TEACHERS' PERCEPTIONS OF THE INTEGRATION OF SOCIO-SCIENTIFIC ISSUES IN THEIR SCIENCE CLASSES

by

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DECLARATION

I, Zaiboenisha Ahmed, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed **Date**

ABSTRACT

The purpose for this study was to reveal the perceptions held by science teachers on the integration of socio-scientific issues in their science teaching. Also pertinent to this investigation was an understanding of what these teachers saw as the purpose(s) of such integration, how they purported to carry out the integration in their classroom, and how they perceive the role of social justice in science teaching. The theoretical principles of critical pedagogy underpinned the study and its methodology was guided by a phenomenological approach.

The qualitative study was confined to eight schools in the Cape Town Metropole and ten science teachers made up the purposefully selected sample. Grounded theory was used as a method of analysis of the transcripts obtained from the semi-structured interviews conducted with the teachers on the socio-scientific issues depicted by two scenarios. Teachers saw the purposes for SSI integration in terms of its focus on the science curriculum, the everyday relevance of science and the impact of science. In addition they thought SSI integration could be useful to inculcate values, encourage behaviour change, advance both society and self, and develop critical thinking. They cited seven different teaching strategies and practices which they preferred for such integration: enquiry-based tasks; science content-specific activities; science-technology-society-environment (STSE) activities; communication of science information; science oriented projects; literacy programmes and deliberation and decision-making. The teachers thought that they could use the SSI scenarios to address socio-economic issues and issues pertaining to equity, self-determination, equality and civic values.

Four general teacher profiles emerged from the research findings. These profiles captured both the commonalities and diversity existing among the participants' perspectives.

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I am grateful to all the teachers who so willingly gave of their precious time to take part in this study.

DEDICATION

I dedicate this work to the following people:

My late mother, Jameela Ahmed, who first taught me the love for learning.

My father, Essack Ahmed, who will always be “The wind beneath my wings”.

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GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
C & W-B	Chapman and West-Burnham
CAPS	Curriculum and Assessment Policy Statement
CP	Critical Pedagogy
DoBE	Department of Basic Education
DoE	Department of Education
GET	General Education and Training
LO and LOs	Learning Outcome and Leaning Outcomes
PoE	Parity of esteem
RNCS	Revised National Curriculum Statement
SA and SAs	Specific Aims and Specific Aims
SEIs	Socio-economic issues
SES	Socio-economic standard
SESPA	Science Education for Socio-political Action
SL	Scientific literacy
SQ	(Research) sub-question
SSI and SSIs	Socio-scientific issue or Socio-scientific issues
STL	Science and Technology Literacy
STS	Science-Technology-Society
STSE	Science-Technology-Society-Environment
USES	Urban Science Education Studies
WCED	Western Cape Education Department

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

One of the aims of the South African Constitution (Act 108 of 1996) is to heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights (DoBE, 2011:3). In post-apartheid South Africa, new education policies formulated in the early 2000's were introduced as the Revised National Curriculum Statement Grades R-9 (RNCS) and the National Curriculum Statement Grades 10-12 (NCS) for all learning areas and subjects. In 2012 the overall revised *National Curriculum Statement Grades R-12* was implemented – a document for learning and teaching in South Africa which has as one of its components a Curriculum and Assessment Policy Statement (CAPS) for all approved school subjects. The statement describes one of the sets of principles on which it is based as follows:

> Human rights, inclusivity, environmental justice and human rights as defined in the Constitution of the Republic of South Africa. The National Curriculum Statement Grades R-12 is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors. (DoBE, 2011:5)

It is in the Natural Sciences learning area, specifically the senior phase (from Grades 7 to 9) of the General Education and Training (GET) band, that the introduction to and the promotion of scientific literacy first take place (DoE, 2002:4-5). During this phase a learner's ability for abstract thinking and reasoning starts to develop, and the curriculum makes provision for this through opportunities to examine and debate issues in a scientific, technological and environmental context (DoE, 2002:4-5). Such a promotion is achieved through the three processes (as operationalised through three Learning Outcomes or LOs), namely the development of science process skills, the development of scientific knowledge and understanding, and an appreciation of the interrelationships between science, technology, society and the environment. The CAPS document for the Natural Sciences (Grade 7-9) replaces the three LOs with three similar operational processes called Specific Aims (SA). Specific Aim 2 calls for learners to have a grasp of scientific, technological and environmental knowledge and be able to apply these in new contexts. Specific Aim 3 calls for learners to be enriched to understand the connections between science and society (DoBE, 2011:10).

Descriptions around the promotion of the second and third operational processes are of particular significance to this study. These processes take into account, among others, the learners' ability to think objectively using a variety of forms of reasoning, the preparation of learners for active participation in a democratic society that values human rights and promotes environmental responsibility, the promotion of an understanding of how science may contribute to social justice and

societal development, and the consequences of decisions involving ethical issues (DoE, 2003:45). Sadler (2004b:41) endorses this line of reasoning and adds that in order for students to achieve scientific literacy, they need to be able to use scientific processes and habits of mind to solve problems faced in everyday life, confront issues that involve science, and make informed decisions.

Also addressed in policy documents over the past few years, is the issue of "social transformation *in* education" (emphasis added), highlighted as a form of redress for past educational imbalances - a legacy of the Apartheid era - to ensure equal educational opportunities for all sectors of the South African population (for example, DoE, 2003). Significant to this study is the statement in the aforementioned policy documents that social justice requires the empowerment of those sectors of the population that were previously disempowered by the lack of knowledge and skills (DoE, 2003). Here, I believe, reference is made to both the previously disadvantaged and the previously advantaged sectors of South African society.

The South African curriculum policies are also very specific in the role they envisage for teachers to ensure its successful implementation. These policies make it incumbent on teachers and other educators to become key contributors to the transformation of education in South Africa, emphasising that the new curricula seek to promote democratic values, human rights, inclusivity, and environmental and social justice as defined in the constitution of the country (for example, DoE, 2003:1-5). The NCS implemented in 2012 prescribes that science should be taught using a variety of teaching and learning approaches to promote an understanding of the contribution of science to social justice and societal development and the need for using scientific knowledge responsibly in the interest of ourselves, of society and the environment.

The maintenance of a democratic state and society is only sustainable in a supportive culture where there is a commitment to democratic values, skills and, particularly, behaviours (De Lange, Pillay & Chikoko, 2011:5). In such a society, it is essential to develop the procedural values that underpin democratic debate. Examples of such values are the celebration of social and political diversity, mutual respect between individuals and groups, equal social and political rights for all people, respect for evidence in forming opinions, as well as respect for the opinions of others based on evidence, and possessing a critical and analytical stance towards information (De Lange et al., 2011:5). Discussing controversial issues in the classroom provides learners with the opportunity to develop such democratic values, as well as the practice of cooperation, bargaining, compromise and accommodation. Although in South Africa the overall education policy is quite explicitly geared towards education for democracy, and its aim is to develop a culture of human rights in schools based on respect and dialogue between teachers and learners, the realities of practice have been shown to depart significantly from such policy (De Lange et al., 2011:6). In the context of the new South African national curriculum, Scholtz, Braund, Hodges, Koopman and Lubben (2008:22) see a need for

teachers to change their pedagogy from one that is more didactic and teacher controlled, to one which encourages more active learner participation and emphasises cooperation, critical thinking and social responsibility.

In Smyth's (2011:28-29) opinion, the identity of the 'preferred' teacher is one who is dutiful, compliant, market responsive and uncritical of the circumstances and conditions around him or her. Teachers are rendered apolitical and non-partisan in a culture that bases success solely on meritocratic effort, and an emphasis on personal effort and appropriate choices to reap social and economic rewards. This technicist agenda asks of teachers to implement decisions, follow directions and not to question. This is contrary to a 'social justice' or socially critical agenda. Smyth (2011:5) prompts us to keep in mind the Freirean view of teaching as work that takes place in the social practice that the teacher is part of, and that as such, teaching is not individual, but social.

1.2 Background to the study

From 2002 till mid-2008, during which time the RNCS and NCS policies were implemented in the GET and FET bands respectively, I was a Natural and Physical Science teacher at two high schools. The first school was located in Mitchell's Plain on the Cape Flats and its learners and teachers were predominantly Coloured. Most of the learners were from communities around and near the school. At that time, the school was one of a few Coloured and Black schools that took part in the Western Cape Education Department (WCED) Dinaledi programme to improve learner performance and increase participation in Mathematics, Life Sciences and Physical Sciences. Regular teacher and learner training and workshop sessions in science, mathematics and computers were held after hours and during school holidays. The second school was a technical high school and a former Model C school located in a predominantly White area in the Southern Suburbs. This school focused specifically on the physical sciences, mathematics and technical subjects. Most of the teachers at this school were White, while its learner population was made up of mostly male Coloured and some Black learners, all of whom were commuting from areas across the Cape Flats.

My time spent at these schools did not reveal any significant changes in the way my colleagues approached their science lessons. Very little effort was made to plan lessons around LO 3 (Science, Society and the Environment). It is my opinion that very little of the noble visions around science teaching and learning embodied in the policy documents were brought to fruition during those years. At the second school especially, emphasis was placed on examination results in science and mathematics and assessment activities which focused on content and rote learning were preferred. Many of my colleagues, though, gave the impression that they were appreciative of the activities pertaining to LO 3 which were regularly addressed at teacher training sessions and workshops run by the WCED. The fact that hardly any of these activities found their way into their lessons could maybe be substantiated by the findings of a study done by Lewis and Leach (2006:1268). Their study found

that science teachers feel that they lack the necessary skills and confidence to manage discussions of social issues and that they tend to view science as value free and objective. These teachers feared that the introduction of values and uncertainty would undermine such a view and therefore they preferred to focus on the content of their subject (Lewis & Leach, 2006:1268).

1.3 The purpose of the study

The purpose of the study is to ascertain how General Education and Training (Senior Phase) Grade 8 and 9 science teachers in the Western Cape perceive the integration of socio-scientific issues in their science classes in terms of the purposes of such integration, the teaching strategies and practice they would employ to do so, and what role they see for social justice in their teaching.

1.4 Research method

In this qualitative study I used a purposive sampling technique to select the ten participants from high schools in the Cape Town Metropole. All ten participants were teaching Grade 8 or 9 Natural Science when they agreed to be part of the study. Natural Sciences is a compulsory subject in the GET phase. The main research instrument was a semi-structured interview schedule (Appendix B) with questions around two scenarios depicting various socio-scientific issues (SSIs). Permission was sought from the Western Cape Education Department before interviewing the participants.

1.5 Limitations of the study

The data collection was done using ten participants from eight schools in the Cape Town Metropole. It can be regarded as a small scale sample and the research findings can therefore not be generalised to all South African schools. In Zientek's (2007:962) opinion, however, this is acceptable, because "…samples are not without limitations but can yield some insights when sample characteristics reasonably well match those of targeted populations" (Zientek, 2007:962).

1.6 Outline of the chapters

In **Chapter One** I provided an introduction and background to the research problem, the purpose of the study and the actual research problem. I also briefly outline the research method of the study and some of the limitations it presented.

Chapter Two outlines the literature pertaining to critical pedagogy, the broad theoretical framework underpinning this study. It also describes the literature on socio-scientific issues, and constructs associated with its teaching such as scientific literacy and social justice.

Chapter Three provides the details of the research design and the methodology of the study, including the data collection and analysis procedures that were followed.

Chapter Four presents the research findings of the study, and a detailed analysis of the emergent themes and the teacher profiles that were developed.

Chapter Five provides a discussion and interpretation of the research findings, and provides recommendations that include implications for teacher-training. Suggestions for further research as well as a conclusion to the thesis are provided.

CHAPTER TWO

A REVIEW OF THE LITERATURE

[Society] must have a type of education which gives individuals a personal interest in social relationships and control, and the habits of mind which secure social changes.

John Dewey
Democracy and Education, 1916

2.1 Overview

In this chapter I contextualise the constructs of socio-scientific issues and social justice against the backdrop of what Abd-el-Khalick (2003:41) calls "the conceptualization of functional scientific literacy", and two of its most significant components, namely the need to address the social functions of science and to develop the ability to make informed decisions regarding science-related personal and societal issues. A review of relevant literature dealing with scientific literacy, socio-scientific issues and social justice is presented. I commence this chapter by exploring the fundamental philosophical ideas and assumptions of critical pedagogy and motivate the positioning of my research study in this theoretical paradigm. Following this introduction is a review of scientific literacy as the concept which attempts to define what ordinary citizens should know about science in order to live more effectively with respect to the natural and social worlds. This is, according to DeBoer (2000:594), the ultimate goal and stated outcome of science education reform, and also on which the science curriculum changes in South African over the last decade have been based. Next, I expand on the construct of socio-scientific issues which provides a possible medium through which the context of scientific literacy could be addressed more explicitly (Sadler, 2004b:39), and more importantly in the context of this study, the means by which to gauge science teachers' perceptions on the role of social justice in the science class. The chapter is concluded by outlining a conceptual framework for this research study - an integrated model of science education and social justice, and its related principles of equality and equity. The conceptual framework allows the findings from this research to be located within a wider educational and social context.

At the outset of this chapter I deem it necessary to clarify my understanding of the difference between a theoretical framework and conceptual framework, and why this study makes use of both of these. In some literature the theoretical framework is described in terms of its overall ideology, or as a "philosophical model of inquiry" (such as in Lincoln, 2005:28), while in others it is simply referred to as the paradigm (for example Mertens, 2005 and Boghdan & Biklin, 2007). I am particularly drawn to how Henning, Van Rensburg and Smit (2004:25) describe a theoretical framework: The theoretical framework positions your research in the discipline or subject in which you are working, enable you to theorise about your research and help in making your assumptions explicit (Henning et. al., 2004:25).

On the other hand, a conceptual framework covers the main features of the research design and their presumed relationships, and its major function is to position the researcher in relation to the research. A broad theoretical framework will thereby logically lead to a certain conceptual framework (Henning et. al., 2004:26). Critical pedagogy is the paradigm which foregrounds the main assumptions underlying this study and what Henning et al. (2004:25) calls the "frame" within which boundaries the research will remain. My conceptual framework specifically considers interpretations around issues of social justice, particularly in and through science education. It reflects a kind of synthesis of earlier research in this field and suggests the important concepts around social justice that should be examined, as well as the context in which it could be seen.

2.2 Critical pedagogy

I consider critical pedagogy (CP) an appropriate paradigm within which to situate this research study, as one of its educational aims is to promote education for the purpose of developing a more socially just world (Breunig, 2005:107). For this reason, critical pedagogy offers an articulation of the pedagogical practices of educators committed to the elimination of social inequality (Jennings & Lynn, 2005:21).

Well known theorists in the critical pedagogical tradition are Paulo Freire (whose 1970 work *Pedagogy of the Oppressed* became the canon for any modern educational theory which focuses a critical perspective on injustice and oppression), Michael Apple, Henry Giroux, Joe Kincheloe, Peter McLaren, Ira Shor and Roger Simon.

In the following sections I give a synopsis of the historical roots of CP and describe what *pedagogy* as a construct means in both the traditional and critical sense. I also elaborate on some theoretical postulates and philosophies of critical pedagogy that support the main assumptions (on science education) underlying this particular study. These assumptions cover the domains of teaching, learning and the science curriculum. I will also discuss four core elements of critical pedagogy, namely dialogue, critique, counter-hegemony and praxis, which are tied to these assumptions, and briefly describe the concepts of ideology and the hidden curriculum which are frequently included in discussions around critical pedagogy.

2.2.1 The historical roots of critical pedagogy

Critical pedagogy derives its name, basic conceptualisations and interests from *critical theory*, the sociological and philosophical theory developed from around 1923 by the neo-Marxist Frankfurt School, a group of intellectuals connected to the Institute of Social Research at the University of Frankfurt in Germany (Kincheloe & McLaren, 1994:138). Around the 1980s, scholars such as Apple, Giroux and McLaren began focussing their efforts on examining and better understanding the role that

schools play in transmitting certain messages about political, social and economic life. The paradigm of critical pedagogy that evolved is considered by many to be the best available approach to critique the societal conditions of education, to raise questions about inequalities of power in a capitalist society and the false myths of opportunity and merit for many students who internalise belief systems that see them abandon aspirations of questioning or changing their lot in life, and through which educators can realise the possibilities of democratic social values within their classrooms (Burbules & Berk, 1999:50; Breunig, 2009:248).

2.2.2 Pedagogy – traditional and critical

Watkins and Mortimore (1999:3) comment that conceptions of pedagogy have become more complex over time. It can mean any conscious activity by one person designed to enhance learning in another. The current view of pedagogy is one of increasingly integrated conceptualisation which specifies relations between its elements: the teacher, classroom or other contexts, content, the view of learning, and learning about learning (Watkins & Mortimore, 1999:8). The more traditional pedagogical view of teaching is that of a technical practice in which learning is seen as the processing of received knowledge (Giroux, 2004:34). A more socially progressive pedagogy highlights the need to critique existing social relations and the utopian hope for education as a tool for greater democratisation (Lee, 2008:194-195). In the critical tradition a pedagogy and its role in knowledge production bring into the spotlight the realities of classroom organisation; for example, the role of the teacher in relation to the learners, particular versions of what knowledge is considered most worthy within a specific institutional context, as well as the social milieu that influences and is subsequently influenced by the learning experience (Giroux & Simon, 1989: 239).

2.2.3 Core elements and definitions in the critical pedagogy tradition

According to Braa and Callero (2006:359) the four core elements of various forms of CP, namely dialogue, critique, counter-hegemony and praxis, are generally lacking in the traditional classroom. Below I discuss these four critical elements, as well as the concepts of ideology and the hidden curriculum. In most of these discussions there is mention of at least one other element, and these overlaps point to the interrelatedness of all these elements.

Criticality and critique

The two literatures of Critical Thinking and Critical Pedagogy both invoke the term “critical” as a valued educational goal, but there are some important differences in how each of them frame this topic (Burbules & Berk, 1999:46). The first perspective sees rationality as the prime aim of education and the learner as a critical consumer of information, driven to seek reasons and evidence to diagnose invalid forms of argument (Burbules & Berk, 1999:48). The second perspective is concerned with social injustices and how to transform inequitable, undemocratic or oppressive institutions and social relations (Burbules & Berk, 1999:47). A critical pedagogical perspective therefore calls for analyses of

persisting inequalities of power and resources as they are structured in society and differentially influence lives by race, ethnicity, class and gender (Ochao & Pineda, 2008:47).

Critical pedagogy advocates a critique of both self and society as a way of learning and proposes a systematic analysis of exploitation, inequality, oppression and domination (Braa & Callero, 2006:359). Through criticality, hidden assumptions and negative aspects in the social context of the classroom and schooling itself are exposed and its transformative possibilities considered (Gall, Gall & Borg, 1999:361; Smyth, 2011:21). Critical consciousness, translated from the Freirean term *conscienticizao* (Burbules & Berk, 1999:51), allows for systematic in-depth examining of subject matter, the status quo and the learning process, connecting student individuality to larger historical and social issues, while encouraging them to examine the relations between their individual experiences and academic knowledge, power and inequalities in society (Shor, 1992:16-17). Through the process of conscientisation, students are empowered to achieve a deepening awareness of the social realities which shape their lives and discover their own capacities to modify them (Darder, Baltodano & Torres, 2009:14).

An overview of the different standpoints taken by these pedagogues shows that social critique may begin with the learners identifying specific issues which may affect them personally. In this process they may then notice forms of advantage (such as class, race and gender), and begin to articulate this by using, what Giroux (2004:36; 2009:691), calls a "language of critique". This may bring students to a juncture from where their critical analyses will reveal structural injustice, making possible problem solving and eventually also social change.

Dialogue

The dialogical method is central to a pedagogy of empowerment. For Freire (1970a:47), "…cultural action for freedom is characterized by dialogue, and its preeminent purpose is to conscientize the people". As a student-centred, teacher-directed communication process which develops critical thought and democratic participation, dialogue intentionally seeks to reconstruct a situation, including the self, and to evaluate consequences (Shor, 1992:85; Glass, 2001:19). Being simultaneously structured and creative, dialogue is co-developed by the teacher and the students, and therefore has mutual discussion at the heart of its method. A dialogical approach serves as the foundation for reflection and action (praxis), one which supports a problem-posing method, and in which both the teacher and the student have something to contribute and receive (Darder et al., 2009:13). Because interaction is directed toward a critical examination of actual student experiences and towards active student participation, students gain a sense of empowerment and the development of a critical social consciousness (Braa & Callero, 2003:359). In their study, Braa and Callero (2003:361) have found that dialogue is particularly energetic, focused and productive of learning when it centres on students' personal experience, and especially when the experience is one of exploitation.

Paulo Freire, in a conversation with Donaldo Macedo, cautions teachers about adopting a simplistic understanding of dialogue as a mere teaching technique or a tactic that involves students in a particular task. He stresses that dialogue characterises an epistemological relationship, and in this sense is "a way of knowing" (Macedo, 1995:379). He furthermore points out that such dialogue (as a process of learning and knowing) differs from dialogue as a conversation that mechanically focuses on the individual's lived experience – the latter can be placed strictly within the psychological sphere (Macedo, 1995:381).

Hegemony and Counter-hegemony

From the 1920s to the 1930s Antonio Gramsci, the Italian political theorist, developed the notion of hegemony as a way to understand power relationships between the dominant and subordinate classes (Arce, 2004:230). Hegemony is the struggle in which the dominant class win the consent of a subordinate class through consensual social practices, social forms and social structures produced in specific sites such as the school, mass media, the political system and the family (McLaren, 2009:67), and is thus dependent on ideology to do its work (McLaren, 2009:69). For Breunig (2005:114-115), teaching methodology represents another source of educational hegemony because it could silence and marginalise students' voices and experience when they function as open repositories to whatever knowledge the teacher choose to "deposit" in them at a particular time.

Counter-hegemony offers a vision of what could be different if less oppressive institutions and ways of knowing were in place (Breunig, 2005:112). By creating counter-hegemonic conditions, teachers use conscious acts of resistance to the dominant ideology (Arce, 2004:228). That is, teachers not only strive to resist teaching as a form of social reproduction, but will necessarily take positive steps to facilitate social change. These would include the promotion of an overall culture of critique, morals and values, as well as a facilitation of praxis (Braa & Callero, 2006:358). Darder et al. (2009:13) also stresses this from a Freirean perspective, that is, for teachers to develop a strong command of their particular academic discipline, and simultaneously provide opportunities for their students to critically engage with classroom content through their own existing knowledge and the events and experiences from their own living histories. The construction of effective counter-hegemonic alternatives is thus facilitated by exposing class contradictions in student lives and showing how dominant ideologies may work against their own material interest (Braa & Callero, 2006:359).

Praxis

Praxis, as an alliance of theory and practice, is an on-going interaction of reflection, dialogue and action (Darder et al., 2009:13) and what connects an emancipatory education such as critical pedagogy to social transformation. It is the philosophy at the centre of Freire's theory. As he contends, "Critical consciousness is brought about not through intellectual effort alone but through *praxis* – through the

authentic union of action and reflection" (Freire, 1970a:48), in order to transform the world (Freire, 1970b:36). Praxis starts with an abstract idea (theory) or experience, incorporates reflection upon such an idea or experience and translates it into purposeful action; as such, it is reflective, creative, active, and contextually and socially constructed (Breunig, 2005:111). For critical pedagogy, to overcome oppressed thinking and demoralisation demands that changing thought and practice must occur together because they fuel one another (Burbules & Berk, 1999:52).

Breunig (2005:115) proposes the use of experiential education as a way to work towards achieving praxis in the classroom situation. She concedes that one of the criticisms levelled against critical pedagogy is the lack of congruence between its pedagogical theories and actual classroom practices. Experiential and practical knowledge provide a way to understand and interpret such theories and the possibility to achieve praxis. Experiential activities may involve small-group work, student presentation, discussion and creative expression, or as simple an act as rearranging chairs in a circle to place the teacher and the students in a physically mutual relationship (Breunig, 2005:115). In another report, Breunig (2009) refers more specifically to the association between critical pedagogy and social justice. She reminds us that the intent of critical pedagogy is to contribute to a more socially just world. She however cautions that social justice is a philosophical and ideological construct and that the mere transmission of theoretical knowledge about these concepts does not ensure that students will act upon the justice-oriented intentions that their theories purports (Breunig, 2009:250). Some of the praxis-oriented activities that she suggests to connect these philosophical and practical constructs are academic service-learning, community service and critical media literacy (Breunig, 2009:250).

Ideology

Ideology is the societal lens or framework of thought that individuals and groups use to create order and give meaning to their social and political world, through which ideas, values, and beliefs (and the way these are expressed and lived out) are produced and represented, and with which perceptions are inevitably structured in a particular direction by the concepts that are used (Darder et al., 2009:11; McLaren, 2009:69). More specifically in the case of teachers, a critical notion of ideology provides the means for not only a critique of educational curricula, texts and practices, but also the fundamental ethics which inform their production (Darder et al., 2009:11). Braa and Callero (2006:358) encapsulate the relationship between ideology and hegemony as follows: "Hegemony…as an organizing principle, or worldview…is diffused by agencies of ideological control and socialization into every area of life." The school, as such an agency, conveys to individuals a system of values, attitudes, behaviours, beliefs and morality that supports and even reproduces the established social order and the class interests that dominate it (Braa & Callero, 2006:358).

Säther (2003: 238) posits that the usage of expressions such as "beliefs and values", "scientific literacy" and "curriculum emphasis" in science education literature shows an interest in fundamental

and philosophical questions. Also, that the use of the concept 'ideology' is part of this tendency toward a philosophical and sociological interpretation of the aims, contexts and possible effects of science education (Säther, 2003:238). This researcher emphasises the connection between the concept of ideology and other concepts such as worldview, politics and values and notes that science teachers often project a hidden character of their worldview during classroom dialogues (Säther, 2003: 238). An important point made by Säther (2003: 242) is that ideologies in education can be located on a continuum from the most obvious, public and articulate statement of purpose, content and rationale, to the most subtle, private and latent view.

Hidden curriculum

Smyth (2004:28) refers to the curriculum as the battleground where the theories and politics of knowledge meet classroom practice in complex and turbulent ways. The traditional view of a curriculum follows a more conceptual approach, in that it is a course of study which includes all the planned instructional activities and experiences provided by the school, the selection (from a number of alternatives) and organisation of knowledge into a timetable, and the mechanism that assists learners in attaining the designated learning outcomes to the best of their abilities (Meighan & Siraj-Blatchford, 2003:67). For (McLaren, 2009:75), as well as Darder et al. (2009:12), the hidden curriculum is informed by ideological views which induce students to comply with dominant ideologies and social practices related to authority, behaviour and morality. For Breunig (2005:113) both the content and form of the curriculum are ideological in nature, and the hidden curriculum presents itself through the messages given to the learners by way of the school structures, the textbooks, the teachers and other school resources. Because such a curriculum is often believed to serve the interest of the power elite (in both school and society at large), it is inherently unable to support an equitable school system or society (Breunig, 2005:113).

For Darder et al. (2009:12), the hidden curriculum is informed by ideological views that structurally reproduce dominant cultural assumptions and practices that silence and thwart democratic participation, and therefore a critical approach to the curriculum will consider it from the point of view of ideology, cultural reproduction and resistance. Braa and Callero (2006:358) summarise the implications of a hidden curriculum in science:

> The failure to teach science as an inherently critical, theory driven process is … an evident omission. Schools tend to present science as a collection of facts or patterns of facts (empiricism and positivism) rather than as a method for developing models or structures (theories) that explain social phenomena.

2.3 Critical pedagogy, the school and classroom

Hytten (2006:223) lays emphasis on the point that critical pedagogy, as a leftist educational movement and tradition, starts from the belief that issues of education and social justice are fundamentally related and thus, in many ways, this movement adopts a social justice framework in relation to education.

Critical pedagogy concerns itself with the question of the social embeddedness of education and its inevitably political character in contemporary Western Society (Wardekker & Miedema, 1997:49). It is a particular history, and a particular economic and political reality, which determine the knowledge that gets into schools; this knowledge needs to be understood by situating it back into that socio-economic context (Apple, 2004:1480). Because a critical pedagogical vision within the school is grounded in the social, cognitive, economic and political context that is part of the larger community and society, it provides a way of thinking about, negotiating and transforming the relationship among classroom teaching, the production of knowledge, the institutional structures of schools, as well as the social and material relation of the wider community and society (Breunig, 2005:109). Through such a vision, Giroux (2004:36-37) asserts, comes the recognition that real social needs must be addressed. This recognition prompts progressive educators to view their teaching as a theoretical resource that both responds to, and is shaped by, the problems that arise in the contexts that connect classrooms with the experiences of everyday life. Mulcahy and Irwin (2008:201), as well as Smyth (2011:33-34) argue along the same line, asking teachers to become political actors in their educational settings in the sense of being clear about how they encounter, understand and feel about their work, and thus to not only deal with questions of schooling, curriculum and educational policy, but to adopt a critical stance and be committed to bringing about fundamental social change.

For teachers, taking a political stance to their work has direct implications for their classrooms situations. Because this perspective means bringing their students' lives, cultures and experiences into the teaching situation, it would most likely be at variance with the centrally prescribed curriculum guidelines (Smyth, 2011:26). It implies a modification of the traditional hierarchically scripted curriculum to allow previously off-limited issues (such as racism, violence, poverty and economic exploitation) to be confronted in the classroom (Smyth, 2011:34).

Critical pedagogy questions the ways in which knowledge is constructed, as well as how and why some knowledge construction is legitimated and celebrated by the dominant culture while others are clearly not (McLaren, 2009:63). For example, the knowledge in the great works of philosophers and scientists accounts as being high status, while the practical knowledge of ordinary people, or margenalised and subjugated groups, is often discredited and devalued (McLaren, 2009:64). In the classroom, this amounts to some forms of knowledge having more power and legitimacy than others, with science and mathematics as good examples. The favouring of science and mathematics curricula

(over that of the liberal arts, for instance) can be explained by the link between the needs of big business to compete in world markets and the imperatives of the new reform movement to bring "excellence" (author's emphasis) back to our schools (McLaren, 2009:64).

A critical pedagogy considers knowing as an ideological process that is linked to particular interests and social relations (McLaren, 2009:72; Smyth, 2011:18). Shor (1992:13;34) reminds us that in no society is knowledge a neutral terrain, as it has always been a place where forces contend for power, and using such power to establish standard knowledge and standard usage of it. The social and economic values embedded in such knowledge are preserved through teachers' modes of teaching, their principles, standards and forms of evaluation. When teachers are prepared to question the nature of their work, how it came to be and what sustains and maintains it, their view of teaching can be regarded as political, their work a form of intellectual labour and their own classrooms and schools as sites of serious inquiry. From such an intellectual basis, teachers come to interrogate the specific ideological conditions under which they work (Smyth, 2011:28). In the authoritarian classroom, for example, students are conditioned to become passive, conformist and obedient members of society, thus generating easily manipulated workers and passive, apathetic citizens (Braa & Callero, 2006:358). Teachers who seek a radical different alternative to the instrumentalist transmission view of education must accept that knowledge does not exist independently of the meaning and significance which students attach to it by virtue of their previous experiences, their class and culture (Smyth, 2011:25-26). Freire's (1970b:72-73) account of the banking education method points out its authoritarian approach of passive lecturing through which information is uncritically and anti-democratically deposited in students and which directly or indirectly reinforces the fatalistic perception of their situation. Contrary to this is his problem-posing approach as a democratic method that allows students to take part in the contention over knowledge and the shape of society. A problem-posing teacher diversifies subject matter, uses students' thought and speech as the base for developing a critical understanding of personal experience, unequal conditions in society, and existing knowledge, while posing any form of knowledge as a problem for mutual inquiry (Shor, 1992:33).

