REVIEWING THE USE OF ENVIRONMENTAL AUDITS FOR ENVIRONMENTAL LEARNING IN SCHOOL CONTEXTS:

A CASE STUDY OF ENVIRONMENTAL AUDITING PROCESSES WITHIN A PROFESSIONAL DEVELOPMENT COURSE

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ABSTRACT

REVIEWING THE USE OF ENVIRONMENTAL AUDITS FOR ENVIRONMENTAL LEARNING IN SCHOOL CONTEXTS: A CASE STUDY OF ENVIRONMENTAL AUDITING PROCESSES IN A PROFESSIONAL DEVELOPMENT COURSE

This case study focuses on the use of environmental audits for learning, by teachers participating in the *Schools and Sustainability* professional development course in Durban, South Africa. It reviews ways in which audits were choreographed and used for lessons within school contexts. It explores ways in which audits shaped meaning-making interactions and environmental learning processes.

This is an interpretive case study, characterized by a moderate realist perspective. Data were generated through interviews with teachers, field observations, photographs, document analysis, and group interviews with learners. Data were analyzed using the general comparative method.

The research takes place in the context of educational transformation in South Africa. Some of the challenges accompanying the shift to Outcomes Based Education seem to be associated with naïve interpretations of constructivism and a view of reality as socially constructed and relative. This seems to have influenced ways in which audits are being undertaken in school contexts. This study argues that a realist orientation to auditing may be a more useful process for engaging with the world and enhancing the way learners perceive and respond to environmental risk.

Ideas about reality-congruence and the interacting processes of involvement and detachment are of central importance in understanding processes of knowledge

construction and meaning making in this study. The study draws on the work of Elias (1987) and Latour (1999) to shed light on the significance of auditing processes in which a close engagement with reality, coupled with a measure of detachment, can lead to the construction of a more reality-congruent account and a more realistic assessment of the environmental issue in focus.

Key findings of the study suggest that the effectiveness of environmental auditing as a pedagogical process was influenced by the teachers' intentions, knowledge and skills, choreography of the audit, nature of the teaching and learning interactions, and ways in which teachers and learners engaged with the findings. The study recommends that auditing activities should be carefully structured and mediated by teachers to be meaningful and to enable learners to identify environmental issues, gather data, engage in critical reflection and deliberate appropriate responses for social and environmental transformation.

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LIST OF ABBREVIATIONS

Recognized abbreviations:

ASS	Assessment Standard
EƒS	Education for Sustainability
EMAS	Eco-Management and Audit Scheme
EMS	Economic and Management Sciences
GREEN	Global Rivers Environmental Education Network
ICC	International Chamber of Commerce
ISO	International Standards Organization
LO	Learning Outcome
LTSM	Learning and Teaching Support Material(s)
NEEP-GET	National Environmental Education Programme – General Education and Training
OBE	Outcomes Based Education
RBL	Resource-Based Learning
RNCS	Revised National Curriculum Statement(s)
SADC-REEP	Southern African Development Community - Regional Environmental Education Programme
SWAP	Schools Water Action Project
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
WESSA	Wildlife and Environment Society of South Africa

Abbreviations used in this thesis to refer to data sources:

AM	Analytic Memo
AS	Analytic Statement
e	Environment
g	Group interview
i	Interview
l	Learner(s)
lp	Lesson plan
lw	Learner's work
o	Observation
p	Portfolio
rw	Reporting workshop
t	Teacher

CHAPTER ONE: INTRODUCTION TO THE STUDY

1.1 Introduction

This case study examines environmental auditing processes within the *Schools and Sustainability* course. *Schools and Sustainability* is a part-time professional development course in environmental education for teachers, with a resource-based and workplace-based approach to learning. This case study gives particular attention to the choreography and use of environmental audits, for environmental learning in school contexts, by teachers participating in the course.

