (teacher education gender/sustainability blind curriculum practices vs ESD curriculum expectations)
Between subjects and object	Weak students, content heavy curriculum, limited contact time vs the need to prepare future SMTs teacher to handle socio-ecological issues in their practice	Between objects of the two activity systems (teacher education ESD blind curriculum practices vs ESD curriculum expectations in the national curriculum statement)
Between community and object	Student with low subject content knowledge vs incorporating gender/ESD issues in curriculum.	Between tools of the teacher education curriculum (traditional SMTs teaching to cover content) vs. object of ESD sustainability responsive SMTs curriculum practices
Between tools and object	No coordinated institutional curriculum tools to support gender and ESD curriculum practices, instrumentalist teaching methodology vs the gendered and socio-ecological context and the need to prepare future teachers for ESD curriculum practices	Between objects of the two activity systems (teacher education ESD blind curriculum practices vs ESD curriculum expectations in the national curriculum statement)
Between division of labour and object	No visible faculty collaboration to incorporate ESD into the curriculum. External examiners who are anti-applied physics vs national curriculum statement	Between objects of the two activity systems (teacher education ESD blind curriculum practices vs ESD curriculum expectations in the national curriculum statement)

It is worth reminding the reader that the study had no intention to study the nexus of SMTs and socio-ecological risk but rather the SMTs nexus with the gendered nature of the socio-ecological risk. As discussed in Chapter Six, it emerged however that there was a group of teacher educators in this case study who was apathetic to having both socio-ecological risk and gender issues included in their curriculum. As a reflexive researcher I had to surface the contradictions within this reduced nexus as shown in Table 7.3. Another cohort of teacher educators was passionate about including both or either socio-ecological risk and gender into their curriculum, but not the nexus of the two. The result, as reported in Section 6.3.3 is a gender blind way of incorporating socio-ecological issues in the SMTs teacher education curriculum. This made the case study very heterogeneous and complex. Nevertheless, it was fairly easy to construct two distinct activity systems from this for expansive learning (see Section 8.3).

The second cohort which was passionate about including socio-ecological and gender issues into the SMTs teacher education curriculum could easily align with the ESD activity system save for some minor contradictions. The major finding was that they ignored the gendered aspect of socio-ecological risk. Because of this, their curriculum object clashed with the ESD driven curriculum activity system in its “pure” form, as articulated in policy intentions.

## **7.4 CONCLUSION**

This chapter was devoted to surfacing contradictions in the two case studies. It emerged that in most cases primary contradictions within an element of the activity system, e.g. lack of ESD pedagogical tools in the subject, evolve into a secondary contradiction, a clash between two elements of the activity system such as subject and object. This further results in a clash between the object of the activity system with that of the esteemed ESD activity system. The chapter used critical discourse inferences to identify and explain the likely causal mechanisms that result in the emergence of the structural contradictions discussed. Scientism, instrumentalist and functionalist tenets, patriarchal norms, racial and class issues emerged as some of the major causal mechanisms that cause current pedagogical practices to clash with the expected ESD curriculum practices. The information reported in this chapter, and that reported in Chapters Five and Six, together respond to the first three objectives of the study as outlined in Section 1.4. The contradictions surfaced were used as a springboard for expansive learning reported in the next chapter.

## Chapter 8: EXPANSIVE LEARNING IN THE TWO CASE STUDIES

### 8.1 INTRODUCTION

*The identification of contradictions in an activity system ... constitutes an important aspect of any effort to bring a change ... (Engeström, 2006, p.28)*

The previous chapter surfaced contradictions in the two activity systems. As highlighted in the above quotation, the purpose of surfacing contradictions was to bring about change in curriculum practice. This chapter describes the expansive learning that took place in the two case studies. It responds to the study goal of supporting expansive learning for gender responsive teacher education curriculum practices as a process of ESD. The guiding question is: *What expansive learning and what mediation tools can the study develop to support gender responsive teacher education curriculum practices as a process of ESD?*

Expansive learning implies a capacity to interpret and expand the definition of the object of activity in ways that produce culturally new patterns of activity (Warmington et al., 2005). It combines the three components of the CHAT based inquiry namely the systems component, the learning component and the developmental component (Dick and Williams, 2004). In accordance with the curriculum transformation agenda of the study, expansive learning was intended to develop conceptual tools for professionals to understand the object of each activity system and to create a shared object between them. Engeström (2001) and Warmington et al. (2005) related the notion of expansive learning to Bateson's third level of learning: radical questioning of the sense and meaning of the context and the construction of a wider alternative context. Engeström and Sannino (2010, p.5) bring into the theory of expansive learning, Bateson's notion of double bind, interpreting it as "a social, societally essential dilemma which cannot be resolved through separate individual actions alone – but in which joint co-operative actions can push a historically new form of activity into emergence". Expansive learning is learning that leads to change in organisational practices (Warmington et al., 2005). In expansive learning, learners learn something that is not yet there, constructing a new object and concept for their collective activity, and implement this new object and concept in practice (Engeström and Sannino, 2010).

Change Laboratory Workshop or Boundary Crossing Workshop was the main methodological tool that was used for expansive learning in the two case studies as discussed in Section 4.4.5. As emphasised by Warmington et al. (ibid., p.11), using activity theory as a shared analytical framework, the workshops were designed to support reflexive systemic

analysis by confronting practitioners' „everyday“ understanding with „scientific“ understanding of system relationships, dynamics and the structural contradictions that might point towards new, expanded forms of practice. In other words, I understood expansive learning or expansive transformation as a collective journey through the zone of proximal development of the activity (Engeström, 2001). The design of the workshop sequence drew upon key elements of Engeström's conception of Developmental Work Research (Engeström 1987, 1999, 2001, 2004) also outlined in Warmington et al. (2005):

- facilitating practitioners' reflective systemic analysis, as a vehicle for examining and promoting change in professional thinking, practices and organisational cultures;
- promoting systemic change by focusing systemic analysis upon (a) collective learning challenges facing practitioners and organisations in the drive towards multiagency working (b) the surfacing of contradictions in past and present practice that might point towards new forms of professional practice (future objects); and
- producing strong conceptual resources for practitioners to use when engaging in the new practices demanded by changes in policy (using the workshop sequence to confront professionals' „everyday“ concepts of practice with „scientific“ concepts derived from activity theory analysis, thereby generating a process of remediation, the creation of tools appropriate to emergent forms of practice).

During the whole expansive learning process, there was need to encourage reflexivity of teacher educators, that is the “self-transformative capacity involving the use of knowledge to generate further knowledge” by focusing on the relational encounter of subjectivity with objectivity (Delanty, 2005, p.120). Focusing on the dialectical relationship of subject and object, as subjects work on their curriculum practice (object), the object works back on the subjects impacting on their subjectivity and how the subjects in turn approach the object (Edwards, 2007), enabled the study to build on human agency, the agency that will be needed if the SMTs teacher education curriculum is to transform into an ESD/gender conversion agent.

## **8.2 EXPANSIVE LEARNING IN THE BTTC CASE STUDY**

The BTTC case study comprised of four activity systems as described in Section 5.2. A total of three change laboratories with several sessions each were planned for this case study. The first change laboratory was held with the teacher education activity system, the central

activity system. It took a total of 12 hours. It stretched over three weeks with two hours per day and two days a week. For this change laboratory, I negotiated to use the time usually allocated for staff development in higher education institutions in Zimbabwe. I was given two afternoons between 2 and 4 p.m. for the three weeks stretching between June and July in 2011. The second change laboratory was held with higher education ministry officials including the gender focal person in the Ministry and the Department of Teacher Education representatives. It took half a day (9 a.m. - 1 p.m.). The last change laboratory took three half days spanning the last two weeks of September in 2011. It brought together all the activity systems of the case study: Department of Teacher Education officials, Ministry officials and teacher educators. In the last two change laboratories I made sure that an official from the UNESCO desk within the Ministry of Higher and Tertiary Education was involved as a representative of the ESD activity system. Two more workshops were held to develop mediation tools that could be used to support the syllabus review that was underway (see Section 8.2.4.3).

Table 8.1 below shows details of the change laboratory sessions that took place within the three activity systems of the BTTC case study. The thematic focus served as a guide to the objectives of particular session. Sessions were designed according to the themes and not time slots as one theme could spill into different time slots over the period.

**Table 8.1** *Change Laboratory sessions in the BTTC case study*

Expansive Learning with:	CL sessions and thematic focus
Teacher Education (central activity system)	<ol style="list-style-type: none"> <li>1. Orientation to the workshop and conceptual tools</li> <li>2. (Re)conceptualising the object</li> <li>3. Analysing contradictions and developing solutions in groups</li> <li>4. Developing mediation tools</li> </ol>
Department of Teacher Education/Head office (rule and tool making activity systems)	<ol style="list-style-type: none"> <li>1. Orientation to the workshop and conceptual tools</li> <li>2. (Re)conceptualising the object</li> <li>3. Analysing contradictions</li> </ol>
Combined activity systems	<ol style="list-style-type: none"> <li>1. Orientation to the workshop and conceptual tools</li> <li>2. (Re)conceptualising the object</li> <li>3. Analysing contradictions and developing solutions</li> <li>4. Modelling solutions and way forward</li> </ol>

### ***8.2.1 Expansive learning in the Teacher Education Activity System (central activity system)***

The change laboratory involved teacher educators from the sciences division made up of three departments: science, mathematics and technical subjects. All teacher educators were invited and a formal announcement was circulated by the vice principal reminding them that the change laboratory was being considered as one of the staff development initiatives of the college so everyone was encouraged to attend. I also made separate arrangements with the head of division and the three respective lecturers in charge of the departments to be present in all the sessions. The average attendance for the sessions was 11.

#### ***8.2.1.1 Introducing conceptual tools***

As a starting point, I presented the expansive learning cycle to participants as is provided by Daniels (2008) and Engeström (1987, 2001 and 2008; see Figure 4.2 in Chapter Four). Presentation of the expansive learning cycle was meant to orient participants to the learning journey which we were embarking on. I explained to the participants that the expansive learning cycle holds together the three components of CHAT inquiry: the systems component, the learning component and the developmental component. Through this I wanted participants to appreciate that the expansive learning cycle helps us to construct meaning from the work situation, learn from those meanings and expand the meanings towards action (Dick and Williams, 2004).

Taking this cue from Hill et al. (2007) (as discussed in Section 4.2.3), I saw the need to introduce the stepwise problem solving model in CHAT (Figure 4.3). I emphasised that the model (ibid.) was designed to assist us to move through a more robust problem identification process that accounts not only for visible problems (actions or events), but also to uncover the more invisible activities that may give rise to these problems. This was pertinent, bearing in mind the critical orientation and the curriculum transformation interest of the study. The hope was that, with a more comprehensive understanding of the object, and the inherent contradictions, participants would be able to design new forms of the activity that give rise to specific actions that can be implemented to provide new solutions.

To facilitate conceptualisation of the learning, constructing meanings from situations in an institutional set up and to orientate that learning towards action, I relied on three sets of surfaces for representing the work activity as shown in Figure 4.4 in Chapter Four. I had to explain the purpose of each surface. I explained that we would use the mirror surface to present a summary of the information that came from them during the exploration phase and

that they were at liberty to dispute or seek further clarity on the information. Furthermore, I pointed out that this was a form of member checking or respondent validation (Merriam, 2009), a credibility strategy used in the study (see Section 4.5). I also explained that we were going to use the same surface to share tentative innovative solutions such as research findings and policy issues around the object (gender responsive curriculum practice).

For the surface of „Model and Vision“ I first explained its purpose as explicated in Section 4.4.5.1. I went on to propose using Engeström’s triangular model, but at the same time invited suggestions for any other model. Participants requested elaboration of the model and after that there was consensus in adopting it for our use. We also agreed to adopt the stepwise problem solving model in CHAT, as a model to guide the expansive learning. It was relatively easy for participants to appreciate the use of the „Ideas and Tools“ surface to capture emerging ideas and representations in progress.

Being accepted as a learning partner was an issue that I thought I should not take for granted. Although I had been in contact with the same participants for a period spanning over a year in the exploration phase, it was important that I was trusted and accepted in the expansive learning process. For that reason, I saw it appropriate to highlight that no one had the role of the teacher in the learning journey as we were all learning and that the learning and knowledge generation was meant to happen simultaneously along the way. This was also intended to diffuse the power gradient that could have been there among participants as the teacher education activity system comprised of SMTs teacher educators (lecturers), lecturers in charge of the three divisions (Sciences, Mathematics and Technical subjects) and the head of the whole department (HOD).

It was also necessary to explain to the participants that the study was located within an ESD framework. I elaborated on some of the curriculum initiatives that they had already experienced, for example the incorporation of environmental education into the curriculum through the Secondary Teacher Training Environmental Education Programme, noting that this was conceived and fits well within the ESD framework. In brief I pointed out the objectives, values, principles and thrust of ESD as highlighted in Section 2.2. I also indicated that it was desirable for us as a group to develop a mediation tool to work with in future. There was also need to clarify that gender responsive pedagogy that we were focusing on is only but one of the ESD thrusts in reorienting teacher education.

### 8.2.1.2 (Re)conceptualising the object, analysis of contradictions and developing solutions in groups

It was important to make sure that everyone was clear on the object(ive) of the workshop. To keep the attention of participants focused, I decided to use lead questions or problem solving questions in every session. The problem solving questions acted as the second stimuli in these workshops. This is accordance with Vygotsky (1978) who argued that:

*By using this approach, we do not limit ourselves to the usual method of offering the subjects simple stimuli to which we expect a direct response. Rather, we simultaneously offer a second series of stimuli that have a special function. In this way, we are able to study the process of accomplishing a task by the aid of specific auxiliary means; thus we are also able to discover the inner structure and development of higher psychological processes. (pp.74-75)*

Reconceptualisation of the object is usually done through questioning current practice. To stimulate this I posed the lead question: *Are we doing enough in teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle gender issues in SMTs learning?* Discussion around the question was opened. Soon it became clear that the question had led participants to respond to the level of visible individual actions and events. By and large participants were reiterating what they had said in interview sessions. Claims like “we speak about it, we sensitise them... we always try to make a reference to that, ... we always point it out that they (trainee teachers) should try as much as possible to motivate our girl child out there to join maths/science” characterised the workshop discourse. This helped to clarify and confirm contradictions surfaced and reported in Chapter Seven.

To deepen the discussion on invisible dynamics of the activity systems I used mirroring, making use of one of the surfaces mentioned above. First I presented the summary of the findings from the exploration phase. On the whole, participants identified with them. There was more or less consensus within the group that as teacher educators, they were doing the best they could to equip future SMTs teachers with the required knowledge, skills, values and attitudes to handle gender issues in their own pedagogic practice.

Then I went on to mirror the Zimbabwe National Gender Policy as another auxiliary stimulating object. Box 8.1 shows the extract from the NGP that was mirrored:

**Box 8.1** *Mirror data from the NGP*

1. Incorporate gender issues in all curricula at all levels of education.
2. Eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology.
3. Promote and encourage girls to take on science, mathematics and technology at all levels of education.
4. Introduce gender awareness programmes to pre- and post-training teacher courses.

Participants were then divided into three small groups for a focus group discussion, to discuss whether and/or how as teacher educators they are responding to such policy pronouncements. Participants raised the need to have a lecturer in charge in every group as some of the policy pronouncements require input from management. Participants were reminded that input from Focus Group Discussion was to feed into the problem solving question: *Are we doing enough in teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle gender issues in SMTs learning?* To cover more ground in the short time provided, we agreed that each Focus Group Discussion concentrate on two of the policy statements in Box 8.1. We also agreed that each Focus Group Discussion should discuss policy statement 1, because it was critical to curriculum practice. The distribution consequently was: BFG1 policy statements 1 and 2; BFG2 policy statements 1 and 3; BFG3 policy statements 1 and 4. The purpose of this activity was to make individuals reflect on their practice based on policy expectations.

Groups were given sufficient time to discuss, summarise on flip charts, and report back. I also participated in the discussions moving from one group to the other. At one time I had to remind participants of the stepwise problem solving model of CHAT (Figure 4.3) that we had put up as one of our vision surfaces. The idea was to encourage them to move beyond visible problems (actions or events) and to engage in a more robust problem identification process to uncover the more invisible activities that may give rise to visible problems. Table 8.2 summarises reports from the three groups. The column emerging contradictions represents insights gained from a broader discussion to visualise absences in the current curriculum practice.

**Table 8.2** Summary of group reports and emerging contradictions

Policy statement	Report	Emerging contradictions/absences
Incorporate gender issues in all curricula at all levels of education	<ul style="list-style-type: none"> <li>- encourage trainee teachers to be sensitive</li> <li>- recommend that they encourage girls not to be shy but to be active</li> <li>- use different examples that appeal to both boys and girls</li> </ul>	<p>Misunderstood the concept of “incorporating” ... into the curriculum</p> <p>No evidence of engaging with:</p> <ul style="list-style-type: none"> <li>- sexist bias in resources, content and language</li> <li>- content, teaching methods and classroom dynamics that encompass girls’ background and learning styles</li> <li>- parents informing them about the importance of science to girls</li> <li>-informing learners about women role models</li> <li>- ontology and epistemology of SMTs not considered</li> <li>- de-emphasising sex-role stereotyping that hinder girls’ progress in science</li> </ul>
Eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology	<ul style="list-style-type: none"> <li>- affirmative action at enrolment level</li> <li>- treat girls equal/the same in class</li> <li>- introduce some incentives like bursaries to keep girls in SMTs.</li> <li>- we need to encourage future teachers to consider culture and traditional practices</li> <li>- issues of gender roles should be considered as well</li> </ul>	
Introduce gender awareness programmes to pre- and post-training teacher courses	<ul style="list-style-type: none"> <li>- seeing the national gender policy for the first time</li> <li>- not sure how to translate this into the curriculum practice.</li> <li>- more training needed for teacher educators</li> </ul>	<ul style="list-style-type: none"> <li>- no written gender policy/programme</li> <li>- no institutionalised programme towards gender responsive curriculum practices</li> </ul>
Promote and encourage girls to take on science, mathematics and technology at all levels of education	<ul style="list-style-type: none"> <li>- affirmative action at enrolment level</li> <li>- teachers should encourage girls to participate in sciences as well</li> <li>- teachers should convey the messages to girls that we are all the same there is nothing like subjects for boys and some for girls</li> </ul>	<p>Absence of pedagogical approaches and other curriculum initiatives in this regard to inculcate skills, knowledge and values in future SMTs teachers. No reference made to the relevancy and quality of SMTs.</p>

It emerged from the above Focus Group Discussion reports that teacher educators conceptualise their object (curriculum practices) differently from the way policy would expect them to do. This was evidenced by the absence of practices such as those shown in the last column in their pedagogy. This led to further clarification of primary and secondary contradictions raised in Chapter Seven. The main contradictions emanated from teacher educators lacking tools to conceptualise gender issues in SMTs (primary contradiction) and this negatively affected gender responsive initiatives in their curriculum practice (secondary contradiction).

These contradictions also confirmed that teacher education in this current form was not doing enough to be considered a conversion agent. The evidence showed that teacher educators did not possess the necessary agentic power to take advantage of the enabling social conversion factors such as the National Gender Policy to establish curriculum conditions that provide a

wider capability set (opportunity freedom) to girls in SMTs. The primary contradictions (lack of tools) resulting in secondary contradictions (clash between subject and object) was a revelation of the lack of personal conversion factors in the subjects themselves (teacher educators), that is failing to convert resources (e.g. policy) into capabilities and functions, in view of personal, social (patriarchal) and social environmental factors.

The above exercise showed, however that participants were starting to look critically at their work practices. It also became evident that the National Gender Policy, just like most policy documents does not pronounce what a teacher should do or be, for example to incorporate gender issues in all curricula or to eliminate all forms of discrimination against boys and girls in SMTs. Because of this inadequacy in the stimulating tool, most of the discussions remained at the level of visible events, transacting between the “obvious” problem to an immediately “obvious” solution, without getting more deeply into the contradictions and the underlying mechanisms. A good example for this is the suggestion of affirmative action at enrolment level as a way to eliminate all forms of discrimination against boys and girls in SMTs. While the thinking is worthwhile and has in fact informed practice in most institutions, it is inadequate in that it is a means and cannot be the end in eliminating gender discrimination in SMTs (Unterhalter, 2005). For instance affirmative action on enrolment cannot address the inherent masculinity in institutions and in the ontology and epistemology of SMTs as school disciplines. It became clear to me as an interventionist researcher that this is one area where a mediation tool could be useful. I therefore decided to work towards this in future sessions.

It is important at this point to highlight that within this progress taking place in the change laboratory workshops reported here, there were also some moments of doubt; some individuals expressed views of not wanting to change or not seeing anything wrong in the way they were doing things, noting that they want to teach „science“ and not sociology.

*But guys remember we are here to teach science, mathematics etc. and not sociology*  
**(B1)**

*How does this gender thing come in when I am teaching the periodic table for example?* **(B2)**

*Science is about facts and principles, proven things and I am not sure how this gender issue comes in.* **(B3)**

For me this depicted dissonance or critical conflicts, situations in which people face inner doubts that paralyse them in front of contradictions between motives unsolvable by

participant alone; it is “the response to a situation of impossibility or unintelligibility” (Vasilyuk, 1988 in Sannino, 2008, p.240). Nonetheless, as aspects of contradictions were articulated more and more in several CL sessions, there was a visible shift from being wary to a resolve to doing something about the situation as discussed in the following sections.

With such experiences, there was need to introduce another stimulating tool that made teacher educators further question their practice. As indicated already, I sought to challenge teacher educators to examine aspects of the activity system so that they could identify contradictions integral in their work themselves. The intention was to stimulate learning at the Batesonian expansive learning level iii that is triggered by double binds generated by contradictory demands imposed on the participants by the context (Engeström, 2001). For this purpose I introduced additional mirror data in the form of a summary of research findings from literature that provides some of the reasons for girls’ avoidance of SMTs (see Section 2.4). The idea was to add on to the instrumentality and mediation tools that teacher educators could engage with in a transformation move towards a curriculum that is potentially a gender conversion agent.

Since there is a lot of information in this area, I prepared a handout (see Appendix 5) that I gave to participants to take home. I planned it in such a way that there was a long time between the first session and the next one in which we were to reflect on the mirror data. This was with the hope that participants would have enough time to read and think through the document before the next session. As discussed before, it was also my plan to develop a mediation tool together with teacher educators that could be used to scaffold future SMTs teachers to practise gender responsive pedagogies. I therefore requested them to come up with a checklist that they would recommend for use by their trainee teachers that could ensure that gender issues are taken care of in SMTs.

In the following session I started by reminding participants of our problem solving question: *Are we doing enough in teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle gender issues in SMTs learning?* In view of the contents of the research findings summarised in the handout, some participants suggested that we break the question down into manageable units to better reflect on how teacher education is helping would be teachers to be gender responsive in their practice as pointed to by the research findings. We agreed to have sub questions: (i) what is happening now; (ii)

possible reasons for what is not happening; (iii) what is lacking/what is needed for the not happening to happen (absenting the absence).

As an interventionist researcher, I was excited to have such suggestions from participants. Using a CHAT framework I interpreted the breakdown as follows:

- (i) what is happening/obtaining now; *life state of practice*;
- (ii) possible reasons for what is not happening... *contradictions, need state, double bind*; and
- (iii) what is lacking/what is needed for the not happening to happen (absenting the absence)... *pointing towards modelling solutions*.

I further interpreted this as leading to a deepening of analysis of own practice and eventually to sharper and more articulated questioning. Furthermore, as advanced by Warmington et al. (2005) such mediational settings support participants and researchers to make the current activity visible for interrogation, reshaping and experimentation. I also concluded that the mirrored data supported reflective systemic analysis (ibid.), enabling participants to confront their everyday understanding with the Vygotskian scientific understanding of system relationships, dynamics and the structural contradictions that might point towards new, expanded forms of practice. In other words, this was really an example of „agentive talk“ – expressing a willingness to address the contradictions (Mukute, 2010, p.147).

To cover ground within the workshop time available, participants discussed different research findings extracted from the handout. Each focus group focused on a different theme but all were guided by the problem solving question above. Table 8.3 presents a summary of the session reports.

The „what is needed“ column pointed towards modelling solutions and the concerns raised became part of the mirror data for the following change laboratory session. There were also questions like: “who should translate policy into curriculum doables”? Is it the policy maker or the implementer? Every participant appeared to have this concern and the question was raised in the context of what are referred to as cross-cutting policies, like the National Gender Policy and ESD policies. The general feeling was that such policies may require additional knowledge and skills that some ordinary professionals in certain fields may not possess, but all the same they are required to implement the policy in their pedagogical practice.

**Table 8.3** Summary of reflections on gender issues in the curriculum

What is happening now	Possible reasons	What is needed
<ul style="list-style-type: none"> <li>- visible gender disparities in SMTs</li> <li>- talk about gender disparities in general</li> <li>- no institutionalised pedagogic practice as suggested in literature and as required by the National Gender Policy</li> <li>- not enough to equip future teachers</li> <li>- previous gender responsive pedagogies staff developments generalise and not in such detail and not focused to SMTs</li> </ul>	<ul style="list-style-type: none"> <li>- aware of gender disparity in terms of enrolment figures not aware of the causal mechanisms</li> <li>- lack of tools to translate policy into practice.</li> <li>- not aware of other ways of doing it (scientism influence pedagogical practices).</li> <li>- patriarchal norms influencing practice (see also Section 7.2.1.)</li> </ul>	<ul style="list-style-type: none"> <li>- not to conflate concepts gender parity, equity and equality</li> <li>- an institutionalised response to gender issues in SMTs</li> <li>- mediation tools for gender curriculum practices.</li> </ul>
<ul style="list-style-type: none"> <li>- do not engage with the interface of gender and socio-ecological risk</li> <li>- SMTs teacher educators not equipping future teachers with skills, knowledge and attitude to handle the following:               <ul style="list-style-type: none"> <li>• sexist bias that may be in resources, content and language</li> <li>•gender prejudice</li> <li>• content, teaching methods and classroom dynamics that encompass girls’ background and learning styles</li> <li>• keeping parents informed about importance of science to girls</li> <li>• informing learners about women role models.</li> <li>•de-emphasising sex-role stereotyping that hinder girls’ progress in science</li> </ul> </li> <li>Quality and relevancy of SMTs such as the relationship between SMTs and gendered socio-ecological risk</li> </ul>	<ul style="list-style-type: none"> <li>- teacher educators not aware of policies that can support them to incorporate gender into SMTs as a process of ESD</li> <li>- not aware of other ways of doing it “we teach the way we were taught to do in our professional development”</li> <li>- view that SMTs are not social sciences but pure sciences (scientism)</li> <li>- rigid, well defined and exam driven curriculum</li> </ul>	<ul style="list-style-type: none"> <li>- learn more concerning ESD and curriculum practices</li> <li>- to be assisted to translate policy into curriculum practice.</li> <li>- mediation tools to incorporate issues of equity and socio-ecological risk for quality and relevancy of SMTs</li> </ul>

This concern pushed the unit of analysis into third generation of CHAT as it shifted from curriculum practice of teacher educators to the interaction between the teacher education activity system and various other institutions (activity systems) that share the common object of teacher education. Such an analysis required additional mediation tools and boundary crossing learning processes became important. Using Akkerman and Bakker’s (2011) mechanisms of learning at the boundary, the concern hinged on identification as one of the mechanisms of learning at the boundary: “a process in which previous lines of demarcation between practices are uncertain or destabilised because of feelings of threat or because of increasing similarities or overlap between practices” (p.11). The concern made it evident that teacher educators were becoming certain of their uncertainties in curriculum development.

This was a „cry“ for help, scaffolding, and for boundary objects to facilitate learning across the zone of proximal development (Engeström, 2001), the distance between the present everyday actions of the individuals and the historically new form of the societal practice that can be collectively generated as a solution to the double bind potentially embedded in the everyday actions. However, as a group we decided to shelve the question/concern for the future combined expansive learning workshop with policy makers and Department of Teacher Education representatives. As an interventionist researcher I had to keep this concern in mind as one of the issues to be mirrored in future change laboratories with relevant activity systems.

The other change laboratory session was dedicated to the nexus between teacher education, gender and socio-ecological risk. As mandated by the ESD framework, the goal was to (re)orient curriculum thinking towards establishing a capability set (opportunity freedom) for girls/females in SMTs in view of socio-ecological risk in a Southern Africa context. The change laboratory session was dedicated to the research question: *What capability set (opportunity freedom) is available for girls in SMTs in view of socio-ecological risk in a Southern Africa context?*

To open the discussion I made reference to the participants' experiences with the Secondary Teacher Training Environmental Education Programme (see Section 5.3.4) as a curriculum transformation project. We decided to interrogate the project using gender lenses. The problem solving question was: *Is the Secondary Teacher Training Environmental Education Programme as a curriculum framework designed in a gender responsive way?* I had to remind participants that this (sub)question was not replacing our main problem solving question: *Are we doing enough in teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle gender issues in SMTs learning?*, but rather feeding into it.

Various responses emerged. Most of them pointed to the fact that environmental issues affect everyone regardless of gender. Some even thought as SMTs teacher educators, they were not in a position to address all these issues in their curriculum. This again confirmed the contradictions surfaced in Chapter Seven, starting from primary contradiction (within the subject), lack of artefacts to comprehend curriculum demands, resulting in the clash between subject and object as well as between rules and object (secondary contradictions) and finally

to tertiary contradictions where the teacher activity system clashes with the ESD as an esteemed activity system.

As usual I decided to mirror other stimulating data to deepen the discussion beyond the visible individual actions and events to the invisible system activity as proposed by the stepwise problem solving model of CHAT (Section 4.2.3). To deepen the discussion I used two stimuli reflected in Box 8.2 below and in Figure 2.2. in Section 2.5.