2.4 Critical Pedagogy and science education

From the 1990s reform initiatives from around the world started calling for the kind of science education that could serve as a vehicle to maintain a vital, just and responsible society through fostering in children scientific understandings and habits of mind, and thus for scientific literacy to be expressed in terms of global changes (Barton & Yang, 2000:875). The proposal of new science curricula started coming to the fore as alternatives to the pipeline ideology (Dos Santos, 2009:362) of traditional school science – one in which scientific knowledge is viewed as universal, coherent, objective and unproblematic (Hodson, 2003:647). The humanistic perspective in school science found

in the scientific and technological literacy (STL) and science-technology-society (STS) fields, for example, promotes practical utility, humanistic values and student orientation (Dos Santos, 2009:362).

Zembylas (2006:665) proposes an approach to science education which also acknowledges that science is situated within larger social and political values. In such a critical science education, science teaching and learning should contain elements that would empower participants to initiate transformations, and promote social justice and emancipation. Emancipation, or liberation, is the empowering process which presents to people the freedom to choose from a range of perspectives on themselves and their social worlds, and requires the ability to recognise their own views as problematic, socially constructed, and subject to social and political influence (Smyth, 2011:21). However, Zembylas (2006:666) stresses that emancipation expresses not only a desire, hope or aspiration, but also an objective and a commitment to act.

2.5 Scientific literacy

In today's science education, *scientific literacy* has become the descriptor of its ultimate aim, and in many ways the criterion for assessing its curriculum and pedagogy (Sadler, 2004b:39). At the 1990 UNESCO World Conference on Education for All the call was made for the kind of science education that would promote a world community of scientifically and technologically literate citizens (Millar, 2006:1499). Science curricula in South Africa also base their vision for science education on the construct of scientific literacy, and as pointed out earlier in Chapter One, clearly articulate this through its various policy statements.

Although it is widely claimed to be a desired outcome of science education, the term *scientific literacy* has defied precise definition and interpretation since its introduction in the late 1950s, and this problem is magnified when scientific literacy becomes the goal of contemporary science education reform (DeBoer, 2000:582; Laugksch, 2000:71). Probably one of its first appearance in print was in an article (*Science literacy: its meaning for American schools*) published in the *Educational Leadership* of October 1958 by Paul DeHart Hurd (considered to be one of the fathers of modern science education), in reference to one of the new goals of science education at that time, that is to prepare citizens to live and work in an era of rapid scientific and technological change in fields such as nuclear energy, space exploration, cell biology and brain physiology, and as part of vastly more complex social organisations (DeBoer, 2000:586; Laugksch, 2000:72). At that point in time, Hurd was concerned whether curriculum workers would be able to devise the educational programs necessary for the maintenance of the delicate balance among scientific, social and economic forces found in that era (DeBoer, 2000:586). Hurd's view of scientific literacy (that is, the ability to cope with rapidly changing scientific and technological changes) is not very common now. In a more recent publication by Hurd (1998:409), he still contends though that in the face of revolutionary changes in the nature,

ethos, and practices of science, a valid interpretation of scientific literacy must be consistent with the prevailing image of science and the radical changes taking place in our society.

A literature review on the wide variety of meanings and descriptions of, as well as approaches to, scientific literacy, shows the works of Feinstein (2010), Dos Santos (2009), Roth and Lee (2004), Sadler (2004a; 2004b) and Laugksch (2000) to be of particular relevance to this study. What follows are extractions of the salient features of each of these works of interest to me in the context of my research goals and objectives.

Laugksch (2000) first places scientific literacy in a historical context, where-after he discusses a number of factors that influence interpretations of this concept. These factors include the different *interest groups* concerned with the promotion of scientific literacy and the methodologies used by them for *measuring* scientific literacy. Of significance to this study are two of the interest groups mentioned here, namely the *science education community* and *science educators employing a sociological approach to scientific literacy*. As Laugksch (2000:75) explains, the main concern of representatives of the first group is the relationship between formal education and scientific literacy, and the group has a specific focus on secondary (although increasingly also primary and tertiary) education. The members of the second group are concerned with the construction of authority with respect to science, and are interested in how individuals in everyday life interpret and negotiate scientific knowledge, and how social access, trust, and motivation are all linked to public uptake of and support for science.

Feinstein (2010) structures his review around what he calls science literacy from a perspective of "usefulness", and maintains that a truly useful version of science literacy must be connected to the real uses of science in daily life, that is, public engagement with science. His very specific and limited notion of scientific literacy posits that science education can help people solve personally meaningful problems in their lives, those that directly affect their material and social circumstances, shape their behaviour and inform their most significant practical and political decisions (Feinstein, 2011:169). He classifies science education research in this field into three categories which frame scientific literacy from either a rhetorical, a logical or an empirical approach, and give examples of each within the research traditions (Feinstein, 2010:171). Of relevance to this study is his SL-logical category, which according to Feinstein (2010:172) has an appealing, common-sense validity and description of science literacy that is quite obviously connected to an idea of usefulness. Examples of work in this category include studies on argumentation, the nature of science and socio-scientific issues. Part of Feinstein's SL-empirical category is also valuable in its consideration of scientific literacy in the context of this study. One of the examples he uses to illustrate how a focus on science in daily life is capable of transforming the notion of science literacy, is that of Angela Calabrese Barton whose work demonstrates how marginalised young people from high poverty urban environments find meaning

and usefulness in science by interweaving it with the experiences of their own lives and pastimes (Feinstein, 2010:176). Feinstein draws attention to research that is done on the convergence of science education and public engagement with science, pointing out that if science educators truly wish their students to pay attention to the scientific issues that run through major personal and political decisions, they should allow them participation in educational activities that involve exploring the knowledge available to them through their communities, and encouraging them to develop skills that will advance them toward their visions of their own futures (Feinstein, 2010:176, 179).

Roth and Lee (2004) continue with this line of argument and propose a conception of science literacy in terms of *citizen science*, that is, a form of science that relates in reflexive ways to the concerns, interests and activities of citizens as they go about their everyday business. This mode of science therefore links to a variety of contexts, ranging from personal matters (such as the accessibility to safe drinking water), livelihood and leisure, to activism or organised protest (Roth & Lee, 2004:266). Contrary to the current ideology of scientific literacy (in general) which views it as a property of individuals, in their approach, scientific literacy is a social practice. As such, the focus is on levels of participation, division of labour and knowledgeability, and the collective and distributive nature of citizen knowledge. In a society where life is fundamentally based on the division of labour, citizens consult and employ specialists (such as medical doctors, motor mechanics and so forth) for advice or help with specific problems. If science in the community is thought of as distributed, it follows that the larger social organisation, rather than its members as individuals, is considered the seat of knowing and learning (Roth & Lee, 2004:266). In terms of science education and educators, they suggest that there should be less focus on decontextualised procedural and declarative knowledge and coaxing *individuals* into certain performances, and more on the setting up of *situations* that allow a variety of participatory modes more consistent with a democratic approach. They further contend that if we wish science education to be relevant to people's citizenship and their everyday lives, students should be allowed to participate in a diversity of relations (the one presented by the institutional school, and the large number in the outside world), setting them up for lifelong participation and therefore lifelong learning (Roth & Lee, 2004:264, 267). As their research has shown, the motive for allowing such student activities integrates well with other immediate life-world aspects, an indication of empowered citizenship as repeatedly pointed out by critical educators such as Henry Giroux (Roth & Lee, 2004:275).

Dos Santos (2009) proposes a humanistic science education approach from a Paulo Freire perspective. A science curriculum is considered humanistic for its promotion of practical utility, its humanistic values and student orientation; and examples of such curricula are to be found in the fields of science and technology literacy (STL) and science-technology-society (STS). Besides their consideration of the relationship between science and technology and the decision-making skills needed for people's personal, civic and professional lives, their aims also include the preparation of students for social

responsibility, socio-political action, and the development of attitudes and values to engage in social issues (Dos Santos, 2009:362). Bringing a Freirean perspective to a humanistic science curriculum means the inclusion of a political agenda of issues such as unequal access to technology around the world, the dominating power of technology and the oppressive context of modern society in terms of science and technology. Its principles and implications thus lie in the changing of the inequitable social reality of the globalised world (Dos Santos, 2009:362). Within a Freirean view, the goals of scientific literacy include the induction, socialisation and enculturation of students into their local, national and global communities in order to transform these, integrating moral reasoning with values, human concerns and scientific reasoning, and even practical and social action (Dos Santos, 2009:368). Urban science education is an example of an STL movement that conveys this radical view of science education in terms of students' engagement with the political, ideological and ethical dimensions of scientific knowledge. Developed to focus on science educational practice for a specific context, namely the disadvantaged urban setting, it focuses on the oppressive and discriminatory conditions of impoverished marginalised communities living in and around big cities (Dos Santos, 2009:369). Within a Freirean humanistic science education perspective, it is not enough to show students how science is present in daily life, but it is necessary to point out the contradiction of this presence in society. For example, it creates awareness of how modern society gives a higher priority to market needs than to human needs, and how human needs have changed because of the needs created by technological systems. Dos Santos (2009:370) reminds us that a Freirean humanistic science education should be based on a strong social and political stance and a focus on the struggle for greater justice and social equity, so that

> beyond identifying chemical products in garbage, or the separation methods adopted in the recycling plant, it is necessary to discuss why there are people in our society living in landfills. It is necessary to discuss not only the benefits of modern technology, but why only one third of the global population has access to technology whereas the other two thirds do not have the most basic, minimally humane living conditions. (Dos Santos, 2009:370).

The notions of scientific literacy as described by these researchers show how such approaches could make science meaningful and useful, and that the participatory methods that it encourages could play an important role in the establishment of sound social and democratic values in learners. The critical pedagogical theorists, Giroux and McLaren (1986:234), emphasise that knowledge has to be made meaningful to students before it can be made critical. One way that teachers can make knowledge meaningful, is by connecting the curriculum with students experiences and histories. Integrating socio-scientific issues in science lessons, allows the classroom to become an open environment where critical issues affecting students, their communities and the world can be constructively addressed. This method involves choosing problems that would entice students to engage with scientific content that requires an evaluation of scientific research and its applications in a socially responsible manner, and allows them to see how science could be used as a tool to uncover social injustices (Chamany, 2006:54-55). In the next section I discuss concepts around socio-scientific issues in more detail, and

following that is a lay-out of the conceptual framework built on social justice and emancipatory science education models.

2.6 Socio-scientific issues (SSIs) in learning science

Science interfaces and interacts with other domains of human activity and thought, including the technological, economic, social, cultural and religious spheres, bringing about a host of personal and societal issues which often requires a response from individuals in the form of decision-making (Abd-el-Khalick, 2003:43). The movement for Science, Technology and Society (STS), which originated in the 1970's, aspired to address controversial issues in a science context; with "controversial" referring here to differences over the nature and content of the science, such as the perception of risk, interpretation of empirical data and scientific theories, as well as the social impact of science and technology (Levinson, 2006:1202).

Sadler (2004a:515) posits that the citizens of a democratic society which is built upon science and technology are constantly presented with SSIs, and the processes of informal reasoning allow them to access these issues, formulate positions and provide supporting evidence.

Abd-el-Khalick (2003) and Sadler (2004b) advance a conception of scientific literacy, as addressed by the STS movement, which involves the negotiation of socio-scientific issues (SSIs) and the moral and ethical implications that accompany these. In order to achieve scientific literacy, students must be able to use scientific processes and habits of mind to solve everyday problems, confront issues that involve science and make informed decisions, as well as construct reasoned arguments and moral judgments through social interaction. Examples of such science-related issues are cloning, stem cell research, alternative fuels, global warming, ozone depletion, nuclear energy and genetically modified foods. This class of scientific issues requires public input and thus necessarily involves societal factors. Sadler (2004b:41) argues that at least one component of scientific literacy must be the ability to negotiate socio-scientific issues and produce informed decisions. In addition to possessing the requisite knowledge about the science underlying the SSIs, or the skills needed to acquire such knowledge, individuals negotiating and making decisions about SSIs should have an understanding of the nature of science, and very importantly, an appreciation of the moral and ethical dimensions associated with these issues. Lysaght, Rosenberger and Kerridge (2006:1236-1237) draw the following distinction between ethics and morals: whereas ethics is an internalised sense of what is right and wrong, a socio-cultural phenomenon and highly contested, morals are externalised prescriptions of socially acceptable behaviour of an individual, be it in a personal or professional sphere. The moral domain is therefore defined by universally recognised prescriptions based on conceptions of human welfare, justice and rights, as well as emotions such as sympathy and empathy (Sadler & Zeidler, 2004:6-7). Sadler (2004b:42) admits that moral and ethical awareness is the most

contentious suggestion for the inclusion of SSIs in science curricula, as strategies for dealing with moral and ethical dilemmas are not typically associated with the cannon of elementary or secondary school science, and that teachers are not trained to address the morality and ethics of socio-scientific decision-making (Sadler, 2004b:44). The juxtaposition of science and ethics can be uncomfortable for scientists, teachers and students who define science in terms of objectivity, and since SSI are value-laden, they are inevitably associated with ethical considerations (Sadler, Amirshokoohi, Kazempour & Allspaw, 2006:354). However, studies exploring reasoning patterns regarding SSIs have indicated that ethical concerns are among the most important factors for individual decision-making, thus motivating the inclusion of ethics in science education. Values and ethics interact with science in a broader sense as well: science, as a human enterprise, is embedded in the culture from which it emanates, and therefore is affected by and reflects the values and norms of a given society at a given time (Sadler et al., 2006:354). Stakeholders in science education should therefore facilitate the inclusion of SSIs in science classrooms with explicit attention paid to their values and ethical implications; failing this will significantly hamper students' ability to make judgments regarding such issues, and by extension limit scientific literacy and the identification of the interconnectivity between science and society (Sadler, 2004b:44; Sadler et al., 2006:354). Lee and Witz (2009) add to this dialogue by referring to the humanistic perspectives of science as motivation for the inclusion of SSIs in the science class: these perspectives agree on science as a collective human endeavour and include values, the nature of science, the social aspects of science, and the human character of science as revealed through its sociology, history and philosophy. SSIs represent all of these perspectives, including the potential to create awareness of the interrelationship between science, technology and society and stimulate participation in social and political decision-making processes (Lee and Witz, 2009:932).

The reasons for motivation of the inclusion of SSI in science classes are varied, as shown in the previous paragraph. Negotiating a SSI means allowing students to make informed decisions by stimulating them to explicitly explore their own principles, emotions and institutions pertinent to science and its social implications (Frijters, ten Dam & Rijlaarsdam, 2008:69 and Sadler 2004b:41). SSIs in the science class calls for the forming of opinions and making of choices on a personal, as well as a societal level, cost-benefit analyses in which risk interacts with values, ethical reasoning, consideration of sustainable development and dealing with conflicting or incomplete scientific evidence (Grace, 2006). Through the integration of SSIs in their science classes, science teachers allow students to engage in "real world" problem-solving in which scientific knowledge and ways of thinking are brought to bear on discussion and decision-making around issues that are immediately relevant to students' lives (Abd-el-Khalick (2003:43). However, it is the moral and ethical implications of SSI content which probably present the biggest contention around its inclusion in science curricula: on the one hand, SSIs are often analysed from different perspectives that may lead to a variety of conclusions (Reiss & Galvão 2009:2; Sadler 2004b: 39, 41-42); on the other hand,

drawing conclusions in ignorance of the moral and ethical dimensions of SSIs may impede the efficacy of those conclusions (Sadler, 2004b: 41; Sadler & Zeidler, 2004:5).

The above arguments and discussions point to the fact that in the context of SSI integration in teaching, it would be difficult to separate issues around ethics and morality from the science embedded in such SSIs. Addressing controversial issues (such as SSIs) in science aspires to linking an understanding of its content to social justice (Levinson, 2006:1202). Bell (2007:13) connects these points in her conversation:

> A commitment to social justice requires a moral and ethical attitude towards equality and a possibility and a belief in the capacity of people as agents who can act to transform their world.

I have set out in this and previous sections of Chapter Two the various contentions and views around critical pedagogy, scientific literacy, and socio-scientific issues. The links amongst these constructs as pointed out by the various researchers substantiate the conceptual framework that I have chosen for this study. For example, Dos Santos (2009) calls for a humanistic (Freirean) approach to scientific literacy, while Feinstein (2010) and Roth and Lee (2004) propose the use of socio-scientific issues to bring across conceptions of SL which would encourage empowering citizenship – the vision of many critical pedagogues. SSIs inevitably introduce moral and ethical dilemmas into these conversations (Levinson, 2006), and these dilemmas are inevitably part of the increasingly widespread theme of social justice (Bell, 2006). In his *Critical Pedagogy for Social Justice*, John Smyth (2011) points out how these two constructs are inextricably connected, that addressing social justice in the classroom calls for teaching for democracy, social responsibility and critical teaching which allows for the student voice to be heard.

Since this study is framed by the ideals of critical pedagogy, the next section lays out a framework which allows for the integration of social justice issues with science content.

2.7 Social justice: general descriptions from the literature

Researchers and authors are quite varied in their definition or description of social justice, and what a just society should look like. In this regard, Hytten (2006:221) sees social justice as an integral feature of democratic life in societies where members strive for equity, self-determination and freedom. For Lewis (2001:189), social justice involves exploring the social construction of unequal hierarchies which result in a social group's differential access to power and privilege, and a simultaneous deconstruction of unjust and oppressive structures. A socially just society, according to Jacobs (2006:23), is one in which all members have their basic needs met, feel physically and psychologically safe and secure, and are able to develop their full capabilities in order to participate as effective citizens of their communities and nation. She further contends that in order for social justice to be

achieved, there needs to be a levelling of the playing fields, so that equitable practices provide all people with an equal chance for success (Jacobs, 2006:23). In such a society, according to Choules (2007:463), as well as Hytten (2006:223), there is a commitment to the equality of negotiated outcomes for all: power, services, opportunities and resources are equitably distributed, and nobody is excluded from full participation on the basis of factors such as gender, religion, ethnicity, socio-economic grouping, nationality, ability/disability or sexuality. The above descriptions of social justice are but a few of an array presented in recent literature. This validates the cautionary comment made by Gates and Jorgensen (2009:165), namely that social justice is difficult to define as it not only depends on one's own worldview, but also somewhat on the situation being analysed - as such, it should be treated as a relative concept.

2.7.1 Social justice education

In the context of this study it is important to clarify the distinction between the two terms 'socially just education' and 'social justice education'. In this regard, I found very useful the description by Moje (2007) of what a social justice education ('social justice pedagogy') entails:

> Social justice pedagogy should…offer possibilities for transformation, not only of the learner but also of the social and political contexts in which learning and other social action take place. Social justice pedagogy offers these transformative opportunities for all youth, even those who are privileged under current epistemological, social, and political structures. (p.3)

An important tenant in social justice education is the empowerment of the learner, and such empowerment can be understood in at least three different senses, namely social, political, and academic (Dimick, 2012:991).

Chapman and West-Burnham (2010:2) state that it is in the more unequal societies that the greatest social problems are found. They view education as the key vehicle for challenging the social injustices existing in such societies, but also recognise its capacity to deepen and maximise systems of social advantage. Smyth (2004:19) holds a similar view, and argues that growing inequalities in society make it imperative that schools reinvent themselves around issues of social justice. He says that teachers, especially in disadvantaged settings, must strive to construct supportive relationships to overcome barriers, impediments and entrapments that make participation in schooling problematic for disadvantaged students (Smyth, 2004:21). For Doster (2008:20), successful social justice education should see teachers striking a balance between debating socio-political problems affecting their students' lives (emphasising dialogue in the process and remaining attentive to each student's social environment) and teaching them academic basics on which they will be tested. Smyth (2004:25) takes this view a step further by describing teaching for social justice as teaching which arouses students, engages them in a quest to identify obstacles to their full humanity and freedom, and then drives them to move against those obstacles. Donnell, Yang, Winfield, Canestrari, Marlow and Kamii (2008:38) are mindful of the fact that while it is relatively easy to teach *about* social justice, teaching *for* social

justice can prove to be more of a challenge. They ponder whether intended teaching for social justice amounts to action by teachers, or action by their students, and ask the very pertinent question, "[How] do we teach in a way that actually translates into action toward a more just world…?". Of course, in the South African context, and specifically in the different sciences across the grades, this is no more a question, as it is incumbent on every teacher to mediate the kind of learning based on respect for democracy, equality, human dignity and social justice (for example, DoE, 2003:5).

2.7.2 Integrating social justice and science education

As explained earlier, Zembylas (2006:665) advocates that science education should also have a 'critical' purpose; that is, its function should be, among other things, to challenge social institutions, public policies and practices in order to bring progressive change, or what he calls 'emancipation'. The inclusion of social justice issues gives science education an essential emancipatory impulse and projects science as a *subjective* way of making sense of the world (author's emphasis). Moreover, this approach acknowledges that science is situated within larger social and political values.

The designing and implementation of successful teaching for social understanding in the science (as well as mathematics) curriculum, while at the same time ensuring that the academic content is well grounded and developmentally appropriate, could be a particular challenge for educators. This point was raised by Garii and Rule (2009:490-491) in the context of a qualitative study of social justice lessons in mathematics and science taught by student teachers; I consider it equally relevant to the situation which professional experienced science educators find themselves in presently.

Traditionally taught, science reflects the institutionalisation of what is deemed as necessary and valued knowledge: answers are known before the questions are asked and there is limited contextualisation between the classroom experience and the world outside of school. According to Atwater (2010:104), taking a more transformative approach to science teaching requires teachers and students to make decisions and take actions related to their understanding of natural phenomena, and it is at this point that science curricula can turn to social justice. In her opinion, a social justice science curriculum is about relevance, rigour, and possibly revolution – the latter alluding to forms of activism and changing the status quo. She alleges that although science is commonly perceived as politically neutral, the field of science education allows racism to permeate the learning and teaching of science as a subject. Science teaching may allow this to happen in the following ways: by masking the real political and economic concerns of science; by not addressing the pilfering of non-Western scientific traditions; by attributing people's oppression and suffering to nature (be it biological or geographical) rather than to the ways that science and nature have been subordinated to political priorities; by not acknowledging the key role that science plays in abusive economic and political systems; by supporting inequalities through the propagation of suppositions about nature and human nature; and by alienating certain groups of students (Atwater, 2010:105).

The issues raised by Atwater (2010) may be addressed through the inclusion of social justice content into the science curriculum. It is the kind of classroom pedagogy which raises questions of values, ethics and the implications of decision-making practices by utilising the tools of science, and creates new understandings of the meanings and uses of science to identify and rectify social inequities (Garii & Rule, 2009:491). For Chamany (2006:54), incorporating social justice into science curricula can attract and maintain the interest of students, who may otherwise shy away from science because of a perceived lack of immediate relevance or role models. Such an approach may allow them to make connections between what they learn in the classroom and what is portrayed in their everyday lives. She further believes that such an approach will encourage students to "view science through the eyes of scientists with humanitarian interests" (Chamany, 2006:54), while vividly illustrating that a basic understanding of science is important if they want to be socially responsible members of society (Chamany, 2006:58).

2.7.3 The conceptual framework: the C & W-B model

The conceptual framework in this study is based on the model of social justice as presented by Chapman and West-Burnham (2010), hereafter referred to as the C & W-B model. These researchers employ a more practical approach to explain the principles of social justice in terms of the two constructs, equity and equality. According to Chapman & West-Burnham (2010:26), the principle of equality has to be reinforced and extended by the practice of equity, and for social justice to become a real possibility, there must be some form of practical task to achieve the equity that reflects an underlying equality. From this perspective social justice exists to the extent to which there is equality and equity in a society or community, and implies that the more these two elements are integrated, the greater the level of social justice. Figure 1 is a diagrammatic presentation of this approach.

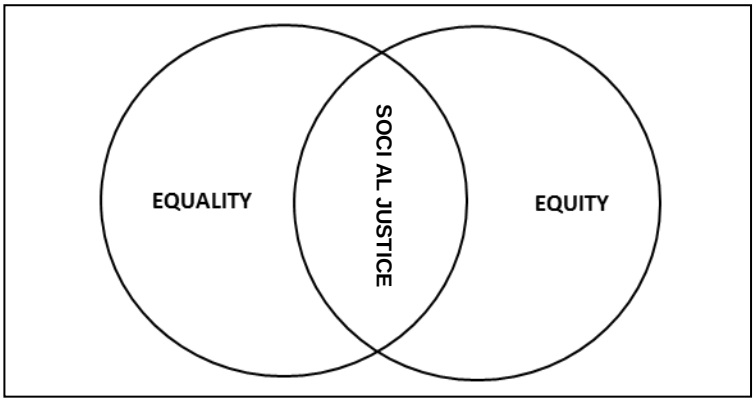

Figure 2.1: Social justice through equality and equity

(Adapted from Chapman and West-Burnham, 2010:27)

The implication of this model is that social justice is manifested through the degree in which the principles of equality and equity are reflected in the actual concrete experiences of all people found in a given social situation. Such experience has to be measured in the extent of equity in outcomes (Chapman & West-Burnham, 2010:26-27). This framework allows for social justice to be defined by the degree to which there is the possibility of both equality and equity in responding to an individual's personal circumstances (Chapman & West-Burnham, 2010:29).

As a fundamental criterion of common humanity, the idea of equality applies to all aspects of life. However, it is not enough to be equal, as there also has to be parity in terms of the measurable outcomes of living in society. Chapman & West-Burnham (2010:26) thus speak of the principles of equality and the practice of equity. In the context of education, equity is focused on outcomes and results and is rooted in the recognition that because children have different needs and come from different circumstances, we cannot treat them all the same (Chapman & West-Burnham, 2010:25).

Aspects of Social Justice

For Chapman and West-Burnham (2010:29), a society committed to social justice would ensure that every child grows up experiencing optimum levels of well-being. Well-being is fundamentally concerned about human rights and people's entitlement to sharing in and contributing to their community. As a subjective and emotional phenomenon, it involves a continuum of responses ranging from childhood immunization to levels of trust and to perceived self-esteem (Chapman and West-Burnham, 2010:114; 36). The C & W-B model proposes that if social justice is to have any meaning at all then it has to deal with the full spectrum of issues or aspects as set out in the adapted framework below. Figure 2 represents all the different aspects which play a role in a person's well-being.

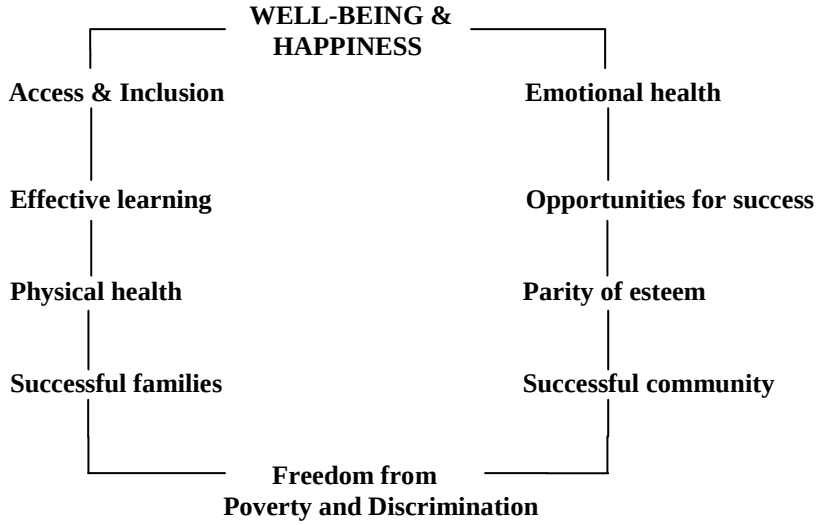

Figure 2.2: Aspects of social justice

(Adapted from Chapman and West-Burnham, 2010:38)

This framework characterises *well-being* and *happiness* as the overarching outcomes of its educational agenda. As a fundamental part of the learning process, well-being lays the foundation for successful physical and social growth, as well as intellectual development. Happiness is a crucial manifestation of well-being; it is relevant to the construction of a good or desirable society and therefore is central to the evaluation of social justice (Chapman & West-Burnham, 2010:37). As these authors contend, "Being happy is not just pleasant. It has a greater function - a positive effect on cognition" (Chapman & West-Burnham, 2010:92).

The C & W-B model is based on eight aspects which are grounded in the ideals of equality and equity. These aspects are Access and Inclusion, Effective learning, Physical health, Successful families, Emotional health, Opportunities for success, Parity of esteem, and Successful communities. A society which strives to uphold these aspects will at the same time be addressing conditions of *poverty and discrimination* which significantly impact the development and well-being of many young people if not addressed early in their lives. These aspects are indicators of what a socially just society is built upon and where schools and the education system could expose unfairness, intervene and even develop strategies that will both strengthen relationships and improve the social and economic environment (Chapman & West-Burnham, 2010:40). Below I give a brief interpretation of each aspect. In certain instances, the authors did not address an aspect separately, but integrated it with another. In such a case, I used an overview of the text to summarise the salient points of an aspect.

Access and Inclusion

The overarching priority here is access to the opportunities to learn, as well as insuring successful inclusion through a flexible curriculum that is attuned to an individual pace of learning. Inclusive practice is a personalised service that respects learner individuality and diversity. This is achieved by addressing inequality for all, and thereby safeguarding the well-being of the child (Chapman & West-Burnham, 2010:107). Equality through inclusive practice challenges the teacher-centred approach and sees learning as a dialogue in which both the adult and the child share equally.

Effective learning

The conflation of academic ability with intelligence is a long-standing ideology, and one which focuses almost exclusively on linguistic and logical skill in formal schooling. The highly diverse nature of intelligence, as well as the uniqueness of learners and their feelings towards different activities must be recognised, as these will impact differentially on skill development. A personalised and differentiated curriculum that takes into account learners' backgrounds and contexts will strengthen their development and aid effective learning. Interest is viewed as a positive feeling which, together with joy and contentment, enriches and enhances learner experience, encourages exploration and increases the ability to take in new information (Chapman & West-Burnham, 2010:92-93).

Physical health

Physical health is directly related to poverty and positions of social disadvantage and economic inequalities. Children from poor communities are very likely to suffer chronic and limiting ailments and mental disorders. They are also more likely to die from certain illnesses such as heart disease. In general children in poor health, or those who do not feel safe, will not be able to learn effectively (Chapman & West-Burnham, 2010:60). Being socially disadvantaged more than likely also means low educational qualifications and levels (Chapman & West-Burnham, 2010:10-11).

Successful families

A balanced and stable family life has far-reaching effects on the well-being and happiness of a young person. Successful families mean supportive relationships and a sense of connection with others (Chapman & West-Burnham, 2010:35). This will contribute to an overall sense of social well-being.

Emotional health

Poor mental and emotional health is both a cause and consequence of social, economic and environmental inequalities. These are consistently associated with unemployment, low educational levels and low income or material standard of living, in addition to poor physical health (Chapman & West-Burnham, 2010:11). Emotional health is also strongly associated with cognitive achievement, as it has been shown to support literacy and numeracy (Chapman & West-Burnham, 2010:20).

Opportunities for success

According to Chapman and West-Burnham (2010:42), the potential for success, and the safety and well-being of already vulnerable children are damaged through the prejudice associated with class stereotypes. By portraying negative images (such as regarding the unemployed as lazy and less intelligent) and ignoring parity, the responsibility for underachievement is laid at the feet of the most vulnerable in the community - those who must currently try hardest to achieve. There should therefore be a better understanding of inequality and poverty, and an articulation of equivalence through clear action, to ultimately break the cycle and change children's lives.