The research focus for this study arose within my role as an employee of the Wildlife and Environment Society of South Africa (WESSA), working to support professional development through courses such as *Schools and Sustainability*. Through this study, I hope to gain insight into how the undertaking of environmental audits within school contexts can foster environmental learning. The research may be useful to inform the future development and implementation of resource-based professional development courses for teachers, and the development of resources to support environmental auditing processes.

I have written this text to report on the research process and to present the evidence collected and interpreted during the study. In doing this research, I have drawn on relevant research and narratives that provided vantage points from which to view and interpret the evidence. The report has also been written to share ideas about the professional development course within which the study is located, and to share what I have learnt through my experience on the course and through this research process.

Chapter One places the study in context by providing background information about WESSA and the *Schools and Sustainability* course, and explains how my interest in environmental auditing arose. The research aim and goals are presented in section 1.5. The chapter concludes with an overview of subsequent chapters to outline how the various parts of the developing story fit together.

1.2 The Wildlife and Environment Society of South Africa

The Wildlife and Environment Society of South Africa (WESSA) was established in 1926. Originally called the Wildlife Protection Society of South Africa, it was later renamed the Wildlife Society of Southern Africa. In 1996, the name was changed again, to include the word 'Environment', and thus it became the Wildlife and Environment Society of South Africa.

These name changes are significant as they reflect the Society's shifting orientations to conservation and environmental education. In its formative years, the Society was concerned primarily with the protection of wildlife and natural resources. Its focus has since broadened to include social, economic and political issues (Taylor, 1997:13). These shifts are also reflected in changes to the Society's mission statement. In 1986, WESSA's mission statement was "… to promote environmental conservation and environmental education in southern Africa" (Taylor, 1997:13). Its current mission statement, in 2006, is "To promote public participation in caring for the Earth".

WESSA has been supporting environmental education and teacher professional development for many years, although its approaches have changed substantially as its environmental education programmes have developed. The first record of teacher professional development activities organized by WESSA dates back to 1969, when trainee teachers were taken on field excursions during weekends, and introduced to ecological principles and techniques for teaching in the field (Taylor, 1997:15). Since then WESSA's environmental education initiatives have branched out into a multi-faceted range of projects and programmes, including four environmental education centres in KwaZulu-Natal, and initiatives such as Share-Net, Eco-Schools, Blue Flag, the ESKOM Energy and Sustainability programme, and the Southern African Development Community Regional Environmental Education Programme (SADC-REEP).

1.3 How my interest in auditing arose

My interest in environmental auditing first arose within my role as an environmental educator at the WESSA Umgeni Valley Environmental Education Centre, in Howick,

South Africa. Much of my work, then, involved developing learning programmes for school excursions to Umgeni Valley Nature Reserve. I was constantly seeking new ideas for educational programmes and in particular, activities with an action orientation. It was here, in 2001, that I first encountered the School Environmental Policy Pack, produced by Share-Net (Share-Net, 1999a). Share-Net is an informal resource materials network located at Umgeni Valley Nature Reserve. The School Environmental Policy Pack, which has since been adapted for the Eco-Schools Programme, encourages schools to audit their resources, such as water, paper and electricity, to develop an environmental policy and management plan based on the findings of the audit, and to take action to improve their school environment (Ashwell, 2003). The School Environmental Policy pack provides questionnaires to help schools undertake a general environmental audit and more specific audits, focusing on topics such as water, waste and the school grounds (Ashwell, 2003). Since that first encounter with environmental auditing, I have noticed a proliferation of audits intended for use in environmental education activities in South Africa, particularly in schools.

In view of this surge of interest in audits in the educational arena, I have been surprised by the apparent lack of published research focusing on environmental auditing in school contexts. In my search for local and international literature on auditing, I found an enormous volume of writing on environmental auditing for environmental management purposes, and numerous stories of audits being undertaken within educational contexts. To my surprise, I struggled to find literature on the educative dimensions of environmental auditing. The widespread interest in audits and the potential impact of auditing processes on learning and environmental management in schools suggest that this research around environmental auditing would be of interest to many people and could inform aspects of WESSA's environmental education activities.