**Box 8.2** *Two aspects of the gender dimension in climate change* (Bäthge, 2010)

- a) Higher vulnerability: women, particularly in developing countries, are more vulnerable than men to the consequences of climate change;
- b) Agents of change: women play different roles in dealing with climate change, whereby women are major actors in several areas of mitigation and adaptation.

Parallel to this box I also mirrored Shiva's (2012) illustration on the relationship between gender inequality and gendered vulnerability, (see Figure 2.2, Section 2.5).

Participants went into focus group discussions to reflect on their curriculum, specifically the section that deals with environmental issues. Each group focused on a specific environmental issue e.g. drought and then did a gender impact analysis using any of the two stimuli above or both. Focus groups had to respond to the following: the impact of the identified environmental issue on men and women and the role played by men and women in mitigation and adaptation. Finally focus groups had to respond to the main problem solving question: *Are we doing enough in teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle such gender related issues in SMTs learning?*

Group reports showed that all the participants were aware of the gender dimension of environmental issues in Zimbabwean society. In all three reports, it was clear that women have a higher vulnerability to all the environmental issues discussed. All the groups also raised in their reports that women had no choice but to come up with alternative ways for mitigation and adaptation. Most examples given had to do with feeding the family as an immediate duty that most women have to face especially in rural areas. Examples such as developing family vegetable gardens, running small poultry projects, and many more were

raised. It also came out clearly that none of the teacher educators had thought of incorporating the gender dimension in their teaching of environmental issues. This confirmed that the Secondary Teacher Training Environmental Education Programme as a curriculum framework was designed and was being implemented in a gender blind manner as also shown in Section 5.3.2

The summative discussion for this session focussed on the quality and relevance of SMTs knowledge that the teacher education curriculum was imparting to future teachers. We interrogated questions on how relevant the science knowledge and technical skills being imparted to teachers are in view of the socio-ecological risks facing the country. There were mixed feelings from the participants. One group FG2 was of the opinion that there was need to reconsider and rethink both the content and the pedagogy used in SMTs. The group raised the following:

*What will be the value of education if it does not talk to the challenges that we face in our lives? If you look around, the kind of challenges we are seeing, for example contaminated water, recent outbreaks of waterborne diseases in this town, these are challenges related to scientific technology, and there is need to look at the social impact of science. Yes we talk about pollution in our disciplines, but we haven't put the gender aspect to that, but as a group we need to address such issues of gender and class as well. (FG2)*

Sannino (2008) describes this as experiencing “the process through which individuals” disposition to act is prepared” (p.244). The other group however still showed signs of inertia. One representative of this group (FG1) said:

*I don't know and I haven't heard of a science curriculum that incorporates all these gender and ecological things, we address ecological issue I know but we have always left the social aspects of gender to social sciences ... yes the Zim-Science<sup>8</sup> tried but it was unpopular, I am not sure, we will see.*

Although there was some sense of doubt in this talk, implicitly there was willingness to act, reflected in the statement “I am not sure, we will see”. The message here seems to be that the discourse producer needed more convincing. My hope then was that further expansive learning would convince such teacher educators, or allow them more opportunity to fully debate their views. Table 8.4 summarises teacher educators’ reflections on gender and socio-

---

<sup>8</sup> A defunct secondary school science curriculum that specifically focused on the Zimbabwean context.

ecological issues as obtaining in the curriculum. These reflections together with those in Table 8.3 formed the basis on which mediation tools were developed.

**Table 8.4** Reflections on gender and social-ecological issues in the curriculum.

<b>Contradiction</b>	<b>Obstacle (cultural-historical context)</b>	<b>Potential (for further expansive learning)</b>	<b>New concept</b>
Socio-ecological issues treated as gender neutral in the curriculum vs ESD curriculum expectations mainstreaming gender to all activities	Patriarchal values; scientism driving pedagogy; non engagement with policies	Few knowledgeable staff members Policy framework (rules) continuous syllabi review (social conversion factors) Reflexivity on relevance and quality of curriculum	Gendered social-ecological risk

With these contradictions I suggested that we develop a tool that could be used as a mediation tool with future SMTs teacher educators in relation to gender and socio-ecological risk. For this we had to rely heavily on the ESD thrust, principles and pedagogic processes. To make it more appealing to the participants I had to emphasise two aspects of quality and relevance of education stressing that education is considered to be of good quality if educational systems are developing learners' cognitive skills, and their values and attitudes in ways that contribute to a wider re-orientation of society towards equity and sustainability (Lotz-Sisitka, 2008a) as discussed in Section 2.2.2.

The tool therefore (Table 8.5) was necessary to assist teacher educators to engage with issues of equity and sustainability in SMTs education. It was designed to assist teacher educators to critically look at the gender dimension of social-ecological risk, with the intention of coming up with appropriate curriculum scientific knowledge that has potential to contribute to gender responsive technologies.

**Table 8.5** Tool to engage with the gendered nature of socio-ecological risk

<b>Social-ecological risk</b>	<b>Gender dimension</b>		<b>Role of SMTs and curriculum relevancy</b>
	Vulnerability	Adaptation/mitigation	
Example: Drought	Low agricultural yield and scarcity of water. Gender reproductive roles - women expected to come up with alternative sources of food and walk long distances to fetch water	Small irrigation usually on basic technical skills and knowledge run mostly by women	- what scientific knowledge and technical skills are required? - adds to the relevance and quality of SMTs - contextualises SMTs knowledge and its applicability

The gender relevance component was meant to align knowledge and skills in SMTs to the socio-ecological needs of a community. The curriculum relevance of this approach was that it had the potential to raise young people's (both girls and boys) interest in SMTs. Reflecting on the perceived „dryness“, decontextualised nature and irrelevance of SMTs especially by girls as reported in the gender and science literature (Section 2.4), such engagement with social and ecological concerns has the potential to raise girls' self-efficacy in SMTs. As reported by MacKay (2010), focusing on projects attractive to females (in this case focusing on science knowledge that has direct bearing on livelihoods and with technical potential to alleviate the burden on women of and also potentially from the socially ascribed feminine roles) has the potential to improve mostly female students' attitudes towards technology as well as their self-efficacy. Secondly, viewing the SMTs curriculum within such lenses has the potential to contextualise SMTs learning for all students. SMTs, whether physics, chemistry or mathematics, taught in such local contexts, relevant to socio-ecological risk are not likely to be perceived by girls or by boys as strongly intellectual and abstract, decontextualised, or distanced from everyday life as reported by Chetcuti and Kioko (2012). Again this is likely to increase the interest of girls in SMTs. Contextualising SMTs in this way does not mean that the intellectual or abstract concept and feature of SMTs would be reduced as argued by Lotz-Sisitka (2008a) as well as Lupele and Lotz-Sisitka (2012).

SMTs , with this basis, has the prospect to be a conversion agent in several ways (see also Section 2.8). Firstly the curriculum will be responsive to environmental factors (socio-ecological risk). To do this the curriculum would need to engage with both negative and positive social and environmental conversion factors. Negative conversion factors would be in the form of e.g. patriarchal norms and values say in gender blind technologies to mitigate ecological risk. Examples of positive conversion factors will be policies for gender equality in education, ESD curriculum principles and many more. Combining this tool and the one discussed below in Table 8.9, the SMTs curriculum can potentially become considerate of the personal conversion factors as well as that pertaining to specific gender needs in learning sciences. In this way, the science teacher education curriculum can potentially be more considerate of the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context, while also developing criticality to engage with the “status quo” of such ascribed roles in society.

Exposing trainee teachers to such curriculum development involves a two pronged approach to enhancing a capability set for females. Firstly an SMTs curriculum of this nature may increase the interest of young girls in the study of sciences as discussed above and also in Section 2.4. Secondly, such a SMTs curriculum has the potential to inculcate into anyone who goes through it (male or female) knowledge that is oriented towards social-ecological sustainability. In other words this gender responsive SMTs curriculum has the potential to teach both males and females social (gender) and ecological relevant science knowledge and technologies, while also raising critical awareness of justice issues in wider society.

### ***8.2.3 Expansive learning with other activity systems***

As shown in the discussion above, the object of study (gender responsive pedagogy in teacher education) trickles beyond the confines of teacher education as an institution, to other activity systems such as the Department of Teacher Education and the Ministry of Higher Education. The whole idea behind this change laboratory was to collaboratively make sense of the object and contribute towards modelling new ways of doing work.

#### ***8.2.3.1 Introducing conceptual tools***

Like in the previous change laboratory, after personal introductions I went on to propose conceptual tools for the workshop. As a starting point, I presented the expansive learning cycle to participants as is provided for by Daniels (2008) and Engeström (1987, 2001 and 2008) as shown in Figure 4.2, Chapter Four. I also reiterated that the expansive learning cycle holds together the three components of CHAT inquiry; the systems component, the learning component and the developmental component (Dick and Williams, 2004). As alluded to in the previous section, the intention was for participants to appreciate that the expansive learning cycle helps us to construct meaning from the work situation, learn from those meanings and expand the meanings towards action (ibid.). Because of the short time available I could not explain the stepwise problem solving model in CHAT (Figure 4.3), but I had to keep it in mind to deepen discussions beyond the visible level whenever needed. I was, however able to explain the uses of the three surfaces (Figure 4.5) as discussed above.

Furthermore I could not hold separate preliminary change laboratories with the two activity systems as earlier envisaged. The reason was that I could not secure time and permission to bring the officials together for the workshops for extended periods. I had to negotiate and maximise the short period available; therefore I had to combine the two activity systems in

one change laboratory. I shared this decision with them (participants) and reflected on the logic of it in the following manner. Firstly, as raised in Chapter Five, these were the two activity systems responsible for tool and rule making. Secondly they had, over the years worked, together through routinised actions, occasionally holding meetings together at the beginning and end of each academic year. Because of that they had a relatively established communicative connection between them, making the boundary between them more permeable.

#### *8.2.3.2 (Re)conceptualising the object and analysis of contradictions*

To introduce this section in the Change Laboratory, I took advantage of participants' individual work profiles as they had emerged from the personal introductions earlier in the workshop. Each one's job specifications had something to do with teacher education. I went on to explain the motive of the gathering which was to look into gender responsiveness of the SMTs teacher education curriculum. As an expansive learning strategy, I thought it would be helpful to start from the known and then move into the tacit, in order to make it explicit. I started by providing mirror data on the obvious gender disaggregated data in SMTs in Zimbabwe and in the region. I also mirrored research findings pointing to: a) lack of gender responsiveness in the pedagogy applied in schools as one major hindrance to improving access, retention and performance of females in SMTs and (b) the fact that though it is now common knowledge that gender imbalances exist in SMTs, teachers of these disciplines are often found to be unaware or unaccepting of the situation and would not naturally feel the need to address them.

With this information mirrored, I immediately launched a problem solving question, adapting the one that was used with the teacher education change laboratory: *Are we doing enough to support teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle gender issues in SMTs learning?*

Various responses came up in the discussion. They included issues such as: "we design policy, they (teacher educators) should implement, we assist them in designing the curriculum ... we facilitate the holding of staff development workshops in teacher training institutions." It was also said that the government of Zimbabwe came up with the policy of affirmative action on enrolment as a response to the calls of Education for All, MDGs, the

Beijing Platform for Action and many other policies that talk to gender equality in education (see Chapter Two).

I discovered that with these utterances, participants were operating at the level of visible problems, raising obvious solutions, the same solutions that have been implemented for years but seemingly with little desired outcome if any at all in terms of “improving girls” participation in SMTs. As an interventionist researcher, my intention was to help people to move through a more robust problem identification process that accounts not only for visible problems (actions or events), but also to uncover the more invisible activities that may give rise to these problems (Hill et al., 2007). To stimulate discussion of this nature, I decided to mirror some of the outcomes from both the exploration and expansive phases with the teacher education activity system. First of all I displayed the National Gender Policy extract shown in Box 8.2. and some of the explanations from the teacher education change laboratory workshops. Next to that I put the ESD framework on reorienting teacher education as spelt out in the Strategy of Education for Sustainable Development in Sub-Saharan Africa as well as from the Southern Africa Development Community Regional Indicative Strategic Development Plan (see Chapter Two). Table 8.6 shows some of the information that was displayed on the mirror surface in this change laboratory. The column “emerging ideas” shows responses/ideas that emerged in this change laboratory and the column for “new concepts/ possible tools” captured new ideas and possible tools that could be used for further learning or influencing new ways of doing work.

**Table 8.6** *Inputs and output of the rule/tool making activity system change laboratory*

<b>Policy doc</b>	<b>Policy pronouncements</b>	<b>What is obtaining in teacher education</b>	<b>Emerging ideas</b>	<b>New concepts/Possible Tools</b>
National gender policy	<p>1. Incorporate gender issues in all curricula at all levels of education.</p> <p>2. Eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology.</p> <p>3. Promote and encourage girls to take on science, mathematics and technology at all levels of education.</p> <p>4. Introduce gender awareness programmes to pre- and post-training teacher courses.</p>	<p>- never heard of such policies</p> <p>- who should translate policy into curriculum doables (<i>I was trained to teach chemistry/physics/mathematics et.c and in my professional course, I was never exposed to cross cutting social issues such as gender</i>).</p>	<p>- some not aware of such policy issues</p> <p>- some clear of the policy but not sure of how to translate them into curriculum practice</p> <p>- few individuals adamant policy interpretation and implementation is the responsibility of teacher educators</p>	<p>- need to learn more</p> <p>- more collaboration needed</p> <p>- prerequisite to engage more with teacher education</p> <p>ESD pedagogic principles could be a good starting point for curriculum development</p>
Strategy of Education for Sustainable Development in Sub-Saharan Africa, SADC RISDP	<p>Sustainable development and the gender question in the country:</p> <p>Low knowledge of SMTs leaves one with lack of information and lack of opportunity for adaptation and mitigation strategies in climate change and its impacts.</p> <p>Adoption of an alternative approach to education that constitutes a challenge to ethics and wisdom in the management of development process by focusing on the constant search for a balance between economic, socio-cultural and environmental imperatives peculiar to Sub-Saharan Africa</p>	<p>- no gender sensitive climate change knowledge;</p> <p>- no gender sensitive technology design</p> <p>- Secondary Teacher Education Environmental Programme implemented in a gender blind manner</p> <p>- SMTs teacher education focusing more on the economic and to some degree on the environmental aspects of development leaving out socio-cultural aspects.</p>	<p>- few haven't considered socio-ecological risk e.g. climate change as gendered</p> <p>- some aware that climate change affects men and women differently especially in low income countries but never considered integration of a gender-sensitive perspective in curriculum.</p> <p>- never thought of engendered human development in curriculum terms</p>	

The time available for this change laboratory could have been extended as there was much to discuss, but given the constraints, I decided to begin focussing on a clearer conception of the ESD framework as data in the exploration phase showed misreading of ESD by some officials (see Section 7.2.2 and Table 8.5 above). I therefore decided to use ESD objectives, values, thrusts, principles and processes as discussed in Section 2.2 to open up discussion on

the ESD framework in a way that participants would appreciate it as a framework that could promote education for sustainability in response to all socio-ecological issues. The representative of the UNESCO desk in the ministry played a prominent role in clarifying issues concerning ESD. Well before this workshop, I had shared with him some of the misconceptions concerning ESD that had emanated from the exploration phase of the study. He therefore attended the change laboratory workshop with a better understanding of the challenges that some of his colleagues were facing in conceptualising ESD. In going through key aspects of ESD, it became apparent to most participants that the framework was not designed to replace or to run parallel to earlier efforts enshrined in the MDGs or Education for All, but instead was intended to help countries make progress towards, and attain the MDGs as well as providing countries with new opportunities to incorporate ESD into education reform efforts. Many questions were raised and discussed, for example:

*What exactly is ESD?... How does it link to traditional efforts under MDGs and Education for All?... is there any space within the ESD framework to fit some of the national challenges and achievements in terms of HIV/AIDS, issues of gender etc?*

The discussion allayed the fear that most officials had that they were seeing ESD as another crosscutting issue that was likely to overburden both learners and educators. Continuous reference to pedagogic processes and principles of ESD helped. The UNESCO desk official kept on emphasising that ESD is a vehicle for countries to achieve all that was laid down in the MDGs and Education for All. He further explained that ESD offers countries more tools for reorienting existing educational programmes to address sustainability.

After some deliberations it became visible that the ESD framework that has been the object of discussion in this change laboratory was shifting to become a tool that could be used in curriculum transformation by these two activity systems. One participant expressed it thus: “so you mean the ESD is there to help us work with MDGs, it does not run parallel to them” (HO1). Another one added: “it is like a pot in which we put all the ingredients of curriculum development and bring all the issues of social, economic and environmental together in curriculum development” (HO3). It remained to be seen in the following change laboratories whether this tool/rule making activity system had actually (re)-conceptualised ESD and would make use of it as a tool for curriculum development.

#### **8.2.4 Expansive learning with all the activity systems**

In the preceding change laboratory sessions, it became evident that teacher educators were facing challenges incorporating gender issues into the curriculum as specified by the National Gender Policy. It also emerged that the tool and rule making activity systems were not providing the necessary support to address the situation. The purpose of this Change Laboratory was to provide a space for all the activity systems to come together and reconceptualise the object. The essence of this was to sow seeds of collective capacity for curriculum transformation and innovations. The idea was to build on what Engeström (2007b) refers to as distributed agency or collective intentionality. The process was meant to facilitate boundary learning across activity systems.

The change laboratory took place over three half days in September 2011. Present in the sessions were representatives from the Department of Teacher Education, Ministry of Higher Education, hierarchically known in education circles as head office. The head office team included the gender focal person and a UNESCO desk official. The teacher education activity system was represented by the senior lecturers of the three SMTs departments (Sciences, Mathematics and Technical subjects). Other teacher educators also attended although they were at liberty to move in and out to attend to their lectures as the sessions were held at their work place and permission to suspend classes could not be granted.

Knowing the organisational culture in the Zimbabwean civil service, power relations were an issue. Having worked in the system myself for eight years, I was aware that the Department of Teacher Education and Head Office were two institutions that are always viewed in their supervisory capacity and are not seen in a collegial role. My challenge as an interventionist researcher was to create an atmosphere of collegiality and to diffuse power relations as far as was possible so as to allow deliberations true to the multi-voicedness principle of CHAT. To tease this out I decided to throw a simple stimulating question: *how often do we come together as institutions working towards the same object of teacher education?* Various answers emerged: “we are always in touch with principals of colleges; we use various means of communication” (D1); “I had a workshop here with some lecturers two weeks ago” (HO2)(gender focal person). However a teacher educator said “we only see Department of Teacher Education and Head Office officials when there is an external examination process going on and HO officials when there is trouble in the college” (B6). Although that was said in a comical manner way, it had some elements of truth in it. The laughter from all the participants helped to ease the atmosphere which became more relaxed as the change

laboratory proceeded. I then went on to explain the purpose of the workshop and to emphasise that we were not seeking right or wrong answers but that the idea was to share and learn from each other.

#### *8.2.4.1 Introducing conceptual tools*

I saw it fit to remind the participants of the conceptual tools used in previous sessions. As a starting point, we revisited the expansive learning cycle as shown in Figure 4.2 Chapter Four. I explained that the exploratory phase that included interviews was meant for the actual-empirical analysis of work practice in terms of gender responsiveness in SMTs teacher education. I further elaborated that the previous change laboratory sessions with different activity systems were conducted to raise critical questioning on current pedagogical practices. I went on to explain the task at hand as two fold (a) to further analyse the systemic and historical causes of such pedagogical practices and (b) modelling a solution, that is construction of new ways of working or engaging with practice.

In addition to the conceptual tools that participants were familiar with, I added the concept of boundary learning and elaborated on the concept of the shared object using Figure 3.6 in Chapter Three. The point was to visualise the object of teacher education as shared by the different activity systems. This is conforming to the CHAT idea that theoretical models function as stimuli for discussing and redesigning practices (Engeström, 2007b).

#### *8.2.4.2 Boundary crossing from questioning to modelling*

My interaction with the activity systems in this case study for more than a year, traversing the two phases of the study, had given me an understanding that two types of boundaries occur with regard to gender and SMTs teacher education. I called these solitude and institutional boundaries after Kerosuo and Engeström (2003). Institutional boundary in this case refers to collaborative relationships between hierarchical levels of the teacher education system as illustrated in Section 5.2.1. The solitude boundary describes inherent practice based sense and meaning making inherent in the individual teacher educator in relation to the curriculum transformation at hand discussed in Chapters Five and Seven. Boundaries in everyday actions occur when a person encounters a problem or dilemma as an expression of those boundaries (Kerosuo, 2001 in Kerosuo and Engeström, 2003). Boundary crossing, which was the main focus of the present change laboratory workshops, was meant to navigate through different languages, registers and cultural issues, as well as local worlds of meaning (Katz and Shotter, 1996 in Kerosuo and Engeström, 2003).

To start the proceedings I used the information that had emerged from previous Change Laboratory sessions as well as some information from the exploration phase of the study. The National Gender Policy remained an appropriate tool to constantly refer to, to stimulate deliberations and to reconceptualise the object. A concern had been raised earlier on in one Change Laboratory session with teacher educators: “who should translate policy into curriculum „doables“?” (Section 8.2.1.2). This concern was raised after teacher educators had faced some challenges with the National Gender Policy requirements. It was therefore worthwhile to revisit the challenges in a boundary learning session, in which other activity systems were represented. To push the analysis further, a stimulus was needed. This came in form of additional items used to unpack or further interrogate the policy statement. Box 8.3 shows the mirrored stimulating tool.

**Box 8.3** *Stimulating questions/points in the Change Laboratory*

**Policy statement:** *Incorporate gender issues in all curricula at all levels of education.*

**Unpacking items:** *What does this mean? How can it be done? Who should do what?*

To assist responses to the items, I reminded participants that they could use the initially agreed upon mediating second stimulus (e.g. the triangle) as an instrument in the design of a new concept or to organise their ideas.

**Table 8.7** *Focus group summaries in the combined Change Laboratory*

<b>Teacher Education Focus Group</b>	<b>Department of Teacher Education and Head Office Focus Group</b>
<ul style="list-style-type: none"> <li>- curriculum interpretation is usually for lecturers but when it comes to drawing from policy some external help may be required</li> <li>- some cross-cutting policy pronouncements may not be accessible to professionals</li> <li>- HO and UNESCO should assist in policy interpretation in order to translate it into curriculum</li> <li>- DTE/HO should extend their supervisory role to seeing to it that relevant policies are interpreted correctly.</li> </ul>	<ul style="list-style-type: none"> <li>-curriculum interpretation is for lecturers (teacher educators) and teachers</li> <li>- for one to be a lecturer he or she should have skills and knowledge to put societal needs into the curriculum</li> <li>-colleges are semi-autonomous to design curriculum for approval by DTE and HO</li> <li>- when the need arises, teacher educators can seek for support from outside</li> <li>- gender focal person can facilitate with staff development funds permitting</li> <li>- DTE play a supervisory role in curriculum review and student assessment</li> </ul>

Participants were divided into focus groups that were purposefully divided into teacher educators as one group, Department of Teacher Education and Head Office as another. This was purposefully done to establish the boundaries and make them visible to all. Participants were given sufficient time to discuss and compile their points on flip charts. Table 8.7 above summarises the reports from the two groups.

The above reports demarcated the boundaries of operation. It became evident that the Department of Teacher Education and Head Office were inclined to maintain their supervisory role and leave policy interpretation and implementation to teacher educators. On the other hand teacher educators were at ease with their role but they felt at times help may be needed to translate policy into curriculum practice. They echoed the same sentiments that they mentioned earlier in their change laboratory session that some policy requirements are a bit divorced from their curriculum expertise and hence there is a need for help. Elements of boundary marking, demarcating and contesting became evident in these focus group reports. It appeared that teacher educators recognise the boundary but are willing to negotiate or contest it, as can be seen by: “yes we understand that we should translate policy into the curriculum practices, but some cross-cutting policy pronouncements are a bit divorced from our expertise so we need help” (Bfg1). Lamont and Molnár (2002) cited in Akkerman and Bakker (2011) raised similar sentiments, noting that boundaries are discussed in a wide variety of social sciences to investigate how markers of difference are created, maintained, or contested at many different levels of institutionalisation and categorisation.

As discussions went on it became apparent that both focus groups had neglected to address two of the unpacking questions: *what does incorporating gender issues in the curricula mean and how can it be done?* (Box 8.3 above). The following session started with these questions. Again work continued in the focus groups. The problem solving question for the Department of Teacher Education/Head Office focus group was: *In your supervisory role (curriculum review and assessment) what would you expect to see that will inform you that gender issues are indeed incorporated into the curricula?* For teacher educators the question was: *What is your understanding of incorporating gender issues into the curriculum and what help may you need from external institutions like Department of Teacher Education and Head Office?* These problem solving items were redesigned with the hope that they would guide participants to move between the past, the present and the future during analysis of problems and development of new solutions or tools for developing model solutions (Daniels, 2008; Engeström, 2008). Furthermore, the purpose of these was to deepen *dialogicality*. Markova

(2003) described dialogicality in a boundary learning context as a Bakhtinian notion, the ontological characteristic of the human mind to conceive, create, and communicate about social realities through mutual engagement of the ego (i.e. self or selves) and others. Furthermore, problem solving items were designed to enhance the multi-voiced process of debate, negotiation and orchestration (Engeström and Sannino, 2010) in the expansive learning. Akkerman and Bakker (2011) added that Bakhtin’s basic line of reasoning was that others or other meanings are required for any cultural category to generate meaning and reveal its depths. Table 8.8 is provides a summary of the group reports.

**Table 8.8** *Outcomes from the two focus groups*

Teacher Education Focus Group	Department of Teacher Education and Head Office Focus Group
<ul style="list-style-type: none"> <li>- first someone should tell us of the existence of a policy (we did not know about the National Gender Policy).</li> <li>- incorporating into a curriculum goes beyond talking about issues to engaging with specific issues. This may need a real curriculum methodological re-orientation.</li> </ul>	<ul style="list-style-type: none"> <li>-s yllabus and examination/assessment items should reflect the issue (gender issues in this case)</li> <li>-we employ people who are competent who should be able to engage with societal issues and translate them into curriculum</li> <li>- we also have the ministry of gender that should see to it that gender issues are incorporated into the curriculum</li> </ul>

As deliberations continued in an open forum, teacher educators insisted “surely someone should inform us of the existence of the policy and it is reasonable for policy makers to come up with some implementing programme” (Bfg1). From this positioning and from the stance taken by Head Office and Department of Teacher Education it appeared that there was a deadlock. To manage this I had to get inspiration from Kerosuo and Engeström, (2003) who talk of the productivity of resistance; “resistance in learning is not an opposing force, but a process of exploring the unknown” (p.348). To further explore the resistance that had emerged especially from the Department of Teacher Education/Head Office focus group I thought of using identification as a mechanism of learning at the boundary. Identification entails a questioning of the core identity of each of the intersecting sites, questioning that leads to renewed insight into what the diverse practices concern (Akkerman and Bakker, 2011). For this purpose we requested the Department of Teacher Education/Head Office to elaborate their role in curriculum development in general. The response from a senior Head Office member was “usually UNESCO gives the guidelines, the framework and to cascade

this down when there is funding we run workshops otherwise the information is disseminated through the meetings with principals”. This response, together with the one given earlier (“we also have the Ministry of Gender that should see to it that gender issues are incorporated into the curriculum”) were quickly captured by teacher educators who thought these statements are addressing their appeal for some help on policy implementation. Deliberations shifted from questioning to suggesting how best to improve the flow of information between policy makers and implementers. As this happened it became clear that the boundary mechanism had shifted from identification to coordination, a situation where individual actors analyse how effective means and procedures are sought allowing diverse practices to cooperate efficiently in distributed work, even in the absence of consensus (Star, 2010). In the expansive learning cycle this is tantamount to designing a model solution. Some of the suggestions that contributed towards a solution of improving the flow of information between policy makers and implementers are shown in Box 8.4.

**Box 8.4** *Towards modelling solution in the BTTC activity system*

- No need for Head Office to seek huge amounts of funds, they can use institutional resources available.
- Head Office can make use of workshops with Heads of Departments from colleges and these can extend the same to their staff
- Principals’ meetings not the best vehicle because of time, and perhaps the capacity of principals to handle pedagogic issues in addition to administrative issues
- Gender focal person to work closely with teacher education and identify areas that are more in need in terms of gender and dedicate time and resources towards those.
- Teacher educators should also be more resourceful and share expertise within them.

These suggestions entail two processes of coordination; enhancing boundary permeability as well as routinisation as boundary learning processes (Akkerman and Bakker, 2011).

Boundary permeability can be improved by reducing problematic discontinuities so that interactions run smoothly (ibid.). As suggested above, absencing or reducing the impact of financial constraints as well as allowing more points of contact between institutions has the potential to enhance boundary permeability to the advantage of SMTs teacher education curriculum development.

Closely related to boundary permeability is routinisation, that is, “finding procedures by means of which coordination is becoming part of automatised or operational practice” (ibid., p.13). Similarly within the suggestions this could be enhanced through multiple contact points and hence more exchanges than before between institutions through principals’ meetings, Heads of Departments workshops and via the gender focal person. Engeström (2008) and Engeström and Sannino (2010) called such emerging modes of collaboration in work settings that move toward co-configuration, „knotworking“. In other words the suggestions in Box 8.4 were aimed at generating a new instrumentality for negotiated knotworking (ibid.).