Parity of esteem (PoE)

Parity is defined as equality of rank or equivalence (*CCD*, 2004:1090). The ideal or principle of PoE relates to situations where a certain group is afforded a higher social status than another. Social status is understood as a ranking or hierarchy of prestige as perceived by the perspective groups. Esteem in this context entails the positive self-evaluation that a group can make on the basis of succeeding in living up to certain standards of value (Du Toit, 2004:196). In education, there should be a greater PoE between the traditional classroom methods and the more holistic democratic approaches. This will allow young people to achieve in more flexible ways, equip them with skills to succeed in today's

global society and more fundamentally, enable them to value each other as equals (Chapman & West-Burnham, 2010:16). There is a relationship between poverty and social status, as personal background often leads to unfair access to community resources such as housing, education, leisure facilities and job opportunities (Chapman & West-Burnham, 2010:16). The attainment of PoE can therefore be linked to the wider social justice goals of transformation (Blom, 2006:16).

Successful community

A successful community, as one of the most positive forces of well-being, allows social justice to flourish in practical and meaningful ways. It creates a sense of belonging in which uniqueness is unconditionally accepted, maintains a culture based on respect for individuals' perspectives, and views collaboration as critical. In this space, personal power is set aside in favour of achieving greater, joint objectives. Relationships thus forged are not only a route to other skills, but centrally important to effective learning (Chapman & West-Burnham, 2010:124-126).

Freedom from poverty and discrimination

The two aspects of poverty and discrimination have far-reaching effects on the well-being of a community and its members. They impact on a number of the other aspect related to the C & W-B model, including physical and emotional health, and hamper the opportunities to succeed for those affected by it. Kyle (1999:258) states that poverty affects both the environment and health of all people. He also emphasises that poverty contributes to disease and death through its secondary effects because poor people are more likely to live in an unhealthy environment.

The holistic C & W-B model described above, frames equality in terms of inclusion and belonging through a deep sense of unity for any group or community as a whole. It attempts to break down the ideology that conflates academic ability with intelligence. In addition, this model challenges the fixed academically focused mind-set that calls for a uniform broad curriculum that ignores personal growth, circumstance or background. It also shows that concerns about worker health, wages, equity, education and basic human rights are inseparable from concerns about water, climate, soil and biodiversity. In the context of successful educational change, it addresses the whole learner through the overarching aspect of well-being. Well-being, as a fundamental basic, directly supports literacy and numeracy, and thus shows the strong association between emotional health and cognitive achievement (Chapman & West-Burnham, 2010:19-20).

It is evident that the school has an important role to play in expressing the ideals of such a holistic approach. An ideal way is to apply real-world ideas in addressing inequality in the local area and the community it serves. The culture of the school both reflects and influences its community. Culture impacts on equity by influencing outcomes, so addressing wider community concerns will improve personal perception and circumstance of the learners. The school can therefore offer opportunities to

share in the activities that shape community transformation. By identifying the pressures, the school can outline a strategy for change and take action to change the lives of the individual child, the family and the whole community. In this way, participants develop wellbeing by applying ideas and identifying the principles and values that underpin them (Chapman & West-Burnham, 2010:114-115).

Social justice and Science education

Two approaches to science education that embody some of the aspects of the social justice conceptual framework, is Urban Science Education Studies and Science Education for Socio-political Action.

2.8 Urban Science Education Studies and the C & W-B model

In an autobiographical account of his experiences on becoming a science educator in an overcrowded inner city high school where most students were African American living in conditions of relative poverty, Tobin (2000:90) makes the following statement:

> It is critical that prospective teachers understand the significance of elements of social class (especially poverty) and ethnic diversity as factors that will shape enacted curricula, the participation of students, and what teachers can accomplish.

Urban schools are generally viewed as being under-resourced, underachieving and populated largely by students who live in disadvantageous economic circumstances, while the curriculum in such schools has been described as limiting, low-level and fragmented (Prime & Miranda, 2006:506). Tobin, Roth and Zimmerman (2001:941-942) add that in urban schools the majority of students are from the working class or from homes in which earnings are below the poverty line, and often experience added social problems such as violence and drug use. Many urban teachers must deal with large classes and little equipment; for this reason, they often use whole-class instructional techniques (such as lectures, class reading and the completing of worksheets) in which students are passive learners (Hewson, Kahle, Scantlebury & Davies, 2001:1131). Teachers in some urban settings have to cope not only with students from impoverished backgrounds, but with many who are not native English speakers. This pedagogy of poverty, as Hewson et al. (2001:1131) call it, provides few opportunities for developing higher-order thinking skills. Students in such circumstances may therefore perceive schooling as a form of hegemony.

Urban Science Education Studies (USES) recognise the uniquely powerful position which science holds in urban societies, the global history of environmental racism and hierarchical relationships between those who know science and those who do not, and the role it plays in demystifying key urban environmental issues such as air and water quality, population density, and toxic dump and building regulations (Barton, 2002:1). The attention given to these environmental issues agree with three aspects of the C & W-B model, namely Physical Health, Successful Communities and Opportunities for Success. USES can be considered to be a critical approach to science education, as it

views education as fundamentally concerned with the understanding of the link between knowledge and power, and offers a foundation for challenging the traditionally held assumptions underlying science education (Barton, 2003:27-28). USES approaches science education specifically from an urban context and themes involving the origins, development and nature of cities, the relationship between people and the built environment, urban economics, government and public policy, and the processes that shape city neighbourhood over time. USES therefore contributes to how we understand the intersections between students, their families and their teachers, science, schooling and the historical, physical, environmental, social, economic and political aspects of urban life (Barton, 2002:4-5). The essence of USES is captured by a set of three commitments: to equity, social justice and a sense of place. These features also show a link to a few aspects of the C & W-B model: Parity of Esteem, Freedom from Poverty and Discrimination, and Successful Communities, in particular. Since equity is a defining concept in USES because of the vast differences in social class, language, racial and ethnic minority backgrounds supported in urban centres, promoting science education calls for hard questions regarding access to material, human and social resources for the underserved populations presented in such a geographic space, where, according to research, students negative attitude towards school science is significantly influenced by their perception of the science teacher (Barton, 2002:7-8;10). The link in this case is to the Effective Learning aspect of the C & W-B model.

2.9 Science Education for Socio-political Action and the C & W-B model

Science Education for Socio-Political Action (SESPA) is an emancipatory science education model and proponent of critical scientific literacy. For Russell and Hodson (2002:488), the major purpose of science education is to ensure critical scientific (and technological) literacy for all as a means to social reconstruction, that is, to enable future citizens to look critically at the societies we have, the values that sustain them, and to ask what can and should be changed in order to create a more socially and environmentally just world. SESPA claims that a proper understanding of science and the scientific enterprise is just as essential as scientific knowledge (in other words, conceptual understanding) in ensuring and maintaining such a socially just democratic society (Hodson,1999:784). It questions the hegemonic view of science and scientific discovery as the inevitable outcome of the correct application of a rigorous, objective, disinterested, value-free and all-powerful scientific method and acknowledges that science and technology are human endeavours that influence, and are influenced by, the socio-cultural context in which they are located. As such, science and technology are driven by the needs, interests, values and aspirations of the society that sustains them. Hodson (1999:785) cites the example of scientific racism (the misuse of the notion of race to perpetuate stereotyping, legitimise discrimination and institutionalise injustice) as proof of how a particular society may define and organise science differently and so produce different science. Another concern that SESPA addresses is the prominent role that science language (and especially the language of school science) and communication plays in creating barriers to universal access. This aspect of SESPA seems to link to

the Access & Inclusion, as also the Effective Learning aspects of the C & W-B model. An emphasis on the formal language of science to the exclusion of everyday ways of speaking and writing may help promote an ideology of authority concerning science and lead students to believe that scientific knowledge is fixed and certain. On the other hand, more familiar vocabulary and language forms may help students see the relationship between science and the real world and cultivate an appreciation of how scientific knowledge derives from and complements everyday, common-sense knowledge (Hodson, 1999:786). The SESPA model can be regarded as a politicisation of science education – by grounding science curriculum content in socially and personally relevant contexts, students are provided with opportunities to confront a wide range of socio-economic issues that have a scientific, technological or environmental dimension. Russell and Hodson (2002:488) suggest replacing the usual content organisation of science education with a mix of local, regional/national and global topics such as health, food, water, agriculture, technology, freedom and control in science and technology, as well as ethics and social responsibility.

Using an issue-based approach can provide the motivation that is absent from abstract, decontextualised approaches that will allow students to construct scientific understanding that is personally relevant, meaningful and important (Hodson, 1999:787). Achieving critical scientific (and technological) literacy through an issue-based approach requires four levels of sophistication, culminating in the preparation for socio-political action. The first level brings about awareness that science and technology are powerful forces shaping the lives of people, and are to some extent culturally determined. Societal impact, both positive and negative, of modern inventions is an example to use at this level. The second level brings the recognition that scientific and technological developments are inextricably linked with the distribution of wealth and power, and that decisions are taken in pursuit of particular interests. Again, in this instance, there is a link to the C & W-B model: the aspects which they appear to have in common here are Physical Health and Opportunities for Success. Here the radical political nature of the curriculum becomes apparent, because science and technology are seen as serving the rich and powerful in society in ways that are often prejudicial to the interests and well-being of the poor and powerless. The third level sees the teacher supporting students in their attempts to formulate their own opinions on important issues, and to establish their own value positions. This mode of anti-discriminatory education fosters deep feelings of self-esteem and personal well-being, and extends to respect for the rights of others, mutual trust, the pursuit of justice, cooperative decision-making and conflict resolution. This is a link to the Emotional Health aspect of the C & W-B model. The fourth level of sophistication assists students in preparing for and taking responsible action, and ensures that they gain a clear understanding of how decisions are made within the local, regional and national government, as well as within industry, commerce and the military. Reaching this level, through taking action while at school, furthers the likelihood that students become active citizens in future.

From this comparison it appears that the Science Education for Socio-Political Action model has at least five features which overlap or link with the Chapman & West-Burnham (2010) model.

2.10 Chapter Summary

In this chapter I gave an overview of critical pedagogy, the paradigm which frames this study, and paid special attention to a number of its core elements which are especially relevant in this study. Important constructs and concepts in the context of this study, namely scientific literacy, socio-scientific issues and social justice education, were also discussed. I outlined the conceptual framework of this study - an integrated model featuring a number of social justice aspects - and contrasted it with the characteristics of two emancipatory science models: Urban Science Education Studies, and Science Education for Socio-political Action.

In the next chapter I will elaborate on how the conceptual model informed the research design of this study through the construction of two scenarios based on socio-scientific and controversial community issues. .

CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

Qualitative researchers are interested in understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences.

Merriam, 2009:5

3.1 Introduction

Merriam (2009:13) poses that the conceptualisation of a research project begins with the researcher examining the purpose(s) of doing the research, and the type of knowledge to be produced through his/her efforts. It requires the researcher to examine his/her own orientation to basic tenets of the nature of reality, that is, the experience of life as lived (Lincoln, 2005:27). In addition, Merriam (2009:13) explains, the researcher has to answer the following questions: What orientations is the best fit with my views? Which is the best fit for answering my research question(s)?

In this chapter I explain my standpoint and answer these questions the best I can in terms of my own study. I put forward an overall approach and rationale for my study and detail its methodological framework and research design. I outline the sampling method and discuss the data collection, interview process and its validation, as well as the manner in which trustworthiness of the study was addressed. I conclude the chapter by clarifying the process of data analysis that was used in the study.

3.2 Overall approach and rationale

Maxwell (2005:17) stresses the importance of selecting a research approach which offers the "best fit" for the study being conducted. By selecting the topic for the study, and using a particular set of "assumptions about the world" and his or her "methodological preferences", the researcher conceptualises the research study (Maxwell, 2005:37). The research approach which best fits the study will guide the researcher to make decisions regarding its research design, the data collection and reporting, and ultimately the response(s) to the research question(s), according to Maxwell (2005:36).

This study was designed to uncover the essential themes of the perceptions held by ten high school science teachers around the integration of socio-scientific issues (SSIs) in their science classes. The goal of the study was to describe the perceptions and experiences of the science teachers with regard to the purposes they see in the integration of SSIs, the teaching methods they employ for such integration, and ultimately their views on the role of social justice in their own science teaching. The overall purpose of the study was to interpret the multiple perceptions held by the teacher participants.

By using a phenomenological methodology, I enabled the science teachers to share their perceived experiences and reveal the perceived beliefs they associated with SSI integration. It also enabled me to create an overall picture of the multiple textured descriptions of their lived experiences.

3.3 Research questions

This study was guided by the broad research question: How do teachers perceive the integration of socio-scientific issues in their science classes?

Sub-research Questions (SQ's)
In an attempt to answer the main research question the following questions were pertinent:

A. What do teachers see the purpose(s) of such integration to be?
B. How do teachers say they would integrate SSI in their science classes?
C. What are teachers' perceptions on the role of social justice in science teaching?

3.4 Methodological framework

Using a qualitative approach to this research study was most appropriate. As Denzin and Lincoln (2005:3) explain, "…qualitative research involves an interpretive, naturalistic approach to the world". A naturalistic approach holds that action is best understood when it is observed in the setting in which it occurs. Concerned with context, the qualitative researcher has to understand the setting in terms of the historical life of the institution of which it is a part, since human behaviour and perceptions may be significantly influenced by such a setting (Bogdan & Biklin, 2007:4-5). I also kept in mind the commentary by Leedy and Ormrod (2005:133) that a qualitative research approach acknowledges that different individuals may hold a multiple of perspectives, but that each of these perspectives have equal validity or truth. As the researcher, I had to attempt to make sense of, or interpret, the phenomenon of SSI integration in science teaching in terms of the meaning(s) that the teacher participants attached to it. The goal of my qualitative study was then to reveal the nature of the multiple perspectives brought by the science teachers about SSI integration.

Two of the purposes of qualitative research described by Leedy and Ormrod (2005:134) are important in this study: *description*, which can reveal the nature of certain situations, processes, relationships or people; and *interpretation*, which enable the researcher to gain new insights or develop new concepts about a particular phenomenon and/or discover problems that exist within the phenomenon.

Methodology is seen as the frame of reference for research influenced by the paradigm in which the researcher places or develops his or her theoretical perspective (Walter, 2006:35). It is noted that in

certain literature the theoretical framework is described as the paradigm (for example Mertens, 2005; Boghdan & Biklin, 2007), or even the "philosophical model of inquiry" (Lincoln, 2005:28). More commonly defined, methodology is seen as the overall approach which links the research with the paradigm or theoretical framework (Mackenzie & Knipe, 2006:198).

Merriam's (2009) classification of the philosophical orientations of research was helpful in my effort as a novice researcher to properly position the methodological framework of this study. She summarises four philosophical orientations, namely Positivist/Post-positivist, Interpretive/Constructivist, Critical and Post-modern/Post-structural, each from the epistemological perspectives of its *purpose*, the *types* of research it represent, as well as its stance on *reality*, as summarised in Table 3.1.

Table 3.1 A comparison of four philosophical orientations of research

Philosophical orientation	*Positivist / Post-positivist*	*Interpretive / Constructivist*	*Critical*	*Postmodern / Post-structural*
Purpose	Predict, control, generalise	Describe, understand, interpret	Change, emancipate, empower	Deconstruct, problematise, question, interrupt
Types	Experimental, survey, quasi-experimental	Phenomenology, ethnography, hermeneutics, grounded theory, naturalistic/qualitative	Neo-Marxist, feminist, participatory action research, critical race theory, critical ethnography	Postcolonial, post-structural, post-modern, queer theory
Reality	Objective, external, out there	Multiple realities, context-bound	Multiple realities, situated in political, social, cultural contexts (one reality is privileged)	Questions assumptions that there is a place where reality resides, "Is there a there there?"

From Merriam (2009:11)

However, Merriam (2009:10, 12-13) cautions researchers not to interpret the table as a rigid differentiation of the four perspectives, and explains that in actual research there is often overlap and intersecting of these perspectives. Finding the orientation which best fits my personal views, meant starting off by examining my own views on the nature of reality, the purpose of doing this research, as well as the type of knowledge I hoped to produce through this study.

My own views on reality resonated with those perspectives which viewed reality as context-bound and situated in political and/or social contexts. The purpose of this study I saw as not only describing how teachers viewed the integration of socio-scientific issues in their science classes, but also an inquiry into these teachers' concerns and values, and how they might address and empower their students in terms of social justice and change. I realised that this last point could be interpreted as giving the study a political agenda. I therefore chose to take a "softer" approach by presenting the research participants with scenarios depicting interrelated social issues to elicit their perceptions on the role of social justice in their science teaching. I was supported in my option by Henning, Van Rensburg and Smit (2004:2), who state the following:

> Researchers are no longer satisfied with predicting or even understanding the researched, but want to address social issues in and through their research as well.

Methodologically, this qualitative study could then be said to be underpinned by the principles of the interpretive perspective, and strongly influenced by the critical perspective.

3.5 Research design

I used a phenomenological research approach for this study. My decision was guided by a number of descriptions and definitions of phenomenology and its research methods found in research literature. Finlay (2009:6) states that the central concern of phenomenological researchers is a return to embodied, experiential meanings with the aim of arriving at a fresh, complex, rich description of a phenomenon as it is concretely lived. According to Moustakas (1994:84), phenomenology allows for evidence to be derived from first-persons' reports of the life experiences of the participants. However, he also contends that "establishing the truth of things" begins with the researcher's own perception/s (Moustakas, 1994:57). The following statement by Phillips-Pula, Pickler and Strunk (2011:67) shows their concurrence with the opinion of Moustakas (1994:57), and was particularly meaningful in terms of the methodology of this study:

> Phenomenological methods are often chosen because of a researcher's philosophical or methodological congruence with the nuances of the approach.

Theoretically this study is underpinned by the philosophical tenets of critical pedagogy, as elaborated on in Chapter Two of this report. My choice of methodology, in light of the overall theoretical framework of this study and the claim by Phillips-Pula et al. (2011:67), was provided an important substantiation by Apple (2004:124): He postulates that phenomenology and critical scholarship are similar in that they present a critically oriented notion coupled with a certain plurality of ways of looking at the world. In addition, all these researchers regard the "truth" as something that can only be seen through the use of the totality of perspectives that one can bring to bear upon it.

The phenomenological study is one of five common qualitative research designs in the interpretive orientation (see Table 3.1). It attempts to understand people's perceptions, perspectives and understandings of a particular situation (Leedy & Ormrod, 2005:139). As a major orientation to social science and a qualitative research approach, phenomenology holds the basic philosophical assumption that we can only know what we experience by attending to perceptions and meanings, and that a person's experience includes the way that experience is interpreted (Merriam, 2009:9).

Wiersma (2000, 238-239) provides a set of assumptions of how phenomenological research should be conducted:

1. *A priori* assumptions (that is, those which proceed from theoretical deductions rather than from observations or experience) regarding the phenomenon being studied should be avoided.
2. Reality should be viewed holistically.
3. Data collection and research instruments should have minimum influence on the phenomenon being studied.
4. The researcher should maintain an open mind to alternative explanations of the phenomenon.
5. Applicable theory should emerge as grounded theory, rather than preconceived theories.

Denscombe (2007) cites both advantages (p.85) and disadvantages (p.85-86) of using a phenomenological approach in social research. Firstly, in terms of advantages, it offers researchers the prospect of providing authentic accounts of complex phenomena. Secondly, it represents a humanistic style of research far removed from any high-minded, abstract theorizing. Thirdly, it is suited to small-scale research which generally relies on in-depth interviews as the method of data collection. Fourthly, it allows for the description of experiences in a way that is immediately accessible and interesting to a wide range of readers. However, the emphasis by the phenomenological approach on subjectivity, description and interpretation may be interpreted as a lack of scientific rigor and treated as a weakness by those who do not share its stance. Another criticism levelled against it, is its strong association with description, but less (or no) emphasis on the analytical abstraction of the research data. Questions may also be raised about the representativeness of the data and how far it is justifiable to generalise from the findings of the generally small samples used in phenomenological studies. Its attention to the routine aspects of everyday day life might be interpreted as mundane, trivial and relatively unimportant. It may also be questioned whether it is at all possible for researchers to rid themselves of their presuppositions, and suspend common sense, about the way they see things work.

3.6 Method

Method refers to systematic modes, procedures and tools used for the collection and analysis of data (Mackenzie & Knipe, 2006:198). In this section I elaborate on the role of the researcher, the sampling

of the research participants, the setting to which the study sample was confined, the type of and procedures followed for the data collection, the process of data analysis, the way trustworthiness was enhanced during the study and its written report, and the ethical considerations that were taken into account.

3.6.1 The role of the researcher

Patton (2002:14) and Maxwell (2005:83) posit that the researcher is viewed as the instrument in qualitative research. As the primary research instrument, the researcher needs to become aware of personal biases (subjectivities and assumptions s/he may hold), as these may lead to preconceived ideas about the possible findings. Therefore, as soon as the researcher has decided on the phenomenon to be researched, s/he should begin a process of self-reflection. This process is needed to monitor and then bracket out (set aside) biases and assumptions (Merriam, 2009:5; Laverty, 2003:5). Lowes and Prowse (2001:473) also speak of bracketing as a method whereby all ideas about the external world and its objects as acquired through society, culture and history, are abandoned, so that knowledge becomes the product of the intentionality of pure consciousness. Hamill and Sinclair (2010:17) compare bracketing in phenomenology to how it is used in mathematics, where its purpose is to separate one part of an equation from another, allowing one to focus on that part in isolation from the other. Similarly, in phenomenological research, brackets hold in temporary abeyance the prior knowledge of the researcher, so that the researcher does not influence the participants' understanding of the phenomenon. Each participant can therefore present the researcher with new knowledge and a fresh understanding in the search for the essence of the phenomenon. The researcher must acknowledge that being unaware of his or her personal feelings and preconceptions has major implications for the rigour of the research, and hence must take every reasonable step to ensure that presuppositions are brought to the level of consciousness, acknowledged, and then bracketed (Hamill & Sinclair, 2010:19). In this way, the researcher maintains an openness or "stance of neutrality" during the data collection process (Patton, 2002:51).

Researcher subjectivities, however, could also make a distinctive contribution to the research process when the unique configuration of personal qualities joins the collected data during the data analysis and discussion stages. It is imperative that the researcher should then make the necessary adjustments and be responsive to changing contexts and situations in order to adapt the research process accordingly (Merriam, 1998:7; Merriam, 2002a:5).

I started this study with a number of preconceived ideas and personal views which I had to acknowledge firstly to myself, and secondly list as part of this report. As a practitioner in the field of science education (in previous years as a high school science teacher, and recently at a tertiary level in the field of teacher training), I was well aware of the onus placed on (science) teachers in terms of the promotion of social justice and societal development. With my personal interest and involvement in

local resistance political movements and community organisations, I have never avoided any opportunity to engage my students in controversial issues of social and political concern. I continue to search for the "science" in issues reported in the news media or conveyed via other means, and my students are used to having their science classes turned into discussions around such issues. In the pre-democratic years, I have known teachers who held similar views on (what we then called) conscientizing learners through classroom practices. Post-1994, teaching *for* and *about* social justice became mandatory through (especially) Learning Outcome 3 of the RNCS for the Natural Sciences. I anticipated that teachers would feel encouraged to start teaching to more than just the science content in their lessons. Teaching *about* social justice requires the kind of classroom approaches that would give learners the opportunity to voice their opinions and be involved in informed decision-making by adopting more student-centred teaching approaches. At that juncture in our educational history, my own classroom approach to engage my learners in social and political issues linked to science topics was already firmly entrenched. This study came about through my interest in how other science teachers deal with controversial social and political issues in their classroom. When I started this study, I believed that most science teachers would hold similar views. All of these personal views and expectations I had to acknowledge and set aside especially during my interactions with the research participants.

3.6.2 Sampling and setting

Sampling

Sampling refers to the selecting of a unit of analysis in a proposed study, that is, the researcher must decide who, what, where and when to interview or observe. A *purposive* (also called purposeful) sampling technique was used to select the teacher participants for this study. A qualitative researcher uses purposive sampling to detect cases within extreme situations in order to maximise variations, that is, to have a range of situations (Gobo, 2007:418). The logic and power of purposive sampling lies in selecting information-rich cases for in-depth investigations, in other words, those cases from which one can learn a great deal about issues of central importance to the purpose of the study (Merriam, 2009:77). It starts by first determining what selection criteria will be used to choose the people or sites for the study (and therefore another term for this kind of sampling is *criterion-based selection*). By creating a list of attributes essential to the study, the researcher can then proceed to locate a unit matching the list. Henning et al. (2004:71) speak of "desirable participants" as spokespersons for the topic of inquiry, and therefore representatives of a theoretical population. They caution that because these participants do not represent a particular group of people, the researcher may not be able to generalise the research findings.

As the researcher, not only did I have to spell out the criteria to be used in selecting the research participants, I also had to acknowledge *why* these criteria were important.

From a phenomenological perspective, the sample included only those participants who I expected to understand and to be articulate in expressing their thoughts about the phenomenon (Corben, 1999:59).

The sample of participants that I selected was based on my own judgment of their experiences relating to the teaching of Natural Science (in the GET Senior Phase) and the purpose of this study. At the time that I approached them for participation in this study, all the participants were teaching Grade 8 and/or 9 Natural Science in a WCED high school situated in the Cape Metropole area. Ten participants voluntarily agreed to take part in the study after I explained its purpose and the procedures that they could expect during participation. From the outset I made these teacher participants aware of their rights with regards to anonymity and confidentiality and their right to withdraw from the study at any stage. They were briefed about the procedures of the interviewing, such as the audio-taping, as well as its transcription thereafter.

I was familiar with all ten of the participants, but through different levels of interactions. Three participants were previously co-teaching Natural Science with me. One other participant and I were in the same cluster of high schools (as demarcated by the WCED) and we came to know each other through the science workshops and meetings we were expected to attend. Another two participants I came to know through a project I participated in at a local university where they were registered for post-graduate studies. A seventh participant and I were in the same post-graduate class at another local university. One of the participants was a student in my science class while she was completing her teaching qualification two years prior to this study. A ninth participant I interacted with over a period of two years when I had to evaluate student teachers during teaching practice sessions at his school. A tenth participant was an acquaintance who I frequently assisted in preparing science lessons and tests.

A number of these participants were selected through my first-hand knowledge of their personal back-grounds and experiences with learners from low socio-economic backgrounds, their involvement with the communities around their schools and their political views. Seven of the participants were teaching Grade 9 Natural Science during the period when learners in this phase had to complete the national Common Task Assessments (CTAs) in all learning areas. The science tasks of the CTAs centred around a socio-scientific issue specific to a South African situation to which most learners could relate. All but one of the ten participants had attended the compulsory five day teacher training workshops before the introduction of the RNCS and/or CAPS science curricula. In addition, all of the participants had attended the regular moderation sessions coordinated by their local education districts throughout the academic years in which the classroom assessment strategies were monitored against the curriculum policies. I therefore felt confident that all the participants would be familiar with the requirements of the science curriculum policies.

Table 3.2 provides some background information to the participants in this study as gleaned from the information sheet that they were requested to complete prior to the interviews. To protect the anonymity of the participants, they were assigned numbers, P1 to P10, and this is how they will be referred to for the rest of this research report. These numbers bear no significance of importance, other than the order in which the interviews of the participants were transcribed.

Table 3.2 Participants' background information

Participant	*Gender and Race**	*Type of School (see descriptions under Settings below)*	*Teaching experience (in years)*	*Subjects and Grades (at time of interview)*	*Qualifications*
1	M, C	Public School A	23	Natural Science Gr 9Life Science Gr 10	B. A.; HDE
2	F, W	Public School B	21	Natural Science Gr 8 & Gr 9	B. Sc; HDE; B. Sc (Hon)
3	F, C	Public School A	22	Natural Science Gr 8-9 Life Science Gr 10-11	HED
4	F, C	Public School A	3	Natural Science Gr 9 Physical Science Gr 12 Life Science Gr 10-11	B. Sc; PGCE
5	M, B	Public School C1	13	Natural Science Gr 9 Physical Science Gr 10 & Gr 12	B. Sc; PGCE; B. Ed (Hon); PGDE
6	F, B	Public School C2	6	Natural Science Gr 9 Physical Science Gr 12	B. Sc; PGCE; B. Ed (Hon)
7	M, B	Public School C1	9	Natural Science Gr 8 & Gr 9	HED; ACE
8	F, C	Public School A	2	Natural Science Gr 8 Technology Gr 8	B. Ed
9	F, C	Independent School D	6	Natural Science Gr 9 Life Science Gr 10-12	B. Sc; PGCE; B. Ed (Hon)
10	M, C	Public School B	4	Natural Science Gr 9 Physical Science Gr 10	B. Ed

*All of the participants chose to fill in the optional entry that asked for race identification on the information sheet given to them.

The sample for this study consisted of six female and four male teachers. There were six Coloured, three Black and one White teacher in this sample. Only Participants 3 and 7 held qualifications in education which were not degree courses (the Higher Education Diploma from former colleges of education). Participants 8 and 10 each held a four-year academic degree in education (Bachelor of

Education) from a university or a university of technology. The other participants all held a degree (in either science or the humanities) and a postgraduate professional qualification in education (Postgraduate Certificate in Education, or the former Higher Diploma in Education).

Setting

The types of schools that I selected represent a range of situations that differ in terms of their former racial character, the socioeconomic character of their neighbourhoods, and post-apartheid changes in their racial composition and feeder areas, as Lemon & Battersby-Lennard, (2009:521) describe the setting in their particular study .

The study was confined to eight high schools spread across the Cape Flats and the Southern Suburbs of the Cape Town Metropole. Two sets of participants (Participants 1 and 8, and Participants 5 and 7) taught at the same school. Seven schools were public schools and one an independent school. The schools are grouped into four types: A, B, C (C_1 and C_2) and D. The student populations of school type A are predominantly Coloured and the schools are all located in Coloured areas of the Cape Flats. Two of these schools are located very close to large informal settlements. School type B are former Model C schools and their student population is now predominantly Coloured. Schools C1 and C2 have only Black learners; school C1 occupies the buildings of a former Whites Only school in a small-business area of the Southern Suburbs, and learners use public transport to commute between the school and home every school day, while school C2 is located in a Black Township of the Cape Flats. School D is an Independent school and most of its student population comes from a very high socio-economic background.

3.6.3 Data collection

Data was collected by interviewing the purposefully selected sample of ten Senior Phase Natural Sciences teachers from eight high schools in Cape Town as laid out in section 3.6.2.

3.6.3.1 Interviews

Probably the most common form of data collection in qualitative research today is interviewing (Merriam, 2009:86), because it is perceive as “talking”, and talking is a natural activity which does not presuppose any statistical knowledge about the research participants (Griffee, 2005:36). Rapley (2007:15) contextualises interviewing as a construct that pervades and produces our contemporary cultural experiences and knowledge of our authentic personal, private selves. He also recognises face-to-face interviewing as enabling a special insight into subjectivity, voice and lived experience. Interviewing allows the researcher to gain explanations and information on phenomena which are not directly accessible, for example perceptions, attitudes and values (Partington, 2001). However, there are also limitations and disadvantages to this method, as Denscombe (2007:203) explains. Those limitations and advantages which he describes and were relevant to what I experienced during this

study are as follows: the *time-consuming* aspects of transcribing and coding the data; the *non-standard responses* of the semi-structured interviews which resulted in relatively open-format data; the impact of the interviewer and the context on the participants which could have affect the *reliability* (dependability) of the study by making consistency hard to achieve, and the *inhibiting effect* which the audio-recorder may have had on some of the participants.