1.4 The *Schools and Sustainability* professional development course

Towards the end of 2003, eThekwini Municipality: Water and Sanitation Department, in Durban, South Africa, approached Rhodes University and WESSA in order to form a partnership to promote environmental education in some of Durban's schools.

Municipal personnel had identified a number of environmental issues and risks affecting several Durban schools that they hoped to respond to through an environmental education course. WESSA and Rhodes University were contracted to develop a professional development short course for teachers.

The *Schools and Sustainability* course is a twelve-credit short course, aligned with one module of the Rhodes University Advanced Certificate in Environmental Education. The course was developed around a resource-based learning approach to professional development (WESSA, 2005) and aims "to work through the curriculum towards a healthy environment and whole school development" (WESSA, 2005).

As part of the work they do for the course, participating teachers undertake an environmental audit in their schools, develop a School Environmental Policy, develop lesson plans to promote active learning, develop and implement action plans for school improvement, use and adapt resource-based learning (RBL) packs focusing on environmental issues, and evaluate their policy, lessons and action plans. The course was piloted in 2004 with a group of fifteen teachers, and was implemented for the second time in 2005. In 2004 and 2005, workshops were conducted at the Northern Treatment Works, a wastewater treatment works, in Sea Cow Lake, Durban.[1]

As a tutor on the course in 2004, and later as course coordinator, I was able to interact with the teachers and engage with their work. As teachers reported and reflected on the lessons they had implemented, I was struck by their enthusiasm for environmental auditing. In many instances, however, teachers were not able to articulate clearly why they valued audits. Audits, like many outdoor educational activities, seemed to hold a great appeal for many teachers and learners. Teachers on the course felt that their learners had benefited enormously from undertaking environmental audits, but they found it very difficult to explain why they felt that way. As I reflected on this question, I became aware that some of the educative dimensions of auditing were not being adequately reported or engaged with in the course.

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[1] Refer to Appendix 1 for an outline of the *Schools and Sustainability* course.

Evidence from teachers' lesson plans, learning and teaching support materials (LTSM) and learners' work reflected both success stories and problems in the way audits were being undertaken. For example, environmental audits seemed to be playing an important role in helping teachers initiate and contextualize environmental learning at school, but the information shared with learners was not always accurate. Teachers were using audits to focus attention on a variety of emerging environmental risks such as waste management, water consumption, resource use, state of the school grounds, environment in the curriculum, and so forth, but the methods they used were not always appropriate. Teachers were using a variety of learning and teaching support materials to support auditing processes, but these were sometimes adopted blindly, without adequate consideration for the age or grade of the learners (Hoffmann, 2004).

A summary of the findings recorded in the evaluation report of the 2004 *Schools and Sustainability* Course (Hoffmann, 2004) is outlined below.

Choreography and use of environmental audits
A variety of auditing methods was used, including questionnaires, interviews, surveys, observations, measurements, meter readings and counting.
Some teachers came to conclusions that were not supported by the evidence generated, suggesting an inadequate grasp of the auditing method and/or the findings.

Curriculum issues
Selection of appropriate learning outcomes (LO) and assessment standards (ASS) for lessons involving audits - Learning outcomes and assessment standards were not well understood by some teachers; several teachers seemed to have interpreted them simplistically; and activities in the lesson plan did not always link appropriately to the chosen learning outcomes and assessment standards.
Learning and teaching support materials used in lessons involving audits - A variety of LTSM was used in the preparations for auditing, in the auditing process and afterwards. Some teachers seemed to have adopted 'blindly' the materials that had been provided on the course and to have used them without the necessary adaptations for their grade, learning area and context. Some teachers selected LTSM without appearing to consider whether the materials would help learners to become more competent in the learning outcomes intended for the lesson. Teachers on the

course seemed to need more support to develop their ability to reflect on their use of LTSM.