As participants tried to come up with a model solution which they could work towards, I thought it wise to deepen the discussion beyond the visible disturbances that advocate for obvious solutions, given the persistent findings that revealed engagement with the obvious and visible as reported in Sections 5.3, 6.3 and 7.2. I thought both activity systems needed to be more aware of what they demand to incorporate gender issues into the curriculum. It was clear that the learning that had taken place in these sessions could indeed assist in changing practice, a situation that could potentially result in curriculum transformation. The learning up to this point had been largely horizontal, placing emphasis on actions of bridging, negotiation and exchange across activity systems, or simply what Kerosuo and Engeström, (2003) call collaboration of networks. Nevertheless, I knew that incorporating gender issues could require some vertical learning as well; this involves acquiring what Vygotsky (1978) would term scientific concepts. To deepen discussion on invisible system activity, I had to use an appropriate stimulating tool. I decided to revisit the question of curriculum integration: *what does incorporating gender issues in the curricula mean and how can it be done?* I also decided to mirror various research findings that talk to the incorporation of gender issues in SMTs as discussed in the teacher education activity system (see Table 8.2 and the handout in Appendix 5). The handout was designed to give teacher educators a feel of the research evidence and indicate that there many possible reasons that may contribute to girls’ avoidance of science. Table 8.2 shows teacher educators’ lack of tools to engage with gender and socio-ecological issues in their curriculum.

The idea was to support participants to develop a more holistic understanding of what it means to incorporate an issue into the curriculum, or as Engeström (1999) said to “make disturbances and innovations visible and analysable to practitioners and researchers” (p.68).

The stimulant was designed therefore to make participants realise that the modelled solution had to have more than mere increased boundary permeability. I was quite aware that teacher educators had expressed that they would prefer some scaffolding for them to be able to really incorporate gender issues into the SMTs teacher education curriculum as reflected in Section 8.2.1.2 above. The aim of reintroducing the same stimulant was to encourage further reflection as a boundary learning mechanism between policy planners and policy implementers.

As before, we had two focus groups to deliberate research findings and to try to answer the question. However the two groups were heterogeneous this time. Teacher educators were mixed with Department of Teacher Education and Head Office officials in each group, so that teacher educators could share with Department of Teacher Education and Head Office officials the challenges that they face in implementing the policy pronouncements into the curriculum. Also, this would allow the opportunity for Department of Teacher Education and Head Office officials to make explicit their understanding of the object of curriculum transformation through policy implementation. The drive behind this was to encourage perspective making and perspective taking as reflexive processes in boundary learning. Boland and Tenkasi (1995 in Akkerman and Bakker, 2011) referred to perspective making as making explicit one's understanding and knowledge of a particular issue, while perspective taking involves taking the other into account, in light of a reflexive knowledge of one's own perspective, as described in Section 3.4.5.

Reports showed that participants, especially the Head Office team, had the opportunity to look at themselves through the eyes of others. There was a significant shift in the perception of the object and the whole issue of gender incorporation into the curriculum. Teacher educators made their case clear that some of the curriculum transformation issues that were of a cultural and social nature, were a bit divorced from the Mathematics, the Physics, the IT and the Wood Technology etc. that they had learnt and hence they would require some help to transform the curriculum along those lines. In view of this, one senior member from Head Office summed it up by stating that:

*usually funds are made available to bring in expertise for staff development of teacher educators for such curriculum transformations, but since the country got into economic challenges a few years ago, our donor community pulling out, we as Head Office, have found it difficult to come up with necessary staff development activities, and we have also learnt to keep quiet for political reasons,*

*because we don't want people to keep on blaming the government, ... I had to say this because we really are cornered here, but ordinarily we simply say competent lecturers should understand this and make things work.*

The utterance by a senior member brought to the fore causal mechanisms of the cultural history of practice that created current contradictions. As a group we went on to deliberate the implications of the statement. Reflection continued after this perspective making by a senior member in Head Office. Perspective taking was quite visible among teacher educators who had up to this moment blamed the Department of Teacher Education and Head Office staff for „reluctantly“ supporting the gender agenda in teacher education curriculum. Everyone understood the political climate in the country where government was intolerant of civil servants who may bring its name into disrepute by publicising the shortfalls in its structures. Against this background, one could see evidence of perspective taking. Compassionate statements such as “it’s understandable... now we understand, so amidst this how then can we move forward, what is the best way forward then” emerged with the idea of moving forward. Kerosuo and Engeström (2003) called this a turning point, highlighting that such turning points “mark” the discovering of the joint object of the agents (p.348). As shown in this discussion the turning point was reached after a cluster of discursive disturbances (Engeström and Sannino, 2010) characterised by disagreements, conflicts and at times threats to continuity.

This boundary learning phase could be described as transformative, that is moving towards modelling new ways of practice. Transformation as a boundary mechanism could be seen in two processes witnessed here: confrontation and recognising a shared problem space (Akkerman and Bakker, 2011). Confrontation as a necessary step for transformation entails encountering discontinuities that are not easily surpassed (ibid.). Kerosuo (2004) reasoned that confrontation with important boundaries can be caused by the appearance of a third perspective. In this case the appearance of the political climate into curriculum discussions added another dimension that had to be taken into account if transformation was to occur. There was also evidence of recognising a shared problem space, in direct response to the confrontation. Teacher educators made empathetic suggestions as shown above.

As deliberations continued, the focus turned more and more to how best we can move forward amidst the current circumstance of low funding, a rigid political climate and persistent gender inequality in SMTs. Teacher educators came up with a proposal that they would want to strengthen the gender aspect of the syllabus in the ongoing syllabus review. It was explained

that syllabi are reviewed every five years, and the cycle for the current review was at an advanced stage. It was also revealed that gender has always been a valid component in the education syllabus of each of the SMTs but teacher educators had never treated it as a policy directive because they did not know about the existence of the National Gender Policy. In addition to that, none of the teacher educators had any experience of how to incorporate gender issues into the curriculum, nor could they engage with issues of socio-ecological risk and hence these issues were treated peripherally. One teacher educator summarised: “after this exercise, we have come to learn that gender issues in science is a discourse we can engage with in our education syllabus, this will really transform the way we have been doing things, for this to happen we need the support of others” (B1). The gender focal person also added her weight to this: “we are in touch with a few organisations that can provide staff development for our teacher educators and probably produce teaching materials. When I get to the office, after this I am sure I can mobilise some resources and we can do the syllabus review together”. These extracts show participants’ commitment to new ways of doing work. Sannino (2008, p.240) referred to this as “commissive speech acts”. She further argued that such talk is agentive because it conveys that things are doable and shows an intention to act in specific ways.

There was consensus that there should also be a syllabus review committee comprising of mainly teacher educators, supported by the gender focal person and at least a representative from Head Office and the Department of Teacher Education. The committee was quickly constituted. This confirmed that the change laboratories had resulted in participants moving from relatively insular or individualistic positions toward the position of a collective change agent through formation of new shared tools, rules and divisions of labour as observed by Virkkunen (2006 in Engeström and Sannino, 2010). This was a rather demanding process that brought together more than a single activity system.

For me, this was an example of hybridisation that is when ingredients from different contexts are combined into something new and unfamiliar (ibid.). It was acknowledged that it is the first time that representatives from the Department of Teacher Education and Head Office had committed to participate in the actual syllabus review process. In the past they had always played the role of directing or supervising from above. If this was to materialise, the hybrid result would take the shape of a completely new practice that stands in between established practices (Konkola et al., 2007). In this case it would increase boundary permeability between teacher education, the Department of Teacher Education and Head Office.

Studying farmer learning in Southern Africa and using a critical realist perspective, Mukute and Lotz-Sisitka (2012, p.359) observed that the process of addressing contradictions involved mobilisation of knowledge plurality and “increased the community members” capabilities to negotiate, to make connections with people with political and cultural capital, and to mobilise community resources”. Similarly in this case, expansive learning showed participants moving from individualised positions to a group approach to a problem. This increased the group’s individual, relational, and collective agency (ibid.).

#### *8.2.4.3 More tools for transformation of work*

To consolidate expansive learning within the BTTC case study we agreed to utilise the remaining session to develop mediation tool(s) to support gender and sustainability responsive science teacher education curriculum practices. The exercise was meant to respond to part of the last research question: “what mediation tools can the study develop to support gender responsive science teacher education curriculum practices that expand females” functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context?” The idea of coming up with simple mediation tools as part of expansive learning was to support SMTs teacher educators with instrumentality for curriculum transformation. Kerosuo and Engeström (2003) described instrumentality as the joint use of mediating artefacts, signs and tools in producing an object and motive at work. The aim was not pedagogic tools only, but Engeström (1990) “grasping developmental potentials and dynamics by initiating, supporting and recording qualitative changes in the practical work activity itself” (Avis, 2009, p.156).

The session was attended mostly by teacher educators, the syllabi review committee members were given a special invitation, and they were all present except for the one Head Office representative who had commitments elsewhere. Our point of departure was the gender inclusive checklist that the teacher educators had to extract from a handout that was given in one of the sessions (see Appendix 5). I had also reminded them in the previous session to bring their checklists to this workshop. The checklist was for possible use with their trainee teachers as a way to guarantee that gender issues are taken care of in SMTs.

Only a few checklists were brought forward, as the majority of teacher educators had not prepared any. We decided to work with the few and develop a comprehensive checklist that would capture most of the aspects available in literature as possible reasons for girls”

avoidance of SMTs. In the end we provisionally put together a checklist (see Table 8.9) as a simplified tool that any teacher within the SMTs disciplines could use to improve gender responsive curriculum practices. I explained to the participants that the tool is a mere checklist; there are a number of other necessary curriculum aspects that should accompany the tool. Aspects such as those related to the reason why girls opt out of science more than boys and what gender responsive pedagogies can be used and the „how“ to do it that (teaching methods and methodology) were not reflected in the tool. We therefore decided to design another tool (see Table 8.10) that a teacher educator can use with trainee teachers to address some of these concerns. To stimulate discussions and designing of the tool I used the capability template in Table 3.1. (see also Appendix 4.2). The template, adapted from Unterhalter (2003, p.118) had the potential to reorient curriculum thinking towards gender and sustainability responsiveness as well as enhancing capabilities. To design the tool, teacher educators were given the template as it appears in Table 3.1. They had to discuss in groups and complete the checklist. There was need though to clarify concepts related to capabilities as they are used in the template. Table 8.10 shows the condensed information compiled from the additions provided by teacher educators to the original draft tool.

**Table 8.9** *Simple gender inclusive checklist tool*

Action	Yes	No	Brief description
Check resources (books, handouts etc.) for sexist bias			
Monitor classroom dynamics to ensure that neither boys nor girls monopolise your attention or equipment			
Ensure that physical sciences are not timetabled against biology or other subjects attractive to girls			
Provide science experiences that girls may not have had elsewhere			
Discourage girls to be passive onlookers and encourage them to participate actively in science activities			
Revise subject content to take account of the range of experiences, including girls“ and boys“ interest.			
Revise your teaching methods to take account of both girls“ and boys“ preferred learning styles			
Check the use of the language itself for sexist bias and use a balance of examples of masculine and feminine nature.			
Make SMTs relevant by linking knowledge and practical applications addressing local social-ecological concerns			
Draw the attention of boys and girls to the presence and contributions of women in science and mathematics			
Provide information on careers in science and invite women workers in science and mathematics into the school			
Keep parents informed of the importance of science education for their daughters			

**Table 8.10** *Capability based Tool for gender and sustainability responsiveness in SMTs teacher education curriculum*

Aspects of capabilities (for boys and girls)	Aspect of Education	Expectations on teacher education (what teacher education should prepare trainee teachers for)
Well-being achievement	<ul style="list-style-type: none"> <li>- Accessing, retention and progressing in SMTs</li> <li>- Better career prospect (aspects that are constitutive of one's well-being)</li> </ul>	<ul style="list-style-type: none"> <li>- Facilitate physical access (parity issues-affirmative action,</li> <li>- Enable cognitive access to SMTs gender friendly teaching. Moving from abstract character to contextualising learning.</li> </ul>
Well-being freedom	<p>Conditions to do well in SMTs (freedom from gender stereotypes, discrimination or violence, socio-cultural constraints etc.).</p> <p>Engagement with issues of well-being (e.g. socio-cultural practices that result in low SMTs self-concept for girls.</p> <p>Relevance of SMTs to socio-ecological risk and environmental health issues</p>	<ul style="list-style-type: none"> <li>- Appropriate pedagogies, learning materials and assessment that account for gendered styles of learning.</li> <li>- Content and pedagogies that enhance quality and relevance of SMTs in relation to gender and socio-ecological risk</li> <li>- Engaging with cultural and sustainability issues</li> <li>- Learning environment that values and is appreciative of gendered experiences in SMTs and society more broadly.</li> <li>- Critical of the gendered ontology/epistemology of SMTs, catering for personal, social, environmental conversion factors</li> </ul>
Agency achievement	Success in (valuing and have reason to value) SMTs and SD content and practice	<ul style="list-style-type: none"> <li>- Raising the self-esteem of both girls and boys in SMTs</li> <li>- Participate in SMT related sustainability practices</li> </ul>
Agency freedom	<p>Having conditions to exercise agency (access to information, chance for discussion and evaluation of learning, freedom to make up one's mind without violence or shame) or exclusion.</p> <p>Participate in SMT related sustainability practices.</p>	<ul style="list-style-type: none"> <li>- Critical/democratic pedagogies</li> <li>- ESD pedagogical strategies e.g. role plays and simulations, group discussions, debates, critical incidents, case studies, reflexive accounts, problem based learning, and modelling good practices</li> </ul>

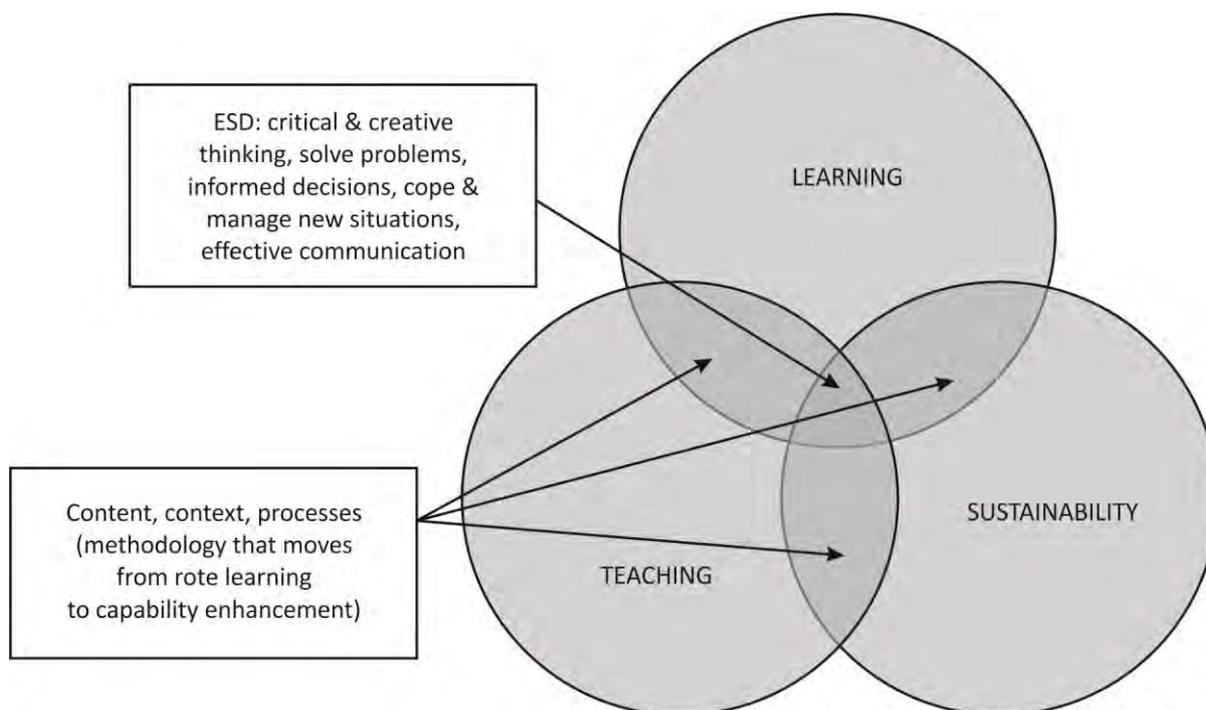
The third tool that we made combined the first tool (Table 8.5) and the gender inclusive checklist. Before we embarked on developing the tool we reflected on the type of education that we thought would be ideal to equip future SMTs teachers with knowledge, skills, attitudes and values in the context of social and ecological risk. To deepen the reflections I used the following extract from a UNESCO document on ESD (UNESCO, 2005b, p.75):

*Education for sustainable development must be an education that aims to help people of all ages better understand the world in which they live, and better act on this understanding ... it needs to address the complexity and interconnectedness of problems such as those characterised by climate change and associated challenges, poverty, environmental degradation, gender inequality, HIV/AIDS, conflicts and many more. It needs to address these topics not only by providing information, but also the abilities needed to understand and use this*

*information, to establish agency and attitudes supporting behaviour that leads to sustainable development.*

As a group we first extracted key ideas from the text describing the type of education being proposed. Participants agreed that the proposed education goes beyond mere understanding of facts and principles, and requires use of information to establish agency and attitudes supporting behaviour that leads to sustainable development. There was a general consensus that usually education in SMTs is restricted to facts and principles, and participants agreed that usually it is geared towards economic development; social or environmental aspects of development are hardly considered.

I also saw the need to focus on the Bernsteinian pedagogic device as discussed in Section 2.9.1 to draw the attention of teacher educators on the distribution, recontextualisation and evaluation rules that govern curriculum knowledge (Scott, 2008). In doing this I was aware of the challenges that teacher educators can face in changing curriculum content. To emphasise the pedagogical aspect of the curriculum, I got support from the ESD concept of equitable access to an education that enhances capability needs to take into account the inter-relatedness of teaching, learning and sustainability (Hoffmann, 2005). The illustration below (Figure 8.2) was mirrored to mediate the thinking and tool development drawing on this ESD concept. We took time discussing the concepts teaching, learning and sustainability and thereafter focussed the discussion to respond to the question: *Which pedagogical processes have the potential to equip future SMTs teachers with skills, knowledge, attitudes and values appropriate for ESD?*



**Figure 8.2** Conceptual framework showing the interrelatedness of learning, teaching and sustainability

The idea was to develop a tool that can be adapted by teacher educators to address multiple values, attitudes and behaviours across SMTs disciplines and topics. Given the time constraints, I reasoned that working with the four pillars of education, later adopted for ESD, as articulated by Hoffmann and Bory-Adams (2005) would allow us to move forward on this question. The pillars were first conceived at the Dakar Framework for Action and they also directly reflect the four principles for achieving sustainable human development enunciated at the Johannesburg World Summit on Sustainable Development in 2002: recognition of the challenge; the indivisibility of human dignity; collective responsibility and constructive partnership; acting with determination (ibid.). Translating these to education will include: learning to know, learning to do, learning to live together and learning to be.

We had a brief deliberation on the meanings of the four pillars. The majority of teacher educators were quite conversant with the environmental language, presumably because of the Secondary Teacher Training Environmental Education Programme that had been working to incorporate environmental issues into teacher education. Each group had a semi completed template based on the four pillars. The task was to develop a working tool by completing the template. The problem solving question was: *How can the SMTs teacher education curriculum support gender and sustainability responsive pedagogies in response to increased*

*socio-ecological risk in a Southern African context?* Focus groups were also given additional tools, such as the ESD pedagogic strategies (see Table 2.1) as well as a summary of ESD principles, values, thrusts and processes (Section 2.2.2).

After group presentations we decided to condense information from various groups into a single tool. It was agreed that the tool should be open ended and easily adaptable for use in various SMTs disciplines and across various topics. After some deliberations we developed the tool in Table 8.11.

**Table 8.11** SMTs tool based on the four pillars of ESD

<b>ESD provision</b>	<b>Sustainable development and capability</b>	<b>SMTs Curriculum input: Content and Processes</b>
Learning to know: Critical thinking in relation to the socio-ecological context	Recognition of the challenge (Practical Reason)  Perception of vulnerabilities and risk	What are the socio-ecological challenges in society?  What is the SMTs knowledge required?  How can SMTs develop critical thinking and cognitive problem-solving skills in view of risk?
Learning to be (Agency)  Sense of purpose	The indivisibility of human dignity (Senses, Imagination and Thought)  Being in the world. Substantive freedoms from restraint  Opportunity freedoms	What are the socio-ecological complexities around the challenges?  Which skills and ways of being are required to cope with the challenges?  How can we engage with gender discrimination in the context of risk?  What are the learning outcomes needed for individuals to exercise agency? Which pedagogical processes can support self-awareness, self esteem, coping, identity building, setting goals etc?
Learning to live together; Interpersonal abilities	Collective responsibility and constructive partnership (Affiliation, Emotions, Other species)	How do challenges affect different people differently? What is the gender dimension of risk? What can SMTs learning offer in terms of knowledge values and processes? What can be done to make SMTs equitably accessible by all? How can gendered discrimination around risk burden be addressed e.g. women and climate change risk in Sub Saharan Africa?
Learning to do (linked to the mastering of tools in order to act) Agency	Taking action, taking control (agency)  Freedom to do things that one has reason to value	Does SMTs equip individuals with tools or patterns of behaviours to act in view of the risk?  How can SMTs make individuals see themselves as non-gendered actors in view of socio-ecological risk?

#### 8.2.4.3 Analysis of expansive learning

In this chapter expansive learning was intended to respond to the research question: *What expansive learning and what mediation tools can the study develop to support gender and sustainability responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context?* In capability terms, expansive learning was designed to guide the curriculum transformation process towards making SMTs teacher education a sustainability conversion agent as described in Section 3.2.2. In this section my aim is to provide a reflexive analysis of the accomplishment of this task. According to Kieser et al. (2001) in Kerosuo and Engeström (2003), the outcomes of organisational learning accumulate in rules and routines that act as a base for future behaviour and learning.

This idea assisted me with a reflexive tool to check on the conceptual artefacts (rules, tools, structures, routines etc.) that the study had developed through the exploratory and expansive phases, to support gender and sustainability responsive SMTs teacher education curriculum practices that expand females' functionings and capabilities in SMTs.

Very tangible in this regard was the formation of the small multi-voiced committee that was selected to incorporate gender issues in the process of reviewing the syllabi for the three divisions specifically focusing on gender. The germ cell of the curriculum transformation process was two layered in this case: the first layer was the formation of a „multi-voiced“ syllabi review committee. This was revolutionary in itself through the involvement of stakeholders from various activity systems which had not worked together before in this manner. Secondly, there was the drafting of a concrete document (syllabus) to guide the curriculum transformation process of incorporating gender issues into the curriculum. These two could be termed boundary objects in terms of boundary crossing learning. As discussed above, these objects had the potential to fulfil a bridging function (Star, 2010) in transforming work.

As discussed in Section 1.6.4 the establishment of a collaborative syllabi review committee was tantamount to ensuring equity from the middle. That is a structure that would translate policy pronouncements into curriculum practices. The outcome was to potentially ensure, equity from below (Section 1.6.4), which would warrant the participation of future teachers in the flows of resources, ideas and values that guarantee gender responsive curriculum

practices in SMTs. In this way the teacher education curriculum would be close to being a „potential conversion agent“ as described in Section 3.2.2. It would be a curriculum that would enable future SMTs teachers to „convert“ retrogressive gendered practices into capabilities for learners through engaging with negative social conversion factors (patriarchal norms and other socio-cultural ills) and take advantage of the enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD and factor them into the curriculum.

However, coming up with boundary crossing objects such as the formation of a heterogeneous syllabi review committee and the drafting of the syllabus are both pertinent to curriculum transformation, the objects are simply a means to an end and not an end by themselves. As an interventionist researcher, I had to hope for crystallization of what had been created. Crystallization takes place by means of developing new routines or procedures that embody what has been created or learned (Akkerman and Bakker, 2011). Crystallisation can occur by means of what Wenger (1998) called reification, that is, to “congeal this experience into „thingness“” (p.58). The reasoning is that it is one thing to create something hybrid at the boundary but quite another to embed it in practice so that it has real significance. For that reason, as an interventionist researcher I felt compelled to stay in touch with the committee, offering moral and conceptual support when needed throughout the syllabi review process. I was granted permission to do this and I had to thank the authorities for the opportunity (as shown in Appendix 2) for the BTTC case study. I was also given verbal permission to keep informal contact with the syllabi review process as reflected in my exit interview with the head of school in Section 8.4. I could not make formal visits to the two sites after the field work because of financial and time constraints. However informal discussions continued through electronic mails.

Formation of instrumentality was another step that was visible in expansive learning and had the potential to support curriculum transformation in this case study. According to Kerosuo and Engeström (2003, p.3), instrumentality is when mediating artefacts, signs and tools, are used jointly in producing an object and motive at work. Formation of instrumentality in this case consisted of jointly using and appropriating instruments across various activity systems concerned with teacher education. For instance engagement with gender and ESD related policies, research findings on gender and SMTs education opened up collective motives for activity, and expanded the object as well as sowed seeds for expanding the boundaries of the

present way of doing work. Furthermore the designing of mediating tools to transform curriculum practices was a remarkable way of coming up with instrumentality. The whole process of formation of instrumentality hinged on dialectics, reflexivity and building agency as discussed in Section 1.8. It was dialectical in the sense that as participants worked on mediation tools (object) as described above, the object worked back on them and impacted on their subjectivity and how in turn, they approached the object and its use in the curriculum. In doing this participants were using knowledge acquired from supporting documents such as policies and reports. Delanty (2005, p.120) saw this as reflexivity “self-transformative capacity involving the use of knowledge to generate further knowledge”.

New tools, knowledge and interactions across various activity systems ensued in the formation of an expanded object of the SMTs teacher education curriculum. Correspondingly the new pattern of activity required and brought about collective and distributed agency (Engeström, 2005). In other words, the expansive learning as experienced in this study consists of a triplet: expanded pattern of activity (working collaboratively across activity systems in curriculum transformation), corresponding theoretical concept (acquisition of knowledge e.g. of gender and sustainability in SMTs, ESD curriculum framework etc.) and new types of agency.

The new instrumentality of collaborative syllabi review theoretically become the outcomes of organisational learning accumulated in rules and routines that act as a base for future behaviour and learning, a germ cell for a new kind of „knotworking“ (Engeström, 2001, p.150) in curriculum development in which no single party has a permanent dominating position and in which no party can evade taking responsibility over the entire curriculum transformation trajectory. The model implies a radical expansion of the object of activity for all the parties, including the expansion of other units of the activity system as well with specific reference to this aspect of curriculum transformation. For instance instead of following the rule that teacher educators review the syllabi with Department of Teacher Education and Head Office playing a supervisory role, the expansive learning created a rule that called for collaboration throughout the process. Because of the collaboration, it would follow that syllabi review tools and artefacts too will be enriched to include policies, gender responsive pedagogy, language, research evidence, gender analytical tools/theories,

quantitative data, social-ecological risk responsiveness and many more that teacher educators could not access previously.

It is however worth noting that while drafting a syllabus document is an initial necessary step in curriculum transformation, it may or may not guarantee the actual transformation. Like in any process of transformation, implementers themselves, in this case teacher educators would need to go through a learning process to interpret and translate the syllabus into pedagogical practice. This process, important as it is, could however not be accommodated within the scope of the study because of time constraints. This being a PhD project, with a specific time frame, there was no room for me to be substantively involved in this phase of curriculum transformation. Nevertheless, another expansive learning phase was planned by the syllabi review committee and it was agreed the process would be spearheaded by the gender focal person who was also prepared to source external expertise whenever necessary. This was another tangible product of expansive learning in the sense of tool creation as discussed above. The process of catalysing local agency for continuing the process started in the expansive learning was also noted by Mukute (2010) in his study. His research found that such “local ownership” of the process further continued to expand learning and agency after formal change laboratory processes in the research were completed.

### **8.3 EXPANSIVE LEARNING IN THE UKZN CASE STUDY**

Chapter Six shows the two activity systems integral to the UKZN case study: the teacher education activity system and the ESD oriented activity system. Chapter Seven further contributed to the construction of these two activity systems through highlighting the contradictions within each activity system and between the two activity systems. As argued in these two chapters, the South African formal school curriculum conspicuously embraces some elements of the ESD framework as discussed in Section 6.2.2. The emergence of this is also described by Lotz-Sisitka (2002; 2011) where she reported on the origins of this in relation to the constitution of South Africa and various programmes.

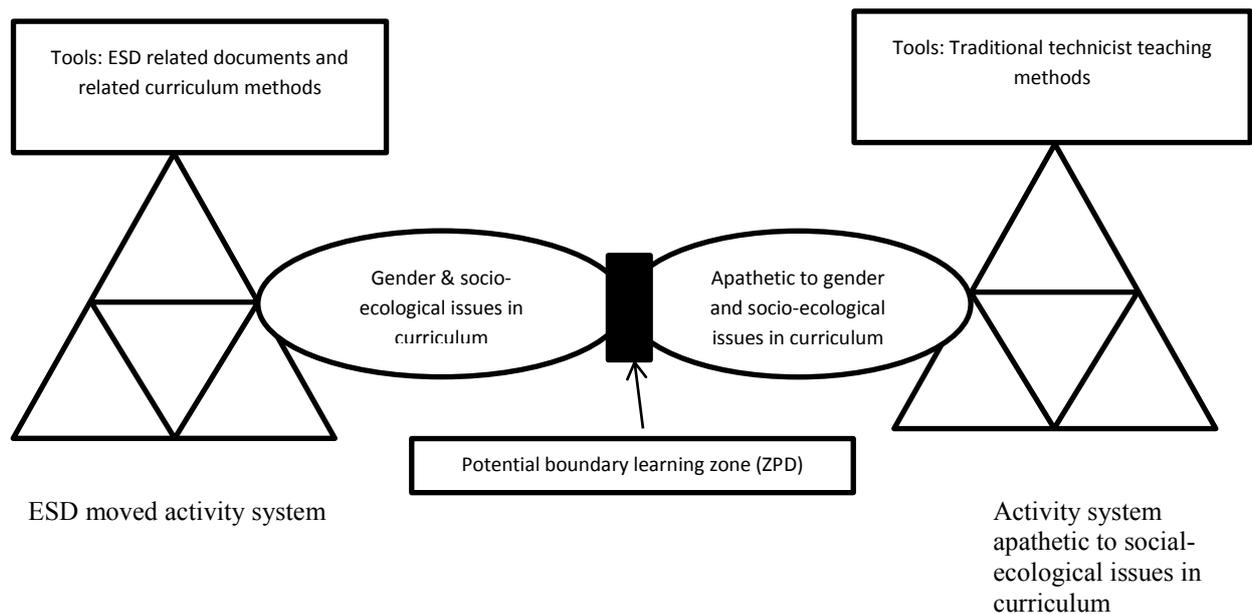
#### ***8.3.1 Activity systems as they emerged from the data***

The major contradictions surfaced in this case study are reported in Table 7.4. Table 8.8 shows representative statements from the two cohorts of teacher educators in this case study. One cohort of teacher educators as shown by the representative statements was apathetic of having both gender and socio-ecological concerns included in their pedagogic practices. To the contrary, the other cohort whom I referred to as „ESD moved“ was to some extent

appreciative of these issues. Teacher educators in this cohort were already, individually though, addressing these issues in their curriculum practices. Figure 8.3 shows the two activity systems constructed from the two cohorts. A point to note is the clash between the objects of the two activity systems.