Semi-structured interviews

The type of interview used in this study is the semi-structured interview, which is most often used in educational evaluation (Griffee, 2005:36). On a continuum of interview types, the semi-structured interview lies between the two extremes, namely the highly structured standardised interview and the unstructured, informal interview (Merriam, 2009:86). In the case of the semi-structured interviews, according to Denscombe (2007:176), the interviewer still has a clear list of issues to be addressed and questions to be answered. However, whereas in the structured interview there is tight control over the format of the questions and answers, with the semi-structured interview the interviewer is prepared to be flexible in terms of the order in which the topics are considered. The interviewee is also allowed to develop ideas and speak more widely on the issues raised by the researcher and elaborating on points of interest to him or her (Denscombe, 2007:175-176).

An interview schedule (see Appendix B) was drawn up using a semi-structured format. It contained a mix of more or less structured core questions and a number of suggestions for possible follow-up questions. The interview schedule for the participants only contained the core questions, while, as the interviewer, I kept the list of suggestions at hand for follow-up questioning during the interviews.

A copy of the interview schedule (together with copies of two SSI scenarios) was faxed, e-mailed or personally delivered to each participant at least two weeks prior to the interview being conducted. The reason for this was to allow the participants sufficient time to familiarise themselves with the questions I would ask during the interview, and to clarify any ambiguity in the core questions that might have cropped up ahead of an interview session.

3.6.3.2 Interviewing procedures

One of the features of qualitative research is its *naturalistic* (interpretive) approach in considering human behaviour to be significantly influenced by the settings in which it occurs. This kind of research therefore seeks to understand a phenomenon in context-specific settings, collecting data on location and supplementing it by the understanding that is gained by being on location (Bogdan & Biklen, 2007:4-5). During the planning stages of this study, data collection, in the form of interviews with science teachers (the research participants), was going to be done on the school premises where the phenomenon of interest would have been allowed to unfold naturally. There was an assumption on my part that the historical backdrops of these institutions could significantly influence the behaviour of

the participants. However, from experience I know the kind of distractions that a teacher could experience during his or her time at school, and I opted to conduct the interviews in locations where the participants would not be constrained by their workload or hampered by other distractions. Seven interviews were conducted at the homes of the participants, one in my office and one in a coffee shop (at the participant's request). Only one interview was conducted in a participant's own classroom, but on a day that he was not teaching and his learners were away on an educational excursion.

During the interviews I was guided by the list of questions on the interview schedule, but was not overly concerned with its exact wording or the order of the questions. As the interviewer, I tried to stay within the parameters defined by the aims of the study. However, as in the case study described by Firmin and Merrick Gilson (2007:33), I also exercised freedom to navigate during the interviews, moving from the scripted questions (on the interview schedule) and allowing the participants at times to lead the interview in the direction of their interests and personal experiences. This flexibility, I believe, enhanced the quality of the obtained information.

I audio-recorded all the interviews I had with the participants. By recording each session, a researcher not only provides an accurate account of the interviews, but also enhances the trustworthiness or validity of the research process (McMillan & Schumacher, 2001: 410). Denscombe (2007:195) cites the advantages and disadvantages of audio-recording:

> Audio recordings offer a permanent record and one that is fairly complete in terms of the speech that occurs. They also lend themselves to being checked by other researchers. However, the downside is that they capture only speech, and miss non-verbal communication and other contextual factors.

Each interview was recorded using a digital audio-recorder and in certain instances, the verbal information from the participants was backed-up by my written field notes. I took precautions to ensure that a new digital folder was selected for each interview and to safeguard its storage in this way. On initial contact with the participants I asked their consent to audio-record the interview session. At the start of an interview, I gave an explanation of the procedure to be followed and informed the participant of his/her right to stop the proceedings at any stage. As the researcher, I guided the interview sessions to help maintain the focus of the process on the interview questions as far as possible. In certain instances, as a sign of respect, I allowed participants to elaborate on issues which were clearly of importance to them, although not significant in the context of the study. Once the interviews were concluded, the audio files were replayed and transcribed verbatim to identify the emerging categories, themes and patterns that would be used to organise this data. This process was followed after each interview with a participant.

During an interview I also made field notes to remark on issues such as a participant's body language, events such as interruptions and general reactions from a participant when clarifying a point. As

Fraenkel and Wallen, (2005:431) point out, such notes could contribute to the credibility, richness and accuracy of the interview when transcribing and analysing the data. Although I used none of the field notes during any stages of the transcriptions or thereafter, it provided another level of insight into how participants felt about certain issues. For instance, one participant became pensive and used frequent head-shaking whenever he mentioned the adverse living conditions of the learners and the communities they come from. Another participant described her enthusiasm to stimulate dialogue sessions in her classroom in an almost animated manner, and on two occasions during her interview burst into laughter when recalling remarks made by her learners.

Interviewing about incidences

On the recommendation of one of my supervisors, I wrote two scenarios based on events that were widely reported on by the local media during 2009. [See Appendix A.] These events were typical of situations experienced by many communities in suburbs and towns across the Western and South-western Cape regions. The use of scenarios based on real-life incidents, as reported in local media, to elicit science teachers' perceptions on SSIs in their science classes, is strongly motivated by researchers such as Sadler, Barab and Scott (2007) and Kolstø (2001). They explain that socio-scientific issues or cases are viable tools to engage and motivate students. Were these SSIs to be introduced to students in the form of scenarios, such as in the case of the study done by Sadler et al. (2007), they could reveal reality to students as effectively as factual narratives such as scientific reports or newspaper articles. The reason and motivation for this approach is further endorsed by taking into account the authors' descriptions of the characteristics of media-reported SSI, namely that they involve the forming of opinions, and address local, national and global dimensions with attendant political and societal frameworks. This is in line with the call for an issue-based approach in science education that includes and addresses historical, philosophical, cultural, sociological, political and ethical perspectives, and carries the potential for capturing the dynamic interplay of science, technology and society (Pedretti, 1999:174).

In the one scenario such concerns focus on the health and well-being problems and other social ills experienced by the residents of low-cost housing schemes. The second scenario highlights the impact of an industrial operation on the environment and a nearby community. Both scenarios show the interrelationships of the economic, environmental, historical, physical, political and social aspects of our society. In addition, they narrate typical South African situations created by a political system that margenalised certain sectors of society along racial lines.

The way that the scenarios were constructed and how they could be used in the science class fit in with the problem-posing dialogic teaching method suggested by Ira Shor (1992). In this approach, education is used to develop critical consciousness, that is, both the teacher and students synthesise personal and social meanings with a specific text or issue, while exploring the historical context out of

which knowledge has emerged and its relation to the current social context. This will allow them to understand that their actions in school and everyday lives can either transform or reproduce the conditions prevailing in society at large. A critical conscious science teacher will contextualise science inside his or her students' own experiences and in relation to power and problems in society (Shor, 1992:128-129).

The content and contexts depicted in the two scenarios are linked to aspects of the conceptual model, as elaborated on in Chapter Two of this research report. The characteristics of the SSI scenarios which emerge from the Chapman & West-Burnham (2010) model are the following:

- They highlight rights and responsibilities, physical and psychological safety and security.
- They point to the interrelationships between people, the built and natural environment.
- They also point to the interrelationships between and among the economic, environmental, historical, physical, political and social aspects of society.
- They allude to the historically (mostly) racial differences and inequitable power relationships that prevailed in Apartheid South Africa.
- They show that a threat to the balance in ecosystems can compromise both environmental and human relationships.

In addition, the scenarios imply that the lower socio-economic sectors of society will suffer most from the consequences of the aforementioned compromised relationships, as they have the least access to financial, educational and political resources to mitigate the problems that may arise from it.

Importantly, the scenarios were written in a way that learners engaging with it could easily associate with both the advantages and disadvantages of the situations described in it. The one scenario portrays the dilemma of a small community's legal battles with a company which is also their major employment provider. While the members of this community earn their living through the company, the pollution fall-out from its production has a serious impact on the health of the community members, and also infringes on other areas of their daily lives. The other scenario describes an impasse between a community and the local city council responsible for the provision and maintenance of the low-cost housing that they occupy. While the community has legitimate grievances about the structural flaws in the houses, they reject a quick-fix to their problems, and demand attention from higher governmental authorities. However, this kind of action also aggravates the health concerns and social impact that the existing socio-economic conditions are already inflicting upon the community.

Piloting

A pilot interview can serve many purposes: getting started, practicing the interview questions and getting feedback on the topic as well as the interview method or technique (Griffee, 2005:36). Partington (2001) adds that data obtained during interviewing might be corrupted by inappropriate questioning, inadequate listening or the absence of desirable interpersonal skills on the part of the interviewer. A pilot study is therefore a way of contributing to the overall dependability of a research project (Struwig & Stead, 2007:135).

I selected two teachers from my sample to do a pilot interview with before commencement of the actual data collection. This was done to check the effectiveness of the interview schedule in terms of the clarity of questions, its length in time, as well as to familiarise myself with the technicalities of the interview process, including the appropriateness of location and the quality of the audio-recording device used. It was also important to hear the teachers' opinion regarding the level of language, length and content of both the scenarios presented to them, bearing in mind that these were pitched for learners at Grade 8/9 level, and both English First and Second language speakers.

The two scenarios and the interview schedule were well understood and found applicable to their teaching context by the two participants of the pilot study. I therefore had no reason to revise or discard any of the questions, change the length of the interview or the language and structure of the scenarios. Each of the pilot interviewees provided information of such a standard that allowed me to make them part of my larger study sample. The data obtained from the interviews of the two pilot participants therefore became part of the overall description of the phenomenon as laid out in Chapters Four and Five of this report.

3.7 Data Analysis

Patton (2002:432) has the following to say about the process of data analysis:

> The challenge of qualitative analysis lies in making-sense of massive amounts of data. This involves reducing the volume of raw information, sifting trivia from significance, identifying significant patterns, and constructing a framework for communicating the essence of what the data reveal.

Although this study did not produce a "massive amount of data", it nevertheless turned out to be a daunting task for a novice researcher like myself to make sense of research information in the form of ten transcripts. As Patton (2002) describes, the researcher has to somehow find the patterns in the significant information and a structure through which s/he could communicate the essence of the data. As I will explain later in this chapter, grouping the participants into general teacher profiles provided me with such a structure.

The data collected in this research study was analysed using a top-down, emergent coding scheme. Choosing and describing the procedures for the data analysis proved to be probably the most challenging part of my research study. As described in section 3.5, the research design of this study follows a phenomenological approach. I was interested in getting first-persons' reports of the life experiences of the participants of their perceptions regarding SSI integration in their science classes.

I could associate with the descriptions of the phenomenological data analysis approach of Paul Coliazzi in the writings of Holloway and Wheeler (2010:223-224) and Phillips-Pula et al. (2011:68-69). Applying Coliazzi's procedure involves, firstly, a thorough reading of the participants' descriptions of the phenomenon (called *protocols*) to gain a sense of the contents as a whole. Secondly, *significant statements*, that is, phrases/sentences directly pertaining to the phenomenon, are extracted from each description. Thirdly, the *formulated meanings* of the significant statements are reflected on in an attempt to clarify hidden connotations and underlying meaning. Fourthly, the overarching or aggregate meanings are organised into clusters of *themes*. These four steps are repeated for the sets of data obtained from all the research participants. The emerging clusters of themes are referred back to the original protocols in order to validate them and to identify the participants' mutual experiences. Contradictory themes or discrepancies among and/or between the various clusters are noted and studied for their relevance to the topic instead of being ignored. The final three steps then follow in order to get to the fundamental structure of the phenomenon. This involves integrating the extracted themes into an *exhaustive description* of the investigated phenomenon. This step also includes bridging gaps in the data by *coding segments* of the text or using intuitive understanding of the phenomenon or topic. Finally, the *essential structure* of the phenomenon is identified by describing it in as unequivocal a statement as possible. In the closing step, input is solicited from the participants as a final *validation*, changes are incorporated and the conclusive statement reproduced.

A serious concern for me at this point was the lack of informative examples to illustrate and clarify the Coliazzi data analysis approach. The input that I got from my research supervisors was that the Coliazzi approach corresponds with *grounded theory analysis*, a popular method of data analysis. Their view coincided with the fifth assumption by Wiersma (2000:238-239) as set out previously in section 3.5, that is that in phenomenological research, theory should emerge as grounded theory (GT). This idea is also strengthened by the side-by-side comparison done by Starks and Brown Trinidad (2007) of three interpretive analytic approaches, namely phenomenology, discourse analysis and grounded theory, in terms of their goals, methodologies, analytic methods and products. They contend that these three approaches are the products of different intellectual traditions, but their co-evolution in the history of ideas means that the boundaries between them are porous. The comparison shows the three approaches converging in the analytic phase, sharing methodologies for decontextualizing and then recontextualising data (Starks & Brown Trinidad, 2007, 1372). Phenomenological data analysis involves the identification of descriptions of the phenomenon, which is then clustered into discreet

categories; taken together, these categories describe the essence or core commonality of the structure of the experience. GT data analysis follows three stages, namely open, axial and selective coding in which emergent concepts are examined and an explanatory framework is developed which integrates the concepts into a core category (Stark & Brown Trinidad, 2007, 1373).

Creswell (2003:184) and Denscombe (2007:98) elaborate on these three coding stages in GT analysis. During *open coding*, categories of information are identified, grouped and conceptually labelled. During the stage of *axial coding*, relationships are sought among the categories, so that links and associations shift the analysis towards the identification of key (axial) components. Finally, in the interpretive process of *selective coding*, the attention is focused on just the key components as the most significant categories or core codes; the interconnections of these categories allows for the elucidation of a story-line or the emergence of a theory.

Figure 3.1 is a flow chart showing the GT analysis procedure that was followed in this study.

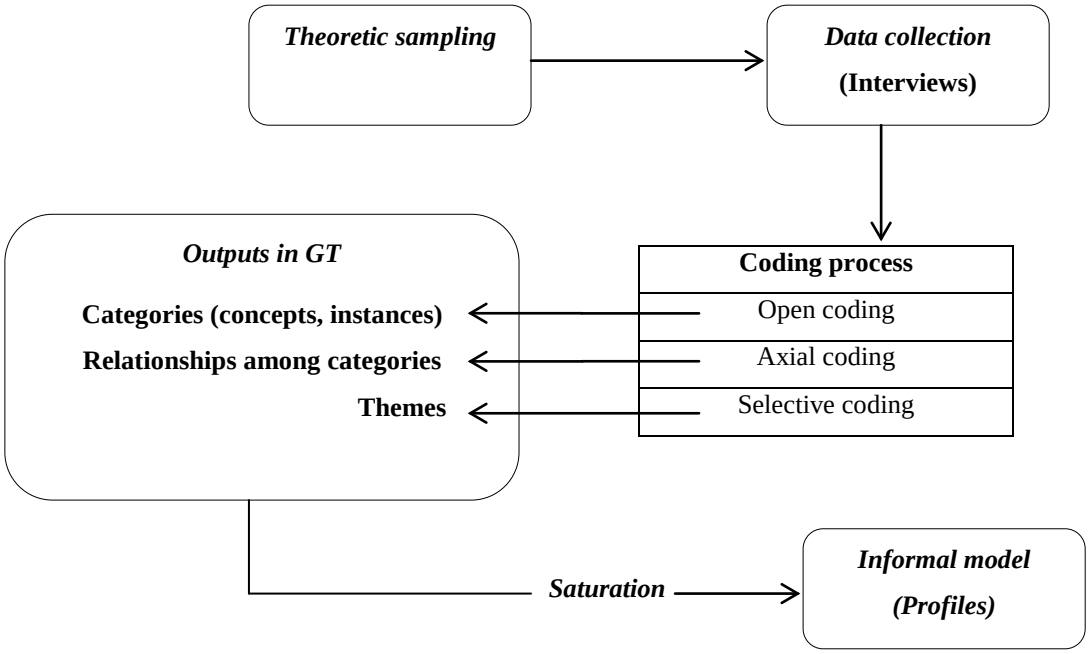

Figure 3.1 Flow chart of the GT analysis procedure

For this study, during the process corresponding with the open coding stage, phenomena located in a transcript line(s), sentence(s) or whole paragraph were assigned conceptual labels and termed *categories*. During the next stage, possible linkages, commonalities and relationships were searched for amongst the categories (equivalent to axial coding) and finally, through selective coding, these compatible categories were condensed into emergent themes.

3.7.1 Theme development

The initial stage of the data analysis process involved the development of themes from a number of categories extracted from interview transcripts, in answer to the three research sub-questions guiding this study.

Coding

I started the analysis process by "line numbering" each transcript in its entirety, using the basic word processing software, Microsoft Word [see Part 1 of Appendix C for an excerpt of a transcript showing line numbering]. Denscombe (2007:197) recommends that each line in the transcript should ideally have a unique line number by which to identify it, in order to locate different parts of the transcript and to help navigate the researcher and the reader to particular points in it. In addition, the page layout for the transcript should include a reasonable amount of clear space on which to write notes and a wide margin on the side of the page that can be used in the process of coding and classifying the data and for writing notes (Denscombe, 2007:197).

The line numbering of each transcript was also useful in the writing up of the research findings and discussions around the findings (Chapters Four and Five). Using quotes or excerpts from the transcripts to represent the data, illustrate a category or theme, and as supporting evidence for an argument, were made convenient by quoting the line(s) in the transcripts where such quotes were taken from. For example, the notation [P3:33-35] refers to a quote from line 33 to 35 in the interview transcript of Participant 3.

During the different coding stages of the process, my two research supervisors and I would first worked independently of one another, then get together to discuss our independent analyses and reconcile the differences where they arose. After a few cycles of discussions and comparisons, we eventually reached consensus on the categories and themes as presented by the coding of the first five transcripts. Coding of the next five transcripts was based on what emerged from the first five.

Coding started by taking each of the three research sub-questions (SQ 1,2 and 3) in turn and correlating it with the number lines in each of the first five transcripts [see Part 2 of Appendix C]. For the open coding phase, each one of us literally read every line of a transcript to find significant instances or concepts with specific features or characteristics. These categories would then be labelled and the line number(s) of the sentence(s) or even paragraph noted. The labels of these significant instances were sometimes descriptive and at other times more analytic in nature. For example, in the transcript of Participant 1, line number [38-39] read "Also for them to understand that, listen here, there is a better life out there, but that you have to work for it". This instance (number 3 on the table in Appendix C) was labelled descriptively as "to project a better life". On the other hand, line number [125-126] from the transcript of Participant 2 read "Is it worth getting a salary at the cost of your life?

Is it worth ruining the environment in order to make money?". The label given to this instance in the transcript was analysed by all three of us coders and its meaning described as "to inculcate values and responsibilities".

Themes

The categories identified were examined for similar characteristics or common central features through the process of axial coding. Next, through selective coding, the different categories were assimilated into significant themes and labelled appropriately.

The initial themes were used as provisional coding schemes for the same five transcripts with an open mind to supplement, re-arrange or re-define the themes at any stage if any of us three coders thought it necessary. This independent coding exercise strengthened the dependability of the analysis method being used.

These coding stages were done for each of the three research sub-questions and applied to all five interview transcripts. In this way, the data was prepared for the construction of profiles of the ten participants. In this study, composing such profiles was an attempt to, as far as possible, capture the perceptions of the ten participants with regard to the purposes that they saw for SSI integration (Research sub-question 1) relative to their perceptions of the role of social justice in science teaching (Research sub-question 3).

In what could probably be described as 'quantification' of the qualitative data, I counted the recurrent themes in the transcript of each participant and collated the information in a frequency table (see Part 3 of Appendix C for an example) for each of the three research sub-questions. In this process I used the frequency of the qualitative categories to ascertain meaningful trends or patterns. However, I kept in mind that I could not interpret such patterns to make any generalizable conclusions about the data and the study.

The prominence given to the themes in the participants' transcripts was presented in terms of four views, namely *insubstantial, fair, significant* and *strong*, as a correlation of the number of times each theme occurred in an interview transcript:

	Insubstantial view: the theme occurs 1-2 times in the transcript
	Fair view: the theme occurs 3-4 times in the transcript
	Significant view: the theme occurs 5-8 times in the transcript
	Strong view: the theme occurs 9 times and more in the transcript

Figure 3.2 Key: Frequencies of themes in interview transcripts

The key in Figure 3.2 shows how the four views correspond with the frequency at which a particular theme was presented in a transcript. Each view was therefore a pointer to the strength of a particular view as inferred from the actual data. I used the frequencies of the themes to construct tables representing the responses of all ten participants for each of the three research sub-question. [See Tables 4.1, 4.2 and 4.3 in Chapter Four.]

3.7.2 Profiles

As found in a study done by Sadler (2009:360), the development of profiles for classifying groups of participants was thought to offer the most effective means of describing similarities among participants of comparable persuasions, while simultaneously highlighting the diversity of perspectives among them. In this study, profiles were also developed to capture the perceptions and lived experiences of participants around SSI integration, relative to the way they view the role of social justice science classrooms. For this purpose, I studied the frequency tables of Research sub-question (SQ) 1 (the purposes for SSI integration) and SQ 3 (the perceived role of social justice in science teaching) to look for initial patterns amongst the participants' responses which could point to emerging profiles. Careful consideration of the frequency tables, coupled with an exhaustive reading of the participants' transcripts, resulted in the development of the profiles in which all ten participants could be positioned. In Chapter Five I elaborate on the different profiles and the participants constituting each.

3.8 Trustworthiness

A researcher needs to feel confident about the degree to which his/her account of the research process accurately represents the social phenomena to which it refers. The quality of research projects has conventionally been judged, from a positivistic perspective, using the following criteria: (internal) validity, generalisability (external validity), reliability and objectivity (Denscombe, 2007:296; Shenton, 2004:64).

Under the umbrella construct of trustworthiness, Lincoln and Guba (1985:290-300) identified four alternative criteria that correspond to those typically employed to judge quantitative work. The notion of trustworthiness is simply a question of how a researcher can persuade his or her audiences that the research findings of an inquiry are worth paying attention to. Table 3.3 summarises the four criteria of conventional criteria against that of Lincoln and Guba's (1985) parallel perspective of criteria to establish trustworthiness in what they term 'naturalistic' inquiry.

Table 3.3 Criteria for quality in quantitative and qualitative research

Conventional terms	*Naturalistic terms*
internal validity	Credibility
external validity (generalisability)	Transferability
Reliability	Dependability
Objectivity	Confirmability

Denscombe (2007) elaborates on the four criteria against which to judge the quality of qualitative research. *Credibility* is the extent to which qualitative researchers can demonstrate that their data are accurate and appropriate (Denscombe, 2007:297). *Transferability* is an imaginative process in which the reader of the research uses information about the particular instance that has been studied to arrive at a judgment about how far it would apply to other comparable instances (Denscombe, 2007:292). *Dependability* demonstrates how far research reflects procedures and decisions that other researchers can 'see' and evaluate as reputable and reasonable (Denscombe, 2007:298). *Confirmability* raises concerns over the extent to which qualitative research can produce findings that are free from the influence of the researcher(s) who conducted the enquiry (Denscombe, 2007:300).

Regular scrutiny of my data collection and initial processing of the research data added to the trustworthiness of this report. I took a data -oriented approach (what some researchers call an audit trail) to enhance the confirmability of the study. This I did by giving an extensive report and a detailed account of the steps that I took during the analysis of the research data.[See for example Appendix C]. The two research supervisors and I would first do all the steps of data coding, theme development and profile independently, then meet to compare categories/themes and to discuss discrepancies until consensus was reached. The inter-coder agreement during different stages of data analysis regularly exceeded 80% , and this pointed to a satisfactory level of trustworthiness.

3.9 Ethical Considerations

Denscombe (2007:141) cautions social researchers to be ethical during the collection of their data, in the process of analysing the data and in the dissemination of findings. Ethical consideration, according to him, therefore means that the researchers should at all times respect the rights and dignity of those who are participating in the research project, operate with honesty and integrity and avoid any harm to the participants arising from their involvement in the research. For Struwig and Stead (2007: 66), research ethics provide researchers with a code of guidelines on how to conduct research in a morally accepted way. Denscombe (2007:141-142) stresses the reasons and norms behind such conduct:

> On moral grounds, these principles stem from the belief that people should be protected from researchers who might be tempted to use any means available to advance the state of knowledge on a given topic. The principles rest on the assumption that researchers have no privileged position in society that justifies them pursuing their interests at the expense of those they are studying – no matter how valuable they hope the findings might be.

Prior to the commencement of data collection for my study, I obtained written permission from the Western Cape Education Department to conduct the research at a specified number of high schools in the Western Cape (see Appendix D). Although interviews with nine of the participants were not conducted on the school premises or during school hours, a copy of the WCED permission letter was made available to all participants, and forwarded to the principals of their particular schools.

3.10 Chapter Summary

In this chapter I reported on the research design and especially went to great lengths to explain the procedure that I followed to collect and process my research data. I presented some of the advantages and disadvantages of data-collection methods that I employed and discussed issues of trustworthiness and ethics.

In Chapter Four, the research findings will be presented to explain how science teachers perceive the integration of socio-scientific issues in their science teaching.

CHAPTER FOUR

RESEARCH FINDINGS

4.1 Introduction

In Chapter Three I presented the rationale for the research framework and procedures used for the collection and analysis of data in this research study. The aim of this chapter is to present the findings in response to the following broad research question:

How do teachers perceive the integration of socio-scientific issues in their science classes?

Through scenarios, depicting modern dilemmas involving socio-scientific issues (SSIs), the following more specific research sub-questions (SQs) were addressed, refining the research question above:

SQ 1: What do teachers see as the purpose(s) for integrating SSI in their science classes?
SQ 2: How do teachers say they would integrate SSI in their science classes?
SQ 3: What are teachers' perceptions of the role of social justice in science teaching?

In the sub-sections 4.2, 4.3, and 4.4 that follow I will expand on the emergent themes extracted for each of the three SQs. I will also consider how prominent a role each theme appeared to play in the science teaching of each participant. As I elaborated on in Chapter Three, the prominence given to the themes in the participants' transcripts is presented in terms of four views, namely *insubstantial*, *fair*, *significant* and *strong*. Each view corresponds with the frequency at which a particular theme is presented in a transcript and is a pointer to the strength of a particular view as inferred from the actual data. Quotes extracted from the transcriptions will be used to typify the essence of each theme. These quotes will show the participants' perceptions on the integration of SSI in the teaching of science, and not merely their views on the importance of the SSI. They indicate how the participants judged the scenarios and their SSI contexts in terms of its purpose(s) for integration, the kind of teaching strategies they would use for such integration, and especially how they perceive the role of social justice in science teaching. This will constitute the first part of the research analysis.

For ease of comparison and further analysis, each sub-section will be accompanied by a graphic display as a synopsis of the participants' views. In the second part of the analysis (section 4.5), I will characterise groups of participants with general profiles. With these profiles I aim to capture the corresponding salient features of the participants' perceptions on SSI integration, particularly with

regard to the purposes that they see in such integration and how they perceive the role of social justice in science teaching.

From here on in this report the code following a quotation indicates the participant who articulated it, as well as the number line(s) of the quotation in the participant's interview transcript. For example, the code [P7:205-207] refers to a quote by Participant 7 as it appears in lines 205-207 of his transcript. [Please refer to Appendix C for further clarification.]

4.2 SQ 1: *What do science teachers see as the purposes for integrating SSIs?*

This sub-question examines the perceived purposes that warrant the integration of SSI scenarios in the science class. I could identify seven themes of purposes from the participants' transcripts and in addition classify these themes under two broad categories of purposes. The first category describes the purposes for the integration of a scenario more directly in terms of the science content embedded in it, whereas the second category expresses a more holistic approach to the purposes for such integration.

The participants judged a scenario as useful and would consider its integration in their science teaching for the purpose of *focusing on the science curriculum and its links*; *illustrating the everyday relevance of science*; *showing the impact of science*; *showing the role of science in the advancement of self and society*; *inculcating values*; *encouraging behaviour change* and *developing critical thinking*. These purposes that the participants thought SSI integration could be used for do not stand isolated from each other, but overlap in a number of instances. In the following sub-sections (4.2.1 to 4.2.7) I elaborate on the seven themes of purposes, and where necessary, point out how they interlink by using examples cited by the participants.

4.2.1 SQ 1 Theme 1 *To focus on science curriculum and links*

Some of the research participants acknowledged the focus that the scenarios bring to particular science contents (and therefore the science curriculum) as a major purpose for considering its integration in their science classes.

Participant 2 commented that "…Scenario 1 has got so much pure science" [369] and thought that "…the possibilities with this scenario are absolutely endless" [259], referring to the large number of science topics the scenario relates to. A number of participants would consider integrating the scenarios with their science teaching for the purpose of using its content to focus on specific chemistry topics. Examples of such topics are the Periodic Table and chemical processes:

> …the chemicals involved here, such as the copper and chrome and any of the other chemicals, you can ask the learners to find their symbols on the Periodic Table, or try to find the chemical formulas of the other chemicals [such as creosote]. [P7:40-42]

> …if we look at coal, we can look at the whole process, from when coal was formed up till the coal tar mentioned in [this scenario]. Also, we can look at all the other chemicals that come up in the scenario. [P8:54-57].

In addition to this content-specific focus, participants also reported the purpose for such integration as connecting the science content of the scenarios to other science aspects or fields (such as health and pollution), as well as to a number of subjects in the school curriculum:

`

> …Scenario 1…we can integrate with Language, Geography, Natural Science… we can take it so deeply into Natural Science. Besides the chemical symbols that we can do, we can also look at the different types of pollution…That will have a major effect, because if you look at it, the pollution will bring about illnesses. So Natural Sciences, and Life Orientation even. [P8:6-10]

> …[the learners must] look at what the chemicals are, look at how they affect…health. But [they must] understand that there are thousands of different scenarios which run along exactly the same line…[with] other chemicals. And that the reaction is going to be different. It could be radiation in which case you're looking at things like leukaemia… It could be water pollution in which case you're looking at digestive problems... [P2:246-248; 250-252]

Using typical social science topics such as population dynamics and scientific racism in combination with the content of his preferred scenario, Participant 1 [34; 60; 48; 68] would use the scenario to link his Natural Science and History lessons. The purpose for this would be to show

> How racism was used in the past, because of your skin colour and the shape of your nose… [49]

4.2.2 SQ 1 Theme 2 *To show the everyday relevance of science*

The research participants reported that they would consider the integration of SSI scenarios for the purpose of relating and connecting its contents to everyday contexts and their learners' personal circumstances or experiences. In this way they would place science in broader contexts and extend its value and meaning beyond the classroom. The participants thought that using the scenarios for this purpose would allow them to introduce, develop or emphasise specific science or other related knowledge to their learners. In so doing, they would also connect this purpose to the previously described one (sub-section 4.2.1) which centres on the science curriculum and its links.

Participant 2 appreciated the opportunity presented by her preferred scenario to get her learners involved in discussions [93-94] on issues that they could relate to. She explained:

> …the understanding that comes out, is worth more than standing in front of [the learners] and teaching them, because they [will be] asking things which are relevant to them. They [will be] getting the answers in the classroom, and suddenly the classroom becomes their lives.

This participant valued what she termed the "environmental connection with life" [P2:77] and would encourage her learners to "start seeing connections between what they learn and what really happens out in life" [P2:127]. She thought that her chosen scenario would allow the learners to see such

connections, thereby making "the science class, science teaching…relevant to everyday life" [123-124]:

The following two comments show how some of the other participants would use the science contents of their preferred scenarios, connect these to the life worlds and everyday experiences of their learners and making science relevant to them in this manner:

> …the Langa Towers [in Athlone], that is what I [would] link [the scenario to. Because…learners want to associate themselves with something which they are familiar with. And with this scenario they can link it with what has happened in their community not so long ago. [P5:161-163]

> …you can put [the] science of [the] scenario to [the learners'] lives so that they can understand it really. In their homes there is energy, electricity…how does it work, all these things? It means you [use the scenario to]…create ways for your learners to understand. [P7:133; 137-138]

The above quote made by Participant 7 showed that he would use the scenario to let his learners see how specific science-based matters were connected to their lives, thereby creating a platform to help them understand the underlying science.