Assessment of learning during audits - Assessment of learning during audits was rarely recorded. Teachers seemed to have assumed, without checking, that learners had learnt what the teacher intended them to learn through the audit. The criteria for assessment did not always correspond with the learning outcomes and assessment standards identified in the lesson plan. Assessment was usually focused on the 'products' of the audit and rarely on the learning processes taking place during the audit. Teachers seemed to have great difficulty finding evidence of achievement of learning outcomes within learners' work. Teachers rarely probed the educational value of the learning processes in any depth. Some teachers' reflections on their lessons were limited to comments on logistical and practical issues.

I began to wonder how teachers made decisions about which audits to do and how to do them. I wondered how the undertaking of environmental audits was shaping environmental education processes in these teachers' school contexts. In particular, I wanted to understand how teachers were using environmental audits as a strategy for lesson planning and how they were choreographing their auditing lessons. These observations and questions strongly suggested that there was a need for more research on the educational dimensions of environmental auditing processes. My role as a tutor and coordinator on the course in 2005 provided me with an ideal opportunity to undertake research on questions that had arisen about environmental audits, with the participating teachers, in a way that might improve my own practice and strengthen the capacity of the course to support teachers.

1.5 Research aim and goals

The aim of this research is to understand how the undertaking of environmental audits can shape environmental education processes in school contexts. To this end, I have used an interpretive case study approach to review environmental auditing processes within the *Schools and Sustainability* course.

The research is guided by the following goals:

- To review ways in which audits are choreographed and used by teachers for lessons within school contexts; and
- To explore ways in which audits shape meaning-making interactions and give rise to environmental learning processes.

1.6 Overview of the chapters

In Chapter Two, I introduce the context of the study and present a review of literature pertaining to this area of research. The chapter starts with an historical perspective on the origins of environmental auditing before introducing an overview of approaches to auditing in school contexts. This leads into a discussion of educational transformation in South Africa, which highlights the changing roles of teachers and the significance of a resource-based approach to learning. I probe the idea of risk literacy in relation to the objectives of environmental education and critiques of science-oriented approaches to environmental education. To help put the constructivist orientation of the *Schools and Sustainability* course in perspective, I delve into ideas about social constructivism and the problem of relativism. After critiquing the postmodern trend of relativism I draw on literature to argue that a realist orientation to auditing may be a useful process for engaging with the world and re-researching the way learners see things. Ideas about reality-congruence and the interacting processes of involvement and detachment are of central importance in understanding processes of knowledge construction and meaning making in this study. The literature review draws on the work of Elias (1987) and Latour (1999) to shed light on the significance of auditing processes in which a close engagement with reality, coupled with a measure of detachment, can lead to the construction of a more reality-congruent account and a more realistic assessment of the environmental issue in focus. I conclude the chapter by exploring how auditing processes may be strengthened through tools and practices involving the gathering of data and the construction of representations. I draw on literature to support the argument that auditing processes such as these may be able to provide learners with the relative certainties they need to know and to act in more sustainable ways.

In Chapter Three, I describe and seek to justify the research design decisions I made to achieve the aims and objectives of this study. I start by explaining why I chose to

approach this research as an interpretive case study. I describe the research process by explaining which research methods I used to generate the data and how the case stories were constructed. I introduce the codes and categories I used in the process of data analysis and explain how I drew on the general comparative method to analyze the data. I also consider issues relating to validity, trustworthiness and ethics and explain how I attempted to deal with potential validity threats.

In Chapter Four, I present the research findings. First, I present the findings of an initial analysis of the data that informed further data generation and analysis. This initial analysis of the data differentiated three approaches to auditing, which I chose to refer to as (1) an impression-based methodology (2) an evidence-generating methodology and (3) an actualizing methodology. I then examine three individual case stories in more depth. Further analysis and interpretation of the case stories reveal some of the relationships between auditing methodology, the choreography of auditing lessons, and knowledge construction and meaning-making processes associated with these. The initial analysis, the three case stories and the analysis of these relationships provide a detailed picture of auditing processes in the *Schools and Sustainability* course for an in-depth discussion in Chapter Five.