**Table 8.12** Representative cohorts that make up the two activity systems in the case study

ESD aspect	ESD moved teacher educators	Traditional, instrumentalist teaching
Gender Issues in SMTs	<p><i>My area of interest is gender and science education By excluding gender in science education we are perpetuating gender inequality The access of girls to science in general and to cognitive aspect in particular in my view can be problematic because of the design of science and its philosophical underpinnings The people who have designed it in my view have done so in a way that is cognitively accessible in general to the male mind So I think that gender issues need to be taken into account as integral part of the modules not added superficially There should also be some work that looks at the way girls think and the activities that girls do well and how science education can be delivered to women By keeping silent we are actually perpetuating gender inequality And there is absolute need to incorporate gender in Physical Sciences, because that is the area in which girls and women are really alienated in many ways and at several levels right from primary school to tertiary (UInt2)</i></p>	<p><i>Uuum I don't know, I think you can try to make initiatives but values, practices, change over a long period of time. There is a cultural limitation, constraints, gender division of labour and roles in some cultures. So if the home situation is more equal, when women start to say I am not doing all the laundry, you do your part, then things can change. The more we start making a fuss about it ... the less we make a fuss about it So I haven't focused so much in the gender aspects (UInt1)</i></p>
Socio-ecological risk	<p><i>No collaboration and not widespread either. I have been busy trying to bring in issues of social justice into my own modules, I never thought of talking to colleagues. I don't know how it will be received by other colleagues I wouldn't want to see it peripheral but central, to talk about it, and to engage with it in a meaningful way (UInt4)</i></p>	<p><i>I did my PhD in mathematical modeling of environmental problems but I don't touch it at all in class not at all, nothing not at all. (UInt1)</i></p>
Collaboration	<p><i>I have to say no unfortunately, no collaboration at all, not since we became part of the university, the only time we come together is when we talk about our researches not our teaching(UInt2)</i></p>	



**Figure 8.3** Two activity systems identified after the exploration phase in the UKZN case study

### 8.3.2 Challenges with expansive learning in the case study

My initial plan was to facilitate boundary learning across the two cohorts. As shown in Figure 8.2 I had planned to concentrate boundary learning along the Zone of Proximal Development (ZPD) zone. The idea was to take advantage of where the two objects are clashing and provide educators in this cohort with boundary learning opportunities. However, I could not hold Change Laboratory workshops as I did in the BTTC case study; I would prefer to call them Developmental Work Research-structured meetings after Edwards and Daniels (2012) because of the following reasons. Some participants in this case study simply did not have the time for a series of Change Laboratory workshops as envisaged. The majority of the members cited their work commitments; others also expressed that they doubted whether they would learn anything new. Ethically I had to respect this and be appreciative of the information that they had provided for the explorative phase of the study. As a reflexive researcher who had been in contact with these teacher educators for almost a year, I had to find acceptable means to engage with an expansive process towards curriculum development towards gender and socio-ecological responsiveness. I had to use existing structures to come up with some form of expansive learning towards this goal. As in the case with the BTTC case study, I had to take advantage of the syllabus review process that was underway. Opportunely, there was a

group of teacher educators who agreed to attend the expansive learning Change Laboratory sessions.

### ***8.3.3 Expansive learning with the 'ESD moved' teacher educators***

This small group of teacher educators who responded to my call for expansive learning was largely a homogeneous group in that they were mostly from Life Sciences and Technology. They were all passionate about having gender and environmental concerns integrated in the syllabus. One of them was a key person in terms of the syllabi review process, being the coordinator of the syllabi review committee.

The change laboratory took two morning sessions from 9 a.m. to 12.30. All the participants could not afford to extend these periods due to work pressure. With the limited time allocated, I decided to focus on two aspects that had emerged as the most contentious during the exploration phase, namely the gender blind manner in which teacher educators in this group were incorporating socio-ecological issues into their curriculum, and the need to establish collaboration within the institution (see Sections 6.3.2 and 7.3.2). The second task meant that there was need to build agency in this ESD moved cohort. Although I had these two tasks planned for the change laboratory workshop, I still had to consult with the participants for their approval that these were real issues that they would want to focus the expansive learning process on so as to enhance their curriculum transformation.

Procedurally as a starting point, I presented the expansive learning cycle to participants as I had done with the BTTC case study. I was pleased to note that most of the participants had a fair understanding of the model. This was very suitable given the time constraints. I also quickly directed the discussion to the three components of CHAT inquiry: the systems component, the learning component and the developmental component. Through this, I sought to communicate that the expansive learning cycle helps us to construct meaning from the work situation, learn from those meanings and expand the meanings towards action (Dick and Williams, 2004). To further facilitate conceptualisation of the learning, constructing meanings from situations in an institutional set-up and to orientate that learning towards action, I relied on the three sets of surfaces for representing the work activity as shown in Figure 4.4 in Chapter 4. Again for others it was more a question of recalling what each surface was for, but the majority had seen the model before. Once more it was necessary to elaborate on the purpose of each of the surfaces as explained in Section 8.2.1.1.

### 8.3.3.1 (Re) conceptualisation of socio-ecological risk as gendered

The rationale for focusing on the gendered nature of socio-ecological risk in the expansive learning process was because of the gender blind manner in which this cohort conceptualised socio-ecological risk in their efforts to integrate them in the curriculum as emerged in the exploration phase (see Section 6.3.2). Reconceptualisation of the object is usually done through questioning the current practice using problem solving questions as second stimuli (Engeström, 2001). To start the discussion in this change laboratory workshop I thought of using one learning outcome from the physical sciences within the formal school curriculum: “Evaluate the impact of science on the environment: evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally” (Kelder et al., 2007, p.v). I mirrored this outcome accompanied by the problem solving question: *Are we doing enough in teacher education to equip future teachers with the required knowledge, skills, values and attitudes to handle such learning outcomes?*

With six participants we could only form two focus groups. Two things could be concluded from the feedback reports. Firstly, there was this strong knowledge and passion towards environmental preservation and protection. For example there was a visible consensus with all the participants that future teachers should be able to engage with the negative impact of scientific and technological advancement as we have them today (see Section 1.7.13). The following extracts from focus group discussions show this:

**UFG1:** *We need to go back to what we use to do as a teacher's college that every student gets some environmental literacy. This has to be across the curriculum. We are fighting for the re-introduction of environmental literacy across all disciplines. We are pushing for this in the curriculum review that is underway. Everyone in Biology and Geography is for the idea; we are still to convince others in other disciplines.*

**UFG2:** *The way we see computer literacy is the way we should view environmental literacy. There is space in every discipline for students to carry out some small environmental related projects; even in disciplines like Life Orientation you cannot separate environmental justice from social justice.*

Various examples from pollution, global warming, biodiversity loss and so forth were mentioned as concepts and issues that every teacher should be able to grapple with in response to the call for sustainability and sustainable development in the curriculum. To me this was a welcome development in curriculum thinking and was in sharp contrast to the traditional/instrumentalist way of teaching SMT as shown in Table 8.8.

In the second place, however, there was a visible absence of the gender element in the socio-cultural dimensions in sustainability thinking, shown for example by:

- U1:** *I don't think anyone of us here has treated environmental issues as gendered. I teach about climate change, poverty, drought and so on but I do not remember emphasizing the gender aspect of it.*
- U2:** *It (the gender component) sometimes comes up unknowingly. For example when students present the information they will have gathered for a project, if issues related to gender or class come up then we have a discussion around that, bring attention to ecological risk and vulnerability.*

Drawing on more holistic accounts of ESD discussed in Chapter Two, one can view this as a limited conceptualisation of sustainability. Sustainability to this group was reduced to biophysical sustainability, centring on the human-ecological dimension. By and large participants were reiterating what they had said in interview sessions that they have not specifically looked at environmental issues with a gender eye as shown in the extracts above. This confirmed the secondary contradiction between subject and object, related to lack of tools as discussed in Section 7.3.2. I also got a sense that participants were operating at the level of visible individual actions and events as shown by statements such as:

- U3:** *At times it is difficult to show the students that climate change, drought or pollution affects people (men and women) in a different way. Everyone goes hungry when there is no food for example.*
- U4:** *To be honest I haven't really focused on gender issues in environmental issues. We look at it in general but not in terms of socio-ecological risk as affecting people differently.*

As a reflexive, interventionist researcher I tried to stimulate discussion at a deeper level into the invisible system activity. For this I needed auxiliary mediating tools. I decided to mirror research data that shows that women and men are affected and respond differently to vulnerability such as climate change, based on Shiva (2012)'s relationship between gender inequality and gendered vulnerability and B athge (2010)'s second gender dimension in climate change (see Section 2.2.2). This was accompanied by the problem solving question: *Should we then incorporate environmental and sustainability issues in the SMTs curriculum in a gender neutral way?* My intention in using these stimuli was to encourage reflexivity amongst SMTs teacher educators i.e. considering their own curriculum practices in relation to new knowledge about sustainability. This was to enable discussion that could potentially contribute to transforming teacher education pedagogic practices, in ways that would allow curriculum as a potential conversion agent as described in 3.2.2. Such a curriculum as

indicated earlier, pays attention to negative social conversion factors (patriarchal norms and other socio-cultural ills) as well as to environmental factors and engages them in a critical and transformative manner. Such a curriculum also potentially allows teacher educators to be more aware of existing enabling socio-political factors such as gender/ESD related policies, critical and emancipatory pedagogies, and research on gender and ESD, and to factor them into their curriculum practices.

A vibrant discussion ensued around the problem solving question above, and as it grew in depth and scope, I saw the need to bring in more mediation tools. For example, there were participants who were concerned that teaching sciences is different from teaching social sciences where people debate and almost every argument has a logical perspective. One of them summarised the thinking by saying: “SMTs are factual subjects and the teaching is based on concept development using natural laws and principles, very little discussion” (U3). This opinion attracted a lot of debate, with one group fiercely opposed to the idea arguing that there is no value-free knowledge as reflected in these phrases:

- U1:**     *... but if those scientific facts and principles contribute to environmental destruction then what are we doing?*
- U5:**     *I am sure it is this view of science that has contributed to the environmental problems that we have today, seeing science as divorced from humanity focusing on making wealth.*
- U4:**     *Yes but can't we teach those scientific principles in ways that contribute to sustainability?*

For me this dialogue depicted dissonance or critical conflicts, a situation in which, according to Sannino (2008), individuals face inner doubts that may paralyse them in front of contradictions between motives unsolvable by themselves alone. Such situations create challenges for interventionist researchers. In response I came up with yet another set of stimulating tools. I decided to use the opportunity to showcase the South African curriculum values ESD pedagogical strategies. For this I extracted an assessment standard from the senior phase physical sciences: “evaluate the impact of science on human development”. As part of the assessment descriptor, the curriculum statement specifies that, “learners should be able to research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications” (ibid.). I related this to one of the commonly adopted ESD pedagogic strategies of problem-based learning in which students are expected to investigate a sustainability-

related issue to generate a body of knowledge, develop a vision of alternative actions and potential solutions to the problem, which they use to devise a plan of action, and the action may then be carried out, followed by a period of reflection and evaluation (UNESCO, 2011). I went on to share the rationale as specified in the same document that such a pedagogic process promotes both the conceptual and practical aspects of sustainability literacy.

As discussion progressed, I introduced further mediation tools that I had sourced during the exploratory phase (see Table 4.1) e.g. South Africa's National Gender Policy Framework, the SADC RISDP report, the UNESCO 2011 expert review, the Strategy of ESD in Sub-Saharan Africa (UNESCO, 2006), the 2011 SADC Gender Protocol Barometer (Morna and Jambaya-Nyakujara, 2011) and various SMTs textbooks used in the South Africa's formal school set-up. I did this deliberately in response to the contradiction that had surfaced in the exploration phase that teacher educators do not engage with policies and conventions that shape the curriculum environment in which they work as shown in Section 6.3.2. With more deliberation, I could see a shift in teacher educators' responses, especially those who had shown some resentment, from being wary to being resolved to want to do something about the situation as shown in:

**U3:** *A lot is happening out there that should come into our curriculum, so does it mean that we should always look out for these policies?*

**U5:** *I am telling you, if you don't then your work becomes irrelevant.*

Right at the end of the prescribed time for this change laboratory workshop, one participant raised a point: "looks like the preaching is to the converted, we needed to all be here, the real people who need this aren't here..." (U6). I got a sense of what the statement meant, but of most importance was the realisation that this was an expression of „agentive talk“, that is expressing a willingness to address the contradictions in a system. There was more evidence of agentive talk in the following expressions: "I am sure we need to convince our colleagues especially in syllabi review meetings with such documents" (U1), (referring to the documents that the researcher had brought into the workshop) ... "I am sure it will be easy to convince anyone" (U2). "...Is it not surprising that all this is reflected in the National curriculum statements but we rarely consider that?" (U5).

### 8.3.3.2 *Building agency*

The second and last change laboratory workshop was held the following day. I had to do my homework the night before, reflecting on the proceedings of the completed workshop as well as pulling together mediation tools that could address the contradictions that had surfaced in this case study as reported in Chapters Six and Seven. For instance Critical Discourse Analysis in Chapter Six had surfaced underlying mechanisms such as distant cultural relationships between teacher educators and students resulting in the „them“ and „us“ culture, subsequently causing non-engagement of gender issues in the curriculum (see Sections 6.3.2 and 7.3.2). The issue of students who are weak in content was also raised as reason for treating gender issues as “something at the end-of-the-day” business, although in sharp contrast to the dictates of the National Gender Policy Framework discussed in Section 2.7.2. Poor or non-collegiality in the faculty because of the university structures of working in silos, also emerged as a structural arrangement that prohibited collaborative learning and institutional uptake of socio-ecological issues in the curriculum (Section 6.3.3). With the time limitations in mind, I reasoned that most of these tensions and contradictions could be addressed by looking at ESD pedagogic strategies and learning processes as outlined in Section 2.6.2. I further drew motivation from the fact that the basic contradiction as shown in Section 7.3.1 was the subjects“ lack of pedagogic tools. It was this primary contradiction that culminated into other secondary and tertiary contradictions as elaborated in Section 7.3. My confidence in anchoring the change laboratory workshop around ESD pedagogic strategies and learning processes was further reinforced by the hope that a firm grounding in pedagogic tools would boost the agentic capacity not only for teacher educators to strengthen their engagement with socio-cultural issues in their own practice but also to enhance collaborative learning amongst them in the faculty. Furthermore, it was also possible that a more substantive grounding in the theoretical and practical aspects of ESD, as spelt out in the pedagogic strategies and learning processes, could potentially enrich the syllabus review that was underway. This also allowed me to dedicate the little time available to further respond, together with the participants, to the research question (Section 1.5): “what expansive learning and what mediation tools can the study develop to support gender responsive science teacher education curriculum practices that expand females“ functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context?” I decided to share some of the literature that reports on females“ avoidance of SMTs with research participants. As said before, I was very aware that the „real people who may need this“ were not part of the group, nevertheless the move was meant to boost agentic capabilities especially in view of the curriculum review process.

I started the workshop by briefly sharing the outcome of the exploration phase for this activity system. I used Table 8.8 to show the case picture at a glance. I also felt literature on gender issues in SMTs in general would provide some conceptual tools for this group to engage in the curriculum transformation agenda. I therefore mirrored an abridged version of this, extracted from Appendix 5. Throughout this process I was guided by Sen's conception of agency freedom, as having the freedom (opportunities) to bring about the achievement that one values (Sen, 1992). Walker (2006)'s interpretation of Sen's work on agency was also enlightening at this stage; one's ability to pursue goals that one values and that are important for the life an individual wishes to lead. My thoughts were based on the findings related to the inadequate tools in the exploration phase, and I reasoned that if this cohort of teacher educators was to succeed in the pursuit of its goal of having gender and socio-ecological issues incorporated into the SMTs teacher education curriculum, they needed to have additional conceptual tools. Such conceptual tools could potentially enhance the syllabus review process as well as provide mediation tools for collaborative learning in the faculty. With this mirrored data, the problem solving question was: *What should we do as teacher education to make sure that our curriculum is gender responsive?* Most responses as expected from this „ESD moved“ group were “we are doing our best”. The opinion that the “preaching is being done to the converted” was repeated. A few points were raised about the fact that the subjects with high gender disparities are the Physical Sciences and Mathematics. There was also mention of the fact that in most cases teachers in those disciplines are more indifferent to and „ignorant“ of gender issues. This confirmed a pattern that had emerged in the exploratory phase as it was participants from these disciplines who had either shown a high degree of obliviousness or unresponsiveness to gender and socio-ecological issues in their curriculum practice. For ethical reasons I did not blatantly share this in the workshop, but the absence of the majority of teacher educators from these disciplines was evidence of the earlier point raised about this absence.

In this I saw the opportunity to dwell on the need for intra faculty collaboration as a response to one of the tensions that emerged from the exploration phase. I therefore decided to re-emphasise the problem solving question, in view of the situation: *What should we as teacher education, do to make sure that our curriculum is gender responsive?* Many suggestions came to the fore. As shown in these data extracts, various responses pointed towards the need to learn more and there was also mention of the need to factor such things into the syllabus

that was being reviewed so that perhaps the whole school of education could consider it in the curriculum transformation agenda.

**U2:** *There is real need to learn more around this and this should be discussed in our research meetings as well.*

**U1:** *Interdepartmental collaboration would be very helpful. I am sure we can bring it for further discussion in our departmental and curriculum planning meetings.*

**U4:** *The other forum that can be used is the curriculum review panel and if sustainability becomes part of every syllabus then we can assist each other in curriculum development towards such a common goal.*

Without wasting much time we agreed to have a look at some of the policies and documents that influence pedagogical processes within the ESD framework. This was partly in response to the contradiction that teacher educators do not adequately engage with policies that shape the curriculum. We managed to work in detail with two key documents as mediation tools, namely the Strategy of Education for Sustainable Development in Sub-Saharan Africa (UNESCO, 2006a) and the UNESCO (2011) ESD expert review. First to be mirrored was an extract from the Strategy of Education for Sustainable Development in Sub-Saharan Africa shown in Box 8.5.

**Box 8.5** *Strategy of Education for Sustainable Development in Sub-Saharan Africa: Aims and principles of implementation, objectives and lines of action*

**Aim:** encouraging and supporting Sub-Saharan African States in promoting and developing education as a means of cultural, social, economic and environmental development.

**Principles of implementation:** Holistic approach, Interdisciplinary and integration approaches.

**Objectives and lines of action:** Promoting basic education, strengthening institutional and operational capacities and adapting teaching syllabi, curricula and tools

Adapted from (UNESCO, 2006a, p.14)

Copies of the UNESCO (2006a) document were made available to participants. It emerged later that participants treated the document as providing guiding principles for curriculum transformation. Participants reflected on their practices and many responses emerged. Some of the key issues raised were;

**U3:** *Do we always think of development in such a broad sense including social, economic and environmental as we teach science?*

**U1:** *We need to reconsider the way we work, when we teach science we hardly think of it having anything to do with contributing to gender equality, culture or good governance.*

From these statements I could see reflexivity in the analysis of contradictions. As Delanty (2005) elaborated, reflexivity is not simply reducible to subjectivity or to inter-subjectivity but arises out of the relational encounter of subjectivity with objectivity. In this talk, there is evidence that the teacher educators were able to look into their own practices and talk about the possibility of changing them, and developed the ability to reflect on and talk about the social world. From this I deduced that one's own practice has to do with the primary contradiction within the subject; examining one's own practice involves facing contradictions of a secondary nature in which the subject confronts the object and finally his/her ability for reflecting on and talking about the social world could be viewed as looking at the object beyond the confines of formal schooling. In this case reflexivity is agentic because of the potential (Abercrombie, Hill and Turner, 2006) for self-transformative capacity involving the use of knowledge to generate further knowledge, as shown in the statement "we need to reconsider the way we work" as expressed by participant U1.

As an interventionist researcher, I was inspired by Sannino (2008) to take further these kinds of exchanges to promote the development of agency among the participants who acknowledged that within these self-confrontation interactions "language is not only a means of explicating what one does or sees, but it is a means of action, a way to bring the other to think, to feel and to act" (p.250). Engeström (1999) also acknowledged the two types of talk as pertinent and that they can have a strong impact on the progress of the expansive learning cycle: talk through which a participant commits to something practical and talk through which a participant relates to previous concrete experiences in his or her practice. The first type of agentic talk conveys commitments from the participants, as is reflected in this case: "we need to reconsider the way we work" (U1). This talk developed into a second type of talk as teacher educators progressively grounded their arguments in their concrete teaching experiences, as shown by these examples of agentic talk "when we teach science we hardly think of it having anything to do with contributing to gender equality, culture or good governance" (U1). More and more participants joined the discussion, emphasising the need to strengthen the syllabi in this regard as shown in the extracts above. For me this represented

the expansion of an individual commitment of one teacher educator into a collective commitment of that small group. This gives agentive connotation to the whole discussion.

To build more on this agentive spirit, I decided to use a particular technique to provoke the debates. I reasoned that the commonly adopted ESD pedagogies in the 2011 ESD expert review (UNESCO, 2011) would give participants further pedagogic capital in the syllabus review process. For that reason, I mirrored information as contained in Table 2.2 to show examples of pedagogic strategies and associated learning processes.

After mirroring these conceptual tools, participants broke into two groups to discuss how they could possibly factor such thinking in their own curriculum practices with specific focus on the syllabi review that was currently running. Close to an hour was allocated to the sense making of the mirrored data. Report backs were more suggestive of the need to have an institutional approach as captured in the following statements by the participants:

**Ufg1:** *This is what we need in our syllabus review; there is nothing bad in having a syllabus that recommends pedagogical strategies and possible learning processes as is the case with school curriculum statement; yes this will actually show that we are really preparing future teachers to work within the ESD guidelines.*

**Ufg2:** *These strategies will definitely help teachers in engaging with the curriculum requirements that they struggle with in schools. A teacher will have a variety of strategies for use. It is our duty as teacher education to make these known to future teachers.*

The ESD pedagogical strategies attracted more positive reactions from the majority of participants as indicated by these group reports. They saw the strategies as enriching in curriculum development and resonating with the demands of the formal school curriculum for which they prepare teachers. From this I could see that the expansive learning process had facilitated the discovering of boundary objects amongst the participants, which are artefacts they could use in the syllabus review process. The learning process was not without agony though, that is dissonance or critical conflicts or situations in which people face inner doubts that paralyse them in the face of contradictions between the current and the proposed ways of doing work. Two participants kept on querying the practical applicability of teaching SMTs using ESD pedagogical strategies:

**U3:** *This is exciting and gives teachers a lot of options, but will this be really applicable to say Physics and Technology?*

**U6:** *I am worried about the student who struggle with content, I mean understanding basic concepts in say in Chemistry or Physics. Will some of these strategies apply to such students?*

Their argument was that while the strategies could bring motivation, context, reflexivity, problem based learning and modelling towards socio-ecological solutions, there should still be room for traditional methods to strengthen conceptual development. Discussions around this led to some sort of consensus that the intention was not to eliminate traditional methods of teaching science but to complement them with other newer strategies that enable the learner to go beyond mere acquisition of scientific concepts, and to make SMTs learning meaningful in providing socio-ecological justice.

Unfortunately because of limited time the expansive learning phase had to end on a less than satisfactory note. There were some milestones achieved though in terms of curriculum transformation. For example, I could safely conclude that the mirrored data supported reflective systemic analysis, enabling participants to confront their everyday understanding of work with the Vygotskian scientific understanding of system relationships, dynamics and the structural contradictions that might point towards new, expanded forms of practice. In other words, this was an example of making contradictions visible and analysable to participants. As an interventionist researcher, however, I thought more could be done to augment the curriculum transformation process. Two processes were feasible; an exit interview with the head of school and a prolonged contact with the syllabus review process through a critical friend in research.

#### **8.4 REPORTING ‘INTERVIEW’ WITH THE HEAD OF SCHOOL**

The term „reporting interview“ could best describe the process and the purpose of this engagement with the head of school. The first objective of the interview was to thank her for the opportunity that I had been given to do research with her school. To prepare for this I had to revisit all the correspondence that I had had with her and her staff prior to and during the research process. During the session I noted with appreciation the effort she had made to persuade teacher educators to join my research journey. I also thanked her once more for her personal input into the research through the interview that I had with earlier in the exploration phase of the study.

The second purpose of the interview was to share with her the research outcome. This had a dual purpose. The first was an ethical one and the second was to seek out management concurrence and support for the curriculum transformation journey that had started.

I shared the research outcome. I used Table 8.8 to mediate my understanding of the status of affairs in the school. I went on to elaborate the tensions and contradictions that came out of the exploration phase as well as some headway that had been made in the expansive phase, again making visible some structural tensions that I thought could be eased with the intervention of her office. For the exploration phase, a key issue reported was the non-uptake of socio-ecological issues into the curriculum by a certain group of teacher educators. I went on to share with her the reasons given and some of the underlying mechanisms as discussed in Sections 6.3. As a critical researcher, I thought it was wise to reflect on structural tensions reported in the exploration phase, for example pertaining to teacher educators not focusing anymore on socio-ecological issues since the merging of the Teacher Education College with the university. The idea was to make the head of school visualise the underlying mechanisms that were shaped by this merger that could have led to „reducing“ the quality and relevance of education from this perspective.

I also shared with the head of school my experience in the Developmental Work Research meetings that we had. I reported on the progress made, and the challenges faced. I also discussed with her my intentions of sustaining contact with the syllabi review process that was underway through a critical friend. The permission was granted although I was told that that I could not attend meetings. My input if any had to come through a critical friend, who had the responsibility to present that to the relevant committee.

In response she thanked me for doing research with her school and for opening up issues that may need attention for curriculum development. She also emphasised that she would support curriculum development through the syllabus review process and would try to look into structural tensions that may hinder curriculum development towards gender and sustainability responsiveness. The extract below illustrates this:

*I am glad you managed to do your expansive learning process with some members who are in this panel (syllabus review). I am sure X was there because she is passionate about sustainability across the curriculum and she is the coordinator of the syllabus review process. I have briefings with her now and again and we will see how it goes.*

*Coming to the merger of the teachers' college and the university ... yes it brought a lot of structural changes and shift in orientation. For example this idea of research and publishing papers for promotion can have ripple effects if not managed properly. It means that those lecturers who used to dedicate their time to community engagement projects with students in communities are now finding less and less time for that because they want to publish. I think we need to re-align our research focus with that. It's great when an outsider like you brings to light such things. This will strengthen our argument especially when we engage with those who are oblivious to having socio-ecological issues in their curriculum.*

## **8.5 CONCLUSION**

This chapter reports on the expansive learning processes that took place in the two case studies. Following the Developmental Work Research Model and the boundary learning models, the chapter reports on the journey of research participants to analyse contradictions and model solutions for different ways of doing work. The chapter links to all the previous chapters in that it focussed on data generated in Chapters Five to Seven, using research methods and theoretical frameworks discussed in Chapters Two to Four and responding to the research question highlighted in Chapter One. The chapter concludes that agency among the participants can be enhanced by relational encounters of subjectivity with objectivity (Delanty, 2005). There was evidence in the expansive learning process that teacher educators were able to look into their own practices and talk about the possibility of changing it. Mediation tools were also developed as conceptual and material tools to support the gender responsive science teacher education curriculum practices as a process of ESD.

## **Chapter 9: SYNTHESIS, IMPLICATIONS and RECOMMENDATIONS**

### **9.1 INTRODUCTION**

The chapter provides a synthesis of the study. It is based on my reflections on the study process and on key findings. The chapter starts with an overview of the whole research journey, highlighting the steps taken to respond to the research questions outlined in Section 1.5. I provide reflections on key findings, and raise implications for teacher education curriculum development. Recommendations based on research findings and experiences are provided at the end of the chapter.

## **9.2 OVERVIEW OF STUDY**

### ***9.2.1 Research aim and purpose***

The aim of the study was to explore and expand capabilities, sustainability and gender justice in teacher education SMTs curriculum practices in two teacher education institutions in Zimbabwe and South Africa. The purpose was to contribute towards social justice through curriculum transformation. To accomplish this aim, the study sought to respond to the following research questions as outlined in Section 1.5:

- i. What is the level of gender and sustainability responsiveness of SMTs teacher educators?
- ii. What are the underlying mechanisms that affect (promote or constraint) gender and sustainability responsive curriculum practices in SMTs teacher education?
- iii. What capability set (opportunity freedom) is available for girls and boys in SMTs in general and in view of socio-ecological risk in a Southern Africa context?
- iv. What expansive learning and what mediation tools can the study develop to support gender and sustainability responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context?