Participants 5 and 10 were teaching in two very diverse school environments and both connected the contents of Scenario 1 to a local example familiar to their learners which they thought could illustrate to them the relevance of science (see the above quote from Participant 5). In this regard, Participant 10 said:

> …leaners can actually go…find out if there are [local] towns and communities sandwiched between industrial areas. [There is] for example [in] the Athlone area…the [cooling] Towers [of the power station] that were thrown down recently. On either side of the Towers you have residential areas… [191-194]

The schools where these two participants were teaching are separated by a considerable distance (approximately 30 kilometres). In the case of Participant 5, most of the learners at his school were living in close proximity to the controversial power station, while in the case of Participant 10 it was more than likely that his learners were familiar with the polemic around it through the extensive media coverage it received at the time of our interview. Both participants regarded the situation depicted by Scenario 1 as relevant to their learners in the light of the power station example. The power station example also provided Participant 10 with another purpose for integrating the SSI scenario in his teaching - as would be discussed next in sub-section 4.2.3.

4.2.3 SQ 1 Theme 3 *To show the impact of science*

The participants would use the content and themes of the SSI scenarios for the purpose of showing their learners how science and technology impact the society they live in. Some participants thought that they could emphasise this impact in conjunction with either the relevance of science (sub-section 4.3.2) or from a focus on the cross-curricular links of science (sub-section 4.3.1).

The following statements are representative of the participants' general awareness of the impact of science, and their commitment to bring across such awareness to their learners, using the contents of the SSI scenarios:

> [This scenario will make] my learners aware of the impact of science activities on humans… [P5:36-37]

> …I can give [my learners] some background to chemicals with [this scenario], and what effects chemicals can have on you. [P10:19-20]

Participant 3 would also use Scenario 1 to refer to the application of chemical substances in the case of the agricultural sector and the impact of such an activity on the environment and ultimately on society:

> [From the scenario the learners will learn that]…whatever way we use insecticides, that it will affect the crops [and] it will affect the water etcetera, so they will get to know and understand...once a plant is affected, we are affected as well. [P3:71-74]

Participant 9 reasoned that she could link the Scenario 1 content to her science teaching on micro-organisms through population dynamics (a branch of life and social sciences). From the situation sketched in the scenario her learners would be able to predict the following negative impact on the environment:

> …a factory situated on a river, with lots of fish on one side [upstream], but on the other side where the tailings of the factory run down, there is hardly any fish. [P9:33-35]

She thought that her science learners would also be able to relate to such a scenario as a reinforcement of the impact of science that she emphasises in class. For example, she had been taking them on excursions to a nearby river:

> …what I also do is, I take my classes to the nearby river and let them see the effects of the alien vegetation on the river. I have a book that shows how [this part of town] was built around that river, how people could do their washing in that river, and do fishing in it; but the alien vegetation has taken over the river. [P9:48-51]

Here the participant was referring to the process of eutrophication, the enrichment of water systems with excess chemical nutrients that stimulate excessive plant growth.

Participant 6 used the contents of Scenario 1 to describe a number of purposes for which its integration in science lessons would be well suited, one of these being the impact of science-based processes on communities and the environment:

> ...[my learners] need to learn that every company has the possibility to produce toxic substances…that will be detrimental to the health of the people and the environment… [P6:76-79]

A number of participants reported that they would integrate the SSI scenarios for the purpose of bringing to their learners' attention both the positive and negative impact of science activities on

society and the environment, or the advantages and disadvantages that accompany the application of science. Participant 5 [45-47] explained why he deemed this important:

> …normally you find that the learners think that science is the solution to everything…they are not aware that science also causes problems.

The following comments show participants' suggestions as to how they would use the scenarios to make their learners aware that there are two sides to how science impact on society:

> [with this scenario]…if you just open up [the learners'] minds a little bit, they will understand how dangerous each of these [chemicals] can be. And then how is it also helpful. I mean, in this scenario it also shows that it is good for the people in the area concerning work. But then the bad side, maybe the acid that is produced. [[P7:57-60]

> …this [scenario] could also [be integrated] with the part on the Periodic Table, because they speak of a mixture of chrome, copper and arsenic. Now it speaks of possibilities of them being advantageous, but now the learners can also see their disadvantages. [P6:91-93]

> ...I like the fact that [Scenario 1] speaks up about the effects…that fumes have on plant life, and I…can link that to my Grade 8 and 9 science, because that is all part of Biodiversity and the Life Science as a whole, since it also speaks about the effects of the fumes on people that are outdoors, and the dangers of those fumes. You can link the Periodic Table to [this scenario], and you can ask your learners about the effects that, for example, arsenic has on the human body… [P10:32-37]

4.2.4 SQ 1 Theme 4 *To inculcate values*

The participants judged the scenarios as useful in bringing about awareness to and fostering respect for basic human and civil rights, health, dignity and freedom of choice, in order to assist learners in their development of a sense of justice and responsibility.

Participant 2 [174-175; 182-183] and Participant 3 [112] indicated that the use of Scenario 1in their science class would allow them to inculcate in their learners values pertaining to human rights and a decent, healthy quality of life. Participant 3 saw this as part of her duties as a teacher to educate her learners in this way:

> It is the duty of the teacher to enlighten the [learners] as to what [their rights are] as human being[s]. That each and every human being has the right to a healthy life style. Even within the education that you can't just shift that to one side, they have a right to know everything, what is good for them and what is not good. [P3:112-115]

She showed confidence in her learners' ability to grasp the general ideas on values as portrayed by the scenarios:

> Most of [the learners] I have had since grade 8 and grade 9, so…they will know exactly about…social injustices… [160-161]

Participant 7 [71-73], Participant 6 [76-84], Participant 8 [94-96] and Participant 10 [108-111] similarly judged the usefulness of Scenario 1 in terms of the values it portrays. According to them, this

scenario shows the responsibility that falls on industrial companies to ensure the rights of neighbouring communities' in terms of their health, safety and well-being. Participant 7 commented:

> It means that they [the community] have insecurity each and every day if you have these factories in a small built-up area…And maybe you look at a dam with these acids; there is also a danger for our little ones if they play there, because they will swim in this dam and drink of the chemicals. It means that when companies build in such areas, they must make sure about the safety of the community. If there is a dam like that, they must secure the area. [71-73]

Participant 6 placed the onus on industrialists to ensure that the health of community members, as a basic human right, is not compromised. She would also extend this responsibility to her learners to uphold values such as a caring attitude and respect for the rights of others - a purpose for SSI integration which is linked to an anticipated behaviour change (as will be described in sub-section 4.2.5).

Participants also considered it important that their learners understand the value of freedom of choice, especially in the context of health and safety. For example, Participant 2 [125-126] said that on the basis of scenario 1 she would ask her learners to ponder over the following dilemma:

> Is it worth getting a salary [as a scientist] at the cost of your health? Is it worth ruining the environment in order to make money?

In addition, participants saw the scenarios as playing an important role in emphasising the value of taking responsibility for a situation instead of conveniently shifting the blame. For Participant P1, using Scenario 1 would allow him the opportunity to present values on two sides of the situation:

> …people must also realise that if we are not responsible for and take account of what we have, we cannot always blame government and municipalities if we ourselves damage our homes. [P1; 183-185]

4.2.5 SQ 1 Theme 5 *To encourage behaviour change*

The participants wanted the scenarios to encourage a change in their learners' behaviour and promote informed decision-making. Such a purpose for SSI integration would mean going beyond, for example, a change in the learners' mind-set, understanding, attitudes and awareness, and put a focus on learning for action and decision-making for action.

From all the participants, it was only Participant 5 who specifically mentioned 'behaviour change' during the interview. However, he did not link this purpose to (or elaborate on) any kind of action he anticipated the learners to be involved in following such a change. He commented, for example:

> …what I would expect [from my learners to get out of the scenario] is the behaviour change, because normally…learners think that science is the solution to everything, sometimes they are not aware that science also causes problems. [P5:45-47]

Another participant who found this facet of SSI integration useful in supporting behaviour change was Participant 6. She stated that she generally does not teach from the textbook and for examination only but "I teach them to understand the world around them" [200]. She believed that the integration of Scenario 1 would encourage her learners to do informed decision-making [112-113].
One of the lesson that they could therefore learn is that every industrial company runs the risk of producing toxic substances that can be detrimental to people and the environment [76-79], so that

> …[from the scenario] the least one can expect the learners to get, is…in future they should take into consideration also the health of the community if they become scientists or the owners of such firms or industrial companies… [P6:81-84]

The above quote from Participant 6 exemplifies this theme, and although weak in terms of future action, it illustrates the kind of change in learners that goes beyond mere understanding of the scenario contents. In addition, it is linked to the positive attitude and disposition to act in a way that would realise the kind of values that this participant regarded as worthy of teaching (as explained in sub-section 4.2.4).

Participant 2 [57-58] and Participant 9 [86; 150] appreciated their preferred scenarios for encouraging their learners to have a balanced outlook in life and to practice informed decision-making. Participant 2 expected her learners to realise that it is imperative to stay practical, grounded and realistic. In this way,

> I would like them to go back home, thinking about where there might be problems in their own environment and what they can do about it. [P2: 168-169].

Later in the interview she reiterated the need for teaching for taking action in relation to fairness.

> So in order to be able to exert their justice for themselves, they have first to understand. It is pointless going like a bullet (sic) in a china shop saying 'Oh this is exploitation, this is social injustice' if you don't understand. [They] have to first know what can be done about it, how it can be done correctly, to get the best results out of [establishing their rights]. So, yes, they need to understand that this kind of thing [in the scenario] doesn't have to exist, but they also have to know that if they want to fight it, they got to get the [science] information, to fight it. (P2: 178-182)

4.2.6 SQ 1 Theme 6 *To use science for the advancement of self and society*

The participants thought that the scenarios could be integrated into their science lessons for the purpose of projecting to their learners the ideal of striving for a better life. The scenarios could in addition illustrate how an appraisal of past conditions could be used to account for and understand situations as they exist presently. Raising such awareness could assist learners to plan for an improved future for themselves and their communities.

This purpose for SSI integration overlap notably with those described previously by Themes 4 and 5.The advancement purpose as expressed by Theme 6 includes that for social transformation, a process

which could require interrogating the systems and practices responsible for the creation and maintenance of adverse living conditions. It means advocating key civic and ethical values such as respect for human rights. To achieve this could require behaviour change based on informed decision-making and a willingness to take some form of action.

Of the ten participants, it was Participant 1 who offered the strongest views on how a scenario could be used to encourage learners to create better lives from themselves and ultimately for their communities. This participant had first-hand experience of his learners' living conditions and social circumstances. Using the contexts of the social issues in the scenarios, and specifically addressing social transformation [82; 186-187], he had the following to say:

> How are we going to transform that child from where he is to where we want him to be? They must take responsibility for that, for gangsterism in the community: How can we eradicate it? How can we stop it? So you must bring it in [the social issues in the scenario], it's important…[P1: 187-189]

Participant 1 further believed that using such a scenario in his class would allow the learners to see that self-improvement is possible, but that they can only create this better life themselves by working for it [38-39; 147-148].

Participant 1 [52-53; 171-172] and Participant 5 [22-23; 36-38] deemed it important that learners should know and understand how historical practices and arrangements, such as the Apartheid system, contributed to the past situation in this country, and how it could be the reason for the socio-economic problems still facing certain communities at present. Participant 1 expressed the hope that through such an understanding, learners will "break the vicious cycle" [60] for themselves, and also have a positive impact on the situations existing in their communities:

> …instilling in our children that passion not to do the same but to overcome that boundaries by creating a scenario for them that, Listen this was the past, how can we make sure that this don't happen [again]? The thing is, many of our students study…and move away from [their] areas and we would like them to go back and say, Let's uplift and change the areas. [111-115]

The example used by Participant 6 (as elaborated on in sub-sections 4.2.3, 4.2.4 and 4.3.5) shows the significance she attached to values such as compassion and respect for others. She would extend these values by promoting the kind of behaviour change that would encourage her learners to work for the common good of their communities and combat the negative impacts of science-based activities:

> …if they were to be scientists who have to produce different products, they need to look beforehand at what would be the toxic substances that will be detrimental to the health of the people and the environment, so as to …diminish the production of the harmful substances, so that they don't end up answering for the health of the community members. [P6:78-81]

4.2.7 SQ 1 Theme 7 *To develop critical thinking*

The participants would consider the integration of SSI scenarios in their science teaching for the purpose of stimulating their learners to think and reflect critically on, and have a deeper understanding of the science portrayed in the scenario. They would encourage their learners to examine their own thinking and beliefs, to justify such beliefs through well researched evidence (through the use of argumentation, for example) and to follow reliable procedures of inquiry. By promoting this kind of thinking in their classrooms, the participants would foster in their learners the development of an enquiring mind and the skill of problem-solving.

Participants 2 and 10 in particular valued this purpose as motivation to integrate their preferred scenario in their science teaching. They had the following to say about the opportunity that the scenarios presented to extend their learners' higher order thinking skills:

> …it makes the kids aware that they have to look at things beyond the superficial. [P2:124-125]

> As a science teacher you always want your learners to think outside the box and thinking about what else could happen. [P10:98-100]

Participants 5 and 6 would encourage critical thinking by applying the argumentation approach to the situations depicted in Scenario 1. In the case of Participant 6, this purpose for SSI integration was linked to the one of relevance (sub-section 4.2.2) and she suggested the use of a practical example from her students' lives to assist them in applying the argumentation approach. Participant 5, on the other hand, thought that argumentation could be used to discuss a socio-economic issue presented in the scenario. The interview excerpts below show their suggestions in using such an approach:

> …[integrating this scenario] will lead me to the use of dialogical argumentation… So I could give…[the learners] short questions where they put their claims as to whether this company [in the scenario] should continue [operating], and they must put their claims around evidence. Because some of [the learners] may have been exposed to smoke which is also contributing to respiratory diseases and sinusitis. So they could possibly relate this to their environment or daily experiences. [P6:53-58]

> …there are elements [in the scenario] that could come up in the form of argumentation… Because that factory [in the scenario]… is important to the people around that area because they get employment, even though now in the end it is causing problems [of ill-health]. So I think there could be a good exercise there on argumentation: what should be done now - employment or people suffering on the other hand. [P5:106-110]

These quotes indicate that teachers valued the scenarios for their possibility to develop their learners' critical thinking skills through argumentation, based on the use of evidence. In sub-section 4.3.7 views will be presented where the role of scenarios in argumentation is seen simply as a teaching strategy for developing conceptual understanding.

The way Participant 2 would stimulate her learners' reasoning skills (and thereby promote critical thinking) when integrating her preferred scenario in her science teaching, is exemplified by the following excerpt:

> … I would first give them specific questions to deal with…there is the scenario, here are the questions, this is how I want you to think about it. So the questions would guide their thinking…[but]…I don't want standard answers…I want to see how you think. And then take it from there…show [the learners] how much further they still could have thought it through. [P2:266-271]

4.2.8 Synopsis: Teachers' views on the purposes for SSI integration

In this part of the findings I described the research participants' perceived purposes that warrant the integration of SSI scenarios in their science teaching. The seven themes of purposes could be grouped in two broad categories, with each category represented by a number of themes.

In the first category, the purposes for SSI integration identified by the participants are focused around the science content embedded in the scenarios and exemplified by Themes 1, 2 and 3 of SQ 1. The participants judged a scenario as useful if it could *focus on the science curriculum and its links*; *illustrate the everyday relevance of science* and *show the impact of science*. The second category of purposes indicates a more holistic approach to how the participants judged the scenarios in the light of the epistemology of teaching and learning science. In this regard, Themes 4, 5, 6 and 7 describe how the teachers judged a scenario as useful if its content could show the role of science in *the inculcation of values; to encourage behaviour change; the advancement of self and society* and *in the development of critical thinking*.

Table 4.1 summarises the responses of the ten teacher participants to SQ 1. It contrasts the prominence given to the seven themes regarding the purposes of integrating the SSI scenarios in the science class. In this case, their views range across the spectrum (as described in Chapter Three) from *insubstantial* to *strong*.

Table 4.1 Responses to SQ 1: *Purposes of SSI integration*

Themes of SQ 1 *Purposes for SSI integration*	**PARTICIPANT**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Focus on science curriculum and links	Significant	Significant		Insubstantial	Insubstantial	Insubstantial	Insubstantial	Insubstantial	Significant	Strong
2. Illustrate relevance of science	Strong	Strong	Significant	Insubstantial	Strong	Significant	Strong	Insubstantial	Insubstantial	Significant
3. Show impact of science	Insubstantial	Significant	Insubstantial	Insubstantial	Insubstantial	Significant	Significant	Insubstantial	Significant	Strong
4. For inculcating values	Significant	Strong	Significant		Significant	Insubstantial	Significant	Insubstantial	Insubstantial	Insubstantial
5. For behaviour change	Significant	Significant	Insubstantial		Insubstantial	Insubstantial	Insubstantial		Significant	
6. For advancement of self and society	Strong		Significant		Significant	Insubstantial	Significant		Insubstantial	
7. For critical thinking		Strong	Insubstantial	Insubstantial	Insubstantial	Significant	Insubstantial			Strong

Insubstantial view Fair view Significant view Strong view

Table 4.1 indicates that more participants saw the purposes of the scenarios in terms of the first category; that is, their embedded science content (as exemplified by Themes 1, 2 and 3). Out of a possible 30 boxes (10 participants and 3 themes), there are 16 which point to a fair-strong view. Fewer

participants saw the purposes of the scenarios in terms of the epistemology of teaching and learning science (as exemplified by Themes 4, 5, 6 and 7). The table shows 15 fair-strong views out of a possible 40 boxes.

When each of the themes are considered separately, the purpose for SSI integration is largely seen in making science relevant (Theme 2), and less so for drawing attention to the impact of science (Theme 3); inculcating values through science (Theme 4); to show the links with the science curriculum (Theme 1) and for the advancement of society/self (Theme 6). The least prominent was the purpose of SSIs to promote behaviour change (Theme 5) or critical thinking (Theme 7).

4.3 SQ 2: *How do science teachers say they would integrate SSIs?*

The focus of this sub-question is on the classroom practices, teaching strategies and methods that the research participants indicated they could or would use to integrate SSI scenarios in their science lessons. The participants in this study connected such integration to the current curriculum requirements, and recognised ways of linking its content to other programmes that form part of their schools' initiatives. They suggested employing a number of teaching techniques and strategies that are combinations of the teacher-centred and learner-centred approaches. In terms of the curriculum requirements (as set out by the national policy statements), the majority of participants concurred that all three the Learning Outcomes of the Natural Sciences (Senior Phase) could be covered by the content and contexts of the SSI scenarios.

The seven kinds of teaching strategies and methods that teachers indicated they would employ for SSI integration are *enquiry-based tasks; science content-specific activities; science-technology-society-environment (STSE) activities; communication of science information; science oriented projects; literacy programmes* and *deliberation and decision-making*.

4.3.1 SQ 2 Theme 1 *Enquiry-based tasks*

One of the strategies that the participants would use to integrate the scenarios in their science lessons is through the investigative or enquiry approach as required by the South African Natural Science curriculum. As such, it corresponds with Learning Outcome 1 of the Revised National Curriculum Statement (Grades R -9) and Specific Aim 1 of the Curriculum Assessment Policy Statement for the Natural Sciences (Grades 7-9). [Both these curriculum policies are elaborated on in Chapter One.] If they should integrate SSI scenarios in their science lessons, participants would incorporate elements of the scientific method such as data handling and statistical analyses through science tasks involving simple surveys. In certain instances, the teachers indicated that they would link the enquiry tasks to social and other issues existing in the communities which the learners themselves come from:

> When I look at [the scenario], can I do an investigation of this? Yes, I can… I thought of sending [the learners] into the community, with a page like this: Go and count the number of houses around there where you live. After that you go count the number of people living in those homes. Then you give them a ratio of what we have here. I mean, here we have this house and there are only four people living here. You have other homes here exactly the same. Then show them the other side. Look at the difference in comparison: Where you might find fifteen houses there and there are hundreds of people. Here you have fifteen houses and sixty people. Why is that wrong? So, it's for them to use the data and analyse it. [P1:124-131]

One of the participants was very positive about the usefulness of his chosen scenario as the basis of an investigative task through which he could draw his learners' attention to the health problems created by particular industries:

> I can use it as an investigation, whereby the learners would carry out a scientific investigation … to find out the common diseases amongst the people living around that area there, and maybe try to link those with that particular company which is working there. I think that could come out clearly. [P5:95-98]

In yet another example, a participant indicated linking the construction of knowledge (which is described under Theme 2) to an investigation task using her chosen scenario as its basis:

> This [scenario] can very easily be turned into an investigative project. Where I can actually say, here are the basics, go and find out about another one. [The learners] can look at coal mines, they can look at ESKOM, any of our big industries and the towns around those places. Sasolburg, a wonderful example; and it is still going, lots of pollution and everything else. So, yes, one could do an investigation, after that could come some basic straight information. [P2:148-152]

According to some participants, the SSI scenarios also lend themselves well to practical work and classroom demonstrations from which learners could draw conclusions about the effects of chemicals and forms of pollution on the human body and the environment:

> [For a scientific investigation] we can use water from the river, look at that water, see if they can notice the pollution, compare the state of the water…to water from other sources. Or they can plant something, then use different sources of water, including the river water and compare the effect that the water samples will have on the growth and health of the plants. [P8:78-81

4.3.2 SQ 2 Theme 2 *Science content-specific activities*

The participants indicated that they could let learners construct and draw scientific and related knowledge directly from the content presented in the scenarios, or from the explanations that could ensue during science lessons around such content. This theme corresponds with the RNCS (Grades R - 9) Learning Outcome 2 and the CAPS Specific Aim 2 for the Natural Sciences.

Some teachers would consider the integration of a SSI scenario purely on the basis of its science content, and getting scientific knowledge across to their learners. The following sample responses are representative of this perspective:

> [Using scenario 2]…you could teach health aspects, of what happens in the community… looking at the structures around them and using the overcrowding sometimes in houses and teach about the illnesses

> that arise from them…as well as the surroundings around the houses and the science basically around the structures itself, the material… [P4:21-25]

> If you look at scenario 1, there is a massive Life Science content and Chemical Science content in there….you will be empowering [the learners] as to say: Look, I know what effect arsenic has on the body, I know the effect that copper has on the body. As a science teacher, I will just be so glad when they…say: Sir, I enjoyed this. Now I know what CCA is. [P10:45-49]

In certain instances, participants who would consider using this teaching strategy did not see the need to link the science content of the scenarios to any critical dimension around the structural problems of low-cost housing or the manufacturing of chemicals (such as the location of a chemical plant near a residential area as a result of discriminatory laws and practices, etcetera). As Participant 10 put it:

> In our discussion it is: What is the effect of the chemicals…and it stops there. [P10:187]

4.3.3 SQ 2 Theme 3 *STSE activities*

This theme typifies the RNCS (Grades R -9) Learning Outcome 3 and the CAPS Specific Aim 3 for the Natural Sciences, and addresses the interrelationships between science, technology, society and the environment. One of the strategies that teachers said they would use to integrate the scenarios, is to link and apply their science content, as well as the context in which it is used, to societal conditions, health and the environment. For example, when prompted about the LOs best served by his chosen scenario, Participant 5 commented as follows:

> I think all the LOs are included, but I think the first one would be LO3 where you look at the impact of science on the society because it talks clearly about the effects of air pollution, the diseases that people would get out of the breathing of the air. [72-73]

Participant 8 explained how she would use her chosen scenario context as the basis to combine an enquiry-based activity (LO 1) with a STSE activity (LO 3) in one task:

> [The learners could] compare the impact of the different kinds of pollution on the community: is air pollution worse than water pollution? Or what? Which pollution will trigger their own illnesses? [85-86]

While the majority of teachers recognised the use of the scenarios to cover all three the Learning Outcomes for the Natural Sciences, many of them considered it to be most valuable in terms of LO 3. In fact, Participant 7 [158] acknowledged that he preferred Scenario 1 because it represented LO 3 for him. This is how he elaborated on his standpoint:

> This [scenario] is part of LO 3, because it deals with the environment. Looking at the environment and then taking it outside of the classroom. It is also interlinking with technology. If you look at technology, how does this machinery work? The building of the factories: when and how the people around there build it and work there. And then society and the illnesses around there. How do the people live in that area? And you look at the dimension of the woods, what is the function of the woods? [P7:150-155]

4.3.4 SQ 2 Theme 4 *Communication of science information*

Participants would use different class activities to allow their learners to communicate with the rest of the science class the science information they gained through the scenario content and context. This would include expressive forms of communication such as class presentations and role play, as well as graphic forms such as posters and collages. In addition, the participants suggested novel forms of communicating science information such as cross science workshops which would involve the teacher initiating the transmission of specific science content and considering its links to closely related aspects such as technology and the environment.

Questioned about the teaching method he would employ to bring across a social justice issue familiar to his learners, Participant 1 mentioned the following:

> …I was thinking about bringing it across orally…I would use role play, because they live in situations like these. [160-161]

Participant 5 on the other hand indicated using cooperative learning strategies that will allow the communication of science information (as gauged from the scenarios) in a more visual form:

> …I can ask them to develop a poster or a collage of the harmful effects of pollution where I would also expect them to work as a group… [63-65]

Participant 4 would incorporate activities in her classroom spanning a number of science and technology fields that would include her learners' experiences in their home environment. She summed up the usefulness of the scenarios in terms of this theme as follows:

> You could teach other science [content], you could teach health aspects, of what happens in the community as well. Looking at the structures around them and using the overcrowding sometimes in houses and teach about the illnesses that arise from them. As well as the surroundings around the houses and the science basically around the structures itself, then the [building] materials. So you could build an entire workshop around this kind of scenario. [P4:21-26]

4.3.5 SQ 2 Theme 5 *Science oriented projects*

Teachers indicated that they could use the scenario contents and contexts as the bases for projects to allow their learners the opportunity to apply their knowledge, skills and values. Projects may involve some form of research around a science theme and could also include the collection of information for oral history projects. Teachers would use field trips or excursions to places of interest, as well as industrial sites through which learners could gain first-hand experience of the impact of their activities on neighbouring communities and the environment. The quotes below present examples of participants' reasons for using the SSI scenarios in science oriented projects, and how they envisaged it could be done:

> …we must expose our learners to these companies…They need to see…what is happening there, how the toxic substances are produced. I can then maybe give them a project whereby they can formulate strategies to diminish the production of these toxic substances. [P6:64-67]

> I think of [using the scenario in] micro-biology. I love micro-biology and taking the kids out of the classroom. So if you do a scenario like this, let's go to the nearby river… [P9:95-96]

> …learners can actually go do research to find out if there are towns and communities sandwiched between industrial areas. For example the Athlone area and the [Power Station Cooling] Towers that were thrown down recently. On either side of the Towers, you have residential areas: What were their effects on Pinelands, Epping and Langa, and why were they thrown down? [P10:191-195]

4.3.6 SQ 2 Theme 6 *Linked to literacy programmes*

Teachers would align the integration of the scenarios with the aims of the literacy and reading programmes run by their schools. The written components of the scenarios could be used to assess and improve learners' reading and conceptual abilities and could take place either with or without teacher guidance. Other functional writing tasks could also be used to give the teachers insight into the knowledge that learners gained through the scenario. Such tasks could be in the form of a summary of the key components of the scenario, a comprehension activity or even an essay. Examples of how teachers would use the scenarios in literacy exercises are given below:

> Obviously it's a reading activity, so I would give them a sort of a writing frame, ask them a few questions, leading questions just to probe their thoughts and how they interrogate the material as well, and what they can take out of the material. [P4:68-70]

> [The scenario could be used]…with greater assistance from my side…especially with the reading and the understanding of certain words. Also this will do well because we need a reading programme…[and] we don't have much time for that. So we can go through this [scenario] and they could use their dictionaries to discover the words that they don't understand as well. [P3:37-41]

> …the learners must collect all the information [from the scenario] and write it down. Another way is asking them to summarise the positive and also negative aspects of the scenario content in a short essay, maybe just 200 words. [P7:168-170]

4.3.7 SQ 2 Theme 7 *Deliberation and decision-making*

Teachers would use the scenarios in their science classes to solicit learner voice. Through group discussions, debating and argumentation sessions, the scenarios would provide the bases for reflection, the raising of opinions and opportunities for informed decision-making. They thought that the integration of the scenarios could lend itself well to classroom strategies such as question-and-answer sessions and peer teaching and learning.

Participant 2 explained why she is so keen to adopt this teaching strategy in her science classes:

> I love this kind of thing because this will get the kids going on to discussions. When one gets a discussion like this going in class, it takes a while for them to get involved. Once they get involved, the questions and answers that come out, the understanding that comes out, is worth more than any standing in front of them and teaching them, because they are asking things which are relevant to them. They [get] their answers in the classroom, and suddenly the classroom becomes their lives. [92-97]

The following are examples of how this teaching strategy would play off in the classroom:

> …what I will do…is to give [the learners] the scenario to read. Then we will talk about it. But I will let them talk more than I would, so that they can argue and debate and make their claims without me influencing their thoughts or opinions. [P6:155-157]

> I would take the scenario and cut it up into smaller sections and they must discuss it in groups. So after that the class will get together, we can look at the different parts of the body that will be affected by the pollution. In Life and Living they will look at posters or models of the respiratory system and the stomach to link that pollution to the science of the bodily systems. [P8:100-103]

Participants 6 and 9 would allow their learners the freedom to voice their opinions through the use of the scenarios for an argumentation lesson (see sub-section 4.2.7). Both participants thought that argumentation skills could lead not only to improved critical thinking abilities, but also to better conceptual understanding. Both teachers also expressed the importance of concluding a classroom discussion or argumentation session with the teacher summarising the overall view to satisfy all concerned:

> As the teacher, I would, after [the learners] have done their own bit, then I would just conclude and help them reach consensus or harmonisation. [P6:161-162]

> …I will in the end make sure that there is a balanced outlook, that consensus is reached. [P9:150-151]

Participant 7 suggested the following classroom strategy when asking the learners to deliberate on aspects of a scenario in the science class:

> You can [ask] the learners to discuss the scenario, its outcomes. In their small groups they can have their discussions, then write down their findings and do a presentation. The groups can ask questions to each other when their findings are not the same as the presenters. [162-164]

Participant 7 in fact combined three teaching strategies with what he proposed, namely deliberation and decision-making (Theme 7), the communication of science information as an oral presentation (Theme 4) and as part of a literacy exercise (Theme 6). [The last two themes were discussed in sub-sections 4.3.4 and 4.3.6.]

4.3.8 Synopsis: Suggested teaching strategies and practices for SSI integration

In this section of the research findings I discussed the following seven themes of classroom practices, teaching strategies and methods suggested by the participants for use during the integration of a SSI scenario in the science class: *enquiry-based tasks; science sense-making activities; science-technology-society-environment (STSE) activities; communication of science information; science oriented projects; literacy programmes* and *deliberation and decision-making*.

I regard this research sub-question (SQ 2) as standing slightly apart from the other two. Whereas the views around SQ 1 and 3 emerged throughout the teacher interviews (either in answer to direct

questions, or volunteered spontaneously), the views on SQ 2 were given mostly after direct prompting [See Question 6 of the Interview Schedule in Appendix B]. However, during the interviews there was also impromptu mention by certain teachers of their preferred strategies and methods, or those they regarded as appropriate and useful. Whilst transcribing the interviews I realised that the preference of certain teaching strategies and methods could be of significance for the compilation of teacher profiles at a later stage. It is for this reason that I used the same four views (namely *insubstantial, fair, significant* and *strong*) as a correlation between the preference for certain teaching strategies and methods and the teachers' perceptions regarding SSI integration in the science class.