In Chapter Five, I discuss the key findings of the research in more depth and in relation to the literature reviewed in Chapter Two. I examine relationships between auditing methodology and the kinds of risks that are audited, and the tendency for education to have a reactive orientation in response to risk. I discuss ways in which auditing choreography influences the nature of teaching and learning interactions, and reality encounters. I approach this task by examining some of the emergent dimensions and tensions of audits choreographed within various educational perspectives, the use of learning and teaching support materials and processes of participation in the case study. I also discuss relationships between auditing choreography and subsequent processes of knowledge construction and meaning making, paying particular attention to ways in which learners engaged with the findings of the audit, and their developing accounts of reality. This requires careful consideration of the interplay between different perspectives in the lesson, the balance between processes of involvement and detachment, and the reality-congruence of learners' accounts. Finally, I discuss the significance of teacher knowledge, skills and experience in shaping auditing methodology, choreography and meaning making.

In Chapter Six I present a summary of the findings of the research process, draw conclusions and make recommendations relating to professional development courses and the development of materials to support teaching and learning through auditing. Finally, I attach a series of appendices to the study.

1.7 Conclusion to the chapter

WESSA has been supporting environmental education, materials development and teacher professional development for many years. There seems to be a need to understand and support these processes better and the *Schools and Sustainability* course appears to be an ideal context within which to research questions about the educative dimensions of environmental auditing. This research may be useful to inform the future development and implementation of professional development courses for teachers, and the development of resources to support environmental learning through auditing processes.

The next chapter presents a review of relevant literature pertaining to auditing and probes various orientations to environmental education. It offers an historical perspective and provides the context within which the research was undertaken. It looks at the problem of risk and the need for risk literacy and raises some of the key questions and tensions associated with scientific inquiry-based orientations to environmental education. It also clarifies key social and learning theories, which are used as vantage points from which to view the research.

CHAPTER TWO: CONTEXT OF THE STUDY

2.1 Introduction to the chapter

In this chapter, I clarify the context of the study, review relevant literature and draw on theory to provide vantage points from which to examine auditing processes in the *Schools and Sustainability* course.

This study on environmental auditing is located within the context of a professional development course, offered by WESSA to schoolteachers, in which the transformational role of the teacher and the use of learning and teaching support materials are given particular attention.

More broadly, this study is located in the context of the South African education system, which is undergoing major transformations, including re-orientation and revision of the school curriculum. Changes have included a re-conceptualization of the role of teachers, the emergence of resource-based learning approaches to teaching (NEEP-GET, 2005b:1) and the corresponding need for new approaches to professional development (NEEP-GET, 2005a:1). Of significance to this study is the uneasy relationship between the ideologies and practices of a curriculum oriented towards outcomes (Outcomes Based Education) and auditing processes which are centred on data gathering and critical reflection to foster change (a socially critical perspective).

Even more broadly, this study is located in the context of a global environmental crisis and heightened interest in the notion of education for sustainability. The questions central to this study are poised at a rocky intersection of ideas about the social construction of reality, the problem of relativism and the role of science in environmental education.

Through this research on environmental auditing, I hope to deepen my understanding of how environmental education processes might be undertaken in ways that are more effective at engaging, clarifying and responding to environmental risk. In

reviewing ways in which audits are choreographed and used by teachers for lessons, I hope to learn more about how teachers and learners can critically explore their socio-ecological contexts. Finally, in probing the educational dimensions of environmental auditing, I hope to learn more about ways in which audits might shape meaning-making interactions and environmental learning processes, to contribute towards a more sustainable environment.