As implied in the aim, and as outlined in the study design, the study had two phases: exploration and expansive. The former covered research questions i-iii, while the latter was guided by the last research question (see Figure 4.1 in Section 4.1).

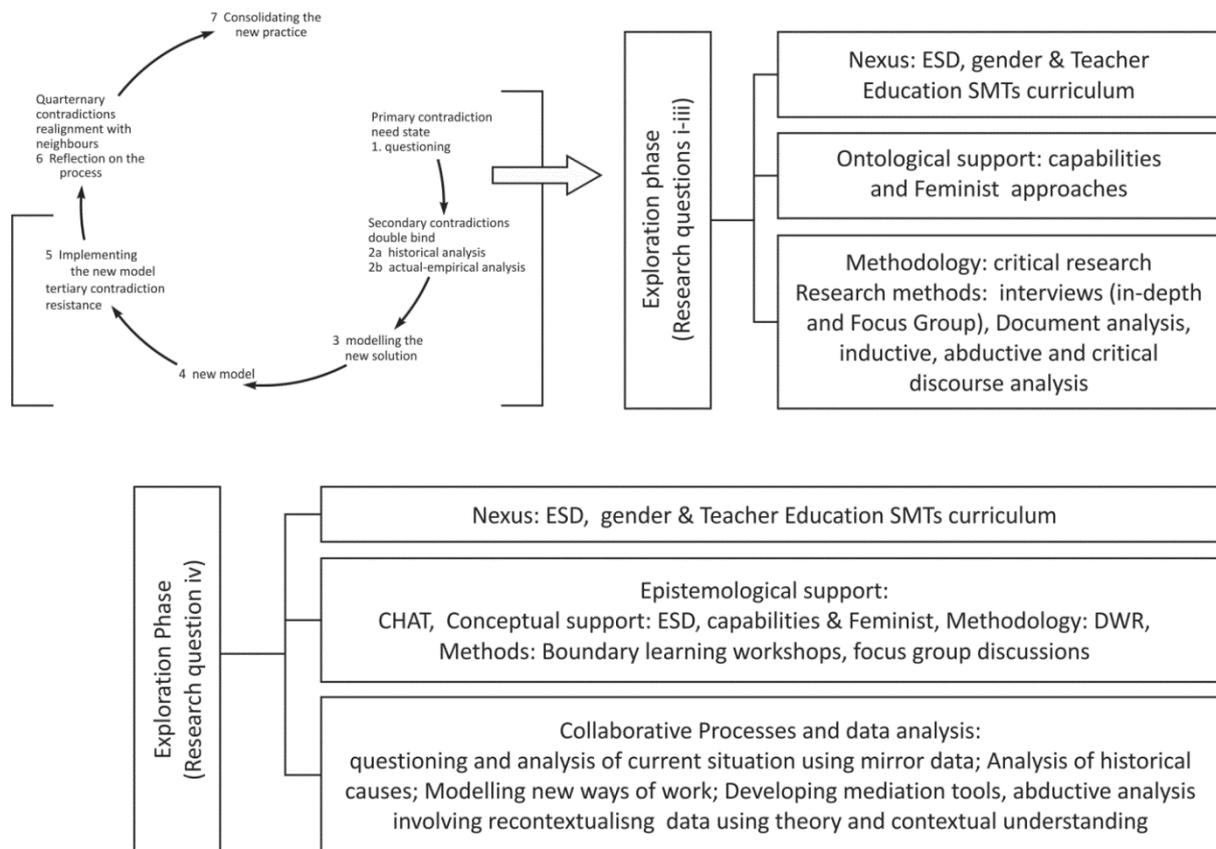
### ***9.2.2 Conceptual framing and location of study***

As mentioned above, this study sought to contribute towards social justice and sustainability through teacher education curriculum transformation. It was therefore necessary to locate the study within ESD developments and ESD discourse and to position ESD as an advanced activity system in the study. Figure 2.3 in Chapter Two illustrates the location of the study at the nexus of ESD, gender and SMTs curriculum. The nexus between ESD, gender and SMTs curriculum facilitated an analysis of issues pertaining to quality and relevance of SMTs teacher education curriculum from a socio-cultural and social-ecological contextual perspective. As discussed in Chapter Two, quality and relevance are measured through how educational systems are developing learners' cognitive skills, and through values and attitudinal development that contribute to a wider re-orientation of society towards equity and sustainability. It is the latter aspects of gender quality and relevance that this study concentrated on.

Feminist and capability approaches provided lenses to explore gender and sustainability responsiveness in SMTs teacher education curriculum practices and helped to scrutinise underlying mechanisms involved. The nexus between ESD, gender and SMTs further facilitated an understanding of the extent to which and the manner in which the SMTs teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context.

The expansive learning phase processes and interactions reported on in Chapter Eight sought to advance a curriculum with a socially just and more sustainable purpose focusing on gender responsive pedagogies. Again, guided by gender theoretical lenses and the ESD framework, (re)conceptualisation of SMTs teacher education curriculum practices as an object, sought to enhance quality and relevance by making the curriculum in the two case studies more inclusive (involving people-people-environment relations). This involved giving attention to the development of SMTs teacher educators' agency and relational agency through critical engagement with gender and SMTs research as well as socio-ecological vulnerability knowledge in Southern Africa as discussed in Chapters Two and Three. As discussed in chapters Six to Eight, the ESD lens enabled consideration of various activity systems at play in SMTs teacher education, as well as consideration of the embeddedness of issues providing for a wider view of SMTs education in the two country contexts.

CHAT provided the epistemological landscape for the whole study. Not only did it offer the tools for expansive learning as explained above, but the entire study was guided by Developmental Work Research, a form of applied CHAT as explained Section 4.2.3. Figure 9.1 below further illustrates this. As shown in the illustration, the exploration phase focused on the need state of the two case studies. The goal at this stage was, as Engeström (1987) said, to describe the need, in terms of a recurring set of problems that are expressions of a historically formed, relatively persistent, critical internal contradiction of the activity in question. As explained before, that focus was on the ESD, gender and SMTs teacher education nexus. Data was generated using in-depth interviews, focus group interviews, document analysis, and was analysed using inductive and abductive modes of inference and critical discourse analysis as also explained in Chapter Four.



**Figure 9.1** Illustration of the Developmental Work Research holding the two phases of the study.

Figure 9.1 shows the extent of the expansive phase. As explained in Chapter Eight, the expansive learning phase went through the three kinds of analysis (Miettinen, 2009): object historical, theory historical and actual empirical, again focusing on the ESD, gender and SMTs teacher education nexus using the tools and processed summarised in Figure 9.1. The need state analysis was done using the data generating methods mentioned above.

### **9.3 KEY FINDINGS OF THE STUDY**

*As highlighted in Chapter Four, I studied two different cases independently without any intention of undertaking comparisons between them. The intention was rather obtain a deeper understanding of prevailing gender and sustainability issues in teacher education SMTs curriculum practices in the two cases so as to influence change through expansive learning.*

#### **9.3.1 Key findings in the exploration phase**

The exploration phase in both case studies sought to understand the status of the teacher education SMTs as a potential conversion agent as illustrated in Figure 2.3. This was done through examining the level of gender and sustainability responsiveness of SMTs teacher educators and gauging the extent to which their curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context with specific reference to the two case contexts. Results show that most teacher educators in the two cases were aware of gender inequalities in SMTs as it pertains to parity. One could say that the majority of teacher educators in the two samples had some basic levels of gender sensitivity, meaning that they had ability to perceive existing gender inequalities as it applies to gender disaggregated data especially when it comes to enrolment and retention.

However there was no evidence of systematic engagement with gender issues or gendered social-ecological issues in the curriculum in both case studies. That is SMTs teacher educators could not show extensive evidence of responding to gender issues in their curriculum practice. There was no coordinated or institutionalised pedagogic device in place aimed at equipping future teachers with knowledge, skills, attitudes and values to handle gender issues in the curriculum. Analysis showed that SMTs teacher educators' curriculum practices were largely gender neutral. This pedagogical tension was visible in both of the case studies. This tension had implications for the quality and relevance of the SMTs curriculum and as well as for engaging with social-ecological sustainability in curriculum and society as discussed in Chapters Five, Six and Seven and further summarised in Figure 9.2 below.

On the other hand, environmental issues, in cases where they were incorporated into the curriculum, were incorporated in a gender blind or gender neutral manner. Ecological concerns were treated as if they were not gendered both in their impact and in their mitigation

and adaptation. Drawing on Downs (2010)'s philosophy underpinning sustainability as it applies to education, that education should lead to the creation of harmony and balance in our relationship with the environment, as well as in our social and economic relationships, the pedagogy in the two case studies was generally not sustainability responsive, in terms of it not being focused on real socio-ecological risk, not being community oriented from a gendered perspective, not being values-centred from a social justice perspective and lacking strong future sustainability perspectives in a southern African context where such issues are highly gendered in contrast to the expectations of the ESD driven curriculum. This was evidenced by some claims of SMTs teacher educators such as:

- Bint1:** *When we teach science we teach science, and I do not see sex stereotyping there.*
- UInt1:** *I don't touch it (environmental issues) at all in class not at all, nothing, not at all. It is too far away ... outside standard math.*
- Bint6:** *As I said science content is very factual and is given, does not have much room for interest (of learners).*

There was however a category of SMTs teacher educators, especially in the UKZN case study with appreciable levels of gender awareness. They showed evidence of going beyond mere ability to perceive existing gender inequalities, to articulate socio-cultural mechanisms that constrain gender equality in SMTs education as shown in Table 8.8, Section 8.3.1. Despite this, they were struggling to be gender responsive in their curriculum practices. As shown in Chapter Six, they lacked the necessary tools for gender responsive pedagogies. As a result, their efforts to bring socio-ecological issues into the curriculum were also being undertaken in a gender blind manner. This was also due to a largely biophysical orientation to environmental concerns as shown Section 6.3.3

Chapter Seven was devoted to surfacing contradictions in the two case studies. As shown in Figure 9.1 primary contradictions were surfaced to examine need state of the activity systems and secondary contradictions to the second phase (double bind). Engeström (1987) defined primary contradictions as those that occur when activity participants encounter more than one value system attached to an element within an activity that brings about conflict (see Figure 4.2, Section 4.2.3). As Miettinen (2009) said, the other latter types of contradictions may be regarded as developmental forms of the primary contradiction. Engeström (2005b) writes that primary contradiction "evolves and takes the form of specific secondary contradictions as the activity system interacts with other activity systems" (p.181). It emerged that in both cases

that primary contradictions within an element of the activity system, e.g. lack of ESD pedagogical tools in the subject, evolve into secondary contradictions a clash between two elements of the activity system such as subject and object. This further caused a clash between the object of the activity system with that of the esteemed ESD activity system pushing the unit of analysis into third generation CHAT.

Abductive and Critical Discourse Analyses were used in Chapters Five and Six for actual empirical and historical surfacing of contradictions, to unearth structural and conceptual mechanisms constraining gender and ESD responsive curriculum practices. Some of the constraints were of a socio-political nature, such as cultural differences between students and teacher educators, patriarchal ideology and hegemony, as well as other interfering binaries such as race and class. Other constraints were seemingly of a curriculum nature, though embedded in the socio-cultural and political nexus. Constraints such as a rigid and content heavy curriculum, coupled with students who come into the system with inadequate content knowledge were reported. Curriculum related constraints also showed tensions embedded in the philosophy informing pedagogy namely scientism, instrumentalist and functionalist tenets. All these led to the clash between current pedagogical practices with those expected by ESD curriculum practices as discussed in Chapters Seven and Eight.

### ***9.3.2 Findings in the expansive phase***

The research task in the expansive phase was to respond to the last research question: *What expansive learning and what mediation tools can the study develop to support gender and sustainability responsive science teacher education curriculum practices that expand females' functionings and capabilities in SMTs in general and in response to increased socio-ecological risk in a Southern African context?*

As reported in Chapter Eight, my task as an interventionist researcher was to facilitate teacher educators to visualise contradictions that relate to gender and sustainability issues in their curriculum practices and engage them in analyses of the present and possible ways of doing work. As explained before, CHAT provided the material and conceptual tools to enhance my interventionist role. For example, the provision of the three surfaces in Figure 4.5 depicting the workshop layout made it easy to show mirror data, arrange emerging ideas and share conceptual tools in the process of analysing and redesigning practice. As shown in Figure 9.2, Developmental Work Research, a form of applied CHAT was also helpful in holding the

theoretical and methodological elements together that I used in the exploration and expansive phase.

There are critical theoretical thrusts of CHAT that I learned, worked with and learned more about in the process of working with them. These thrusts include: using knowledge to create new knowledge; learning is conterminous with the creation of new forms of activity; activities are learned as they are created; learning that which is not yet there.

In the process of challenging SMTs teacher educators to appropriate and use new conceptual tools to analyse and redesign their own practice, I found these thrusts very useful. For instance, I had to use their own knowledge of gender parity in SMTs as well as their own experiences of the gendered nature of social-ecological risk in their societies. Then, using a problem solving question I invited them to take part in the analyses of their curriculum practices in view of such complexity. In addition, using information from policies e.g. national gender policies, ESD, research findings, syllabi and many more, enabled collaborative learning of that which was not yet there. The learning that took place gave rise to the creation of new forms of activity. A typical example in the BTTC case study was the creation of a „multi-voiced“ syllabi review committee. As Puonti (2004, pp. 52-53) says “... knowledge is not about putting theory into practice but about the transmission and transformation of practices”.

In the expansive phase of the study, I also experienced that taking participants out of their work to attend change laboratory sessions was not always easy, especially at the initial stage of the phase. Participants always wanted to know what new things they would learn, how this would affect their work and how it is likely to help them with challenges they face both as individuals and as institutions. During the course of my engagement with participants, I learned that using well thought-out tools like policies and frameworks can make it possible to move people from their offices to the workshop and into the expansive learning process. For example, in the case of the BTTC case study, it became fairly easy to invite senior ministry officials after mentioning that the workshop would discuss, among other issues, possible ways of working with the National Gender Policy and the Strategy of Education for Sustainable Development in Sub-Saharan Africa.

There were also „frustrating“ moments in the expansive learning journey. As discussed in Section 8.3, about half the „targeted“ group in the UKZN case study could not attend the change laboratory sessions, citing various reasons. Ethically, I had to accept their position

and thanked them for their valuable contribution in the exploration phase. Reflecting on this, I considered various reasons that could have led to that situation. However, I decided to slightly adjust the focus of the workshops to suit the new situation as discussed in Chapter Eight.

Throughout the expansive learning phase I worked with the concepts of boundary-crossing and boundary objects. These offered a means of conceptualising the ways in which collaboration between participants from different institutions or disciplines generate new professional practices. As discussed in Chapter Eight, the conceptual tools associated with boundary learning, such as identification, coordination, reflection and transformation, from Akkerman and Bakker (2011) helped me to promote and trace new knowledge creation, learning for the creation of new forms of activity, in which activities are learned as they are created (Engeström, 1999). For example in the UKZN case, the following expressions that came out of a learning activity involving mediation tools from the ESD framework resulted in perspective making:

**Ufg1:** *This is what we need in our syllabus review;... this will actually show that we are really preparing future teachers to work within the ESD guidelines.*

**Ufg2:** *These strategies will definitely help teachers in engaging with the curriculum requirements that they struggle with in schools. A teacher will have a variety of strategies for use. It is our duty as teacher education to make these known to future teachers.*

For the BTTC case study, the expansive learning phase involved boundary learning processes of identification, coordination, reflection and transformation as reported in Chapter Eight. Using Unterhalter (2009)'s framing of equity (Section 1.7.3), the expansive learning processes had the potential to strengthen equity from the middle. Revelations made by some participants in some of the change laboratory workshops, after perspective making and perspective taking such as:

**HO1:** *...so you mean the ESD is there to help us work with MDGs, it does not run parallel to them.*

**B1:** *After this exercise, we have come to learn that gender issues in science is a discourse we can engage with in our education syllabus, this will really transform the way we have been doing things, for this to happen we need the support of others...*

were promising to the movement of ideas, time, money, skills, organisation or artefacts that may facilitate gender and sustainability responsive curriculum practices in SMTs teacher education in the case study.

The expansive learning phase also provided space for collaboration among people who do not normally work together. This was visible in the BTTC case study where supervisors and their „subordinates“ were able to share tensions that affect work. The space also provided room to analyse the “invisible or implicit mediational properties of institutional structures” (Daniels, 2010, p.381) that act in a rule-like manner against the implementation of the ESD related policies in teacher education curriculum. The pronouncements by the senior member of the Head Office in Section 8.2.4.2 provide evidence of this:

*... as Head Office, we have found it difficult to come up with necessary staff development activities, and we have also learnt to keep quiet for political reasons, because we don't want people to keep on blaming the government, ... I had to say this because we really are cornered here, but ordinarily we simply say competent lecturers should understand this and make things work.*

#### **9.4 IMPLICATIONS OF FINDINGS FOR SMTs CURRICULUM DEVELOPMENT**

The findings summarised above have numerous implications for SMTs teacher education curriculum development. Two categories of implications can be drawn out: the policy-practice gap and quality and relevance of education.

##### **9.4.1 Policy-practice gap**

Unterhalter (2009)'s conception of gender equity (Section 1.7.3) provided theoretical lenses to analyse the policy-practice gap established by the study in the two cases. Chapter Two discusses many conventions and declarations that Zimbabwe and South Africa, like most of the SADC countries, are signatories to. It further elaborates on how the two countries made strides in trying to meet international, regional and national curriculum requirements towards gender equality especially through international drivers such as MDGs, Education for All and Beijing Platform for Action. For instance, the two countries developed their own national gender policies, drawing from these international drivers to guide development including curriculum transformation. Judging from the UN country reports discussed in the same chapters, ESD is also widely accepted by policy planners as a guiding framework for curriculum development in the two countries. All this ensures equity from above: laws about fair access and participation which could expand a capability set across profound differences of gender, class and caste (Unterhalter, 2009).

Research findings, however, show that curriculum development in the two case studies does not fully accord with policy expectations. Policy planners and curriculum planners are

working in isolation as was clearly evidenced in the BTTC case study. The majority of teacher educators in both case studies had not heard of the policy, five years following its pronouncement. The policy-practice gap is also compounded by the misreading or misinterpretation of international and national policies. A good example of this is the suggestion by teacher educators of affirmative action at enrolment level as a way to eliminate all forms of discrimination against boys and girls in SMTs. I interpreted this as misreading of Goal 3 of the MDGs which states that it is necessary to 'promote gender equality and empower women'. Commentators such as Aikman, Unterhalter and Challender (2005), Unterhalter (2005), Unterhalter and North (2011) raise concerns that the wider goal of gender equality in political, economic, social and cultural relations is narrowly interpreted in a limited form as equal numbers e.g. of boys and girls in formal schooling.

While the strategy of affirmative action is worthwhile and has in fact informed practice in most institutions, it falls short in that it is a means and cannot be the end to eliminating gender discrimination in SMTs, as was found to be the case in both case studies. For instance affirmative action on enrolment cannot address the inherent masculinity in institutions and in the ontology and epistemology of SMTs as school disciplines. Subrahmanian (2005) advised that reaching parity in enrolment is necessary, but not sufficient, for achieving equality and should be considered a first stage measure of progress towards gender equality in education.

Misunderstanding of ESD as a framework was another factor that emerged as potentially contributing to the widening of the policy-practice gap. It emerged that some senior officials who are in positions of interpretation and initiating policy implementation misunderstood ESD as another cross-cutting issue that was likely to add congestion to the already crowded curriculum. This misunderstanding meant policy planners and implementers could not take advantage of the ESD principles, thrust, pedagogic strategies and values not only to help their countries make progress towards, and attain the MDGs, but also to add relevance and quality to their education systems.

Such a set-up in institutions work against the establishment of equity from the middle, that is establishment of structures that facilitate movement of ideas, time, money, skill, organisation or artefacts (Unterhalter, 2009) that guarantee gender and sustainability responsiveness in SMTs teacher education.

The philosophy informing the education system also emerged as contributory to the policy practice gap. For instance, an education system that is influenced by an instrumentalist view,

focusing solely on enhancing economic growth is not compatible with ESD principles that focuses on socio-ecological sustainability and which requires engagement with the relations between society, economy and environmental sustainability. It emerged in the study that the education systems of the two countries, associated with the two cases investigated reflect some tenets of meritocracy, functionalism and instrumentalism and as such, incorporating socio-ecological sustainability issues has remained peripheral, especially so from a gender perspective.

Working in silos and lack of collaboration within an institution and between institutions was found to be another contributory factor that hinders translation of policy into practice. It emerged that policy makers come up with policy with curriculum implications but without the necessary structures in place to support policy implementation, another symptom of lack of equity from the middle. At the institutional level, there was evidence of lack of collaboration between departments, especially in the UKZN case study. The implication is that curriculum development or part of it remains detached from policy, and silos reduce the possibilities of dialogue and knowledge exchange, and maintain the status quo.

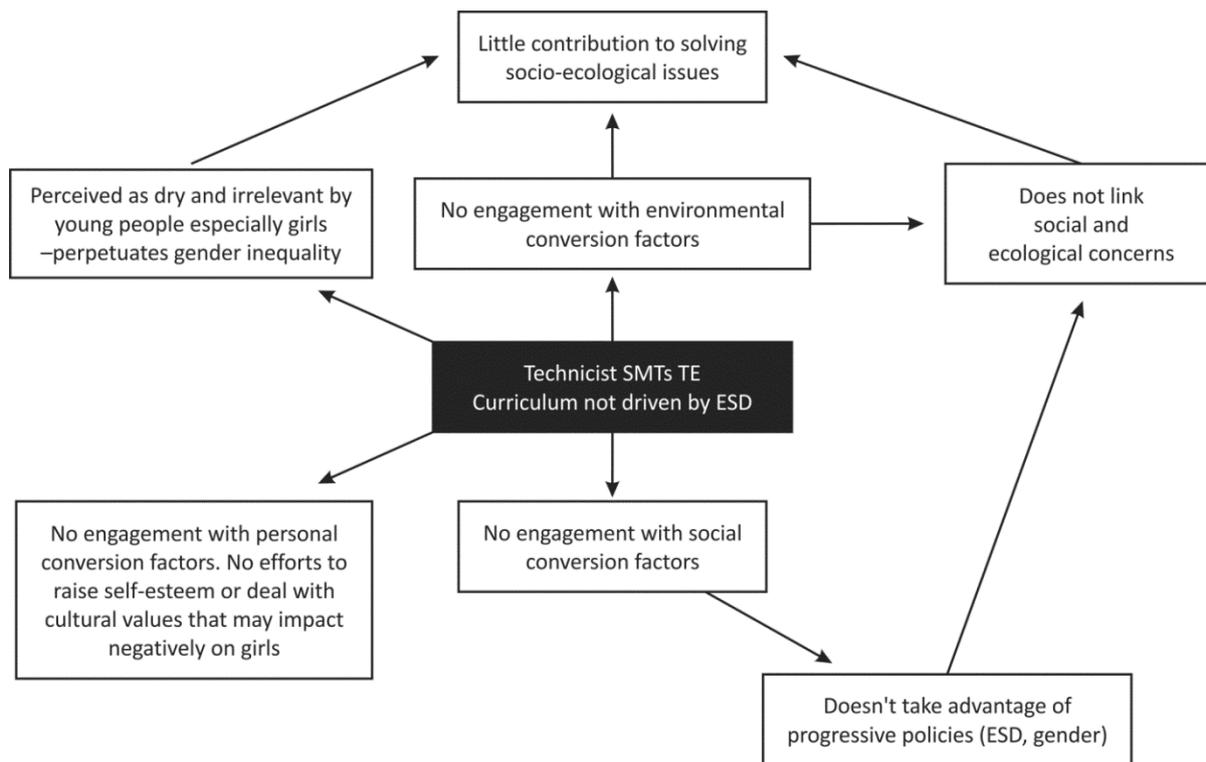
#### ***9.4.2 Implications for quality and relevance of SMTs teacher education***

The second implication has to do with quality and relevance of the teacher education SMTs curriculum. This is closely related to the policy-practice gap discussed above in that SMTs curriculum development conceived outside of the ESD framework has implications for quality and in its relevance to society. For instance it emerged that the SMTs curriculum in the two cases is largely operating within the traditional technicist science teaching approaches driven by economic needs at the expense of ecological and social aspects of development. Beck (1992) accused such science and technology for abandoning their foundation of experimental logic on real issues that concern society in favour of business (see Section 1.7.13). Such a curriculum as shown in the findings does not engage with social-ecological issues or they are treated narrowly or peripherally. This implies that trainee teachers are not exposed to gender and sustainability responsive pedagogies during training. Furthermore, they are not equipped with skills, attitudes and values necessary to handle social ills, such as patriarchal norms that impact negatively on science learning or on social practices as discussed in Chapter Two. Teacher educators in the two case studies showed little evidence of engaging with progressive social conversion factors such ESD and national gender policies. In the same manner, trainee teachers are not exposed to practical ways of

engaging with personal conversion factors of young learners, such as dealing with gender issues. In other words, there is no evidence in the two case studies of pedagogic practices that would guarantee equity from the middle with regard to gender and sustainability in SMTs. All this has implications for the quality of the teacher education curriculum in the sense that trainee teachers are not exposed to alternative pedagogies to deal with gender issues in SMTs or with social ecological concerns or gendered social-ecological practices in society (e.g. climate change vulnerability of women in Sub Saharan Africa). Eisner (1985, p.97) in his conception of the null curriculum would argue that:

*... what schools do not teach may be as important as what they do teach ... because ignorance is not simply a neutral void, it has important effects on the kinds of options one is able to consider, the alternatives that one can examine, and the perspectives from which one can view a situation or a problem.*

It also emerged that teacher SMTs education curriculum which is not ESD driven did not show any capacity to engage with social-ecological complexities such as climate change, gender, poverty and many more issues that are common in the region. One could ask questions of the relevance of any education system that is not geared to contribute towards solving the challenges facing communities. Non-engagement with socio-ecological issues that bedevil society has the potential for negative implications to well-being achievement and well-being freedom in SMTs to both boys and girls. As discussed in Section 2.4 many studies have shown that females shy away from science because they perceive it as abstract, dry, irrelevant, not useful in everyday life, decontextualised, distanced from everyday life, alienated from society (Osborne and Collins, 2001; Semela, 2010; Chetcuti and Kioko, 2012). Figure 9.2 summarises implications of technicist teacher SMTs education curriculum on quality and relevancy, especially when viewed from the conception of quality education as proposed by Lotz-Sistka (2008) cited in Lupele and Lotz-Sistka (2012) from a capabilities perspective. The figure also considers how this can be addressed using Unterhalter's three levels of equity as described in Section 1.7.4.



**Figure 9.2:** *Technicist teacher SMTs education curriculum*

## 9.5 RECOMMENDATIONS

The key findings and implications discussed in this chapter point towards some key issues that may inform curriculum development in teacher education. Some of the recommendations I propose here are quite general and may be applicable to different situations in teacher education. By doing so I do not aim to generalise from the two case study contexts analysed in some depth in this study, but rather to provide fuzzy generalisations. Hammersley (2001, p.221) commenting on Michael Bassey’s concept of fuzzy generalisation points out that “when a case study produces evidence for a relationship between variables in a particular case or in several cases, a fuzzy generalisation can then be tentatively formulated to the effect that the same relationship may be found in other cases”. Bassey (1999) noted that such fuzzy generalisations allow and invite others to consider the recommendations in similar or different contexts, and adapt them where possible. Implicit in these two statements, is that fuzzy generalisations contain an inherent element of uncertainty as they may or may not be useful in other contexts. In the same vein, in reporting findings of the study, I tried not to “overclaim” transformational powers for the research process, choosing rather to report on what did happen, as well as what did not, with respect to the transformational intent.

### ***9.5.1 Need for closer cooperation between policy makers and implementers***

This study had a curriculum transformation interest and the curriculum transformation process was focused mainly to addressing a policy-practice gap as discussed in Chapter Four. With respect to the findings, I would recommend closer cooperation between policy formulation and policy implementers. As it emerged from the two case studies, teacher educators were not aware of the policies that are meant to act as tools and rules in their curriculum development. There are two approaches or processes that I can recommend in this regard. Firstly, policies as tools that are meant to establish equity from the above; they need to have in-built artefacts that guarantee equity from the middle. As Unterhalter (2009) put it:

*... we were thus concerned to chart the ways in which equity from the middle articulated with equity from above, that is some rules regarding the provision of quality education to all children, and equity from below... (p.421)*

According to Akkerman and Bakker (2011) such artefacts, tools or even auxiliary ideas can facilitate the translatability or applicability of the policy into curriculum practice. A case in point is the Zimbabwe National Gender Policy (2004, p.9) which simply states: “Eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology”. Without auxiliary explanation, the policy statement is rather dry and open to various interpretations and misunderstandings as discussed in previous sections. The misinterpretation at national level of, for example Goal 3 of the MDGs as discussed in Section 2.6, could be reduced by developing policies with attached boundary objects or other necessary arrangements that may facilitate flow of ideas from policy to practice. This could be in the form of institutional structural arrangements and/or conceptual ideas that could facilitate the translation of policy into practice. Table 2.1 shows adopted ESD pedagogies in higher education in Section 2.2.2 as an example of a boundary object that could facilitate translation of the ESD policy framework into curriculum practice, as are the mediating tools developed and refined in this study (presented in their refined form in Chapter Eight). I recommend development and use of similar objects for policies that have curriculum transformation implications. Such boundary objects could be very beneficial if they are developed by both policy makers and implementers in expansive learning processes, as shown in this study.