The responses of the ten teacher participants to SQ 2 are summarised in Table 4.2.

Table 4.2 Responses to SQ 2: *Teaching strategies and methods for SSI integration*

Themes of SQ 2 *Teaching strategies and practices*	**PARTICIPANT**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Enquiry-based tasks	Fair	Insubstantial	Fair		Fair	Fair	Insubstantial	Fair	Insubstantial	Insubstantial
2. Science content-specific activities	Insubstantial	Insubstantial	Insubstantial	Fair	Significant	Insubstantial	Significant	Significant	Fair	Fair
3. STSE activities	Insubstantial	Insubstantial	Insubstantial	Insubstantial	Insubstantial	Insubstantial	Fair	Fair	Fair	Insubstantial
4. Science info communication	Insubstantial			Insubstantial	Insubstantial		Insubstantial			Insubstantial
5. Science oriented projects	Insubstantial		Insubstantial		Insubstantial	Insubstantial			Insubstantial	Fair
6. As link to literacy programmes	Insubstantial	Insubstantial	Insubstantial	Fair		Insubstantial	Significant	Insubstantial	Fair	Insubstantial
7. Deliberation and decision-making	Insubstantial	Fair	Insubstantial	Significant	Insubstantial	Significant		Insubstantial	Fair	Insubstantial

Insubstantial view Fair view Significant view Strong view

Table 4.2 shows that the major teaching strategy/method for SSI integration (as suggested by the research participants) is to link the scenarios to science content (Theme 2). A considerable interest is shown to applying the scenarios in enquiry-based tasks (Theme 1) and the development of deliberation and decision-making skills (Theme 7). Some opportunities are seen in using the scenarios for STSE activities (Theme 3) and to utilise them during literacy programmes (Theme 6). The table also shows that very little interest is shown in using the scenarios for science communication (Theme 4) or for science projects (Theme 5). In retrospect, though, Theme 4 and Theme 5 could be considered as special cases of the literacy programmes (Theme 6) and the enquiry-based tasks (Theme 1), respectively. In that case, the results from the table show that the four main teaching strategies /methods for SSI integration suggested by the participants are science content-specific activities (Theme 2), deliberation and decision-making skills development (Theme 7), linking up with literacy programmes (Theme 6) and enquiry-based tasks (Theme 1).

4.4 SQ 3: *What are teachers' perceptions of the role of social justice in science teaching*?

This sub-question addresses the construct of *social justice* and explores teachers' perceptions of the connection between science teaching and the efforts to improve the human situation. These

perceptions of the connections between science and society include their interrelationships with technology and the environment.

The constructs of equality and equity are particularly meaningful indicators here, as they are inextricably bound to the promotion of social justice. Whereas it is generally accepted that equity refers to the ideal of fairness or impartiality, equality implies sameness or equivalence. Equity could also be regarded as the means through which equality (as the outcome) could be achieved. The aim of social justice is the promotion of fair treatment and impartiality in the sharing and distribution of social, environmental, economic and political benefits, regardless of the background and status of individuals or groups of people. This research sub-question probes the participants' understanding of social justice and the roles (if any) social justice plays in their science teaching.

The data show five themes related to social justice in science teaching. These themes suggest that participants perceived a role for science in creating awareness of *socio-economic issues*, *equity*, *self-determination and –improvement*, *equality* and the *promotion of civic values*.

4.4.1 SQ 3 Theme 1: *The role of science in socio-economic issues*

The teachers regarded it their responsibility to raise awareness of the role of science within the social contexts of their learners' backgrounds. They linked science knowledge to the socio-economic and socio-political real-world problems facing the learners and their communities. In addition to showing an awareness of the role of science in socio-economic (SE) problems in the community, some participants also acknowledged the right of learners to know how past and current political systems (such as Apartheid) and other social practices contributed, and still contribute, to the development and persistence of such problems.

Participants 3 and 4 would use Scenario 2 to raise awareness of the role of science in SE problems facing communities and their learners directly. For both these participants this awareness stemmed from their first-hand knowledge of their learners' personal backgrounds, and they thought that their learners' experiences would allow them to relate to the scenario. They described how they would link the science drawn from the scenario to the problems typically associated with low-cost housing:

> …where my learners come from, [there are] also low cost housing and the diseases…I have a learner…last year [his] brother passed away with TB, so [the scenario] is very relevant… [P3:173-175]

> [The scenario] relate so well to the learners and their home environment …[I could use] the overcrowding…in houses and teach about the illnesses that arise from them, as well as the surroundings around the houses and the science basically around the structures itself… [P4: 23-24]

Participant 1 similarly showed great awareness (largely through his first-hand encounters) of the injustices around his learners' adverse living conditions. He believed that in the classroom such an

awareness of the role of science could be raised within a political perspective. Not only would he use the science class to make his learners aware of their own situation, but also that they should understand how Apartheid contributed to the circumstances that they find themselves in at the present moment. As he explained, "… it is the past that caused the socio-economic problems that [they] face today" [52-53], and therefore "…they are living the consequences of that history" [107]. Scenario 2 struck a chord with him in the following way:

> …thinking of where we come from, our past, and also looking at how people are living today, and coming out of a community like […] where I'm teaching, where our children basically live in these conditions. With low grade housing and because of this they suffer of all kinds of illnesses….and the socio-economic problems that they face. [20-23]

He indicated that he would raise these issues and the causes for their existence mainly through his Life Science lessons [136-137]. In addition, he would bring in topics and terms more typical to the Social Sciences, such as "scientific racism" and "population dynamics", to show the historical development of the socio-economic issues facing his learners and their communities [38; 48-49; 60]:

> …racism was used in the past, because of your skin colour and the shape of your nose…people were then oppressed in that sense, so they…[began] to live in those socio-economic circumstances… [49-51]

Participant 3 described her learners that come from low SE backgrounds in the following manner: "Their whole mind-set is totally different…to other learners" [93-94]. To her they appeared accepting of their fate, with no aspiration to improve their situation:

> …they are struggling; socially there is nothing for them, because all they know is drugs and the taxis, being a taxi driver or a taxi guard. [84-86]

She believed that these learners would be able to relate to the scenarios and that she would use it in her science teaching to point out to them

> That [they] can uplift [themselves], get out of that situation, have a better life… [P3:92-93]

Scenario 1 depicts how the health of community members could be adversely affected by living near an industrial site. Such residents are often left with no alternative but to endure the unfavourable living conditions associated with the pollution from such sites. Participants 7 and 8 could see a similarity between the conditions described in the scenario and those experienced by the most disadvantaged sectors of (South African) society:

> …most of the people living around such areas [as depicted in the scenario] will be Blacks…the workers, but not only that, the poor workers. [P7:89-94]

> My mind tells me that in this scenario there might be Blacks staying there, there might be an informal settlement somewhere. [P8:26-27]

Whereas some participants showed a willingness to use science teaching to make students aware of the role of science in socio-economic problems faced by communities and of the political and social reasons for such problems, Participants 9 and 10 regarded this unnecessary or inappropriate in science teaching:

> …they learn about things like Apartheid and Nazism in history…so I don't consider it necessary to bring it into science, there are other avenues to follow to make it fun and interesting, instead of the political route. [P9:71-73]

> …there is [no] room for politics in the classroom. If we are to move forward in South Africa as a country that is being equal to everybody, then I don't think that is needed…In our discussion it is: What is the effect of the chemicals, and it stops there. [P10:184-187]

Those participants who would include topics around injustice and oppression in their science classes justified their particular teaching approach as follows:

> Isn't politics where we come from? Isn't our whole life politics? How do you learn for the future if you don't use the past as an example?" [Participant 1; 45-46]

> …learners need to know about where they come from, the history of this country, because what happened… in the past might still affect them as we talk now. [Participant 5; 23-25]

> It is difficult to separate the learner from politics. We don't have to preach politics, but these things [described in the scenario] happen in their areas and the learners know what is happening there. [Participant 7; 205-207]

4.4.2 SQ 3 Theme 2: *Awareness of equity through science teaching*

The participants in this study showed concern over issues such as community and individual health, welfare and well-being, and the disparities existing in certain social sectors through historical compartmentalisation. They indicated that they would use their selected SSI scenarios to create understanding of such issues and to examine the role of science in human rights violations, such as exploitation, discrimination and injustice.

Both Participant 1 and 2 were particularly forthright in their views on health, people's living and working conditions and environmental issues. Implicit in their discussions was the assumption that they regard inequitable situations as unacceptable, and in need of attention and intervention.

Participant 1, in reaction to a situation similar to the one described in Scenario 1, expressed concern over the standard of low-cost housing provided to certain population sectors:

> …the houses were built not to last, and that is why you find the houses breaking down…I believe…that if you build somebody a low-cost house you are telling him: that is how I want you to live. [P1:139-142]

His concerns appeared to centre around his awareness of similar conditions experienced by his own learners [32]. In his science class he would then also use the inequitable conditions depicted by his

preferred scenario to allow the learners "…to get an understanding of the socio-economic problems that people are living in" [33-34]. He would specifically pay attention to the social ills such as gangsterism [36, 71], health problems [70, 139, 147] and issues such as overcrowding [35, 129, 151], associated with this kind of housing scheme and which selectively impact on its residents.

In her science class Participant 2 would emphasise the universality of injustices generally associated with practices of materialism and, what she called, "profit-motivated" industries [321]. In addition, her learners would be made aware that inequitable conditions still exist in South Africa, despite the abolishment of Apartheid [316-317]. They would have to understand that the kind of politically contentious issues depicted in the scenarios

> …[were not] limited to Blacks or Coloureds or Whites…it was limited to the poorer class of people throughout the world…they were exploited by those who had the money to set these kinds of situations up. [P2:312-314]

She regarded it as important to foster an understanding of how such exploitation could be linked to the state of human health. Through her science lessons she would address this issue by considering the problem of pollution associated with the coal-mining and large oil-refining industries in the South African context [149-151]. Her learners would need to understand that as a result of urban sprawl [225-226] and the lack of regional planning [310], the health of people forced to live in close proximity to such industries are unfairly put at risk due to the environmental problems associated with them. Participant 2 was also unwavering in her belief of what lies at the root of historical and current inequities of exploitation and health disparities:

> …it is not so much a political problem, as an economic problem that developed with the growth of capitalism, not only in SA, certainly not because of Apartheid…[P2:40-42]
> …it was a problem of capitalism and ignorance and unwillingness to do what was correct on the part of the people who were making the money. [P2:310-311]

For Participant 6, the issue of equity that she would like to make her learners aware of through the scenario was expressed as a very explicit value statement:

> …[companies] cannot justify the fact that they are destroying people's health… you cannot buy a person's health. It is unjustifiable. [P6:99-100]

4.4.3 SQ 3 Theme 3: *The role of science in self-determination and -improvement*

Some teachers considered how science could be utilised to encourage self-determination and -improvement through informed and balanced science-based decision-making and responsible actions. Self-determination refers to a person's need to gain knowledge or take some course of action through his/her own free will. Closely linked to self-determination is self-advocacy, that is, knowing one's rights and responsibilities, speaking up for such rights and taking action on one's own behalf.

The following description by Participant 2 about the role of social justice in her science teaching embodies the essence of this theme:

> So in order to be able to exert their justice for themselves, they [the learners] have to first understand, know what can be done about it, how it can be done correctly to get the best result out of it.…They have to know that this kind of thing [injustice] doesn't have to exist in the world, but also that if they want to fight it, they got to get the information, to fight it. So it all goes back to them understanding that they have rights, they can look for social justice, but not if they don't know what, why, how, where or anything else about looking for it. [P2:179-183]

The same self-advocacy competencies were also stressed by Participants 6, 7, 8 and 9. These teachers believe in encouraging their learners to know and value themselves to consider multiple options, anticipate the consequences of decisions and to work towards set values. They cited (or implied) that they could link the scientific content and problem-solving skills emphasised by the scenarios to these principles of self-determination. Building learners' self-confidence to communicate their opinions to others is seen as one approach to achieve these outcomes [P6:162-163]

Participant 7 used the example of burning tyres during protest actions against poor service delivery prevalent in the economically disadvantaged communities of the Western Cape townships: for him such protest actions would present an opportunity to talk about the reasons for the community's anger, and also to encourage informed decision-making and consider the consequences of one's actions:

> 'What is happening there?' But you can also use that to ask them about the smoke! What is happening to that smoke? The sulphur from that smoke will react with the atmosphere and contribute towards acid rain. [P7:213-215]

The following are also examples that participants indicated they could use in their science teaching to encourage self-determination (through communication skills such as negotiation, compromise, and persuasion to reach goals) and self-improvement:

> …your father is working [at a company producing toxic substances]…. Would you like this company to be shut down…or would you rather your father continue and you will take the risk of suffering from respiratory tract illnesses. [6:147-149]

> …[the learners] know about tailings and effluent that go with mining. The whole issue around pollution, but also the other side of mining, that is job creation. [P9:102-103]

Participant 9 however also admitted that although she always encourages her learners to weigh up options and develop a balanced outlook, she usually avoids politically contentious issues (such as those depicted by the scenarios) "so that we can get back to the issue of science itself" [87].

4.4.4 SQ 3 Theme 4: *Awareness of equality through science teaching*

Some of the participants indicated that they would create awareness of the construct of equality through their science teaching, that is, they would be attentive to issues of equal opportunity and equivalence or sameness. In this study, teachers addressed or stressed equality and equal opportunity

(or the opposites of these constructs) in terms of race, socio-economic class, special needs, type of residential area, and beliefs (opinion) in the context of the scenarios.

Using her selected scenario, Participant 8 highlighted the basic human right of access to clean and safe water in specific reference to the issue of social justice. She commented on the discrimination and inequality experienced by a poor community in a residential area which typically receives little or no municipality services. The following statement shows how and why she would connect Scenario 1 to her science teaching:

> … in this scenario, if there are people in an informal settlement living near a polluted river, they will be affected unfairly, because they depend on the water for their basic living. So it is important that [learners] know about these things. [P8:94-96]

Both Participants 1 and 7 would address the inequalities suffered by groups of people in terms of their working and/or living conditions as a result of race and class barriers. For Participant 7, one of the scenarios reminded him of how South African migrant workers, who were mostly poor and Black [90, 94], had to endure the effects of pollution resulting in diarrhoea or asthma [86]. On the other hand, the more privileged workers would not suffer as badly from the effects of industrial pollution, because

> Those other workers that survive will be staying far away from such [polluted] areas…they will be travelling there in their cars or have other kinds of transportation to move. [P7:94-96]

4.4.5 SQ 3 Theme 5: *Civic values through science teaching*

Teachers considered the role that science teaching plays in the promotion of community-based values and civic responsibilities. They revealed their understanding and concerns with the interrelationships between humans and the natural world, accentuating concerns such as poverty and fostering respect for human health and well-being, communal property and resources, as well as environmental protection.

Some participants showed concern over the impact that certain sectors of society, such as industry and mining, have on the state of the environment. Participant 8 [62-63] thought that her selected scenario would allow her learners to "…recognise that certain plants and trees will be damaged by…polluted water and other air pollution". Participant 9 [48-51] had on occasion taken her science classes to see first-hand the effects of alien vegetation on a river running close to her school, while Participant 2 regarded it her duty to ask the following question in her science class:

> Is it worth ruining the environment in order to make money? [P2:125-126]

In this way, Participant 2 indicated how she would bring to her learners' attention the precarious association between economic development (and citizens earning an income) and environmental

degradation. She also indicated that she would use the last paragraph of her selected scenario to make her learners aware of the outcome of materialism in a capitalistic system (both past and present):

> …[the learners] need to think about [it], that these days everybody is so geared to thinking about money. And to say to [them], you know you can't exploit others for your own gain, because this is what ends up happening. [P2:51-53]

For Participant 10 [115-117], the social justice ideas that he would bring across in his science teaching was that it should also be incumbent on industrial companies to set the example for promoting and carrying out civic values. The following statement expresses the participant's opinion that these companies should not compromise people's health and well-being, and the state of the environment, but should take appropriate action to minimize their impact in this regard:

> …if you know that your factory is leaking fumes, then you as the owner or owners must take the proper measures to clean up, or make sure that the fumes are not integrated into the air of the community. [P10:115-117]

The participants also placed the onus to uphold similar and other civic values on ordinary citizens. The learners of Participant 9, for example, participated in a community service project involving the removal of litter from a river [56]. This participant however remarked that although her learners were aware of "the injustices that prevail in [their] communities" and had taken part in charity drives involving the less fortunate [9:209-210],

> …I don't want to bring into the science class the reasons why there are such poor people on our doorsteps.

In the light of the frequent protest action around service delivery in this country, Participants 1[183-185] and 2 [345-351] showed understanding and insight into why communities would vent their frustrations and anger by wilfully damaging government or municipal property (such as their own homes), but did not condone such actions. They therefore deemed it important to let their learners see alternative ways to deal with complaints, because

> …all you do is sabotaging yourself in the process of trying to get attention. [P2:350-351]

4.4.6 Synopsis: Teachers' perceptions of the role of social justice in science teaching

Table 4.3 summarises the responses of the ten teacher participants to SQ 3 from their interview transcripts by contrasting the prominence they displayed to the five extracted themes. In the context of this study the responses are regarded as significant indicators of these teachers' perceptions around social justice and how they would integrate social justice issues in their science teaching.

Table 4.3 Responses to SQ 3: *The role of social justice in science teaching*

Themes of SQ 3 ***Social justice in science teaching***	**PARTICIPANT**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Science in SE issues										
2. Science and equity										
3. Science and self-determination										
4. Science and equality										
5. Science and values										

Insubstantial view Fair view Significant view Strong view

As shown on Table 4.3, the responses to the question as to how teachers perceive the role of social justice in their science teaching ranged across the spectrum from *insubstantial* to *strong*. Half of the participants supported the view that science teaching needs to include and address the reasons for science-related socio-economic problems (Theme 1). Views on science and self-determination (Theme 3), as well as science and values (Theme 5) are well represented on Table 4.3: fair-strong and fair-significant views respectively are offered in this regard by half of the participants. The science and equity (Theme 2) and science and equality (Theme 4) themes did not attract much support, with only 2 participants giving significant-strong views on equity, while two participants support science and equality with fair views.

4.5 Teacher profiles in terms of SSI integration and social justice

Repeated readings of the ten interview transcripts gave me a good sense of the research participants' collective and individual views on the purposes for SSI integration and their perceptions on the role of social justice in their science classes. It also gave me an overall sense of their preparedness or reluctance to translate such awareness into classroom practices through various teaching strategies and approaches.

The analysis process up to this point revealed that although similar views were evident among multiple participants, a significant amount of diversity also existed in their various perspectives. In this round of the research analysis one of the research supervisors put forward the idea of characterising groups of participants with general profiles aimed at capturing the salient features of their common perspectives. I realised that the construction of such general profiles would be a useful approach to simultaneously describe commonalities and highlight diversity existing among participants' perspectives. Using profiles also appeared to be a more manageable and practical way in which to answer and discuss the research questions (in Chapter 5) compared to a cumbersome process involving ten individual participants.

For my first attempt at profile extraction, I examined the participants' statements around political issues. These were either in the form of answers to direct prompts (during interview sessions) about the inclusion of political contentious issues in the science class, or implicitly expressed in their dialogue on SSI integration. In line with the theoretical underpinnings of this study, I regarded these statements as testimonies of the socio-political consciousness of the participants - their awareness of the interdependent relationship between the social and political factors affecting society. I compared their political statements for ways in which they might criticise, challenge or even legitimise historic and current practices that sustain and promote injustices and inequitable situations. Four possible profiles emerged from this round of the analysis.

To further develop the emerging profiles, I re-examined the visual displays of extracted themes set out in Tables 4.1, 4.2 and 4.3 in this chapter. I thought it likely that participants fitting the emerging four profiles might also present matching patterns of responses for the three research sub-questions (SQ 1, 2 and 3). From the visual displays I could gauge that the participants corresponded significantly with regards to their views on the purposes for SSI integration (their responses to SQ 1), and the role of social justice in their science teaching (their responses to SQ3). In the first instance, therefore, the profile development was based on teachers' views regarding SQ1 and SQ3, and subsequently, patterns in their views regarding SQ2 (the teaching strategies) for the different profiles were explored.

For ease of reference, I present Table 4.4 – a summary of participant responses to the different themes of SQ 1 and SQ 3 in terms of the four strengths of view as elaborated on in Chapter Three.

Table 4.4 Participants' strength of views in terms of the *purposes for SSI integration* and the *role of social justice in science teaching*.

Themes of SQ1	**PARTICIPANT**									
Purposes for SSI integration	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Focus on science curriculum and links	Fair	Fair		Insub	Insub	Insub	Insub	Insub	Fair	Significant
2. Relevance of science	Strong	Strong	Fair	Insub	Significant	Fair	Significant	Insub	Insub	Fair
3. Impact of science	Insub	Fair	Insub	Insub	Insub	Fair	Fair	Insub	Fair	Significant
4. For inculcating values	Fair	Significant	Fair		Fair	Insub	Fair	Insub	Insub	Insub
5. For behaviour change	Fair	Fair	Insub		Insub	Insub		Insub	Fair	
6. For advancement of self and society	Strong		Fair		Fair	Insub	Fair		Insub	
7. For critical thinking		Significant	Insub	Insub	Insub	Fair	Insub		Insub	Significant
Themes of SQ3	**PARTICIPANT**									
Social justice issues in science teaching	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Socio-economic issues	Strong	Strong	Fair	Insub	Significant	Insub	Significant	Insub		
2. Equity	Fair	Strong	Insub	Insub		Insub	Insub	Insub	Insub	Insub
3. Self-determination and –improvement	Fair	Strong	Insub		Insub	Fair	Fair	Insub	Fair	Insub
4. Equality	Fair						Insub		Fair	
5. Civic values	Fair	Significant	Insub			Significant	Insub	Insub	Significant	Fair

Insubstantial view Fair view Significant view Strong view

Throughout the process of profile development, I was involved in data re-evaluation, discussions on interpretations and negative case analysis with my two research supervisors. For example, during the initial round of this profile extraction, all three of us positioned Participants 1, 2 and 7 within one profile, and Participants 3 and 5 within another. Our subsequent re-examining of transcripts, consolidation and refining of the analyses resulted in Participant 7 being repositioned in the second profile, together with Participants 3 and 5. Eventually, all ten participants were positioned within one of the FOUR profiles (labelled A to D) which emerged after thorough consideration of the data. These four profiles were not mutually exclusive, but presented overlap of some (or parts) of their salient features.

Three characteristics were found to be common across all four profiles: two characteristics concerned the purposes that participants saw in SSI integration, while the third was a teaching strategy that they would employ during such integration. All ten participants reported that they would integrate SSI scenarios in their science teaching to illustrate the everyday relevance of science (SQ 1, Theme 2) and the impact of science on modern day society (SQ 1, Theme 3). The common teaching strategy that all ten participants cited was soliciting the learners' voice through deliberation and decision-making in the science class (SQ 2, Theme 7).

Each of these common characteristics described above, however, encapsulated an array of individual presentations by the ten participants (as will be seen from the descriptions and participant quotes in sections 4.2.2, 4.2.3 and 4.3.7).

Below I outline the salient features of each of the four profiles A to D consecutively. Each profile is described using the following layout: Firstly, I report on how strongly the profile participants expressed their consideration of actually integrating a SSI scenario in their own science teaching. Secondly, I relate the participants' thoughts on how their learners could benefit from such integration. Thirdly, I describe the participants' statements around political issues. These first three profile descriptors are drawn from the total evidence for each participant. In the fourth section I lay out the shared or comparable perceptions and interpretations of the participants on the following aspects: the mutual purposes and usefulness that they see in SSI integration (from SQ1); and the role of social justice in science teaching (from SQ3).

Each profile description is accompanied by a table in which I summarise the salient features of the profile sketch in terms of the fourth section aspects mentioned above. Each table also contains representative interview quotes which exemplify the manner in which participants enact the profile features. Where needed, I clarify or validate salient profile features, and report on significant standpoints and variations presented by individual participants within any one profile.

4.5.1 PROFILE A: SSI integration for the development of science and related content

This profile describes the comparable perceptions and interpretations of Participants 4 (female) and 8 (female) with regard to the aspects mentioned in the previous section.

Profile A participants would consider integrating SSIs (such as those presented by the two scenarios) in their own science teaching after thoughtful deliberation. One of the participants said:

> …as a teacher I must first look at [the scenario] to see which parts of the curriculum can be covered. If there are things that the learners do not know or will be confused by, it is a good opportunity to introduce it to them. [P8:46-48]

Participants of Profile A anticipated that their learners would get from the scenarios the motivation to engage in learning school science, in addition to recognising the impact of science on the environment. They also expected the leaners to ponder the consequences involved in the situations depicted by the scenarios, and to adopt preventative measures needed if faced with similar personal situations after discussing these in class.

> I know that many of [my learners] live in conditions like these [in the scenario], because they speak to me about it. So I think if you bring [the science] closer to home, they would connect more with it. [P4:42-44]

> …maybe that they must protect themselves from the illnesses that go with this kind of set-up. Not to drink from the water in the area there. [P8:61-62]

The views and arguments of Profile A teachers can be described as non-political in terms of the manner in which the idea of politics is framed in this study. They either did not recognise the scenarios as being political (only as technical or objective), or they equated the concept of politics with legislative policy-making and interventions from government departments (such as local councils).When asked whether she would label the last paragraph of her chosen scenario as “political”, Participant 4[103-104] exemplified this line of thinking by anticipating her learners reaction to the paragraph:

> Indirectly yes it is, because [the learners] would then say: But the council is responsible for this and you can’t blame the people…And [the paragraph] would then be political.

Profile A participants shared similar views mainly on three *purposes* of SSI integration in the science class. All three of these were classified under the first category of purposes directed towards a curriculum content focus as expanded on in Section 4.2 of this chapter. With regard to the science content embedded in the scenarios, the participants recognised its value in focusing on the topics of the science curriculum (including the interconnections between science and other subjects), the everyday relevance of science as a motivator to learn school science and the impact of science on society and the environment. They considered the relevance of the scenario contents as a useful approach to introduce and expand their learners’ knowledge on certain science topics and themes. They thought if their learners could make meaning of science content through the socio-technological

contexts of the scenarios, they could then use this knowledge to reflect on their own concrete experiences and real-life situations to make science even more relevant to them.

The participants constituting this profile showed relatively weak viewpoints on *social justice issues* in science teaching compared to most of the other participants. They acknowledged two broad topics in this regard: the socio-economic conditions and challenging personal circumstances of the learners and their communities, and the health issues afflicting them directly as a result of the environmental impact and effects of industrial activities. They showed awareness of certain inequitable conditions - such as those existing in the housing sector – but did not propose creating classroom opportunities for critical engagement with the social and economic hardships of the communities as presented by the SSI scenarios. Their learners would not be encouraged to probe the interrelationships between such hardships and issues of health and the environment, the history of such development or the political systems and practices which could be held accountable for their existence.

Table 4.5 below is a summary of the salient features of Profile A, together with participant quotes exemplifying these features.

Table 4.5 Profile A: salient features and representative interview quotes

Salient feature	Example
View content driven purposes for SSI integration in terms of science curriculum, relevance and impact	[the scenario] relate[s] so well to the learners and their home environment. You could teach other science, you could teach health aspects, of what happens in the community…looking at the structures around them and using the overcrowding… in houses, and teach about the illnesses that arise from [it], as well as the surroundings [of] the houses and the science basically around the structures itself, the material… [P4:21-25] …we can take [the scenario] so deeply into Natural Science. Besides the chemical symbols that we can do, we can also look at the different types of pollution… [P8:7-8]
Extend mainly cursory attention to social justice issues	…… My mind tells me that in this scenario there might be Blacks staying there, there might be an informal settlement somewhere. [P8:26-27] …[the learners] are faced with these things [depicted in the scenario] on a day to day basis and it is part of their lives, so…they would see the social issue behind it. [P4:17-18]

4.5.2 PROFILE B: SSI integration for a balanced view of science

Participants 3 (female), 5 (male) and 7 (male) revealed similar perceptions and interpretations on certain aspects of SSI integration and therefore constitute this profile.

All the participants of Profile B showed a disposition to use and integrate the SSI scenarios in their science teaching. Although their justification for such integration differed, the following comments by two participants bear testimony to their willingness to do so:

> If you [test] the ability and thinking of the learners, you can use this scenario, and then you try to find out their understanding concerning this topic. [P7:35-36]

> Yes, I can include it, because…learners need to know where they come from, the history of this country… [P5:21-22]

What Profile B participants wanted their learners to get from the scenarios corresponds with the points raised by their Profile A colleagues: the scenarios could stimulate their learners to think about the environmental impact of science, and the science and scientific explanations behind their everyday activities. Furthermore, Profile B participants believed that the scenarios could let their learners recognise the dual role that science play in society as both the solution to and the creator of problems. The quote below from Participant 5 exemplifies this feature of Profile B:

> …normally you find that the learners think that science is the solution to everything, sometimes they are not aware that science also causes problems. [P5:45-47]

Profile B teachers could be described as being politically conscious. They recognised that historically some sectors of the South African society have suffered economically and socially more than others. Although they did not emphatically express their understanding of the concept of politics, they were consistent in their belief of their learners' right to know the history that led to present day situations of injustice and discrimination in South Africa. They recognised SSI integration as an opportunity to not only make the learners aware of how (past and present) discriminatory systems and practices brought about inequalities, but also to instil in them a sense of justice and responsibility to prevent a repeat of such practices in future. In this way they would ultimately improve life for themselves and their communities. This line of thinking is reflected in the following quotes:

> …you have to make the children aware of [the past]…They have the right to know the reason why things are the way they are. [P3:48-50]

> I think …this [scenario] is making my learners aware [of]…what happened in the past, the legacy of the Apartheid era. [P5:36-38]

Although Profile B teachers went a step further than Profile A teachers with regard to politically contentious issues in the classroom, they did not mention how they would foster the skills, knowledge, attitudes and values that their learners require to critically examine issues around social injustice and the ultimate aim of social transformation.

In terms of the *purposes* they saw for SSI integration, the common characteristics of Profile B participant are defined by both the broad categories as explained previously in Section 4.2: while they appreciated the content of the scenarios for highlighting the relevance and impact of science to their

learners, they also realised its significance in the holistic development of these learners. As far as this second aspect is concerned, the participants thought that the scenarios could be particularly useful to bring across points pertaining to values and life improvement to their learners. In their opinion, the contents of the scenarios illustrated both the positive and negative impact of science on society, and would therefore not only bring across a balanced view of science to their learners, but also emphasise to them the personal value of leading a balanced life.

Participants of Profile B expressed the purposes they saw for SSI integration primarily through one broad *social justice theme*, namely the role of science in raising awareness of socio-economic issues. They related socio-economic status, social class and racial groups to various forms of discrimination and implied that differences in terms of privilege and material disadvantage lie at the root of health and other wider social inequalities. They also recognised exposure to environmental pollution and the consequences of industrial activities for its negative impact on human health.

This balanced view as the overarching feature of Profile B participants is integrated in some of the salient features summarised in Table 4.6. One participant mentioned the use of insecticides; she alluded to their benefits in ensuring healthy crops, but also recognised their polluting effects on water and ultimately the harm they pose for human health. Another participant acknowledged the more social aspect of this dual effect of science: while it plays a positive role in industrial processes and ultimately in providing employment, it is also negatively implicated in the ill-health of the industrial workers. The participants valued the scenarios for emphasising this aspect to their learners (as pointed out above by the quote from Participant 5), and presenting an ideal way to let learners weigh up the pros and cons of science activities for themselves

Table 4.6 shows the salient features of Profile B and some participant quotes exemplifying how these features are portrayed in their science teaching.