2.2 Environmental auditing

2.2.1 Origins of environmental auditing

Environmental auditing originated in Europe and the United States of America (USA) during the 1970s and 1980s as a way of testing compliance with environmental legislation (Sampson, 2000:6; Callenbach, Capra, Goldman, Lutz & Marburg, 1993). Although environmental auditing is an internationally recognized way of working towards effective environmental management, it is a fairly new practice in South Africa (Sampson, 2000:3). Its emergence in South Africa coincided with the country's reintroduction to the global arena, growing commitment to the principles of the new Constitution and consequently, increasing awareness among the public of the impacts of human activities on the environment (Sampson, 2000:3).

The term 'audit' is derived from financial auditing. In its original sense, auditing refers to a process of carefully comparing company practices with company policies, government regulations or generally accepted standards of practice (Callenbach *et al.*, 1993:67). The European Communities Eco-management and Audit Scheme (EMAS) defines an environmental audit as

> … a management tool comprising a systematic, documented, periodic and objective evaluation of the performance of the organization, management system and process designed to protect the environment with the aim of:
>
> (i)   facilitating management control of practices which may have an impact on the environment;
> (ii) assessing compliance with company environmental policies.
>
> (Sampson, 2000:4)

Prior to the 1980s, many companies saw environmental protection as something to be avoided, if possible. Some regarded environmental protection as a costly expense that could make companies less competitive. However, environmental disasters in the 1970s and 1980s, such as those at Bhopal and Chernobyl in Europe and the Valdez oil spill in the USA, led to a dramatic increase in environmental awareness throughout Europe and the USA. Ecological activism increased and environmental groups began to lobby for stricter State environmental legislation and eco-friendly corporate policies (Callenbach *et al.*, 1993).

In the USA, for example, the Environmental Protection Agency was established to implement policies for the regulation of emissions, discharges, environmental impact assessments, pesticide use and so on. Quantitative assessments of impacts on air, water, toxicity levels and health standards became widespread. Since the mid-1980s, the Environmental Protection Agency has strongly encouraged corporations to undertake environmental audits (Callenbach *et al.*, 1993). The International Standards Organization (ISO) has developed a range of standards, including the ISO 9000 and ISO 14000 series, that refer to quality, health and safety and the environment (McIntosh, Thomas, Leipziger & Coleman, 2003). This approach to auditing is often called 'compliance auditing', because it is directed towards compliance with the law and the avoidance of fines and lawsuits (Callenbach *et al.*, 1993). It seems that the influence of this approach can still be seen in certain kinds of environmental audits as they have been co-opted into the educational arena (see section 2.2.3).

As people began to realize the social and ecological costs of economic activities, interest in voluntary auditing grew. Different countries developed various sets of principles and auditable standards, to serve as baseline standards of ecological responsibility, and to which companies could voluntarily become signatories (Callenbach *et al.*, 1993). The Global Sullivan Principles of Corporate Social Responsibility, launched in South Africa in 1977, became a voluntary standard that sought to change corporate practices and supported efforts to eliminate apartheid. Companies which endorsed the Sullivan Principles agreed to apply the eight principles of corporate social responsibility. The fifth principle reads as follows: "As a company which endorses the Global Sullivan Principles … we will … Provide a safe and healthy workplace; protect human health and the environment; and promote sustainable development" (Baker, 2005). Later, the Industrial Environmental Forum of Southern Africa, founded in 1990, contributed to the development of an

International Code of Conduct for business, and the development of guidelines for eco-auditing (Callenbach *et al.*, 1993).

ISO 14001, launched in 1996, is a voluntary standard for industry based on five key elements:

- An environmental policy;
- An assessment of environmental aspect;
- An assessment of legal and voluntary obligations;
- A management system;
- A series of periodic, internal audits and reports to top management (McIntosh *et al.*, 2003).

More recently, the Global Compact, initiated by UN Secretary General Kofi Annan, includes nine basic principles on environment, labour and human rights. These principles draw on, amongst other, the Universal Declaration of Human Rights and the Rio Principles on Environment and Development (McIntosh *et al.*, 2003).