A second recommendation is attached to boundary crossing from policy to some of the translation into curriculum tools. As discussed above, most participants were not aware of

policies that can guide their curriculum development, and this is long after the policy was formulated. What this seems to show, is that policy makers tend to develop policy without adequate attention to its translation into practice. In view of this, I recommend bridging structures that can physically open policy up to dialogue and make it accessible to implementers. As shown in this study, proposed structures could be established in the form of multi-voiced teams with representatives from all stakeholders. As mentioned above, such structures will have the potential to strengthen equity from the middle. As Unterhalter (2009) reasoned, such institutional conditions can foster equity from below, enabling conditions that could support the development of agency and process freedoms in education for diverse individuals. In an SMTs teacher education scenario, as in the two case studies, such structures may facilitate translation of policy into curriculum practice, and thus enhance reflexivity and agency in future SMTs teachers and equip them with the range of real curriculum alternatives they can consider for both boys and girls in expanding their capability set in SMTs.

### ***9.5.2 Holistic curriculum transformation***

Making recommendations for holistic curriculum development arises from the mismatches that emerged from the study. These are primarily mismatches between curriculum practice and socio-ecological risk and between curriculum aspirations and the philosophy informing the whole education system. The former reflects on the quality and relevance of education. As shown in this study I recommend holistic curriculum transformation towards a curriculum that has the potential to pay attention to negative social conversion factors (patriarchal norms and other socio-cultural ills) and their gendered intersections, and also negative environmental conversion factors (climate change and related ills) and engage them in a critical and transformative manner. There is also need to take advantage of the enabling socio-political factors such as gender related policies, critical and emancipatory pedagogies and research on gender and ESD and factor them into the curriculum as discussed in Section 3.2.2.

For a curriculum to achieve this, there is need for alignment between curriculum aspirations with the philosophy informing the whole education system. For instance a curriculum that is founded on instrumentalist ethos is likely to be unable to deliver democratic and equality values as expected by the ESD framework.

Section 2.3 shows how ESD was set up for “harnessing” all aspects of education, including public awareness and training and to take into consideration societal ills in order to make progress towards more sustainable societies (UNESCO, 2012 n.p). Giroux questioned “how can we make education meaningful by making it critical, and how do we make it critical so as to make it emancipatory” (Scott, 2008, p.3). As emerged from this study, policy implementation, while it is a starting point and indeed an important point, on its own it does not guarantee curriculum transformation. For policy to translate into curriculum transformation there is need to consider many different factors, some of which were observed in this study as having to do with policy implementers accessing the policy, and having knowledge of it as discussed in the previous section. As shown in this study, the existence of a policy and its accessibility by curriculum implementers does not always guarantee curriculum transformation. A clear example from this study is the case of the UKZN SMTs teacher educators who were aware of the need to include environmental issues in their curriculum but could not do so because of other factors that did not align with curriculum transformation requirements set by the policy, for example their biophysically dominated views of sustainability issues. Other issues raised included low content knowledge on the part of trainee teachers; external examiners who do not appreciate applied physics, as well as teacher educators’ own values as discussed in Chapter Six. The issue of teacher educators’ own values impacting negatively on incorporating gender into the curriculum also arose strongly in the BTTC case studies as discussed in Chapter Five. In the same case study, political ideologies were also a strong influencing factor. The point here is that attempts to transform curriculum need to take into consideration all such factors, and that such factors as shown in the two case studies, vary from context to context. This requires a contextual model of policy implementation in which teacher educators can deliberate the meaning of policy in relation to context. As shown in this study, this also requires critical engagement in contexts and making the invisible system activities more visible and open to reflexive scrutiny.

ESD and its holistic approach to sustainable development, oriented towards ecological sustainability, social justice, and a more benign economic system is informed by critical approaches as discussed in Chapters Two, Three and Four. On the other hand, SMTs curriculum development has been informed for centuries by patriarchal and instrumentalist ideas as argued by feminist standpoint theorists (Section 3.3) and capability theorists (Section 3.2). The two have different world views. Re-orienting curriculum using the former is not likely to be successful if it is done superficially without shaking the instrumentalist and

patriarchal roots that shape values of teacher educators. Daniels (2012) reminded us that the way in which the social relations of institutions are regulated have cognitive and affective consequences for those who live and work inside them. Unterhalter and North (2011) supported this, arguing that gender inequality is deeply imbued in the norms of institutions, their decision-making processes, forms of exercising power, their rules, unwritten cultures, and approaches to allocating resources. My recommendation in this regard is that for successful curriculum re-orientation to occur, there is also need to engage with invisible or implicit mediational properties of institutional structures that shape human thought and action (ibid.), as illuminated by various instances of the same in this study.

### ***9.5.3 Recommendations for further study***

In view of the research findings, experiences and recommendations above, I recommend further studies in the following areas:

- A study on policy-curriculum nexus. It will be helpful to have a study that brings policy planners and implementers together to map ways in which the three forms (borrowing from Unterhalter's three forms of equity) the above, the middle and the lower levels interact in any curriculum development.
- A study in which future SMTs teachers play a significant role in exploring and expanding on ESD thrusts in their professional growth. This could include involving trainee teachers in gender and ESD related research projects or even following trainee teachers on teaching practice and into contexts of teaching practice using longitudinal study designs.
- A study that focuses on invisible or implicit mediational properties of institutions at the nexus of ESD, gender and SMTs curriculum. As shown in this study, these are powerful enablers of curriculum transformation.
- A study that focuses more at the nexus of ESD, gender and technical subjects curriculum, as it was downplayed in this study.

## **9.6 NEW KNOWLEDGE**

I believe that this study opened up possibilities and opportunities to guide on-going efforts towards gender equality in SMTs teacher education curriculum within an ESD framework. I have tried to show that in endeavours to develop and implement gender equality in education, we need to think beyond parity, and critically look into physical and cognitive access to

learning as well as the wider social-ecological context of gender relations and social practices. This requires us to interrogate the real transaction between teacher, learner what is learnt, how it is learnt and societal and social-ecological context. It was also my intention to further show that locating the study at the nexus of ESD, gender and SMTs curriculum facilitates interrogation of issues relating to quality and relevance of the curriculum. The study also showed that the use of theoretical lenses such as the combination of capabilities and feminist approaches and socio-cultural approaches to learning and change (CHAT), enriches the understanding of curriculum practices in terms of gender and sustainability and enables expansion thereof.

The study further revealed that there is need to practically develop situationally relevant, yet challenging structures to mediate equity from the middle in terms of gender and sustainability responsiveness in SMTs teacher education curriculum development. This may be in the form of methodological tools that create opportunities for professionals who usually work in isolation to come together, reflect on their practice, analyse tensions and contradictions, design and implement new ways of doing work. In this regard, the study demonstrates that the use of CHAT related concepts and tools can make this possible, and can provide new mediation tools at the nexus of ESD, gender and SMTs that can help with dialectical boundary learning between policy and practice in teacher education. I also strongly feel that mainstreaming ESD in teacher education will provide a platform to re-orient education towards mitigating socio-ecological risk, notwithstanding the complexity of the whole ESD terrain.

## **9.7 LIMITATIONS OF THE STUDY**

The study involved a small sample involving small numbers of teacher educators. A larger sample could have meant more teacher educators involved in the study and perhaps more could have been involved in conceptualising their curriculum practices in terms of gender and sustainability. A small sample also makes it difficult to generalise. Although this was not the intention of the study, a broader range of cases could have strengthened the research evidence, with potentially wider acceptance and policy relevance. Developing this study into a longer term research programme may therefore be potentially interesting. The voice of trainee teachers is also absent in this study, the reason being that the focus of the study was

on teacher educators mainly due to the ability of a PhD study to handle the two. However I acknowledge that bringing in trainee teachers could have added to the richness of the study.

As noted in Chapter Eight, time was also a limiting factor. Being a PhD project with a limited time frame, I was not able to follow the implementation and reflection on the mediation tools produced during the expansive learning cycle step 7 of the Developmental Work Research cycle as shown in Figure 9.1. It was also impossible to follow the implementation of the syllabi that were reviewed with the input from the research as this would take a long period of time. Post-doctoral studies could include follow up in the two case study sites, say in one to two years from now to determine catalytic impact of the study. However, the research produced enough evidence to show that some of the processes initiated were being taken forward.

Another limitation of the study was the practical restriction of the ESD thrust to gender and ESD focusing largely to environmental and ecological dimensions leaving out other broader dimensions of ESD as discussed in chapter 2. This was because it was impossible to handle all the aspects of ESD in a single study. I acknowledge however that this limitation had a constraining bearing on the capabilities that could have been discussed in the project.

The use of many theoretical referents had its own constraining powers. Although by and large this provided various lenses and frameworks to draw from, it was not always easy to pull all threads throughout the research. In some cases it proved to be a daunting task to draw meanings and make sense of data using various theoretical positions.

## **9.8 MY ROLE AS A RESEARCHER**

In this study, I was an interventionist researcher who sought to enhance the agency of participants (SMTs teacher educators) as highlighted in Chapter Eight. The research had two phases, and was action oriented, working with teacher educators to reflect on their curriculum practices. In the initial stages of the research journey I set out to explore curriculum practices. In this case I equate my role to that of an explorer, scrutinising curriculum practices of the subjects (SMTs teacher educators). My exploration role encompassed identifying activity systems, examining the motive-goal-instrumental conditions of activities and making sense of the collective meaning-making process (Yamagata-Lynch, 2003). This required that I make sense out of emerging data, and this involved consolidating, reducing and interpreting what

participants had said and planning for the next move. As I needed depth understanding, I engaged in inductive, abductive and critical discourse analysis.

In the expansive learning phase, I played a facilitating role, engaging and stimulating participants to reflect on and question their curriculum and their curriculum practices. I also assumed the role of an analyst, by supporting participants towards reconceptualising their curriculum object drawing on findings related to their practice, policy discourse and questioning views of socio-ecological risk used as mirror data to provide for “double” stimulation. Enhancing agency required participants to construct meaning from the work situation, learn from those meanings and expand the meanings towards action (Dick and Williams, 2004). This required engaging with boundary objects and other mediating tools such as policies and problem solving questions which were developed from and in relation to the context of practice as the process unfolded. In such cases I had to play the role of a boundary crossing facilitator or boundary broker. This involved sourcing, drafting and using these to engage the participants in reflecting and reconceptualising work. In my role as a boundary broker I also had to provide inspiration, surfacing the invisible or undiscussable contradictions, stimulating a developmental dialogue around them (Dick and Williams, 2004). For example, in Zimbabwe participants were at first not comfortable to deliberate government’s failures and the effects on education. In South Africa issues of race and class were discussed with apprehension. As an interventionist researcher I had to assist participants to confront and reflect on such potential discontinuities. It was also my role as a boundary broker to level the power gradient in change laboratory workshops. The study contributes in-depth insight into science teacher education curriculum development. As highlighted in Section 2.4 and discussed in various other parts of the thesis, locating the study at the nexus of gender and Science, Mathematics and Technical subjects within the Education for Sustainable Development discourse, using the ontological lenses of feminist and capabilities it was possible to interrogate aspects of quality and relevance of the science teacher education curriculum. The study also provides insight into participatory research and learning processes especially within the context of policy and curriculum development. It provides empirical evidence of mobilising reflexivity amongst both policy makers and policy implementers towards building human agency in policy translation for a curriculum transformation that is critical for responding to contemporary socio-ecological risks.

Despite the developments reported in this thesis, I cannot however, “over claim” the transformational powers of the research process, as the study mainly focused on the

pedagogic device in SMTs teacher education curriculum as a way of understanding and transforming curriculum in this sector. In other words, the study focused on more tangible aspects of the curriculum such as distribution, recontextualisation and evaluation rules as highlighted by Bernstein (Scott, 2008) (see Section 2.9.1). I was nevertheless aware that the curriculum field in a Bourdieurian concept is a social arena of struggle over the appropriation of certain species of capital (Thorpe, 2009), structured internally in terms of power relationships (Bourdieu, 1993). In this sense, curriculum practices of SMTs teacher educators are shaped by their habitus; a battery of dispositions which orientate a person towards all aspects of life; embodied, incorporating the emotional, the physical and practical as well as the cognitive; dispositions that are developed (learned) throughout life, (Hodkinson et al., 2007). Given the scope of this PhD study, there was no room to fully engage with all the cultural aspects (habitus) that shape curriculum practices. For instance, „situated knowledge“, the claim that knowledge derives from an ontological position, is a key idea in feminist epistemology, and feminist theorists argue that position is what needs to be critically examined since it is not occupying a fixed location (Smith, 2006). In this study the position of SMTs teacher educators was interrogated only as it relates to the Bernstinian pedagogic devices mentioned above. There was very little room to go beyond this, such as engaging other cultural patriarchal situations out of the formal education context that has shaped and continue to shape teacher educators“ curriculum practice.

## **9.9 CONCLUSION**

This chapter presents a summary of the key research findings, their implications, recommendations emerging from these two. The chapter starts by highlighting the conceptual framing of the study. Thereafter I discussed aspects that emerged from the study findings and their implications for SMTs teacher education curriculum development. I further provided some recommendations that may assist with future curriculum planning and implementation in teacher education. I also discussed the new knowledge contribution of the study and identified areas for future research in relation to sustainability in SMTs teacher education curriculum development. I closed the chapter and thesis with a reflection on the role of the interventionist researcher, particularly as it pertains to objectives of curriculum transformation in an essentially unequal society that is facing serious social-ecological risk and vulnerability, that is (once again) likely to affect those most vulnerable (women) most severely.

## References

- Aalbers, J., Kok, K., and Poelman, K. (2012). Learning Styles and Physics Achievement in Secondary Education. Unpublished PhD thesis, Utrecht University.
- Abercrombie, N., Hill, S., and Turner, B. S. (2006). *The Penguin Dictionary of Sociology* (5<sup>th</sup> ed.). London: Penguin Books.
- Adams, W. M. (2006). *The Future of Sustainability Re-thinking Environment and Development in the Twenty-first Century*. Cambridge: IUCN.
- African Development Bank. (2009). Checklist for gender mainstreaming in the education sector with special focus on higher education, science and technology subject sector.
- Aikenhead, G. (2002). *Whose scientific knowledge? The colonizer and the colonized*. Retrieved January 23, 2007, from <http://www.usask.ca/>
- Aikman, S. and Unterhalter, E. (2013). Gender equalities, capabilities and the terrain of quality education. In L. Tickly and M. Barrett (Eds.) *Education quality and social justice in the global South: Challenges for policy, practice and research* (pp.25-39). New York: Routledge.
- Aikman, S. and Unterhalter, E. (2005). Introduction. In S. Aikman. and E. Unterhalter (Eds) *Beyond access: Transforming policy and practice for gender equality in education*. Oxford: Oxfam.
- Aikman, S., Unterhalter, E., and Challender, C. (2005). The education MDGs: achieving gender equality through and curriculum and pedagogy change. *Gender and Development, 13*(1), 44-55.
- Akkerman, S., Admiraal, W., Simons, R. J., and Niessen, T. (2006). Considering diversity: Multivoicedness in international academic collaboration. *Culture and Psychology, 12*, 461-485.
- Akkerman, S. F. and Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research, 1*-38.
- Akkerman, S. F. and Van Eijck, M. (2011). Re-theorising the student dialogically across and between boundaries of multiple communities. *British Educational Research Journal, 1*-13.
- Alkire, S. (2005). *Valuing freedoms: Sen's Capability approach and poverty reduction*. Oxford: Oxford University Press.
- Alvesson, M. and Skoldberg, K. (2000). *Reflexive methodology: New vistas for qualitative research*. London: Sage.
- Archer, M. (2000). *Being Human: The problem of agency*. Cambridge: Cambridge University Press.

- Archer, M. (1982). Morphogenesis versus structuration: on combining structure and action. *British Journal of Sociology*, 33(4), 455-483.
- Archer, M. (2003). *Structure, Agency and Internal Conversation*. Cambridge: Cambridge University Press.
- Archer, M. (2007). *Making our way through the world: Human reflexivity and social mobility*. Cambridge: Cambridge University Press.
- Annot, M. (2002). *Reproducing gender? Essays on educational theory and feminist politics*. London: Routledge Falmer.
- Avis, J. (2007). Engeström's version of activity theory: a conservative praxis? *Journal of Education and Work*, 20(3), 161-177.
- Avis, J. (2009). Transformation or transformism: Engeström's version of activity theory. *Educational review*, 61(2), 151-165.
- Bassey, M. (1999). *Case study research in educational settings*. Buckingham: Open University Press.
- Barker, C. (2005). *Cultural Studies: Theory and Practice*. London: Sage.
- Barnes, T. (2000). "We women worked so hard": Gender, urbanisation and social reproduction in colonial Harare, Zimbabwe 1930-1956. Portsmouth: Heinemann.
- Bäthge, S. (2010). *Climate change and gender: economic empowerment of women through climate mitigation and adaptation?* Postfach: Deutsche Gesellschaft für.
- Beck, U. (1992). *Risk society: Towards a new modernity*. London: Sage.
- Beck, U. (2000). *World risk society*. Cambridge: Polity Press and Blackwell Publishers.
- Beijing Declaration. (1995). *Fourth World Conference on Women; Action for Equality, Development and Peace*. Beijing.
- Beijing Platform for Action country report. (2010). *A Fifteen-Year Review of the Implementation of the Beijing Platform for Action in Africa (BPfA) +15 – From 1995-2009*. Economic Commission for Africa.
- Bernstein, B. (1970). Education cannot compensate for society. *New Society*, 15(387), 344-347.
- Birkett, H. (2011). *A Critical Realist Approach to Identity*. Retrieved March 27, 2012, from [http://www.organizzazione.unina.it/cms7/proceedings/proceedings\\_stream\\_12/Birkett.pdf](http://www.organizzazione.unina.it/cms7/proceedings/proceedings_stream_12/Birkett.pdf)
- Blacker, F., Crump, N. and McDonald, S. (2000). Organizing processes in complex activity networks. *Organization Articles*, 7(2), 277-300.

- Blankenship, J. D. (1996). Education and the Arts in Plato's Republic. *Journal of Education*, 178, 67-98.
- Bloch, G. (2009). *The Toxic Mix: What is wrong with South Africa's schools and how to fix it*. Cape Town: Tafelberg.
- Bloor, M. and Wood, F. (2006). *Key words for qualitative methods: A vocabulary of research concepts*. London: Sage.
- Bogdan, R. C. and Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods*. Boston: Pearson.
- Bogenrieder, I. and van Baalen, P. (2007). Contested practice: Multiple inclusion in double-knit organizations. *Journal of Organizational Change Management*, 20(4), 579–595.
- Bourdieu, P. (1986). The forms of capital. In J.G. Richardson (Ed.), *Handbook of theory and research sociology of education* (pp. 241–258). New York: Greenwood Press.
- Bourdieu, P. (1990). *The logic of practice*. Cambridge: Polity Press.
- Bourdieu, P. (1993). *The field of cultural production*. Cambridge: Polity Press.
- Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge: Cambridge University Press.
- Bourdieu, P. (2000). *Pascalian Meditation*. (R. N. Stanford, Trans.) London: Stanford UP.
- Bourdieu, P. (2004). *Science of science and reflexivity*. Cambridge: Polity Press.
- Brickhouse, N. W., Lowery, P., and Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching*, 37, 441-458.
- BRIDGE. (2008). *Gender and climate change, mapping the linkages; A scoping study on knowledge and gaps*. BRIDGE, Institute of Development Studies (IDS), UK.
- Brighouse, H. and Unterhalter, E. (2002). Primary goods, capabilities and the milenium development target for gender equity in education. Paper presented at the second capabilities approach conference, St Edmunds College, Cambridge, September 2002. Retrieved February 25, 2008, from [www.St-edmunds.com.ac.uk/vhi/nassbaum](http://www.St-edmunds.com.ac.uk/vhi/nassbaum)
- Brooks. D., Gibbon, D., and Patrick, M. (2008). *OBE for FET Physical Sciences grade 11 learner's book*. Cape Town: Nasou Via Afrika.
- Brundtland, G. H. (1987). *Our common future: The world commission on Environment and Development*. Oxford: Oxford University Press.

- Buck, G., Cook, K., Quigley, C., Eastwood, J., and Lucas, Y. (2009). Profiles of urban, low SES, African American girls' attitudes toward science. *Journal of Mixed Methods Research*, 3, 386-410.
- Buthelezi, T. (2010). Edgewood: an African perspective. In J. Wassermann and A. Bryan (Eds.) *From college to faculty of education; memories of the Edgewood campus of the University of KwaZulu-Natal* (pp.111-113). Pinetown: University of KwaZulu-Natal.
- Calabrese Barton, A., Tan, E., and Rivet, A. (2008). Creating hybrid spaces for engaging school science among urban middle school girls. *American Educational Research Journal*, 45, 68-103.
- Campbell, R. (2004). Gender, ideology and issue preference: Is there such a thing as a political women's interest in Britain? *British Journal of Politics and International Relations*, 6 (1), 20-29.
- Carr, W. and Kemmis, S. (1986). *Becoming critical*. Lewes: Falmer.
- CEDPA (Centre for Development and Population Agency). (2000). Gender and development Training Manual Series, Volume 3. USAID.
- Chambers, C. (2005). Masculine Domination, radical feminism and change. *Feminist Theory*, 6(3), 325-346.
- Charlsworth, H. (2005). Not waving but drowning: Gender mainstreaming and human rights in the United Nations. *Harvard Human Rights Journal*, 18, 1-18.
- Charmaz, K. (2003). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin and Y. S. Lincoln (Eds.), *Strategies for qualitative inquiry* (2nd ed.) (pp. 249-291). Thousand Oaks, CA: Sage.
- Chesters, G. and Welsh, I. (2011). *Social movements: Key concepts*. New York: Routledge.
- Chetcuti, D. (2009). Identifying a gender-inclusive pedagogy from Maltese teachers' personal practical knowledge. *International Journal of Science Education*, 31, 81-99.
- Chetcuti, D. and Kioko, B. (2012). Girls' Attitudes towards Science in Kenya, *International Journal of Science Education*, 1-19.
- Chikunda, C. (2010). Assessing the level of gender awareness of science teachers: the case of Zimbabwe's two education districts. *African Journal of Research in Mathematics, Science and Technology Education*.
- Chisholm, L. (2005). The politics of curriculum review and revision in South Africa in regional context. *Compare*, 35(1), 79-101.
- Christidou, V. (2007). Greek students' science-related interests and experiences: Gender differences and correlations. *International Journal of Science Education*, 28, 1181-1199.

- Christidou, V. (2011). Combining students' voices with the voices of school Science, teachers, and popular science. *International Journal of Environmental and Science Education*. 6 (2), 141-159.
- Clark, D. A. (2005). *The Capability Approach: Its Development, Critiques and Recent Advances*. Manchester. Retrieved January 15, 2012, from Global Poverty Research Group website, <http://www.gprg.org/>.
- Clegg, A. (2007). *Girls into science: a training module*. UNESCO.
- Clewell, B.C. and Campbell, P.B. (2002). Where we are, where we've been, where we are going. *Journal of Women and Minorities in Science and Engineering*, 8, 255-284.
- Cohen, L., Manion, L., and Morrison, K. (2000). *Research methods in education* (5th ed.). London: Routledge.
- Cohen, L., Manion, L., and Morrison, K. (2007). *Research methods in education* (6th ed.). London: Routledge Falmer.
- Cohen, L., Manion, L. and Morrison, K. (2010). *Research methods in education* (6th ed.). London: Routledge.
- Cohn, C. (1996). Sex and death in the rational world of defense intellectuals. In B. Lasslett and S.G. Kohlstedt (Eds). *Gender and Scientific Authority* (pp. 183-214). Chicago: University of Chicago Press.
- Collins, P. H. (1990). *Black feminist thought; knowledge, consciousness and the politics of empowerment*. Boston: Unwin Hyman.
- Corbin, J. and Strauss, A. (2007). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. CA: Sage: Thousand Oaks.
- Cornbleth, C. (1990). *Curriculum in context*. London: Falmer Press.
- Creswell, J.W. (2003). *Research Designs: Qualitative, Quantitative and Mixed-methods Approaches*. Thousand Oaks, CA: Sage.
- Cresswell, J. W. (2007). *Qualitative inquiry and research* (2nd ed.). CA: Thousand Oaks.
- Crocker, D. A. (2008). *Ethics of Global Development: Agency, Capability and Deliberative Democracy*, Cambridge: Cambridge University Press.
- Danermark, B., Ekstrom, M., Jakobsen, L. and Karlsson, J. (2002). *Explaining Society; Critical realism in social sciences*. London: Routledge.
- Daniels, H. (2001). *Vygotsky and pedagogy*. London: Routledge.
- Daniels, H. (2005). *An introduction to Vygotsky* (2nd ed.). London: Routledge.

- Daniels, H. (2007). Analysing third generation activity systems: labour-power, subject position and personal transformation. *Journal of Workplace Learning*, 19(6), 377-391.
- Daniels, H. (2008) Reflections on points of departure in the development of sociocultural and activity theory. In B. van Oers (Ed.), *The Transformation of Learning: Advances in Cultural-Historical Activity Theory*. Cambridge: Cambridge University Press.
- Daniels, H. (2010). The mutual shaping of human action and institutional settings: a study of the transformation of children's services and professional work. *British Journal of Sociology of Education*, 31(4), 377-393.
- Daniels, H. (2012). Institutional culture, social interaction and learning. *Learning, Culture and Social Interaction*, 1(1), 2-11.
- Daniels, H. and Warmington, P. (2007) Analysing third generation activity systems: labour-power, subject position and personal transformation. *Journal of Workplace Learning*, 19(6), 377-391.
- Dean, K. (2009). Agency and dialectics: What critical realism can learn from Althusser's Marxism. In K. Dean, J. Joseph, J.M. Roberts, and C. Wight. *Realism, philosophy and social science*. Hampshire: Palgrave and Macmillan.
- Delanty, G. (2005). Return of the actor: The reflexive turn and feminist standpoint epistemology. In *Social Science: Philosophical and Methodological Foundations* (2nd ed). Maidenhead: Open University Press.
- deMarrais, K. (2004). Qualitative interview studies: Learning through experience. In K. A. deMarrais, *Foundations of research* (pp.51-68). NJ: Erlbaum.
- Department of Education. (2002). National Curriculum Statement Grade R-12. Pretoria: Department of Education.
- Department of Education. (2010). *Education for All (EFA)*. Pretoria: Department of Basic Education.
- Dick, B. and Williams, B. (2004). *Enhancing evaluations using systems concepts*. Retrieved May 26, 2012, from <http://www.qualitative-research.net/fqs-texte/3-04/04-3-34-e.htm>
- Dieltiens, V., Unterhalter, E., Letsatsi, S., and North, A. (2009). Gender blind, gender-lite: a critique of gender equality approaches in the South African Department of Education. *Perspectives in Education*, 27(4), 365-374.
- Dillon, J. and Wals, A. E (2006) On the dangers of blurring methods, methodologies and ideologies in Environmental Education Research. *Environmental Education Research*, 12(3-4), 549-558.
- Domahidy, M. (2003). Using theory to frame community practice. *Journal of the Community Development Society*, 34(1), 75-84.

- Donati, P. (2011) *Pacem in Terris* and the Principle of Subsidiarity: Beyond the misunderstandings. PASS Plenary Session. Retrieved February 13, 2012, from <http://ordosocialis.de/pdf/Donati/Donati-Pacem%20in%20Terris.pdf>
- Down, L. (2010). Teaching and Learning in, with and for community: Towards a pedagogy for education for sustainable development. *Southern African Journal of Environmental Education*, 27, 58-70.
- Duffy, J. Warren, K and Walsh, M. (2001). *Classroom interactions, gender of teacher, gender of student and classroom subject. Sex Roles: A journey of Research*. Retrieved December 23, 2011 from [http://findarticles.com/cf\\_dls/article.jhtml](http://findarticles.com/cf_dls/article.jhtml)
- Dupont, C. (2012). Gender and Climate Change: An Introduction. *Global Environmental Politics*, 12(1), 128-129.
- Economic Commission for Africa (2010). *A Fifteen-Year Review of the Implementation of the Beijing Platform for Action in Africa (BPfA) +15 – From 1995–2009*. Economic Commission for Africa.
- Edwards, A. (2005). Working collaboratively to build resilience: A CHAT approach. *Social Policy and Society*, 6(2), 255-264.
- Edwards, A. (2007). Relational agency in professional practice: A CHAT analysis. *An International Journal of Human Activity Theory*, 1, 1-17.
- Edwards, A. and Daniels, H. (2012). The knowledge that matters in professional practices. *Journal of Education and Work*, 25(1), 39-58.
- Edwards, R. and Fowler, Z. (2007) Unsettling boundaries in making a space for research. *British Education Research Journal*, 33, 107-123.
- Eisner, E. (1985). *The educational imagination*. New York: Macmillan.
- Elder-Vass, D. (2007). Reconciling Archer and Bourdieu in an Emergentist Theory of Action. *Sociological Theory*, 25(4), 325-346.
- Elder-Vass, D. (2010). *The Causal Power of Social Structures*. Cambridge: Cambridge University Press.
- Elliot, J. (2007). From „human capital“ theory to „capability theory“ as a driver for curriculum reform: A reflection on the educational implications of Amartya Sen in light of John Dewey’s account of educational values. In B. Somekh and T. Schwadt (Eds.) *Knowledge production. Research work in interesting times* (pp 142-165). London: Routledge.
- Engeström, Y. (1987). *Learning by expanding: An activity theoretical approach to developmental research*. Orienta-Konsultit: Helsinki.