Table 4.6 Profile B: salient features and representative interview quotes

Salient feature	Example
View content driven purposes for SSI integration in terms of science relevance and impact	This [scenario] is also relevant to [the learners] because…where [they] come from, it is also low cost housing and the diseases there… [P3:173-174] …in this scenario it shows that [the company] is good for the people in the area concerning work. But then the bad side, maybe the acid that is produced. [P7:59-60]
Consider SSI integration for the purpose of holistic development of values and advancement	It is the duty of the teacher to enlighten the [learners] as to what [their] rights [are] as …human beings[s]. [P3:112-113] [the scenario] clearly specifies the injustices of the past. So I think from there… learners can…see, if there are plans for new firms or factories, what should these companies take into consideration which will assist with transformation now. [P5:86-88]
Link social justice to science teaching through socio-economic and self-determination issues	…[learners can] find out the common diseases amongst the people living around that area there, and maybe try to link those with that particular company which is working there. I think that could come out clearly [from the scenario]. [P5:96-98] …[nowadays, the workers] stay closer to the factory…in their minds [it] is only the money, they don't consider their health. But if the [factory workers]…can stay some kilometres away from it, they may not suffer from diseases such as diarrhoea or asthma, because they will live away from the area that is polluted. [P7:84-87]
Value the use of SSI scenarios to emphasise a balanced view of science.	[Learners] will understand how dangerous each of these [chemicals] can be. And then how is it also helpful. [In] this scenario it shows that it is good for the people in the area concerning work. But then the bad side, maybe the acid that is produced. [P7:58-60] …that factory, like it says in the scenario, it is important to the people around that area because they get employment, even though now in the end it is causing problems, so…what should be done now - employment or people suffering on the other hand. [P5:107-110]

4.5.3 PROFILE C: SSI integration to show socio-political implications of science

Participants 1(male) and 2 (female) presented comparable perceptions and interpretations on the integration of SSI in science teaching and constitute this profile.

Profile C participants showed considerable enthusiasm for integrating socio-scientific issues and extending it even beyond the science class:

> …it is not just in science, I was looking at all the links to other subjects you can use [the scenario] in. [P1:29]
>
> I actually like it, I haven't thought of anything like this [before], but I would very definitely [use it]. In fact I am fully intending taking it and using it in my classroom, with your permission! [P2:32-33]

According to Profile C participants their learners would get from the scenarios that science also has a negative impact on the environment and that they might be challenged to do something about it. They also believed that from the scenario the learners would realise that self-improvement is possible despite the past challenging circumstances that their parents had to endure. The quotes below reflect how they expressed themselves on these matters:

> …[using this scenario] makes [the learners] think. I would like them to go back home, thinking about where there might be problems in their own environment and what they can do about it. [P2:167-169]

> …[from the scenario] the [learners] understand why [their] parents are in a situation like this, to understand the problems of the past, understand where it came from, and also to break the vicious cycle… [P1:58-60]

Profile C teachers displayed a more comprehensive insight into the construct of politics compared to most other profile teachers. They could see a link between politics and economic and class status, and drew attention to the development of injustice and exploitation through the systems of Apartheid and global capitalism. They indicated that in the science class they would extend such awareness to address politically contentious issues - particularly those directly affecting the learners, their communities and society at large - with conviction and enthusiasm. Their empathy with the plight of less privileged and oppressed groups stemmed from their general knowledge, personal backgrounds and experiences growing up.

> At the end of the day it is about the holistic growth of the learner. It is no use teaching learners one thing but shying away from the other. Fortunately for us…we come out of situations like this, so when we carry this across to our learners we can do it with a passion… [P1:79-82]

> So you can use [apartheid]… you bring that in…as an example, also to identify the illnesses, because most of our children can identify with these illnesses…with the gangsterism that goes with it, and with the socio-economic problems. [P1:69-72]

> I think these kids have been told too much and too often that everything, every ill in this country, is because of apartheid. This was not an apartheid limited problem. It was a problem of regional planning, across the world, it was a problem of capitalism and ignorance and unwillingness to do what was correct on the part of the people who were making the money. And it wasn't limited to Blacks or Coloureds or Whites, or anyone else, it was limited to the poorer class of people throughout the world, that they were exploited by those who had the money to set these kinds of situations up. [P2:308-314]

These teachers recognised how inequitable power and resource distribution put certain sectors of society in privileged positions with unfavourable consequences to others (of all race groups) who experience barriers to such distribution. In their science classes they would not hesitate to focus on these political issues, and to instil the kind of values in their learners that could prevent future situations of injustice and inequality.

> If you look at Scenario 1 it is important that we look at the apartheid years, look at the planning, look at why it was planned like that . Look at why the government of the time decided to build homes and to build areas in this way and understand why people were moved away. If you look at most of these areas, it is either close to an industrial area or close to a mine. [P1:172-176]

> It's not just a SA problem, it [is] a world-wide problem, and … the kids need to know about these things and need to think about them; that these days everybody is so geared to thinking about money.

> And to say to the kids, you know you can't exploit others for your own gain, because this is what ends up happening. [P2:49-53]
>
> Isn't politics where we come from? Isn't our whole life politics? How do you learn for the future if you don't use the past as an example. Yes, it's political but also to make our children aware of not to make the same mistakes in the future. [P1:45-47]

Representatives of this profile viewed the *purposes* for the integration of SSI scenarios in terms of its science content, as well as the holistic development of the learners. With regard to the first category, they concurred on the usefulness of the scenarios to direct attention to the science curriculum (while showing the interconnections of science across different fields and subjects), to illustrate the relevance of science, as well as its impact on society and the environment. For second category purposes they recognised the role that the scenarios could play in instilling values and encouraging behaviour change in their learners.

The shared perceptions held by Profile C participants on the role of *social justice in science teaching* are shown through four representations: they envisage a role for science in considering socio-economic issues, creating awareness of equity, encouraging self-advocacy and promoting civic values. More specifically, they recognise the potential of the scenarios to bring to their learners' attention the local manifestations of the particular (social justice) problems it portrays. They not only indicated a willingness to engage with such issues in their science class, but considered it their duty to do so. In addition, they valued their learners' right to know the historical background to environmental degradation and the current socio-economic dilemmas existing in their communities. In their science classes it would be imperative that their learners understood how they were directly affected by such factors. Therefore they would challenge their learners to show socially and environmentally responsible conduct in their striving for more equitable conditions. In preparation for such a struggle, they recommended that learners should first gain the necessary knowledge and then translate such knowledge into sensible action on matters of socio-economic, environmental and ethical concern.

Table 4.7 presents a summary of the salient features of Profile C and participant quotes exemplifying how these features are portrayed in the science class.

Table 4.7 Profile C: salient features and representative interview quotes

Salient feature	Example
View content driven purposes for SSI integration in terms of science curriculum, relevance and impact	…science is linked to all other subjects, it does not matter which subject you look at, science is being used. Normally…I try [to] link it to other subjects… [and what] I spoke to you about…scientific racism… [P1:66-69] …if you don't understand your own body…through the basic knowledge of human biology, then you're not going to understand that the fact that you ill could be …could be coming from your environment… [P2:70-72]
Consider SSI integration for the purpose of holistic development of values and behaviour change	…[learners] need to understand that [injustice]…doesn't have to exist in the world, but they have to also know that if they want to fight it, they got to get the information, to fight it. So it all goes back to them understanding that they have rights, they can look for social justice, but not if they don't know [the] what, why, how, where…about looking for it. So it all goes about underpinning the importance of having an education. [P:180-185] …instilling in our children that passion not to do the same but to overcome that boundaries by creating a scenario for them that 'Listen this was the past, how can we make sure that this won't happen again'. [M]any of our students study… and move away from these areas and we would like them to go back and say 'Let's uplift and change the areas'… [P1:111-115]
Link SSI integration to science teaching through SEIs and issues of equity, self-determination and civic values	…coming out of a community like […] where I'm teaching, where our children basically live in these conditions. With low grade housing and because of this they suffer of all kinds of illnesses and...the socio-economic problems that they face. [P1:21-23] …you will have some [learners] saying, but where I live there is a factory just near by. Then you get them onto a discussion about urban sprawl and how housing has spread into areas which were previously zoned for industry because of the need for more space, more people... [P:223-226] …a subject like this…is good for our learners. Also for them to understand that listen here, there is a better life out there, but that you have to work for it. So yes, you can use [this scenario] in science. [P:37-39] I will take something like [this scenario] and make the kids rather see that people's frustrations can cause them to do irrational things. That's not the way to handle it. Don't you go ahead and one day do this kind of thing... [P:348-349]

4.5.4 PROFILE D: SSI integration to stimulate aspirations in science and related fields

The participants that constitute Profile D are Participants 6 (female), 9 (female) and 10 (male).

The support that Profile D participants showed for the integration of SSI ranged from mild scepticism to total certainty. When asked about the possible use of the scenarios, two participants commented:

> It's difficult, because I don't know specifically how we would use the scenario… [P9:32]
>
> One hundred percent…Yes. I was actually going to ask for your permission to use [the scenario] in my exams. [P6:16-19]

When probed about what their learners would get from the scenarios, Profile D participants placed great emphasis on stimulating an interest in science as a subject and future careers in different science fields. They thought that the scenarios could also allow learners to consider possible measures to prevent the negative impact of science based activities on society and the environment:

> …to ignite that fire within the learners to say: I WANT to do chemistry, or even to go further than that by saying: I want to do medical science, or I want to do forensic science, or engineering. [P:42-44]

> …they need to look beforehand at what would be the toxic substances that will be detrimental to the health of the people and the environment, so as to reduce those…so that they don't end up paying fines or end up answering for the health of the community members. [P6:78-81]

Profile D participants were opposed to the idea of politics in their science teaching. However, their statements around politics (or political contentious issues) suggested interpretations which were distinct from how the term is defined and described in the context of this study (and comparable to one used by a Profile A teacher). Their perception of the construct was more in line with what could be considered "party politics" and legislative policy- and decision-making:

> I personally do not think there is room for politics in the classroom. If we are to move forward in South Africa as a country that is being equal to everybody, then I don't think that is needed. If you are not going to vote about it, then why speak about politics in the first place. [P10:183-185]

> I am not a fan of politics to be honest to you. The reason is that it can create some conflict because maybe one parent is involved in this and the other parent is involved in that, and when [the learners] get out of the school yard they can get into fights. It can grow into something big and then maybe I might just have influenced that conflict. [P6:25-28]

These participants stated a number of reasons why they would deliberately avoid dealing with politically contentious issues in their science classes. One participant felt ill-equipped to deal with such issues personally and would therefore not expect it of her learners to do so. Additional validations for these teachers to exclude it from their science teaching were that politically contentious issues could cause division and stir up unnecessary guilt feelings given the diversity and social backgrounds of their learners. Moreover, it would add to the already demanding content dealt with in the science class and could create a barrier to meaningful learning. Profile D participants believed that they should focus on the science content presented by the scenario and leave the political issues to be dealt with in other school subjects. Below are some of their comments:

> ….I am not going to take on the City Council, so I will not push my learners to ever feel that they have to do something like that….So it is difficult for me to teach the learners to take on the Big Powers. [P9:190-191; 200]

> That is not our discussion to say: Look the council says that you are wrong but you are saying that the council is wrong. In our discussion it is: What is the effect of the chemicals… and it stops there. [P10:185-187]

> …I would omit [the last paragraph] in order to use [the scenario]…You teach a diverse group of learners from different race groups, but you cannot think of them like that, they are just 13-, 14- and 15-year olds...they do not need the guilt trip. Besides, they learn about things like apartheid and Nazism in history, for example, so I don't consider it necessary to bring it into science, there are other avenues to follow to make it fun and interesting, instead of following the political route. [P9:65-67; 71-73]

Profile D participants indicated that they would integrate SSI scenarios mainly on the basis of their science content. They considered such integration for the *purposes* of focusing on the science curriculum, and to illustrate the relevance of science and its impact on society and the environment. In terms of a more holistic vision for their science teaching, they viewed the scenarios useful to inculcate values and develop critical thinking in their learners.

While Profile D participants showed significant appreciation for the subject-specific content of the scenarios, and would integrate them on this basis, this was not so much the case for the social aspects presented by the scenarios. The two mutual *social justice* themes, through which these participants would express their recognised purposes for SSI integration, were the use of science teaching to create awareness around equity issues and to promote civic values.

The salient features of Profile D, together with exemplifying quotes from participant transcriptions that show the enactment of such features in the science class, are presented in Table 4.8.

Table 4.8 Profile D: salient features and representative interview quotes

Salient feature	Example
View content driven purposes of SSI integration in terms of science curriculum, relevance and impact	…this [scenario] I could also integrate with the part on the Periodic Table, because they speak of a mixture of chrome, copper and arsenic. Now it speaks of possibilities of them being advantageous, but now the learners can also see the disadvantages. [P6:91-93] I like the fact that [the scenario] speaks up about the effects…that fumes have on plant life, and I can link that to my Grade 8 and 9 science… [P:10:32-33] But for me this [scenario] would come after doing the mining section in science, so [the learners] know about tailings and effluent that go with mining. The whole issue around pollution, but also the other side of mining, that is job creation. [P:9:101-103]
Consider SSI integration for the purpose of holistic development of values and critical thinking	…… …the least one can expect the learners to get here…[is that]…in the future they should take into consideration also the health of the community if they become scientists or the owners of such firms or industrial companies as this. [P6:81-84] …[the scenario] speaks about the fact that everything has been built in such away, that an industrial area is a stone's throw away from a residential area, and it makes [the learners] think about the effect that these industries have on the residential areas. [P10:86-89]
Link social justice to science teaching through issues of civic values, self-determination and equity	…… ...everybody has rights, especially a community. If you are living in a residential area, then surely you must have the freedom to walk outside without a mask, or worrying about getting sick when you inhale too much of the air. Those are things that especially industry must take into consideration. [P10:108-111] …in my class I always create an atmosphere…so that learners can speak out without me influencing their thoughts or opinions. So I would open up that atmosphere which is conducive for them to make a decision as to whether [what is presented by the scenario] is OK or not…I know some of them will say that it is OK, some will say that it's not OK. In most of my lessons there is never just a 'yes', because if there is just one answer it would mean that I influenced their answer. [P6:107-112]

4.6 Teaching strategies and practices across the four profiles

In section 4.3 of this chapter I expanded on the seven central themes of classroom practices and teaching strategies that emerged from the participant interviews. These were: *enquiry-based tasks*, *science content-specific activities*, *STSE activities*, *communication of science information*, *science oriented projects*, *literacy programmes*, and *deliberation and decision-making*. In this sub-section I continue to search for possible patterns or commonalities for the integration of SSI in and across the four profiles in terms of the seven teaching strategies and practices listed above. To assist me in this regard I rearranged the information in Table 4.2 and compiled Table 4.9, clustering Profiles A – D to show the individual participants' suggested and preferred teaching strategies and practices. Table 4.2 was put together to indicate the strength of the participants' views on the basis of the number of times

a particular aspect (theme) appeared in their interview transcripts. However, I did not consider this frequency of the essence for this part of the data analysis, choosing instead to focus on noteworthy views and suggestions offered by the participants.

Table 4.9 Profile A – D: suggested teaching strategies and practices for SSI integration

TEACHING STRATEGIES OR PRACTICES (Themes of SQ 3)	PROFILE									
	A		B			C		D		
	P4	P8	P3	P5	P7	P1	P2	P6	P9	P10
1. Enquiry-based tasks										
2. Science content-specific activities										
3. STSE activities										
4. Science info communication										
5. Science oriented projects										
6. Linked to literacy programmes										
7. Deliberation & decision-making										

Insubstantial view Fair view Significant view Strong view

I could not uncover any meaningful patterns or commonalities (in terms of the seven teaching strategies/practices) in or among the four profiles from Table 4.9. In general, it shows that the curriculum requirements for the GET (Senior Phase) Natural Sciences are well represented through the participants' suggestions of using the scenarios for enquiry-based, science content-specific and STSE activities. These three themes correspond with the Learning Outcomes 1, 2 and 3 of the recent RNCS and the Specific Aims 1, 2 and 3 of the current CAPS requirements. While the participants across all four profiles presented similar opinions regarding these curriculum requirements, there is however one minor exception. Profile A participants' suggested scenario-related teaching strategies would be based on the science content within the scenario (Theme 2), and their indicated use of the scenarios illustrated a teacher-centred presentation of such science content. Conversely, Profile C participants' suggested use of the scenarios was not on the basis of its science content, but rather around the socio-economic dilemmas posed within it. Also, they would prefer to use the scenarios for enquiry-based tasks, or in exercises to promote critical thinking.

During their interviews, the participants either stated (after direct prompting) the LOs which they believed were best served by the scenarios, or their descriptions at other times allowed me to make appropriate deductions.

The following two quotes are from Profiles C and D participants after direct prompting:

> This scenario would be] predominantly outcomes 3, but there are aspects of it that come into the other two LOs as well. [P2:147]

> Initially I thought it would be LO 3 and LO 2 [which are best served by this scenario], as I was reading. LO3 is the one that integrate society and science and technology, and then LO2 is the one that deals with asking direct questions…But as a science teacher I am very much in love with LO1 and I can't resist using it. Now LO 1 has to do with practicals. So what I would also do with this scenario is to formulate a practical around it… [P6:119-123]

The next two quotes show how a Profile B participant (P3) thought she could apply the SSI scenario to cover the LO 1 requirement of the science curriculum, while for the Profile D participant (P9) it would be applicable for both LO 2 and LO 3.

> …for the Grade 8 and 9's I would give a little investigation to do, and then there is data handling as well: Go and see how many people do have this type of lung diseases. [P3:131-133]

> I would present [the scenario] as a comprehension and a data-handling exercise. [For] me this would come after doing the mine section in Science, so that [the learners] know about tailings and effluent… [P9:101-103]

The participants' views around STSE activities (Theme 3) and Deliberation and Decision-making (Theme 7) were particularly meaningful in the context of this research study: the STSE theme because it involves the social dimensions of science and its interrelationship with technology and the environment, and the classroom opportunities of deliberation and decision-making for the prominence that it gives to the learner voice. Below I discuss the parallel views on the use of these two teaching strategies during SSI integration as expressed by participants representing some of the profiles.

STSE views

The STSE classroom strategies that participants suggested they could apply using the SSI scenarios show their awareness around the interconnections between science, technology, society and the environment. These strategies include the curriculum component (in both the RNCS and CAPS documents for the GET Senior Phase Natural Sciences) that makes it compulsory for teachers to include aspects of such interconnections in their science teaching. The participants' views in this regard showed no significant trend across the four profiles, or within one specific profile.

A Profile D participant, for example, had the following to say about the way he would use the science content of his chosen scenario, in particular the effects of the chemicals that it mentions, and linking it to society and the environment:

> …one of my approaches would be to have learners grouped together and then just talk about: I live in Steenberg or Grassy Park, and this is what is happening there. Because these learners won't have the same experiences. Grassy Park does not have an industrial area, whereas Steenberg does. So bringing the society and the environment into it, you will find that Grassy Park is an environmentally protected area…while Steenberg is not. [P10:137-142]

In another example highlighting the STSE interconnections, a Profile B participant recognised an opportunity to link the content (electricity and light) of a compulsory knowledge strand in the science

curriculum to the content of Scenario 2. He would then relate such science content to a socio-economic issue (gangsterism) and technology:

> In the second [scenario]…they deal with poor street lighting. In Natural Sciences light falls under the Energy and Change strand. [The learners] can…determine whether street light are connected in parallel or in series. Also, what is happening with their own street lights – the gangsters may damage one of the lights, so if the lights are connected in parallel, what happens to the other street lights? [P7:227-231]

The quotes below express how representative participants of profiles A and C recognised the science interconnectedness in the contents of the two scenarios, as well as their willingness to use it in their science teaching:

> …if you look at LO 3, you can use [the scenario] there as well; where you can use life science…you can use the environment. I mean, it is because of the environment that… the sicknesses come… [P1:136-138]

> …from the scenario [you could work around] a very big aspect of LO 3, where you can use the environment and link it to science and technology… And how science and technology could be used to improve these structures [mentioned in the scenario]… [P4:30-32; 35]

Deliberation and Decision-making views

The leading and most meaningful classroom strategies which the participants reported they would employ to encourage and support their students' voices during SSI integration were *discussions*, *questioning*, *argumentation*, *debating*, *peer- teaching*, *expressing of opinion* and *informed decision-making*. The participants also thought that any number of these strategies could be employed or would develop spontaneously from the learners themselves during a lesson involving SSI integration. The following interview quote from a Profile B participant provides an example of this approach:

> You can get the learners to discuss the scenario, its outcomes. In their small groups they can have their discussions, then write down their findings and do a presentation. The groups can ask questions to each other when their findings are not the same as the presenters'. [P7:162-164]

For the purposes of deliberation and decision-making, participants across all four the profiles indicated the use of various forms of discussions and questioning. Group discussions leading to class presentations, discussions initiated by learners and using their personal experiences, as well as teacher-learner discussions were examples given. Participants representing Profile A and D had the following to say:

> I would take the scenario and cut it up into smaller sections and they must discuss it in groups. So after that the class will get together [and] we can look at the different parts of the body that will be affected by the pollution… [P8:100-103]

> [The learners] are used to [discussions] like this [scenario content]; they would actually launch into a discussion before [doing] the writing frame because it is something they could speak about from personal experience. [P4:79-81]

> [Learners] will…ask questions such as "Why don't [the residents] just move?" [referring to the situation depicted by scenario 1]. Then we will discuss the reasons why it is not so easy for them just to uproot themselves and move. [P9:183-185]

Participants thought that classroom questioning would be useful to test their learners understanding of the scenario content (without clarifying it to them first), and to draw out their personal opinions on the issues depicted by the scenario. In addition, they pictured that the scenario would stimulate spontaneous questioning from the learners themselves. The following Profile B and C quotes are typical of this classroom strategy:

> [I will] ask [the learners] questions to check their understanding of their reading…before they write down the information. If they do not understand I will read it to them for the second time, slowly, so they get what the scenario is all about. But you don't explain to them anything yourself. [P7:185-187]

> I think that I am very lucky with having a very broad general knowledge, so that they can throw questions at me, and they appreciate it and they really love it. They appreciate it because they can go over such a wide range of topics. [P2:280-282]

Profiles A, B and D participants envisaged the introduction of argumentation to their learners and allowing them to use their argumentation skills during SSI integration. They also thought that the use of the scenarios could provide the learners opportunities to do straightforward arguing and debating.

> …that factory, like it says in the scenario, it is important to the people around that area because they get employment, even though now in the end it is causing problems. So I think there could be a good exercise there on argumentation: what should be done now- employment or the people suffering on the other hand. [P5:107-110]

> So what I will do…is give [the learners] the scenario to read. Then we will talk about it. But I will let them talk more than I would, so that they can argue and debate and make their claims without me influencing their thoughts or opinions. [P6:155-157]

One of the Profile C participants would consider using peer teaching for SSI integration. Profile C and some Profile D participants also appreciated the possibility that it could empower learners to voice their own opinions and promote informed decision-making during classroom activities:

> …probably some of the learners will know the answers and they can explain to each other in the group. One thing that I have found about them working in a group is that learners can then tap each other's brains and learn from one another before they come to you [the teacher]. [P1:226-228]

> …if I'm using this scenario, I know some of [the learners] will say that it is OK [the issues raised in the scenario], some will say that it's not OK. In most of my lessons there is never just a 'yes', because if there is just one answer it would mean that I influenced their answer. So it would definitely transform them to give them that freedom to make a[n] … informed decision. [P6:110-113]

4.7 Summary of the findings

In this chapter I presented the research findings and related it to the research problem: How do teachers perceive the integration of socio-scientific issues (SSIs) in their science classes? The main findings of the data can be summarised as follows:

The purposes teachers see for integrating SSI in their science classes

The teacher participants judged the purposes for SSI integration firstly through the science content embedded in the presented scenarios, and secondly through a holistic approach in terms of the epistemology of teaching and learning of science. The first category included a focus on the science curriculum, the everyday relevance of science and the impact of science. The second category involved approaches to inculcate values, encourage behaviour change, advance both society and self, and develop critical thinking.

The teaching strategies and methods teachers would use to integrate SSI in their science classes

The participants suggested the following teaching methods and practices for SSI integration in the science class: enquiry-based tasks; science content-specific activities; science-technology-society-environment (STSE) activities; communication of science information; science oriented projects; literacy programmes and deliberation and decision-making.

The perceptions teachers hold on the role of social justice in science teaching

The participants thought that they could use their science teaching to address socio-economic issues and issues pertaining to equity, self-determination, equality and civic values.

Profiles capturing the salient features of participants' perceptions on SSI integration

Participants were grouped into four general profiles with the aim of capturing the salient features of their common perspectives. These profiles captured both the commonalities and diversity existing among the participants' perspectives. Profile A participants would use SSI integration to develop science and related content as per curriculum requirements. Profile B participants saw the usefulness of SSI integration in stimulating their learners' aspirations in science and its associated fields. Profile C participants appreciated SSI integration for presenting a balanced view of science. Profile D participants recognised the potential of SSI integration to show the socio-political implications of science

In Chapter Five I will provide further discussion of the above findings, relate the findings to the literature review and the conceptual framework of the study, and make some recommendations that include implications for teacher training. I will also draw some general conclusions from the whole study.

CHAPTER FIVE

DISCUSSION, INTERPRETATIONS, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

The aim of this study was to establish the perceptions of science teachers (in the GET Senior Phase) on the integration of socio-scientific issues (SSIs) in their science classes. To achieve this aim, I explored the teacher participants' views on the purposes for such integration, the teaching methods and strategies they suggested they would employ to do so, and their perceptions on the role of social justice in the science class. These three categories were based on the participants' answers to the three research sub-questions guiding this study. The participants clarified their views after considering the various interrelated SSIs highlighted by scenarios based on two well publicised community and regional disputes.

In Chapter Four I presented the research findings in the form of themes extracted from the answers and views presented by the teacher participants on the three research sub-questions. I analysed the research findings further by identifying mutual perceptions and commonalities amongst the various themes of participant views. Through this process I compiled four teacher profiles which captured the participants' shared views on the purposes for SSI integration relative to the role of social justice in the science class. In addition, I discussed the most common teaching strategies and practices indicated by participants across the four profiles with regard to SSI integration.

In this chapter I continue to discuss the research findings. The discussion will be divided into three sections. In the first section I will give an overview of the themes as they relate to each of the three research sub-question. By drawing on these overviews, I will also be answering the broad research question of this study, namely: How do science teachers perceive the integration of socio-scientific issues in their science classes?

In the second section I will discuss the findings as summarised by the four teacher profiles by relating it to the literature review of this study. I will start off by considering how the findings (the four teacher profiles) supported or diverged from those assumptions and constructs encapsulated by core elements of critical pedagogy (CP), the fields of urban science education (USE) and science education for socio-political action (SESPA), as well as the construct of scientific literacy (SL). Next, I will reflect on whether the findings correlated with the literature on SSIs and how it is linked to CP and SL. I will include a review of the conceptual framework underpinning the study. In the third section of this chapter I will discuss the suitability of the conceptual framework and the methodology used in the study. To conclude this thesis I will discuss the limitations of the study, provide recommendations that

include implications for teacher-training, and suggest the direction for further research in the area of socio-scientific issues in the classroom.

5.2 Themes related to the Research Sub-questions

In this section I answer the three research questions by summarising the essential themes extracted from the participants views on each of questions (as laid out in sections 4.2, 4.3 and 4.4 of Chapter Four), and relating it to aspects of scientific literacy and the construct of socio-scientific issues as discussed in sections 2.3 and 2.4 of Chapter Two.

5.2.1 Themes related to Research Sub-question 1

In this part of the discussion I consider the research findings in relation to SQ 1: *What do teachers see as the purpose(s) for integrating SSI in their science classes?* This study shows that teachers firstly judged the purposes for SSI integration through the science content that it presents in terms of the science curriculum requirements, the everyday relevance of science and the impact of science on society. Secondly, SSI integration presented them with a holistic approach in terms of the epistemology of teaching and learning of science, to inculcate values, encourage behaviour change, work for the advancement of both society and self, and develop critical thinking.

The literature from a number of researchers in the field of scientific literacy (some of who has been reviewed in Chapter Two, section 2.3 of this report) appears to correlate with the responses of participants in this study around the purposes for SSI integration. The report by Fensham (2004) seems especially valid in terms of the two broad stances adopted by the teachers in this study when considering SSI integration. Fensham (2004) positions scientific literacy in terms of four social purposes, collectively seen as Science for Citizenship. In this way he links SL to the discourse involving SSIs (Fensham, 2004:15). His category which considers science for a personal well-being purpose is of particular value to some of the research findings around SQ 1 found in this study. The personal well-being classification provides a way to connect the two broad categories of purposes suggested by the teachers. This classification calls for science curricula to adopt an interdisciplinary integrative approach, seeing that most real world situations involving science are multi-disciplinary (Fensham, 2004:22). In addition, it calls for a serious attempt by teachers to implement scientific argumentation in their classrooms (Fensham, 2004:22). Most of the purposes within the two broad categories identified in these research findings (as pointed out in the introduction to this section 5.2.1) can be connected through the personal well-being approach suggested by Fensham (2004). For example, the purpose for SSI integration which centres around the science curriculum showed that teachers recognised such integration as linking science to a number of other disciplines and fields. Fensham's (2004) call for scientific argumentation to be used in the science class also agrees with the

participants' views on the development of critical thinking as a useful purpose for SSI integration (section 4.2.7 of Chapter Four elaborates on their views in this regard).

The issue of the everyday relevance of science identified by the teachers as a purpose for SSI integration is substantiated by Feinstein (2010:180). He proposes that the pursuit of SL is fundamentally about identifying relevance, a reaching into the social worlds of science in an attempt to connect scientific ideas with lived experience. The connection between SL and the use of SSI in the classroom, as suggested by Feinstein (2010), as well as the call for the inclusion of scientific argumentation by Fensham (2004), is further corroborated by Sadler and Zeidler (2004:4). The teachers' suggestions in this study agree with the view of Sadler and Zeidler (2004:4) that the use of SSI could make science learning more relevant to learners' lives, that it could improve their argumentation skills and therefore is a useful way to promote scientific literacy.

5.2.2 Themes related to Research Sub-question 2

The research sub-question SQ 2 posed the question: *How do teachers say they would integrate SSI in their science classes?* The study found that the main teaching strategies and classroom practices suggested by science teachers to integrate SSIs in their science lessons, are enquiry-based tasks; science sense-making activities; science-technology-society-environment (STSE) activities; communication of science information; science oriented projects; literacy programmes and deliberation and decision-making.

A second social purpose for SL as suggested by Fensham (2004), that of socio-economic well-being, presents some bearing on the teaching strategies suggested by the teachers in this study, in answer to SQ 2. In this regard, Fensham (2004:24) posits that learners' regular experience of scientific investigations will lead to good conceptual learning, confidence in approaching problems and appropriate scientific habits of mind. This purpose (around socio-economic well-being) addresses a particular important need in that it considers developments in the field of technology and their societal impact. The STSE approach to SSI integration as suggested by the teachers in this study therefore relates to this aspect of Fensham's (2004) social purposes for SL. Another argument from the literature which also seems to have a bearing on this set of research findings, is the one proposed by Nielsen (2012:429). This researcher argues that the most forceful justification for placing socio-scientific activities on the agenda is that they epitomise a key goal of science education, namely the enabling of students to make decisions that are informed by science on real-life issues. This argument links with the suggested classroom strategy of deliberation and decision-making identified by the teachers in this study. Nielsen (2012:429) extends his line of reasoning by adding that socio-scientific deliberations are all about what to do, not just what is true. As such, they always reflect the ideological and personal principles to which the deciding party adheres. Therefore, socio-scientific decisions are essentially political products (Nielsen, 2012:429).