- Engeström, Y. (1993). Developmental studies of work as a testbench of activity theory: The case of primary care medical practice. In S. Chaiklin and J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 64–103). New York: Cambridge University Press.
- Engeström, Y. (1995). Polycontextuality and boundary crossing in expert cognition: Learning and problem solving in complex work. *Learning and Instruction*, 5, 319–336.
- Engeström, Y. (1999). Expansive visibilization of work: An activity-theoretical perspective. *Computer Supported Cooperative Work* (8), 63-93.
- Engeström, Y. (2000). Activity theory as a framework for analysing and redesigning work. *Ergonomics*, 43(7), 960-974.
- Engeström, Y. (2001). Expansive learning at work: Towards an activity theoretical re-conceptualisation. *Journal of Education and Work*, (1), 133-156.
- Engeström, Y. (2004). New forms of learning in co-configuration work. *Work management and culture seminar* (pp. 1-10). California.
- Engeström, Y. (2005a). *Developmental work research: Expanding activity theory in practice*. Berlin: Lehmanns Media.
- Engeström, Y. (2005b). Non scolae sed vitae discimus: Towards overcoming the encapsulation of school learning. In H. Daniels (Ed.) *An introduction to Vygotsky: (2nd ed.)* (pp.157-176). London: Routledge.
- Engeström, Y. (2006). Development, movement and agency: Breaking away into mycorrhizae activities. In K. Yamazumi (Ed.) *Building activity theory in practice: Toward the next generation*. Osaka: Center for Human Activity Theory, Kansai University (CHAT Technical Reports #1).
- Engeström, Y. (2007a). From stabilization knowledge to possibility knowledge in organizational learning. *Management Learning*, 38(3), 271-275.
- Engeström, Y. (2007b). Enriching the theory of expansive learning: Lessons from journeys toward coconfiguration. *Mind, culture and activity*, 14(1-2), 23-39.
- Engeström, Y. (2008). *From teams to knots: Activity-Theoretical studies of collaboration and learning at work*. Cambridge: Cambridge University Press.
- Engeström, Y. and Miettinen, R. (1999). Introduction. In Y. Engeström, R. Miettinen, and R. L. Punamaki (Eds.). *Perspectives on Activity Theory*. New York: Cambridge University Press.
- Engeström, Y., Miettinen, R., and Punamaki, R.L. (1999). (Eds.) *Perspectives on Activity Theory*. New York: Cambridge University Press.

- Engeström, Y. and Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review*, 1-24.
- Fairclough, N. (2001). The Discourse Analysis of New Labour: Critical Discourse Analysis. In M. Wetherell, *Discourse as Data. 2001* (pp. 229-266). London: Sage.
- Fairclough, N. (2008). A dialectical-relation approach to critical discourse in social research. In R. Wodak and M. Meyer (Eds.) *Methods in Critical Discourse Analysis*. London: Sage.
- Faith, K. (1994). Resistance: Lessons from Foucault and Feminism. In H. L. Radtke and H. J. Stam (Eds.) *Power/gender: Social relations in theory and Practice* (pp. 36-66). New Delhi: Sage.
- Farrar, T. (1997). The Queen mother, Matriarchy, and the Question of Female Political Authority in Pre-colonial West African Monarchy. *Journal of Black Studies*, 579-597.
- FAWE. (2005). *Annual Report*. Nairobi: FAWE House.
- FAWE. (2008). Bringing gender-responsiveness to African education: advocacy, action and impact (FAWE Annual Report 2007). Nairobi: FAWE.
- Fien, J. (1998). Environmental education for a new century. In D. H. R. Slaughter, *Futures Education - World Yearbook of Education*. London: Kogan Page.
- Fien, J. and Tilbury, D. (2000). The global challenge of sustainability. In D. Tilbury, *Education and Sustainability Responding to the Global Challenge* (pp. 1-12). London: IUCN Commission on Education and Communication.
- Fisher, D. and Atkinson-Grosjean, J. (2002). Brokers on the boundary: Academy-industry liaison in Canadian universities. *Higher Education*, 44, 449-467.
- Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12( 219), 219-245.
- Foot, K. (2001). Pursuing an evolving object. *Mind, Culture, and Activity*, 9, 132-149.
- Foucault, M. (1978). *The History of Sexuality* (Vol. 1). London: Penguin.
- Fukuda-Parr, S. (2003). The Human Development Paradigm: Operationalizing Sen's Ideas on Capabilities. *Feminist Economics*, 9(2-3), 301-317.
- Gadotti, M. (1996). *Pedagogy of praxis: A dialectical philosophy of education*. New York: State University of NY.
- Gadra Education. (2012). *Transforming the educational landscape in Grahamstown and beyond; strategic plan 2012-2015*. Grahamstown: Gadra.

- Gaidzanwa, R. (1992). Bourgeoise theories of gender and feminisms and their shortcomings with reference to Southern African countries. In R. Meena, *Gender in Southern Africa: Conceptual and theoretical issues* (pp. 271-297). Harare: SAPES Books.
- Garnham, N. (1997). Amartya Sen's „Capabilities“ Approach to the Evaluation of Welfare: Its Application to Communications, *The Public: Journal of the European Institute for Communication and Culture*, IV (4), 25-34.
- Gee, J. P. (2005). Retrieved January 30, 2012, from <http://diskurs.hum.aau.dk/english/Seminars/GeeSeminar.htm>.
- Gibson, H. L. and Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education*, 86, 693-705.
- Giddens, A. (1999). *Runaway world: How globalisation is reshaping our lives*. London: Profile Books.
- Giddens, A. (2006). *Sociology* (5th ed.). Cambridge: Polity.
- Giddens, A. (2009). *The Politics of Climate Change*. Cambridge: Polity.
- Gilbert, J. and Calvert, S. (2003). Challenging accepted wisdom: Looking at the gender and science education question through a different lens. *International Journal of Science Education*, 25, 861-878.
- Gilgun, J. F. (2002). *Some notes on the analysis of qualitative data*. Retrieved January 19, 2010, from [http://ssw.che.umn.edu/img/as\\_sets/5661/Data%20analysis%2010-02.pdf](http://ssw.che.umn.edu/img/as_sets/5661/Data%20analysis%2010-02.pdf)
- Giroux, H. (1983). *Theory and resistance in education: a pedagogy for the opposition*. New York: Bergin and Garvey.
- Giroux, H. (1992). *Border crossings: Cultural workers and the politics of education*. London: Routledge.
- Goetz, A. (2007). Gender justice, citizenship and entitlements. Core concepts, central debates and new directions for research. In N. M. Mukhopadhyay, *Gender, justice, citizenship and development*. New Delhi: Zubaan.
- Gordon, R. (1994). Education policy and gender in Zimbabwe: The state and the reproduction of patriarchy. *Gender and Education*, 6(2), 131-139.
- Gordon, R. (2003). *Readings in Sociology of Education* (vol ii). University of Zimbabwe.
- Gorodetsky, M. and Barak, J. (2008). The educational-cultural edge: A participative learning environment for co-emergence of personal and institutional growth. *Teaching and Teacher Education*., 24(7), 1907–1918.

- Gosling, C. (2004). Challenges facing high school physics students: An annotated synopsis of peer-reviewed literature addressing curriculum relevance and gender. *Journal of Physics Teacher Education Online* 2(2), 1-9.
- Gough, A. (1997). Founders of Environmental Education: narratives of the Australian environmental education movement. *Environmental Education Research*, 3(1), 43-57.
- Gough, A. (2002). Mutualism: a different agenda for environmental and science education. *International Journal of Science Education*, 24, 1201-1215.
- Gough, A. (2006) Sustainable schools in the UN Decade of Education for Sustainable Development: Meeting the challenge. *Southern African Journal of Environmental Education*, 23, 48-63.
- Green, B. (2009). The primacy of practice and the problem of representation. In B. Green, *Understanding and researching professional practice* (pp. 39-54). Rotterdam: Sense Publishers.
- Griffin, G. (2007). The uses of discourse analysis in the study of gender and migration. *Research Integration*, 1-34.
- Grrotenboer, P. and Ballantyne, J. (2010). Mathematics Teachers: Negotiating professional and discipline identities. In L. K. Sparrow, *Shaping the future of mathematics education* (pp. 225-232). Merga: Freemantle.
- Grundy, S. (1987). *Curriculum: Product or Praxis*. Lewes: Falmer.
- Habermas, J. (1972). *Knowledge and Human Interests*. London: Heinemann.
- Hammersley, M. (2001). On Michael Bassey's Concept of the Fuzzy Generalisation. *Oxford Review of Education*, 27(2), 219-225.
- Harding, S. (1991). *Whose science? Whose knowledge*. Ithaca, N.Y: Cornell University Press.
- Harrington, A. (2005). *Modern social theory: An introduction*. Oxford: Oxford University Press.
- Hartsock, N. C. M. (1983) *Money, Sex, and Power: Toward a Feminist Historical Materialism* (Longman Series in Feminist Theory). New York: Longman.
- Hattingh, J. (2004). Speaking of Sustainable Development values...a response to Alistair Chadwick's viewpoint responding to destructive interpersonal interactions: a way forward for school-based environmental educators. *Southern African Journal of Environmental Education*, 21, 154-165.
- Hemson, C. (2010). Edgewood and me. In J. Wassermann and A. Bryan (Eds.) *From college to faculty of education; memories of the Edgewood campus of the University of KwaZulu-Natal* (pp.122-132). Pinetown, University of KwaZulu-Natal.

- Herz, B. and Sperling, G. B. (2004). *What works in girls' education?* New York, NY: Council of Foreign Relations.
- Hill, C, P. (2002). Symposium on West and Fenstermaker's „Doing Difference“ in S. Fenstermaker and C. West (Eds.), *Doing Gender, Doing Difference*. New York: Routledge.
- Hill, R., Capper, P., Wilson, K., Whatman, R., and Wong, K (2007). Workplace learning in the New Zealand apple industry network: A new co-design method for government "practice making. *Journal of Workplace Learning*, 19(6), 359-376.
- Hodkinson, P., Ford, G., Hodkinson, H., and Hawthorn, R. (2007). Retirement as a learning process. *Educational Gerontology*, 34, 167-184.
- Hoffmann, A.M. and Bory-Adams, A. (2005). The Human Capability Approach and Education for Sustainable Development: Making the Abstract Real. Paper presented at the 5th Conference on the Capability Approach, Paris.
- Hopkins, C. and McKeown, R. (2005). Mobilising for education for sustainable development: Towards a global learning space based on regional centres of expertise. UN university, UNU-IAS. Retrieved June 24, 2005 from <http://www.aip.org/statistics/trends/reports/hsreport>
- Horvath, J. (2010) Critical discourse analysis of Obama's political discourse. *Incommensurable Discourse in Applied Linguistics*, 15(2), 45-56.
- Huckle, J. (1996). Realising sustainability in changing times). In J. H. Sterling, *Education for Sustainability*. London: Earthstar Publications.
- Human Development and Capability Association (2005) *Capability and Functionings: Definition and Justification*. Retrieved January 5, 2012, from [http://www.capabilityapproach.com/pubs/HDCA\\_Briefing\\_Concepts.pdf](http://www.capabilityapproach.com/pubs/HDCA_Briefing_Concepts.pdf)
- Hutton, E. (2009). Critical Theory and Feminist Epistemology. Retrieved December 20, 2011, from <http://ericahutton.blogspot.com/2009/03/critical-theory-feminist-epistemology.html>
- Huyer, S. and Westholm, G. (1999). Gateway: Toolkit on collecting gender disaggregated data. Retrieved June 24, 2010, from <http://gstgateway.wigsat.org/ta/data/ch2.html>
- ILO. (2007). *Woman worker, women's rights, equal employment opportunity, ILO Convention, ABC of women workers' rights*. Geneva: International Labour Office.
- Inlay, L. (2003). Values: The Implicit Curriculum. *Educational Leadership*, 60(6), 69-71.
- International Institute for Sustainable Development. (2012). Improving Distribution of Environmental Benefits and Burdens. Retrieved December 2, 2011, from <http://www.iisd.org/gender/>

- Jackson, S. (2005). Sexuality, Heterosexuality and Gender Hierarchy: Getting our Priorities Straight. In C. Ingraham (Ed.) *Thinking Straight: New Work in Critical Heterosexuality Studies* (pp.15–38). New York: Routledge.
- Janks, H. (1997). Critical Discourse Analysis as a research tool. *Studies in the Cultural Politics of Education*, 18(3), 329-342.
- Janks, H. (2001). Critical literacy: Models, methods and motivation. *46th International Reading Association Convention* (pp. 1-19). New Orleans, Louisiana: University of Witwatersrand.
- Janse Van Rensburg, E. J. (1995). Environmental education and research in Southern Africa: A landscape of shifting priorities. Unpublished PhD thesis, Grahamstown: Rhodes University.
- Jarvis, B. (2010). Edgewood: what was, what is, and what might have been. In J. Wassermann and A. Bryan (Eds.) *From college to faculty of education; memories of the Edgewood campus of the University of KwaZulu-Natal* (pp.82-89). Pinetown, University of KwaZulu-Natal.
- Jonathan, C. (2006). Britain as a container; immigration metaphors in the 2005 election campaign. *Discourse of Society*, 17(5), 563-581.
- Kabeer, N. (1994). Gender Aware Policy and Planning: A Social Relations Perspective. In M. Macdonald, *Gender Planning in Development Agencies: Meeting the Challenges*. Oxford: Oxfam: UK.
- Kalu, I. (2005). Classroom interaction in physics lessons, relative to students' sex. *African Journal of Research in Mathematics, Science and Technology*, 9(1), 55-66.
- Kaptelinin, V. (2005). The Object of Activity: Making Sense of the Sense-Maker. *Mind, Culture and Activity*, 12(1), 4–18.
- Kaptelinin, V. and Miettinen, R. (2005). Perspectives on the object of activity. *Mind, Culture and Activity*, 12(1), 1-3.
- Kelder, K. H., Govender, D., and Govender, J. (2007). *Physical Sciences: study and master grade 12*. Cape Town: Cambridge University Press.
- Kelly, A. V. (1985). *The curriculum: Theory and practice*. London: Harper and Row.
- Kelly, J. (2000). Rethinking the elementary science methods course: a case for content pedagogy, and informal science education. *International Journal of Science Education*, 22, 755-777.
- Kerosuo, H. (2001). Boundary encounters as a place for learning and development. *Outlines*, 3(1), 55-65.

- Kerosuo, H. (2004). *Boundaries in action: An activity-theoretical study of development, learning and change in health care for patients with multiple and chronic illnesses*. Helsinki: University of Helsinki, Department of Education.
- Kerosuo, H. and Engeström, Y. (2003). Boundary crossing and learning in creation of new work practice. *Journal of Workplace Learning*, 15(7), 345-351.
- Kingdom, G. (2003). „Where has all the bias gone? Detecting gender bias in the intra-household allocation of educational expenditure“, Center for Study of African Economies, Oxford Working Papers. Retrieved March 23, 2008, from [www.csae.ox.ac.uk/workingpapers/pdfs/2003](http://www.csae.ox.ac.uk/workingpapers/pdfs/2003)
- Kidd, S. A. and Kral, M. J. (2005). Practicing participatory action research. *Journal of Counseling Psychology*, 52, 187-195.
- Konkola, R., Tuomi-Grohn, T., Lambert, P., and Ludvigsen, S. (2007). Promoting learning and transfer between school and workplace. *Journal of Education and Work*, 20, 211-228.
- Kost, L. E., Pollock, S. J and Finkelstein, N. D. (2009). Characterizing the gender gap in introductory physics. *Physical Review Special Topics - Physics Education Research*, 5 (1), 1-14
- Kronlid, D. O. (2009). Climate capabilities and climate change education research. *Southern African Journal of Environmental Education*, 26, 27-37.
- Krueger, R. A. (2008). *Focus group: A practical guide for applied research* (4th ed.). Thousand Oaks CA: Sage:
- Lederman, L. (1998). A response. *Studies in Science Education*, 31, 130-135.
- Leesa, W. (2007). Blending activity theory and critical realism to theorise the relationship between the individual and society and the implications for pedagogy. *Studies in the Education of Adults*, 39(2), 183-196.
- Leggatt, I. (2005). Learning to improve policy for pastoralists in Kenya. In S. Aikman, S. and E. Unterhalter (Eds.) *Beyond access: Transforming policy and practice for gender equality in education*. Oxford: Oxfam.
- Leont'ev, A. N. (1978). *Activity, consciousness and personality*. Englewood Cliffs, CA: Prentice Hall.
- Leont'ev, A. N. (1981). *Problems of the development of the mind*. Moscow, Soviet Union: Progress.
- Lincoln, Y. S. and Guba E.G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

- Livingstone, D. W. (2006). Contradictory class relations in work and learning: some resources of hope. In P. Sawchuk, N. Duarte, and M. Elhammoum *Critical perspectives on activity: Explorations across education, work and everyday life* (pp. 145-159). Cambridge: Cambridge University Press.
- London, J. L. et al. (2002). Pesticide usage and health consequences for women in developing countries: Out of sight, out of mind? *International Journal of Occupational Environmental Health*, 8(1), 46-49.
- Lotz-Sisitka, H. (2002). Curriculum partening in Environmental Education: A review of developments in south Africa. *Environmental Education ethics and Action in Southern Africa* (pp.97-120). Pretoria: HSRC/EEASA.
- Lotz-Sisitka, H. (2008a). Environmental education and educational quality an relevance. Opening the debate. *Southern African Journal of Environmental Education*, 25, 5-12.
- Lotz-Sisitka, H. (2008b). Change-oriented Workplace Learning and Sustainability Practices. *SAQA and RUEESU Research Programme Proposal*. Rhodes University, Grahamstown.
- Lotz-Sisitka, H. (2011). Teacher Professional Development with an Education for Sustainable Development Focus in South Africa: Development of a Network, Curriculum Framework and Resource for Teacher Education. *Southern African Journal of Environmental Education*, 28, 30-64.
- Lotz-Sisitka, H., Gumede, M., Olvitt, L., and Pesanayi, T. (2006a). *History and context of ESD in Southern Africa: Supporting participation in the UN decade of education for sustainable development*. Howick: SADC REEP.
- Lotz-Sisitka, H., Gumede, M., Olvitt, L., and Pesanayi, T. (2006b). *Partnership, networking and ESD in Southern Africa: Supporting participation in the UN decade of education for sustainable development*. Howick: SADC REEP.
- Lotz-Sisitka, H., Gumede, M., Olvitt, L., and Pesanayi, T. (2006c). *ESD practice in Southern Africa: Supporting participation in the UN decade of education for sustainable development*. Howick: SADC REEP.
- Lotz-Sisitka, H. and Raven, G. (2004). Learning through cases: adopting a nested approach to case study work in the Gold Fields participatory course initiative. *Environmental Education Research*, 10(1), 67-87.
- Lupele, J. and Lotz-Sisitka, H. B. (2012). *Learning today for tomorrow: sustainable development learning processes in Sub-Saharan Africa*. Howick: SADC REEP.
- Macey, D. (2000). *Dictionary of Critical Theory*. Penguin Books: London.

- MacKay, J. R. (2010). The effect of gender and context on using wiring diagrams as a tool to reveal student thinking. Paper presented at the ICPE international Symposium, Bangkok, Thailand.
- MacKay, J. R. (2011). "We shouldn't have to do this; we're girls!" An examination of gender, self-efficacy and conceptual understanding in electro-technology for a class of teacher trainees in design and technology at a South African University. Unpublished PhD thesis, University of Kwa-Zulu Natal.
- MacKay, J. and Parkinson, J. (2010). Gender, self-efficacy and achievement among South African Technology teacher trainees. *Gender and Education*, 22(1), 87-103.
- Madziva, J.S. (2000). Gender and Curriculum: Teaching girls science and mathematics. Policy makers' Seminar. Ministry of Education, Sport and Culture, Kadoma, Zimbabwe.
- Marcus, G. E. (1994). The modernist sensibility in Recent Ethnographic Writing and then Cinematic Metaphor of Montage. In L. Taylor, L (Ed.) *Visualising theory: Selected Essays from V. A. R. 1990-1994* (pp. 37-53). London: Routledge.
- Markova, I. (2003). *Dialogicality and social representations: The dynamics of mind*. Cambridge: Cambridge University Press.
- Martin, J. R. and Wodak, R. (2003).(Eds.) *Re/reading the past. Critical and functional perspectives on time and value*. London: Benjamins.
- Marshall, C. and Rossman, G. B. (2011). *Designing qualitative research* (5th ed.). Thousand Oaks,CA: Sage.
- Masika, R. (2002). Gender and Climate Change: Editorial. *Oxfam Gender and Development*, 10(2), 2-9.
- Matrikelnr, Y. H. (2006). *Critical Discourse Analysis; Analyzing the Beauty Advertisement Discourse: Dove's Campaign for Real Beauty*. Viadrina: Europa Universität.
- Mawere, D. and Chikunda, C. (2006). An evaluation of the implementation of the national gender policy in teacher education. Unpublished.
- Maxwell, J. A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks,CA: Sage.
- Mbilinyi, M. (1991). Struggles over Patriarchal Structural Adjustment in Tanzania. *Focus on gender*, 1(3) 26-29.
- McCowan, T. (2010). Reframing the universal right to education. *Comparative Education*, 46(4), 509-25.
- McCullough, L. (2004). Gender, context, and physics assessment. *Journal of International Women's Studies*, 5(4), 20-30.

- McKay, V. (1994). Feminism and sociological theory. In N. A. Romm, *Social theory* (pp. 340-369). Isando: Heinemann.
- McKernan, J. (2008). *Curriculum and imagination: process theory, pedagogy and action research*. London: Routledge.
- McSharry, G. and Jones, S. (2002). Television programming and advertisements: help or hindrance to effective science education? *International Journal of Science Education*, 24, 487-497.
- Mercer, N. (2004). Sociocultural discourse analysis: Analysing classroom talk as a social mode of thinking. *Journal of Applied Linguistics*, 1(2), 137-168.
- Merchant, C. (1980). *The Death of Nature: women, ecology and the scientific revolution*. San Francisco: Harper and Row.
- Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.
- Miettinen, R. (2009). Contradictions of the High-Technology Capitalism and the Emergence of the New Forms of Work. In A. D. Sannino, *Learning and Expanding with Activity Theory* (pp. 160-175). Cambridge: Cambridge University Press.
- Millar, R., and Osborne, J. (Eds) (1998). *Beyond 2000: Science Education for the future*. London: King's College.
- Millennium Development Goals country report for South Africa. (2010). Millennium Development Goals Status Report South Africa, Government of South Africa.
- Millennium Development Goals country report for Zimbabwe. (2010). Millennium Development Goals Status Report Zimbabwe, Government of Zimbabwe.
- Miller, P. H., Blessing, J. S., and Schwartz, S. (2007). Gender Differences in High-school students' views about Science. *International Journal of Science Education*, 28(4), 363-381.
- Mlama, P. et al. (n.d). *Gender Responsive Pedagogy: A Teacher's Handbook*. Nairobi: Forum for African Women Educationalists.
- Momsen, J. (2010). *Gender and Development*. London: Routledge.
- Morna, C., L. and Jambaya-Nyakujara, L. (2011). *SADC Gender Protocol Barometer*. Johannesburg: Southern Africa Gender Protocol Alliance.
- Morrison, K. R. (1995). Dewey, Habermas and reflective practice. *Curriculum*, 16(2), 82-94.
- Moser, C. (1993). *Gender planning and development. Theory, Practice and Training*. London: Routledge.

- Moser, C. (2001). The Gendered Continuum of Violence and Conflict: An operational Framework. In C. M. Clark, *Victims, Perpetrators or Actors? Gender, Armed Conflict and Political Violence*. London: Zed Books.
- Moser, C. (2003). *Gender planning and development: Theory, practice and training*. London and New York: Routledge.
- Mukute, M. (2010). Integrating sustainability in school curriculum and practice: the case of the schools and colleges permaculture programme in Zimbabwe. *ICID+18, August 16-20, 2010* (pp. 1-19). Fortaleza - Ceará, Brazil.
- Mukute, M. and Lotz-Sisitka, H. (2012). Working With Cultural-Historical Activity Theory and Critical Realism to Investigate and Expand Farmer Learning in Southern Africa. *Mind, Culture and Activity, 19*(4), 342-367.
- Murphy, E. and Rodriguez-Manzanares, M. A. (2008). Using activity theory and its principle of contradictions to guide research in educational technology, *Australasian Journal of Educational Technology, 24*(4), 442-457.
- Murphy, P. and Whitelegg, E. (2006). *Girls in the Physics classroom: A teachers' guide* London: Institute of Physics.
- Mutasa, N.G and Willis, G.M. (1994). *Modern practice in education and science*. Gaborone: Longman.
- Mwamwenda, T. (2010) Viva, viva Edgewood. In J. Wassermann and A. Bryan (Eds.) *From college to faculty of education; memories of the Edgewood campus of the University of KwaZulu-Natal* (pp.133-137). Pinetown: University of KwaZulu-Natal.
- Mwanza, D. (2002). Conceptualising work activity for CAL systems design. *Journal of computer assisted learning, 18*, 84-92.
- Naidoo, S. (2011). *Women's Occupational Health Working in Small-Scale Agriculture in South Africa*. Pietermaritzburg: Boutique Books.
- Nardi, B. A. (2005) Objects of desire: Power and passion in Collaborative Activity. *Mind, Culture and Activity, 12*(1), 37-51.
- Ndawi, O. (1987). Pedagogical Possibilities of African Cultural Activities from Zimbabwe. in P. Obanya (Ed.) *Pedagogical Possibilities of African Games, World Confederations of the Organisations of the Teaching Profession(WCOTP)*, Morges, Switzerland.
- Nelson, D. and D. Rogers. (2004). *A National Analysis of Diversity in Science and Engineering Faculties at Research Universities*. Research Report, University of Oklahoma. Retrieved July 26, 2011, from <http://www.now.org/issues/diverse/diversity>

- Neumayer, E. and Plümpner, T. (2007). The gendered nature of natural disasters: the impact of catastrophic events on the gender gap in life expectancy, 1981–2002. *Annals of the Association of American Geographers*, 97(3), pp. 551-566.
- Neuschatz, M. and McFarling, M. (2003). *Broadening the Base: High School Physics Education at the Turn of a New Century*. AIP Report R-439. Retrieved June 29, 2011 from <http://www.aip.org/statistics/trends/reports/hsreport2003.pdf>
- Niederle, M. and Vesterlund, L. (2007). Do women shy away from competition? Do men compete too much? *Quarterly Journal of Economics*, 122(3), 1067-1101.
- Niederle, M., and Vesterlund, L. (2010). Explaining the Gender Gap in Math Test Scores: The Role of Competition. *Journal of Economic Perspectives*, 24(2), 129-44.
- Nussbaum, M. (2004). Liberal education and global community. *Liberal education*, 90(1), 42-47.
- Nussbaum, M. (2005). Beyond the social contract: capabilities and global justice in G. Brock, and H. Brighouse (Eds.) *The political philosophy of cosmopolitanism*. Cambridge: Cambridge University Press.
- Nussbaum, M and Sen, A. (1993) (Eds.) *The Quality of Life*. Oxford: Clarendon Press.
- Nyoni, R. (2005). Gender and Feminism. A paper presented at a gender workshop. Gweru 22-23 February 2005.
- O'Connor, J. E. (2000). Teachers are the problem, not girls! Retrieved August 24, 2006 from [http://library.unesco-iicba.org/english/secondary\\_science\\_series\\_article](http://library.unesco-iicba.org/english/secondary_science_series_article)
- Oldham, G. (2001). Gender mainstreaming in science and technology: Does it matter? Retrieved July 7, 2006 from <http://gab.wigsat.org?Oldham.html>
- Onions, C. T. (1964). *The Shorter Oxford English Dictionary*. Oxford: Clarendon Press.
- Osborne, J., and Collins, S. (2001). Pupils' views of the role and value of the science curriculum: A focus-group study. *International Journal of Science Education*, 23, 441–467.
- Osborne, J., Simon, S., and Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*, 25, 1049-1079.
- Oxford English, D. (2007). *Oxford English Dictionary*. Oxford: Oxford University Press.
- Paraskeva, J. M. (2010). *Conflicts in curriculum theory: Challenging Hegemonic Epistemologies*. New York: Palgrave Macmillan.
- Paterson, G. I. (2007). *Boundary infrastructures for chronic disease*. Unpublished PhD thesis, Dalhousie University, Halifax, Canada.

- Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousands Oaks, CA: Sage.
- Peal, D., and Wilson, B. (2001). Activity theory and web-based training. In B. Khan (Ed.), *Web-based training* (pp. 147- 153). Englewood Cliffs NJ: Educational Technology Publications.
- Pendlebury, S. (2008). Meaningful access to basic education. In S. Pendlebury, L. Lake, and C. Smith (Eds.), *South African Child Gauge 2008/2009* (pp.24-29). Cape Town: Children's Institute.
- Peter, F. (2005). Gender and the foundations of social choice: The role of situated agency. In A. Bina, J. Hampries, and I. Robeyns (Eds.), *Amartya Sen's work and ideas: a gender perspective*. London, Routledge.
- Pollock, S. J and Finkelstein, N. D. (2009). Sustaining educational reforms in introductory Physics. *Physics review, special papers*
- Postlethwaite, K. (2007). Boundary crossings in research: Towards a cultural understanding of the research project 'Transforming learning cultures in further education'. *Educational Review*, 59, 483–499.
- Prasad, G. (2004). Gender issues in technology development in Lesotho. Institute of Southern Africa Studies: National University of Lesotho. Roma, Lesotho.
- Pressley, L. (2005). Whose Knowledge is it Anyway? Feminist Epistemology and Science. *An Annotated Bibliography* Information Sources and Services. LIS 620 University of North Carolina – Greensboro.
- Price, L. (2007). A transdisciplinary explanatory critique of environmental education. Unpublished PhD thesis, Grahamstown, Rhodes University.
- Puonti, A. (2004). Learning to work together: collaboration between authorities in economic-crime investigation. Center for Activity Theory and Developmental Work Research: Unpublished PhD thesis, Helsinki: University.
- Queck, A. and Alderson, A. (2002). An activity approach to understanding the difficulty of applying web engineering in practice: Technical report. Staffordshire: Staffordshire University.
- Rahman, M. A. (1991). Glimpses of the "Other Africa". In O. Fals-Borda and M. A. Rahman (Eds.) *Action and Knowledge: breaking the monopoly with Participatory action research*. New York: Intermediate Technology Pubs/Apex Press.
- Reinecke, J. M., Manning, S., and Von Hagen, O. (2012). The Emergence of a Standards Market: Multiplicity of Sustainability Standards in the Global Coffee Industry. *Organization Studies*, 33(5/6), 789-812.

- Robeyns, I. (2000). An Unworkable Idea or a Promising Alternative? Sen's Capability Approach Re-examined. *Econometrics*, 1-32.
- Robeyns, I. (2005) The capability approach - a theoretical survey. *Journal of Human Development and Capabilities*, 6(1), 93–114.
- Robottom, I. (1993). Paradigms and the ideology of environmental education research. Research in Environmental Education. *Research in Environmental Education: Engaging the debate*, 18-27.
- Rosenberg, E. (2004). Sustainable development-maintaining profits, or sustaining people and planet? In Parry-Davis, D. (Ed). *Enviropaedia*. Cape Town: Eco-Logic.
- Roth, W. and Lee, Y. (2007). Vygotsky's neglected legacy: Cultural historical activity theory. *Review of Educational Research*, 77(2), 186-232.
- Roulston, K. (2007). Theorizing the qualitative interview. *Third International Congress of Qualitative Inquiry*. Illinois: Urbana-Campaign.
- Roychoudhury, A., Tippins, D.J. and Nichol, S.E. (1995). Gender-inclusive science teaching: A feminist constructivist approach. *Journal of Research in Science Education*, 32(9), 897-924.
- Russell, D. R. (2001). *Looking Beyond the Interface: Activity Theory and Distributed Learning*. In M. Lea *Understanding Distributed Learning* (pp.64-82). New York: Routledge.
- Rwodzi, M. (2006). Similarities and differences in attitudes towards mathematics among Form 3 pupils in Gweru urban schools. *Zimbabwe Journal of Educational Research*, 18 (3), 420-439.
- Ryder, J. (2002). School science education for citizenship: strategies for teaching about the epistemology of science. *Journal of Curriculum Studies*, 34, 637-658.
- SADC Gender Monitor. (1999). *Women and the Remaking of Politics in Southern Africa*. Gaborone: SADC.
- SADC Protocol on Gender Equality. (2008). SADC Protocol on gender. Retrieved July 23, 2011, from <http://www.sadc.int/documents-publications/show/803>
- SADC REEP. (2002). *Education and Climate Change: Living and Learning in Interesting Times*. Howick: SADC REEP.
- Sannino, A. (2008). From talk to action: Experiencing interlocution in developmental interventions. *Mind, culture and activity*, 15, 234-257.
- SARDC. (2000). *Beyond inequalities: Females in Southern Africa*. Harare: SARDC.

- Sawchuk, P.H. (2009). *Social Movement Studies and the Role of Socio-Cognition for Understanding Change: The Case of Emergent Community/Union Coalition in Toronto, Canada*. Retrieved July 23, 2011, from <http://www.adulterc.org/Proceedings/2011/papers/sawchuk.pdf>
- Schmidt, E. (1994). Peasants, Traders, and Wives: Shona Women in the History of Zimbabwe, 1870-1939. *Africa: Journal of the International African Institute*, 64(3), 416-418.
- Schiebinger, L. (1999). *Has feminism changed science?* Cambridge, MA: Harvard University Press.
- Scott, D. (2008). *Critical essays on major curriculum theorists*. London: Routledge.
- Semela, T. (2010). Who is joining physics and why? Factors influencing the choice of physics among Ethiopian university students. *International Journal of Environmental and Science Education*, 5, 319-340.
- Sen, A. (1992). *Inequality Re-examined*. Oxford: Clarendon Press.
- Sen, A. (1999). *Development as Freedom*. Oxford: Oxford University Press.
- Sen, A. (2002). Health: Perception versus observation. *British Medical Journal*, 324, 859-860.
- Sen, A. (2005). „Human rights and capabilities“, *Journal of Human Development* 6(2), 151-166.
- Sen, A. (2009). *The idea of justice*. London: Allen Lane.
- Senteni, A. (2005). Innovative learning and knowledge communities for the integration of ICTs in enhancing education, WITFOR 2005 White Book-Education Commission (Best Practices Case Study), Gaborone (Botswana), August 2005.
- Seppänen, L. (2004). Learning challenges in organic vegetable farming: An activity theoretical study of on-farm practices. Helsinki: University of Helsinki, Education Department.
- Sewell, W. J. (1992). A Theory of Structure: Duality, Agency, and transformation. *American Journal of Sociology*, 98(1), 1-29.
- Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects *Education for Information*, 22, 63–75.
- Sheyholislami, J. (2008). Identity, discourse, and media: The case of the Kurds. *Canadian Journal of Communication*, 1-15.
- Shiva, V. (1989). *Staying Alive - women, ecology and development*. London: Zed Books.

- Shiva, V. (2012, March 12). *Democracy and Peace*. Retrieved November 5, 2012, from <http://engagechina.wordpress.com/2012/05/23/gender-based-approach-to-climate-change-governance-the-role-of-women-and-media/>
- Shumate, M., and Fulk, J. (2004). Boundaries and role conflict when work and family are colocated: A communication network and symbolic interaction approach. *Human Relations*, 57, 55–74.
- Shumba, O. (2005). *Guidelines for the integration of education for Sustainable Development (ESD): Perspectives into national education policies*. Harare: UNESCO.
- Shumba, O., Kasembe, R., Mukundu, C., and Muzenda, C. (2008). Environmental sustainability and quality education: Perspectives from a community living in a context of poverty. *Southern African Journal of Environmental Education*, 23, 81-97.
- Siegel, M. A. and Ranney, M. A. (2003). Developing the Changes in Attitude about the Relevance of Science (CARS) questionnaire and assessing two high school science classes. *Journal of Research in Science Teaching*, 40, 757-775.
- Sinnes, A. T. (2004). Three approaches to gender equity in science education. *Nordic Studies in Science Education (Nordina)*, 2, 1-6.
- Sinnes, A. T. (2006). Approaches to gender equity in science education: Three alternatives and two examples. *African Journal of Research in Mathematics, Science and Technology Education*, 10(1), 1-12.
- Sjøberg, S. (2002). Science and technology education in Europe: Current challenges and possible solutions. *Connect: UNESCO International Science, Technology, and Environmental Education Newsletter*, 27, 1-5.
- Smith, B. (1987). *The Truth that Never Hurts*. New Jersey: Rutgers University Press.
- Smith, D. (1974). Women's Perspective as a Radical Critique of Sociology. *Sociological Inquiry*, 44, 7-13.
- South African Government. (n.d.). *South Africa National Gender Policy Framework*. Johannesburg: Government of South Africa.
- South African Government (2010). *Education for All country report*. Department of Basic Education.
- Stake, R. E. (2005). Qualitative case study. In N. K. Denzin, *The Sage handbook of qualitative research* (3rd ed.) (pp.443-466). CA:Sage: Thousand Oaks.
- Stake, R. E. (2007). Recosidering generalization and theory in case study research. *Annual meeting of the American Educational Research Association*. Chicago.

- Stanford Encyclopedia of Philosophy. (2011). Metaphysics Research Lab, CSLI, Stanford University. Retrieved February, 5, 2012 from <http://plato.stanford.edu/entries/capability-approach/>
- Star, S. L. (2010). This is not a boundary object: Reflections on the origins of the concept. *Science, Technology and Human Values*, 35, 601-617.
- Star, S. L. and Griesemer, J. R. (1989). Institutional ecology, “translations” and boundary objects: Amateurs and professionals in Berkeley’s Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, 19, 387–420.
- Status of Women Canada 2004-05. *Estimates: A report on plans and priorities*. Status of Women Canada, Retrieved September 23, 2011, from <http://www.swc-cfc.gc.ca/abunans/index-eng.html>
- Stetsenko, A. (2005). Activity as Object-Related: Resolving the Dichotomy of Individual and Collective Planes of Activity. *Mind, Culture, and Activity*, 12(1), 70-88.
- Stetsenko, A. (2008). From relational ontology to transformative activist stance on development and learning: Expanding Vygotsky’s (CHAT) project. *Cultural Studies of Science Education*, 3, 471-491.
- St<sup>2</sup>eep. (2006). *St<sup>2</sup>eep guide to resource materials: Using resource materials in secondary and tertiary education*. St<sup>2</sup>eep, Harare, Zimbabwe.
- Stromquist, N. (1990). Gender equality in education: Accounting for women's subordination. *British Journal of Sociology of Education*, 11(2), 137-153.
- Struwig, F. W. and Stead, G.B. (2001). *Planning, designing and reporting research*. Cape Town: Pearson Education.
- Subrahmanian, R. (2005) Gender equality in education: definitions and measurements. *International Journal of Educational Development*, 25, 395-407
- Syed, J. and Ali, F., (2005), The Contextual Dimension of Emotional Labour and Working Women in Pakistan, Academy of Management Conference, Honolulu, 5-10 August Retrieved January 5, 2010, from <http://www.historians.ie/women/syed.pdf>
- Taylor, N. (2011). priorities for addressing South Africa's Education and Training crisis. Retrieved November 23, 2012, from <http://www.jet.org.za/publications/research/Taylor%20NPC%20Synthesis%20report%20Nov%202011.pdf>
- Teaching Profession. (2011). Ministry of Higher and Tertiary Education Zimbabwe, Harare.
- Tebbutt, K. (2010) An Octogenarian remembers... In J. Wassermann and A. Bryan (Eds.) *From college to faculty of education; memories of the Edgewood campus of the University of KwaZulu-Natal* (pp.26-29). Pinetown: University of KwaZulu-Natal.

- Thorpe, H. (2009). Bourdieu, Feminism and Female physical culture: Gender reflexivity and the Habitus-Field Complex. *Sociology of Sport Journal*, 16, 491-516.
- Tickner, J. A. (2001). *Gendering World Politics: Issues and Approaches in the Post-Cold War Era*. New York: Columbia University Press.
- Tickly, L. (2010). Towards a framework for understanding the quality of education . *EdQual Working Paper No.27*,.1-25.
- Tickly, L. and Barrett, M. (2013). Education quality and social justice in the global South: Towards a conceptual framework. In L. Tickly and M. Barrett (Eds.) *Education quality and social justice in the global South: Challenges for policy, practice and research* (pp.12-22). New York: Routledge.
- Toma, D. J. (2011). Approaching rigor in applied qualitative research. In C. F. Conrad, *The Sage Handbook for Research in education* (2nd ed.)(pp. 263-280). Los Angeles: Sage.
- Turpie, J. K., Marais, M. and Bignaut, G. (2008). The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. *Ecological Economics*, 65(4), 788-798.
- UN. (2000). *Report of the Ad Hoc Committee of the Whole of the 23rd Special Session*. United Nations.
- UN. (2005). United Nations General Assembly (2005). 2005 World Summit Outcome, Resolution A/60/1, adopted by the General Assembly on 15 September 2005. New York: UN.
- UN. (2010). *Country Analysis Report for Zimbabwe*. Harare: UN.
- UNDP. (2005). *Human Development Report*. New York: Oxford University Press
- UNDP. (2010). *2010 Millennium Development Goals Status Report Zimbabwe*. Harare: Government of Zimbabwe.
- UNDP. (2012). *International Human Development indicators*. Harare: UNDP.
- UNESCO. (2000) The Dakar Framework Education For All: Meeting Our Collective Commitments. Adopted by the World Education Forum Dakar, Senegal, 26-28 April 2000. Paris.
- UNESCO. (2003). *EFA Global monitoring report 2003/4*. Paris: UNESCO.
- UNESCO. (2004). *Education for All: The Quality Imperative*, EFA Monitoring Report 2005. Paris: UNESCO.
- UNESCO. (2005a). *Education for All: The Quality Imperative*. Global monitoring report. Paris: UNESCO.

- UNESCO. (2005b). *United Nations Education for Sustainable Development (2005-2014): Linkages between the global initiatives in education*. Paris: UNESCO.
- UNESCO. (2005c). *Gender inclusive science and technology education survey*. Paris: UNESCO.
- UNESCO. (2006a). *Strategy of Education for Sustainable Development in Sub-Saharan Africa*. Paris: UNESCO.
- UNESCO. (2006b). *Towards implementation of the Decade of Education for Sustainable Development in Sub-Saharan Africa*. Windhoek: UNESCO.
- UNESCO. (2008). *Quality education, equity and sustainable development: a holistic vision through UNESCO's Four World Education Conferences 2008-2009*
- UNESCO. (2009). *Workshop 5: Education for food security – the contribution of ESD. UNESCO World Conference on Education for Sustainable Development, 31 March to 2 April, 2009, held in Bonn, Germany.*
- UNESCO. (2010). *UNESCO Chair on Reorienting Teacher Education to Address Sustainability: International Network*. Retrieved August 2, 2012, from <http://www.unesco.org>
- UNESCO. (2011). *Education for Sustainable Development Expert Review of Processes and Learning*. Paris: UNESCO.
- UNESCO. (2012). *Education for Sustainable Development; Source book*. Paris: UNESCO.
- UNFPA. (2009, November 13). *Population, gender, and climate change*. Retrieved September 23, 2012, from [http://www.unfpa.org/webdav/site/global/shared/documents/publications/2009/climateconnections\\_2\\_policy.pdf](http://www.unfpa.org/webdav/site/global/shared/documents/publications/2009/climateconnections_2_policy.pdf)
- UNICEF. (2009). *Multiple Indicator Monitoring Survey 2009*. Harare: UNICEF.
- UNPF. (2009). *UNFPA State of the world population 2009. Facing a changing world: females, population and climate*. Bonn: UN.
- Unterhalter, E. (2003). *Education, capabilities and social justice; Gender and Education for All: The Leap to Equality*. Background paper prepared for the Education for All Global Monitoring Report 2003/4. Retrieved March 24, 2011, from <http://unesdoc.unesco.org/images/0014/001469/146971e.pdf>
- Unterhalter, E. (2005). Global inequality, capabilities, social justice: The millennium development goal for gender equality in education. *International Journal of Education Development*, 25(2), 111-122.
- Unterhalter, E. (2007). *Gender, schooling and global social justice*. London: Routledge.
- Unterhalter, E. (2009). What is Equity in Education? Reflections from capability approach. *Springer Science+Business Media*, 28, 415-424.

- Unterhalter, E. and North, A. (2011). Responding to the gender and education. Millennium Development in South Africa and Kenya: Reflections on education rights, gender equality, capabilities and global justice. *Compare: A Journal of Comparative and International Education*, 41(4), 495–511.
- Van der Berg, S. (2008). Education Roadmap: Diagnostic. Retrieved January 3, 2012, from <http://www.dbsa.org/Research/Education%20Roadmap/Diagnostics%20on%20Education>
- van Dijk, T. A. (1993). Principles of critical discourse analysis. *Discourse and Society*, 249-283.
- van Dijk, T. A. (2001). Critical discourse analysis. In H. Hamilton (Ed.), *Handbook of Discourse Analysis* (pp.352-371). Oxford: Basil Blackwell.
- Vietzen, S. (2010) Edgewood: a rugged and glorious past. In J. Wassermann and A. Bryan (Eds.) *From college to faculty of education; memories of the Edgewood campus of the University of KwaZulu-Natal* (pp.11-18). Pinetown: University of KwaZulu-Natal.
- Vygotsky, L. (1978). *Mind in society: the development of higher psychological processes*. Cambridge: Harvard University Press.
- Vygotsky, L. (1986). *Thought and language* (A. Kozulin, Ed., Trans.). Cambridge, MA: MIT Press. (Original work published 1934).
- Walby, S. (2005). Gender mainstreaming: Productive tensions in theory and practice. *Social, politics: International studies in gender, state and society*. 12(3), 321-343.
- Walker, M. (2005). Amartya Sen's Capability Approach and Education. *Education Action Research*, 13(1), 103-110.
- Walker, M. (2006). *Higher education pedagogies*. Berkshire: Open University Press.
- Warmington, P., Daniels, H., Edwards, A., Brown, S., Leadbetter, J., Martin, D., et al. (2005 14th-17th of September). Surfacing contradictions: intervention workshops as change mechanisms in professional learning. *British educational research association annual conference, University of Glamorgan*, (pp.1-27). University of Glamorgan.
- Wells, G. (2002). The role of dialogue in activity theory. *Mind, Culture, and Activity*, 9, 43–66.
- Wells, J. C. (2003). The Sabotage of Patriarchy in Colonial Rhodesia, Rural African Women's Living Legacy to their daughters. *Feminist Review*, 75, 101-117.
- Wenger, E. (1998). *Communities of practice, learning, meaning and identity*. Cambridge: Cambridge University Press.
- Wertheim, M. (1995). *Pythagoras' trousers God, physics and the gender wars*. New York: W. W. Norton.
- White, M., Hartel, C. E. J., and Panipucci, D. (2005). Understanding cross-cultural negotiation: A model integrating affective events theory and communication accommodation theory. In N. M. Ashkanasy, C. E. J. Hartel, and W. J. Zerbe (Eds.), *Emotions in organizational behavior* (pp.167–182). Mahwah, NJ: Erlbaum.

- Wodak, R. (1999). The Discursive Construction of National Identity Chapter two. In R. E. Wodak *The Discursive Construction of National Identity* (pp.7-10). Edinburgh: Sage.
- Women and Gender Constituency. (2009). *Draft Charter of the Women and Gender Constituency*. Women's caucus climate at the change conference, October 2009, Bangkok, Thailand. Retrieved January 5, 2011 from [http://www.gendercc.net/fileadmin/inhalte/Dokumente/Network/2wia09\\_15talkpoints\\_gotelind.pdf](http://www.gendercc.net/fileadmin/inhalte/Dokumente/Network/2wia09_15talkpoints_gotelind.pdf)
- World Bank. (2004). Girls' Education in the 21st Century Gender Equality, Empowerment, and Economic Growth. Retrieved January 3, 2011, from <http://siteresources.worldbank.org/>
- World Bank. (2005). *Pro-poor Growth in the 1990s: Lessons and Insight from 14 Countries*. Washington, DC: World Bank.
- World Bank. (2006). *Gender Equality as Smart Economics*, World Bank.
- Yagelski, R. P. (2011). *Writing as a Way of Being: Writing Instruction, Nonduality, and the Crisis of Sustainability*. New York: Hampton Press, Inc.
- Yamagata-Lynch, L.C. (2003). Using Activity Theory as an Analytic Lens for Examining Technology Professional Development in Schools. *Mind, culture and activity*, 10(2), 100–119.
- Yin, R. K. (2008). *Case study research: Design and methods* (4th ed.). CA: Thousand Oaks.
- Zakieldeen, S. (2009). *Building resilience*. Khartoum: Sudanese Conservation Society.
- Zevenbergen, R. (2005). The construction of a mathematical habitus: implications of ability grouping in the middle years. *Journal of Curriculum Studies*, 37(5), 607-619.
- Zimbabwe Millennium Development Goals Progress Report. (2004 and 2010). Harare: The government of Zimbabwe.
- Zimbabwe Millennium Development Goals Status Report. (2010). Government of Zimbabwe.
- Zimbabwe National Gender Policy. (2004). Harare: Ministry of Gender and community Development.
- Zimbabwe National Statistics Agency. (2011). *Zimbabwe Demographic and Health Survey*. Harare: Zimbabwe National Statistics Agency.
- Zimbabwe Women's Resource Centre Network. (2009). *Gender analysis of the education sector*. Harare: Zimbabwe Women's Resource Centre Network.

## Appendices

### **Appendix 1 Sample letter requesting partnership in research**

No 5 Kareather Court 71 Main Road  
Howick  
3290

19 July 2010

Dear Dr Govender

REQUEST TO ACCESS SCHOOL OF SCIENCE, MATHEMATICS and TECHNOLOGY  
EDUCATION FOR PHD RESEARCH.

This letter serves to request access to your School of SMTE as one of the research sites for my PhD studies.

I am a part time PhD student registered with the Department of Education, Rhodes University, Grahamstown. The focus of my study is Exploring and Expanding Gender Responsiveness in Science Teacher Education Curriculum Practices: Case studies in Zimbabwe and South Africa?. Because I am currently teaching at a school in Howick, it will be cost effective and expedient to engage with your school.

My planned stages of the research are:

- 1.Document analysis
- 2.In depth interviews
- 3.A focus group discussion with lecturers
- 4.One workshop with lecturer to share my analysis of the data from above as well as for them to identify limitations and tensions.
- 5.One workshop to develop tools to address some of the limitations
- 6.One workshop to critique tools developed.

The process will probably spread over six months and I will negotiate the most suitable times. I have enclosed my research proposal which has been accepted by the Rhodes University Higher Degrees Committee

Should you need more information please do not hesitate to contact me or my supervisor, Prof. Heila Lotz-Sistka, h.lotz-sisitka@ru.ac.za

Charles Chikunda  
(RU student number:g10c7615 )  
cchikunda@yahoo.com 074 241 9183

**Appendix 2 Sample letter: thanking participants and appreciation for extended contact**

*Rhodes University  
Environmental Learning and Research Centre  
P O Box 94  
Grahamstown 6140  
South Africa  
Cell: +27-742419183  
26 October 2011*

*The Head of Department (Sciences)  
Belvedere Technical Teachers' College  
P. O. Box BE 100  
Belvedere  
Zimbabwe*

*Dear Sir*

*As I come towards the end of my field work, I would like to sincerely thank you for affording me the opportunity to do research in your department. I want to particularly thank you for the interest, eagerness and effort that you and your staff showed when taking part in this research. May you please extend my gratitude to the college authorities for allowing teacher educators to participate in this study during working hours.*

*May I also take this opportunity to register my appreciation for allowing me to continue working closely with the newly formed integrated syllabi review committee. I truly enjoy working with your team. I intend to come back and follow up on the progress in due course.*

*Wishing you all the best*

*Charles Chikunda (PhD Student)*

## **Appendix 3.1 Interview guide for Teacher Educators**

*This interview schedule guided the conversation between the researcher and teacher educators. Its format is informed by dimensions of the activity theory. It was designed to generate data needed to assess the level of gender and sustainability responsiveness of SMTs teacher educators; to scrutinize underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices in SMTs teacher education and to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context. At the same time the interview was intended to establish the current contradictions in the activity system and trace their root causes. The information gathered through this tool was used as mirror data in subsequent change laboratory workshops.*

### **A. Background and History**

1. Please tell me about your history in teaching Science and in teacher education
2. What is your experience with the participation of girls and boys in SMTTs?

### **B. Teacher educators as Subjectivity: level of gender awareness.**

1. Why do you think girls become less and less interested in sciences as they continue with their education?
2. Do you see any link between the culture at home and the learning of SMTs in school?
3. Do you think girls and boys may have different preferred learning styles?
4. As we teach science do we take into consideration the socio-ecological risks and their gendered nature?

### **C. Curriculum practice as Object: Level of gender responsiveness (practices)**

1. What curriculum efforts are there/are you putting in your practice to impart gender responsive skills, knowledge, and attitudes to future SMTs teachers?
2. Do you have actual focus on gender issues such as developing skills in trainee teachers to be able to check on gender stereotypic information in language or paying special attention to the constraints faced by girls as they attempt to study?
3. What efforts do you put in place to ensure education for all in SMTs as prescribed by Education for All policy for example?
4. How do you make sure that emerging issues e.g. climate change, gender issues are incorporated into the curriculum?
5. Do you in anyway teach future SMTs teacher to any of the following?: (see appendix 4.2)

### **D. Rules**

1. Are there any constraints that you face in incorporating socio-cultural issues in your curriculum?
2. Which policies or regulations do you work with in incorporating socio-ecological issues in your curriculum?

### **E. Division of labour/community**

1. Whom do you work with in all this?
2. Do you know of anyone who can help you in incorporating gender and ESD into the curriculum?

## **Appendix 3.2 Interview guide for other Activity Systems**

*This interview schedule guided the conversation between the researcher and officials from rule and tool making activity systems. Its format was also informed by dimensions of CHAT. It was designed to generate data needed to assess the support given to the SMTs teacher education curriculum by these rule and tool making activity systems. Data generated helped me to respond to the research goals of scrutinizing underlying mechanisms that affect (promote or constrain) gender and sustainability responsive curriculum practices in SMTs teacher education and that of gauging the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context. The interviews also established the current contradictions in and within activity systems. The information gathered through this tool was used as mirror data in the change laboratory workshops.*

### **A. Background and History**

1. Please tell me about your history in working with teacher education
2. What exactly is the mandate of your office in terms of teacher education curriculum.

### **B. Subjectivity: individual conceptions, level of gender and sustainability awareness**

1. How far do you influence teacher education curriculum development in view of current socio-ecological issues such as gender inequality in education?
2. What is your opinion on the low involvement/participation of females in sciences?
3. In your planning for curriculum development do you take into consideration the socio-ecological risks and their gendered nature?

### **C. Object: Level of gender and sustainability responsiveness in curriculum practices.**

1. As curriculum drivers how do you ensure that emerging issues e.g. climate change, gender issues are incorporated into the curriculum and whom do you work with?

OR As a gender focal how do you make sure that gender issues are incorporated into the SMTs curriculum and whom do you work with

2. How do you cascade the relevant knowledge down to teacher education say from UNESCO

3. As Head Office/DTE do you have the mandate to check on assessment and give input e.g. querying why ESD is not well reflected in assessment items or gender issues into the curriculum?

4. Do you have actual focus on gender issues such as developing skills in trainee teachers to be able to check on gender stereotypic information in language or paying special attention to the constraints faced by girls as they attempt to study?

5. How would you evaluate your efforts so far, do you think your efforts are having an impact in establishing gender equality in sciences?

6. As we teach science do we take into consideration the socio-ecological risks and their gendered nature?

#### **D. Rules**

1. Which policies do you work with in this curriculum development effort?
2. Why do you choose these policies that you have mentioned?
3. Are there any structures in place to facilitate translation of policy into curriculum practices?
4. Are there any constraints that you face in incorporating the process of translating policy into curriculum practices?

#### **E. Division of labour/community**

1. Whom else is or should be involved in this and why?
2. Do you know of anyone who can help you in incorporating gender and ESD into the curriculum?

### **Appendix 3.3 Document Analysis Tool**

*This Document Analysis Tool was designed to generate data from written documents to supplement the information gathered from the interviews. The tool was designed to assess the level of gender and sustainability responsiveness in the curriculum practices of SMTs teacher educators as to gauge the extent to which the science teacher education curriculum practices consider the functionings and capabilities of females in relation to increased socio-ecological risk in a southern African context. Documented information in policies and curriculum statements was also used to establish contradictions in the activity systems. As shown below the tool was designed to assess the document’s engagement with issues at three levels not mentioned, mentioned in passing and critically discussed. The tool also looked at whether documents look at issues at the gender socio-ecological risk nexus.*

Docu ment	Gender issues in SMTs			Socio-ecological issues in SMTs			Nexus of gender and Socio-ecological risk
	Not mentioned	Mentioned in passing	Critically discussed	Not mentioned	Mentioned in passing	Critically discussed	
1							
2							
3							

## **Appendix 4.1 Interview analysis tool**

<b>Element of activity system</b>	<b>Guiding Question</b>	<b>Notes</b>
Tools	Any evidence of conceptual and/or material tools/artefacts used towards gender and sustainability responsiveness in SMTs teacher education curriculum?	
Subject(s)	Who is doing what or is supposed to do what in terms of gender and sustainability in SMTs teacher education curriculum?	
Object	Any evidence of gender and sustainability as object of curriculum practice?	
Outcome	Is there any desire to impart skills, knowledge, attitude and values for gender and sustainability responsiveness to SMTs trainee teachers?	
Community	Who are the people who are working or supposed to be working towards the curriculum object of gender and sustainability responsiveness in SMTs teacher education curriculum?	
Rules	What are the explicit and/or implicit policies, regulations, norms and values that constrain or enable gender and sustainability responsiveness in SMTs teacher education curriculum?	
Division of labour	What are the horizontal and vertical allocation of responsibilities which mediate relationship between the community and the object (gender and sustainability responsiveness in SMTs teacher education curriculum)?	
Relational agency	What opportunity is revealed that can be utilized to expand the object through working with others and drawing on available resources.	

## **Appendix 4.2 Capabilities Checklist**

<b>Capability aspect in SMTs Education</b>	<b>Evidence indicators</b>
Analyse sexist bias/gender stereotypes in resources, content and language.	
Examine content, teaching methods and classroom dynamics that encompass girls' and boys' interest, experiences and learning styles.	
De-emphasizing sex-role stereotyping that hinder girls' progress in science.	
Draw the attention of boys and girls to the presence and contributions of women in science and mathematics	
Alert future teachers to be on the watch out for boys/girls who want to dominate classroom proceedings to the detriment of others	
Ensure that future teachers are able to deal with counter cultural practices that may impact negatively on girls'/boys' pursuance of sciences	
Expose future teacher to various ways to help empower girls and raise their self-esteem in sciences.	
Assist future teachers to add relevance and quality to science by drawing attention to socio-ecological issues	
Prepare future teachers to be sensitive to be sensitive to gender connotations in learning contexts.	
Issues of relevance and quality of education	
Evidence of developing critical thinking	
Assist future teachers to add relevance and quality to science by drawing attention to socio-ecological issues	
Evidence of engagement with conversion factors (Personal, social and environmental).	