The rationales set out by Fensham (2004) and Nielsen (2012) correlates with the teachers' views around STSE activities, and deliberation and decision-making. As I clarified in section 4.6 of Chapter Four, I regarded these two teaching strategies/classroom practices as particularly meaningful in the context of this research study: the STSE theme because it involves the social dimension of science and its interrelationship with technology and the environment, and the classroom opportunities of deliberation and decision-making for the prominence that it gives to the learner voice.

5.2.3 Themes related to Research Sub-question 3

A number of points emerged from the findings in answer to the research sub-question, SQ 3: *What are teachers' perceptions on the role of social justice in science teaching?* These points showed that teachers would use their science teaching to address socio-economic issues and issues pertaining to equity, self-determination, equality and civic values.

In discussing the teachers' responses to this research question, I draw from the research done by Dimick (2011) and Garii and Rule (2009). The research findings in this study showed that most teachers were not only positive about the role of social justice in their science teaching, but that their views indicated a willingness to incorporate social justice into their own teaching. As Garii and Rule (2009:490) found in their study, it was especially around the construct of socio-economic issues that most of the teachers in this study showed their willingness to create awareness and to support their learners' inquiry into and understanding of inequitable power relationships in society. The research findings in this study corroborate Garii and Rule's (2009:491) description of a social justice pedagogy, namely the linking of academic content to the personal lives of learners to empower them within the contexts of their lives and those of their communities. However, contrary to what Garii and Rule (2009) found in their studies, most teachers in this study would allow for a significant level of contextualisation between the learners' classroom experience and the world outside of school. In a few cases, however, the tension brought about at times by a social justice pedagogy (Garii & Rule, 2009:491), was also evident in the reluctance shown by some teachers to allow for the critical examination of SEIs if they were to use such examples in their science classes. In such instances, the teachers' stance was that in the science class it is all about the content (in those SEIs), and that a discussion around the reasons for the existence of SEIs, or its implication, is not appropriate or required.

Teachers in this study could be said to be open to a social justice agenda in their science teaching. They indicated a disposition to draw on science curricula that could be described as both academically rigorous, but counterhegemonic and empowering in content and pedagogy (Dimick, 2012:992). Their counterhegemonic character was evident in their suggestions to use classroom pedagogies that would raise questions about values, ethics and the implications of decision-making practices. In addition,

they showed a willingness to connect their science lessons to real-world issues and concerns (Garii & Rule, 2009:490- 491).

The set of social justice issues which teachers in this study indicated they would engage their learners in during science teaching is substantiated by Dimick's (2012) student empowerment model. Her model proposes that the social, political, and academic empowerment of learners are necessary to challenge them academically while also preparing them for the responsibilities of citizenship and the creation of a socially just society (Dimick, 2012:994). The political and academic empowerment is of particular significance to the social justice issues raised by the teachers in this study. Some of the teachers indicated that they would use their science teaching to create awareness around the political structures and forces that establish and maintain power inequities. They would also stimulate their learners to critically examine such structures. This finding can be linked to Dimick's (2012:995) vision of political empowerment as an ideal in social justice scholarship. The SEIs and equity issues indicated by the teachers in this study could be linked to this dimension of political empowerment. Dimick (2012:996) explains that this kind of empowerment could extend outside the classroom, by providing learners with first-hand experiences in civic processes, helping them understand the ways that they could influence political structures and find solutions to (and even causes) of environmental problems. The issue of civic values as identified by the teachers thus also link up with this ideal of Dimick (2012:996). On the other hand, academic empowerment within social justice education requires that students be taught sound academic knowledge and skills so they can succeed in today's educational, social, and economic structures, while also being taught to think critically about the ways these structures affect their lives (Dimick, 2012:996). This type of empowerment embraces all the social justice issues identified by the teachers in this study. Most of these teachers could connect the use of socio-scientific issues to the science curriculum, and therefore to the academic empowerment of their learners. However, only a few of these teachers would extend such empowerment to incorporate the model proposed by Dimick (2012). For these few teachers, academically empowering their learners would mean encouraging them to use the science that they learn in the classroom to critically examine the relationships of power existing among the structures in society, to realise how inequitable situations may result from such relationships of power and to help them see their potential in bringing about a change to such situations.

5.3 Positioning the teacher profiles against relevant literature

In this section I relate the teacher profiles extracted from the research findings to relevant theoretical assumptions discussed in the Literature Review of this report.

5.3.1 Critical pedagogical elements in the science class

The elements that will be discussed here in relation to the research findings are *criticality*/*critique*, *dialogue*, *hegemony*, *ideology*, *praxis* and the *curriculum*. These elements inform one another, and although I expand on each one separately, to consider them in an integrative manner would actually be a more appropriate approach. In the following sub-sections where the CP elements are discussed, their overlap and influence on one another are obvious.

Criticality and critique

Of the four teacher profiles extracted from the research findings, Profiles B and C are the ones who the construct of criticality applied to. Profile B teachers linked their learners' present day circumstances to the South African apartheid era. They acknowledged their learners' own understanding in this regard, and generally felt it their duty to make the learners aware of the history leading up to the injustices still existing today. They also showed an awareness of how socio-economic problems are connected to social class. However, in this study it is the Profile C teachers who showed a willingness to teach from a critical perspective. These teachers would link the concrete realities of their learners' everyday lives to broader societal and political issues. In addition, they showed a willingness, as Beyer (2001:156) puts it, to "intervene in the lives of their students so as to help construct with them futures that are personally rewarding, socially responsible, and morally compelling". In their science classes, the teachers fitting this profile would link the present day issues facing their learners (SE problems in particular) to oppressive and exploitative policies and practices on the local and global scale. Their proposed modes of classroom interaction indicated that they would critically engage their learners to question the social structures responsible for their current positions (Smyth, 2011:33). This kind of empowerment would broaden their understanding of themselves and society and create conditions for social transformation (McLaren, 2009:77).

Dialogue

Dialogue, albeit in various forms, was a thread that ran through almost all of the classroom practices that emerged as central themes from the research findings. The kinds of dialogue in this study ranged from questioning (such as testing learners' understanding and providing them with opportunities to raise their opinions), to group discussions and class presentations, debating and argumentation. Participants 3, 4 and 6 showed an inclination to use the kind of dialogue that Freire would describe as "conversation that mechanically focuses on the individual's lived experience" (Macedo, 1995:381). Participant 6 seemed to prefer dialogical argumentation – a teaching and learning skill that falls mainly in the critical thinking category. Participants 5 and 9 also referred to argumentation during their interviews. A number of teachers across the four profiles signalled that they would create dialogical interaction in their science classes by posing and discussing real-life issues with their learners. In doing so, they transcend the traditional mode of teaching, what Freire (1970b) calls 'banking education' and adopt his problem-posing approach. Participant 7 revealed a tendency in this regard; he would involve his learners in dialogue in which they would critically reflect on the consequences of

certain actions. However, Participants 1 and 2 were the teachers who showed that they would use the kind of dialogical approach which would put their pedagogical practices directly into the political sphere (Giroux & McLaren, 1986:215). They would not hesitate to stimulate their learners into questioning how some knowledge gets produced and to provide them opportunities to critically analyse the material conditions around them.

Hegemony/Counter-hegemony

Both Participants 1 and 2 (Profile C) would use their classes to teach contrary to what a traditional science curriculum would probably expect from them. Instead of shying away from political issues, they would engage their learners to question the material and social conditions around them. Participant 7 (Profile B) also showed a willingness to teach in what could be termed a counter-hegemonic manner, but not to the extent to which especially Participant 1 would challenge his learners. On the other hand, the hegemony of school science was evident in the way Participant 9 and 10 (Profile D) indicated they would teach: for these participants, there would be no discussion on "why there are so many poor people on our door step" (Participant 9); in their classes it would be "What is the effect of the chemicals… and it stops there" (Participant 10). Their learners would engage in science presented as (or thought of) as a collection of facts with no opportunity to raise critical questions about social phenomena (Braa & Callero, 2006:358).

Praxis

Participants 9 and 10 (Profile D) put forward practical suggestions based on SSI scenario integration that were very much in line with the experiential praxis-oriented activities as described by Breunig (2005; 2009). Participant 9 would take her learners to a nearby river, to assist in clearing up the area of litter, to show them first-hand to changes that the river underwent as the community living around it expanded over the years, and to show them the physical effects of chemical effluent on the state of its water. She also brought to attention the charity work done in poverty- stricken communities by the learners from her school. Participant 10 would show video clips to connect the science content of his lessons to society and the environment. In addition he could also envisage taking his learners on field trips to a nearby wetland reserve to show them how industrial areas are not put up near environmentally protected areas, but that some residential areas actually have industrial sites on their doorsteps. While these activities correspond with what Breunig (2005; 2009) suggests, they cannot be categorised as praxis-oriented, as there was no intent shown by the teachers to encourage their learners to engage in transformational social action, or even just in critical dialogue around the issues at hand. One of these participants commented that she did not see the need that her learners should know why there are so many poor people around; neither would she encourage such discussion, lest it offends some of the learners. In this case the participant was referring to the learners in her class who are considered part of the historically advantaged group of the pre-apartheid era.

Participant 1 could see using one of the SSI scenarios to send his learners into their communities to do assessment activities that would expose them to the realities of inequality and socio-economic problems. Both Participant 1 and 2 (Profile C) would use classroom discussion that would involve the consideration of the political practices and policies which gave rise to the conditions which continue to affect the learners and their communities. Although these two participants did not elaborate on any action that they thought their learners could follow doing these assessment tasks, they regarded it as a duty to make their learners conscious of the issues at hand.

In this study the participants did not suggest clear-cut ideas or views which I could interpret as a praxis-oriented teaching approach.

Ideology

It appears from the research findings that the participants in this study hold a range of ideologies (or worldviews) with regard to their perceptions and purported practices around SSI integration. While the design of this study did not make it possible to come to conclusions on the individual ideologies of the participants, I could nevertheless discern some kind of worldview which groups/pairs of the participants presented – it could possibly also account for the profiles distinguished (and reported on) in Chapter Four of this report. The continuum of ideologies in education which Säther (2003:242) reported on, seem to be applicable in this regard. There are a few ideological dimensions that come to mind when reflecting on the views of the different participants (on SSI integration) and this could possibly extend to their fundamental view (or ideology) on science. One of these dimensions could be: How is science connected to human activity? All the participants could be said to hold this worldview, albeit to different degrees. Another dimension mentioned by Säther (2003:244) is: The relationship between science and technology, and the potential for both to cause and solve problems. Here, the balanced view of science as presented by Participants 7 and 5 (Profile B) comes to mind. The importance placed on aspirations in science and related fields by Participants 9 and 10 (Profile D) could be linked to Säther's (2003:244) dimension emphasising the curriculum: Why learn science anyway.

According to Säther (2003:253), the study of ideological aspects in science education ought to be focused not only on the formal level (e.g., policies, textbooks, curriculum statements), but research should also be directed to teachers' experience and thinking to identify more of how the curriculum is put into practice. Critical pedagogy extends this view by adding that a critical notion of ideology provides the means for not only a critique of educational curricula, texts and practices, but the fundamental ethics which inform their production (Darder et al., 2009:11).

Hidden curriculum

After much reflection on the views presented by the participants in this study, I conclude that the concept of a hidden curriculum was only applicable in the case of two Profile D participants, namely Participants 9 and 10. The natural sciences curricula explicitly call for the promotion of an understanding about how science contributes to social justice and societal development, as well as a consideration of the consequences involving ethical issues. These aims have been part of the recent natural sciences curricula (RNCS) and are still embedded in the present CAPS curricula. Participants 9 and 10 have been teaching to both of these curricula at the time of their interviews for this study. Beyer (2001:155) describes their way of teaching as promoting social apathy, passive involvement, and hands-off learning, all in a virtually affectless environment. However, I am mindful that I am judging these participants on what admittedly was only a glimpse into their daily teaching realities. What they indicated during their interviews could well have been their views regarding the particular SSI scenarios presented to them, because, as Arce (2004:232) cautions us in this regard:

> While teachers may accept and apply many hegemonic beliefs and practices in their classrooms, it is likely that they also display and perform oppositional modes of behaviour.

5.3.2 The teacher profiles and the C & W-B model

In this section I position the four teacher profiles against the conceptual framework (CF) used in this study, that is, the Chapman West-Burnham 2010 model (C & W-B model). Throughout the data analysis procedures the model was purposefully not imposed on the data. It is only at this stage of the study that the CF is evaluated against the research findings, in particular the teacher profiles which emerged. This approach made allowance for the possibility that additional aspects to what is offered by the CF could come to the fore, or that in retrospect, some important aspects were not taken into consideration by the framework.

In Chapter Four of this report I have given a detailed description of the characteristics of the teacher profiles, as well as the their perceptions around the purposes for SSI integration, the preferred teaching strategies and practices, and their view on the role of social justice in science. In the following sections I will therefore very briefly consider each profile individually in terms of the aspect(s) of the C & W-B model which is/are most representative or descriptive of it. Because most of the different aspects could be considered interrelated (and the model should be seen in an integrative way), one must bear in mind that individual teachers in a profile could exemplify aspects that I would not necessarily mention in the discussions hereafter.

Profile A and the C & W-B model

The two main aspect of the model which describe this profile, is *effective learning* and *physical health*. This profile is all about the science curriculum and the motivation to learn and apply science. After optimising the curriculum, the teachers of this profile thought that they could use socio-scientific issues to stimulate more effective learning. They would also link their curriculum motive with their awareness and understanding of their learners' and community members' health and other physical aspects.

Profile B and the C & W-B model

This profile principally portrays the *access and inclusion* and *successful community* aspects of the framework. The individuality of learners is considered by adopting an open and flexible approach to the curriculum content; this approach shows that equality is a big consideration in the classroom situation. This kind of flexibility is carried through by using SSIs in the science class to give a balanced view of science and emphasising the many facets of science. This profile also sees the instilling of values as a worthy ideal of science education. A classroom ideal like this has a wider connotation in that the larger community will ultimately also reap its benefits and the success of its laudable outcomes – in a way giving them also access to what is done by the learners in the classroom.

Profile C and the C & W-B model

The aspect of the C & W-B model which describes the essence of Profile C is the *freedom from poverty and discrimination* one. This aspect could be regarded as encompassing many (if not all) of the others as laid out in the framework. It reflects the principles of equity and equality and has as its ultimate objective a state of happiness and well-being for all people. Another aspect of the C & W-B model which therefore can be associated with this profile is the *parity of esteem* one. Although it is a more challenging aspect to explain in terms of the research findings, it can be seen as a language of negotiation which can be put to use in times of conflict and negotiation. The teachers of this profile use the SSIs to create their awareness around social justice and concept of parity of esteem to bring diplomacy and co-operation for peaceful co-existence. A deep sense of values is what goes with the aspects of the C & W-B model which describe this profile.

Profile D and the C & W-B model

The *opportunity for success* and the *effective learning* aspects express what this profile stand for. There is a sense that (science) education should be all about stimulating aspirations to become or make a success in a science or related field. For these profile teachers it is important to use SSI integration to optimise the learning of science to as to ensure a successful outcome.

5.4 The suitability of the C & W-B framework

The two aspects of the framework which did not directly feature in the four profiles were those of *successful families* and *emotional health.* Reflecting on the content and principles embodied in the SSI scenarios used in this study, I anticipated an awareness of the emotional aspect to be revealed by the teachers, especially in terms of how it could be linked to the aspect of physical health.

A particular aspect that could have been included in the C W-B framework to give a more comprehensive view of social justice, equality and equity, is environmental sustainability. While the teachers in this study showed acute awareness of the way the environment is affected through science-based activities (and how this in turn affect communities), there were no suggestions offered by them on creating awareness of environmental sustainability in the classroom. Such an aspect could be regarded as a link to provide skills and knowledge to support education *for* the environment. In some circles, this may be a contentious issue, according to Thomas (2005:108), as it involves critical analysis of the development of the nature, forms and formative processes of society generally, and of the power relationships within a particular society; as such, it has an overt agenda of political literacy, values education, and social change. He nevertheless recommends its introduction in educative programmes to create a new environmental paradigm which could promote an ecologically sustainable, people-environment relationship (Thomas, 2005:108).

5.4.1 Alternatives to the C & W-B framework

A "Science Education for Socio-political Action" model as alternative framework?

As I have explained in section 2.9 of Chapter Two, the SESPA model can be regarded as the politicisation of science education, as it grounds science curriculum content in socially and personally relevant contexts through the confrontation of SEIs that have a scientific, technological or environmental dimension. It also provides vocabulary and language forms to make visible the relationship between science and the real world, and to cultivate an appreciation of how scientific knowledge derives from and complements every day, common-sense knowledge (Hodson, 1999:786). With this instrument, it becomes possible to confront a wide range of socio-economic issues that have a scientific, technological or environmental dimension.

The Science Education for Socio-Political Action model has at least five features which overlap or link with the Chapman & West-Burnham (2010) model, as shown in section 2.9. In my opinion, it would have been too limiting as an alternative conceptual framework, despites its many links to the C & W-B framework and its proposed four levelled system for the development of socio-political consciousness. Comparing the features of the different profiles to these four levels shows that Profile C could be classified at level three in terms of its teachers' socio-political consciousness. The other profiles could be classified at the first level of this system. If a larger sample was used in this study, it

could have included teachers (and profiles) opposed to the integration of SSIs, and this would have placed an added limitation on the use of such a framework.

An "Urban Science Education Studies" model as alternative framework?

In section 2.8 of Chapter Two I gave an account of USES and the recognition that it gives to the uniquely powerful position which science holds in urban societies, the global history of environmental racism and the hierarchical relationships between those who know science and those who do not, as well as the role science plays in demystifying key urban environmental issues. In addition, I pointed out that USES approaches science education specifically from an urban context and themes involving the origins, development and nature of cities, the relationship between people and the built environment, urban economics, government and public policy, and the processes that shape city neighbourhood over time. In addition, the USES model shows an association with all the aspects of the C & W-B model which were linked to the four profiles that emerged from the research findings. USES is fundamentally concerned with the understanding of the link between knowledge and power, and it thus offers a foundation for challenging the traditionally held assumptions underlying science education. The literature shows that many projects that are shaped from this perspective often reflect deep-seated issues concerning race, class, social and cultural issues associated with communities of the lower socio-economic levels of society. For example, the research done by Tobin et al. (2001) point to the necessity for teachers working in such conditions to employ a radically different approach from one which is successfully employed by teachers in schools from middle- and upper-class settings. They postulate that this is needed since students in such circumstances might experience schooling as hegemony – that is, the participation and achievement patterns (the cultural production) of such students become a site for the reproduction of inequity and oppression (Tobin, et al., 2001:942).

In my opinion, a conceptual model framed by the approaches and methodologies of Urban Science Education Studies would have been better suited for a study of this nature. Most of the schools in this sample accommodate large learner populations from similar socio-economic backgrounds as those described by the USES approach. The C & W-B did not attend to the demographics of the schools where the participants were teaching. Developing the research instrument and design of the study would have had to take this aspect into account if a USES model were to be used. Questions posed directly around the circumstances of the learners could therefore have presented a different set of researching findings, especially in terms of social justice views, than those obtained from the C & W-B framework.

5.5 Limitations of the study

It probably happens in most qualitative phenomenological research that the data collection and analysis are performed and interpreted by the researcher him- or herself. This presents a high risk of

researcher bias. In this study, I was familiar with all of the participants in the study, some on an academic or professional level, others on a more personal level, and in some instances on both these levels. I was aware of the risk of bias from the inception of this study, through numerous discussions with my research supervisors. I also read Patton's (2002:553) suggestions on how to reduce the risk of such a bias risk. He recommends to researchers to explore their predispositions, to make their biases explicit and to engage in mental cleansing processes as far as possible. It was therefore important that I listed a fairly comprehensive background to my prior involvement with the participants and to give an account of personal details such as their professional and academic qualifications. My supervisors knew why I chose certain individual teachers to be part of my sample – there was an expectation from my side as to the kind of responses to the interview questions I could expect from them. I had to learn to "bracket" such expectations as is required from a phenomenological perspective, and had to be open to the voices of the participants.

In retrospect, I am satisfied with the methodological procedures that I followed for this study. The interview data were expected to be more meaningful if the SSI scenarios were made known to the participants beforehand, rather than during their interviews. This precluded the question enquiring into their current use of SSI scenarios in their classes [See Appendix B, Interview schedule], which would have been useful as an indication of their commitment to the usage of current issues in science teaching. However, the interview provided opportunities for the participants to note that they already used similar approaches in the class. In fact, some of the participants did mention this. The provision of the scenarios beforehand had the added advantage that there would be agreement on the terminology, at least on the exemplars of this social justice teaching strategy.

The data obtained in this study was from a small scale project; I was well aware of the cautious attitude needed in interpreting data that was limited in scope and methodology. This sample was limited to a few schools and thus cannot be generalised to all South African schools, or even all Cape Town schools. I acknowledge that the conclusions drawn can be open to other interpretations and analysis. However, as it was not my intention to generalise the outcomes of this study to a wider situation, I am satisfied that it provides some descriptions and examples around SSI integration and ultimately how a small group of teachers from a number of diverse school settings perceives the role of social justice in the spheres of their everyday lives.

5.6 Implication for practice

From personal experience as a former high school teacher, I know that curriculum policy influence has a strong presence in classrooms. In this study, as I have set out in the Chapter One, the different curriculum policies over the past few years make it encumbent on science (and all other) teachers to use their teaching to infuse the principles of social, environmental justice and human justice as defined in the Constitution of the Republic of South Africa (DoBE, 2011:5). While this tall order confronts

teachers on a daily basis, the education departments pay very little attention as to how this could be undertaken by teachers in their daily preparation. Teachers in this small study sample showed that they are quite open to the idea of using a method such as SSI integration in their classrooms. The research data revealed a very limited understanding of the construct of social justice amongst the participants. However, an accessible tool such as a media reported science based practice and its social implications (such as those presented in the scenarios) presents a way in which teachers could achieve the vision set out in our curriculum policies.

5.7 Implications for research

More studies such as this one may help to define the cumulative effects of curriculum policy. It would be interesting to hear the teachers' voices themselves as to how else they could teach their science lessons and introduce the social justice theme through meaningful themes and topics, while at the same time maintain the rigour of the science curriculum and secure a strong academic ethos in their classrooms.

5.8 Conclusion

This small scale qualitative study showed that teachers found a number of purposes to justify the integration of socio-scientific issues in their science teaching. They would do so through a number of traditional, curriculum-centred methods and other holistic approaches. In doing so, they (in many instances unknowingly) incorporate some social justice themes in their lessons and allow their learners to deliberate the social implications of science-based activities on society and the environment.

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APPENDICES

Appendix A: The two SSI scenarios

Scenario 1

The following scenario is based on the legal battle of a small community in the South Western Cape to stop the chemical operations of a local sawmill that posed a serious threat to the environment and health of people living in its vicinity.

The people of Danville * have been battling for years to stop Duncan's Mill* from operating in their area. Community members have been plagued by illness and ailments such as asthma, sinusitis, respiratory and stomach problems and skin rashes from the toxic fumes coming from the sawmill. These are mainly caused by creosote, an oily chemical made from coal tar that stops wood from rotting. Apart from causing ill-health, polluting the air and causing damage to plant life in the area, the chemical operations of Duncan's Mill also impact on the everyday activities of this community such as hanging out their laundry and enjoying the outdoors. Another concern that the residents have about the sawmill, is the use of CCA, an odourless mixture of chrome, copper and arsenic that stops insects and micro-organisms from damaging wood. These chemicals are thought to cause lung and bladder cancer.

Duncan's Mill runs a heavy industry in an area zoned for light industry and is the biggest provider of employment for Danville and people of the surrounding areas. Every time that legal action is taken against them, they find a way to continue operating.

The plight of Danville's community is not unique, but one of the legacies of apartheid-era town and regional planning across South Africa, where many communities are sandwiched between heavy industries and exposed daily to the harmful effects of pollution and toxic waste products.

Scenario 2

The following scenario is based on the 2008 rent boycott and resistance campaigns of a number of Cape Flats communities living in low-cost housing schemes. They were protesting against the poor workmanship of the construction company responsible for the building of their houses, and the hardships that they had to endure as a result of it.

Almost three thousand residents of four low-cost housing schemes have been delaying efforts to repair the structural problems of their houses caused by the poor workmanship of the building company contracted by the city council.

Inadequate foundation structures, damp and cracked walls, loose roof tiles, as well as poor plumbing and brick-laying have left the residents not only with crumbling houses, but a host of health problems and other social ills. Poor street lighting has kept them indoors as gangsters take advantage of the situation. Complaints are heard of communities weakened by chronic diseases such as asthma and coughing, an increase in the number of tuberculosis cases and children having to be hospitalised as a result of infectious diseases such as diarrhoea and gastro-enteritis. Such illnesses can be attributed to dampness and cold and poor sanitation as a result of inadequate sewerage systems. The latter are also breeding grounds for pests such as cockroaches and disease carrying rodents.

Besides these ailments, residents are also fed-up with the lack of privacy due to the thin walls, resulting in high levels of stress. They want a proper inspection by the National Housing Department to determine all the flaws to the houses and the surrounding streets before any company is allowed to start with a remedial project.

In the meantime the city council has accused residents of causing most of the structural damage to their homes and the street lights themselves, and claims that they cannot be held responsible for burst pipes, stolen outside taps, malicious damage and lack of maintenance of properties.

Appendix B: Semi-structured interview schedule

Thank you very much for making time available to talk to me. The discussion will be confidential, and in the reports I will not include your name or that of your school. Since this conversation will be confidential, I hope you will be as frank as possible.

1. I hope you have had the time to read through the two scenarios. Could you please select the one you prefer us to talk about. What are some of the reasons for your preference?

2. Would you consider using this scenario in your science class?

   (If the answer is no: QUESTION: what is wrong with it? How do you feel about including political contentious issues in your science classes, etc.)

3. What do you think you would get out of the use of the scenario in your science teaching?

   (Possible answers: Motivation of learners in learning; their contribution to the lessons; linking science with life, that is LO3)

4. What would you want your learners to get out of it?

   (If the answer refers to the understanding of science content only: QUESTION: Is there anything else your learners may benefit from the scenario?

5. Which Learning Outcome(s) is/are best served by these scenarios?

   (POSSIBLE PROBING QUESTION: What aspect of LO3 is covered?
   If the answer does not refer to LO3: FURTHER QUESTION: Some teachers may use this as a way to cover some aspects of LO3 - what do you think about that?)

6. What teaching methods would you use for including this scenario in your science classes?

   (POSSIBLE FURTHER PROBES AND QUESTIONS: Some teachers say that it may be used as a comprehension, a topic for classroom debate, the promotion of argumentation skills, awakening and instilling a sense of social justice, etc. What do you think?)

7. Consider the last paragraphs of the two scenarios: Would you use it or omit it?

8. What are your reasons for this decision?

9. What are the main problems with the other scenario?

   (POSSIBLE REASONS: Language, length; syllabus coverage, political content)

Appendix C: Example of procedures for theme and profile development

Part 1: Excerpt from Interview Transcript of Participant 7 showing line numbering:

P: Let me put it to you like this: If your child asks you for bread, and you tell the child, "No, we haven't got bread"...that is politics. It is difficult to separate the learner from politics. We don't have to preach politics, but these things happen in their areas and the learners know what is happening there. There are fights in their areas, there is the burning of tyres...

I: For service delivery?

P: Yes, for service delivery, and they know all that. So why would the teacher say No, I cannot use this in the class? This type of thing is part of their lives. And you can ask the learners when there is the burning of tyres, 'What is happening there?' But you can also use that to ask them about the smoke! What is happening to that smoke? The sulphur from that smoke will react with the atmosphere and contribute towards acid rain. All that from what is happening in their areas; and they will understand that.

I: Will your learners also understand that there is the burning of tyres because they want better conditions for their communities, such as clean running water and proper sanitation?

P: yes, they will understand that, but on the other hand they won't understand or think about the bad side of burning the tyres.

I: You have chosen scenario 1 for this discussion. If we consider scenario 2: was there any particular reason why you did not choose the second one, did you have any problem with it?

P: No, both of them are good. In the second one for instance they deal with poor street lighting... In Natural Sciences light falls under the Energy and Change strand, they can also determine whether street lights are connected in parallel or in series. Also, what is happening with their own street lights – the gangsters may damage one of the lights, so if the lights are connected in parallel, what happens to the other street lights? So anything that is happening in their areas we can put in science, it becomes relevant.

I: I see what you are saying.

P: Also in scenario 2 there is the illness diarrhoea, what is the causes of diarrhoea. So that falls under Live and Living, and the street lights will be Energy and Change. It also deals with the housing department and how the houses are built, that is technology but in Natural Science that also falls under LO3 - Science, Society and Technology – because there is cement there, and there could be asbestos , so we can consider the chemicals involved. For both scenarios there are the positive and the negative side. I do not have any problem with scenario 2, you can use both in the classroom, but it depends what you are dealing with at a particular time. If we are doing chemistry and acids, then I

Part 2: Draft of Research sub-question 1 (SQ 1) correlation to transcript line numbers (incomplete) for Participants P1 and P2:

Research Sub-question	Transcript Number line		
	Participant 1	**Participant 2**	**Categories (instances or concepts)**
SQ 1 (Purposes for SSI integration)	29 (1); 34-38 (2); 38-39 (3); 45-447(4); 48-49 (1); 56-62(2); 63-65(3); 66-68(1; 69-72 (2); 72-73 (2); 122-123(2); 147-148 (3); 165-166(2); 183-185(3, 5?)	12 (1)? Check! 49-53 (5) 68-74(2) 83-85(2) 107-115 (2) 132(2) 125-126(5) 161-168 (6) 169(3)? 191-194(8) 289-298(9)	The *purpose of SSI integration* is to 1. illustrate link with other subjects 2. connect Science to learners' daily contexts 3. project a better life: work for it! 4. learn for the future from the past 5. inculcate values and responsibilities 6. illustrate links across science 7. show Science contribution to society 8. develop enquiry/critical reflection 9. emphasise balance of life 10. change behaviour 11. realise the right to health 12. to gain specific knowledge

Part 3: SQ1 Frequency table

Participant	(1)	(2)	(3)	(4)	(5)
Themes in Transcript	1; 2; 3; 4; 5; 6; -	1; 2; 3; 4; 5; -; 7	-; 2; 3; 4; -; 6; 7	1; 2; 3; -; -; -; 7	1; 2; 3; 4; 5; 6; 7
Frequency of themes	1 (4x) 2 (8x) 3 (1x) 4 (2x) 5 (2x) 6 (9x) -	1 (2x) 2 (8x) 3 (3x) 4 (6x) 5 (3x) - 7 (6x)	- 2 (1x) 3 (1x) 4 (5x) - 6 (3x) 7 (1x)	1 (1x) 2 (2x) 3 (1x) - - - 7 (2x)	1 (1x) 2 (5x) 3 (2x) 4 (1x) 5 (2x) 6 (4x) 7 (1x)

Appendix D: Permission from WCED

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Wes-Kaap Onderwysdepartement

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

Mrs Zaiboenisha Ahmed
20 Lugmag Avenue
KENSINGTON
7405

Dear Mrs Z. Ahmed

RESEARCH PROPOSAL: TEACHERS' PERCEPTIONS OF THE INTEGRATION OF SOCIO-SCIENTIFIC ISSUES IN THEIR SCIENCE CLASSES.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. The programmes of Educators are not to be interrupted.
5. The Study is to be conducted from **14th July 2010 to 30th September 2010.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as submitted to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

Signed: Ronald S. Cornelissen
for: **HEAD: EDUCATION**
DATE: 15th June 2010