Increasingly, companies are recognizing the practice of ecological auditing as an important tool of contemporary business management. The practice has been championed by the International Chamber of Commerce (ICC). Some companies have begun to see environmental protection as an investment in the future, which could even give a company a competitive advantage. Individual companies all over the world have begun to initiate projects such as recycling, car-pooling, and energy-efficiency programmes (Callenbach *et al.*, 1993). Similarly, schools all over the world have begun to see the benefits of developing policies and action plans to improve and manage their school environment better (Henderson & Tilbury, 2004).

2.2.2 Ethical orientations to environmental auditing

Callenbach *et al.* (1993) distinguish between environmental management and ecological management. They argue that environmental management "lacks an ethical dimension, does not question the dominant paradigm, perpetuates the illusion of economics as a value-free science, and subscribes to the ideology of economic growth". In contrast, ecological management is "motivated by an ecological ethic. It involves a shift from mechanistic to systemic thinking and from a value system based

on domination to one based on partnership. It replaces the ideology of economic growth with that of ecological sustainability" (Callenbach *et al.*, 1993:xii-xiii).

Callenbach *et al.* (1993) subscribe to the views of Arne Naess and Warwick Fox who distinguish between shallow environmentalism and deep ecology. Shallow environmentalism accepts the ideology of economic growth for human benefit. Deep ecology challenges the ideology of unrestricted economic growth and focuses, instead, on ecological sustainability (Callenbach *et al.*, 1993).

In keeping with these distinctions, Callenbach *et al.* (1993) also distinguish between "shallow" environmental auditing, and "deep" ecological auditing. In their view, shallow environmental auditing is motivated by the idea that action leading to environmental improvement can benefit the company concerned (or school, in the instance of this study). In contrast, eco-management, with its deep ecology perspective, is motivated by an environmental ethic and a concern for the wellbeing of future generations (Callenbach *et al.*, 1993).

Awareness of this range of ethical perspectives may help to illuminate some of the complex issues associated with the role and educational value of environmental auditing in schools.

2.2.3 The logic of practice behind various approaches to auditing in environmental education

As I reviewed the literature on environmental auditing in environmental education, I tried to detect the logic of practice behind different kinds of audits. It became evident that different kinds and ways of undertaking audits were associated with particular intentions and assumptions about learning. As Fien (1993) put it,

> Either a teaching activity serves to integrate children into the current
> social order or it provides children with the knowledge, attitudes and skills
> to deal critically and creatively with that reality in order to improve it. In
> any case, all teaching is embedded in an ideological background.

> (Grant & Zeichner, 1984, as quoted by Fien, 1993:15)

In the following sections, I review several approaches to auditing which seem to be associated with particular intentions, assumptions about learning and ideological perspectives. [2]

2.2.3.1 Auditing-as-measurement, within environmental monitoring approaches

Hart's (1997:133) research, focusing on environmental actions by children, indicates that the idea of involving children in monitoring the environment is not new. His examples of environmental monitoring by children all over the world indicate that the practice is widespread too.

One of the earliest environmental audits in environmental education in South Africa was developed by R. O'Donoghue, then working for the Natal Parks Board. O'Donoghue developed a low-cost water quality auditing kit, in partnership with the USA-based Global Rivers Environmental Education Network (GREEN), to enable school children to assess the health of rivers in supported fieldwork activities (Taylor, 1997:89). The water audit kits contained simple equipment and guidelines for auditing water quality using the indicators of visible life, total coliform bacteria, turbidity, temperature and pH. The materials were adapted several times and sold at Share-Net in different forms including (1) the Starter Kit (2) the Coli-form Tin and (3) the GREEN Catchment Action Manual (O'Keeffe & Day, 1992).

When reflecting on those water audit kits, O'Donoghue noted that the water audit booklets had a propositional orientation, a particular logic of practice which choreographed the water auditing processes in particular ways (R. O'Donoghue, personal communication, May 8, 2005). It is that logic of practice and the choreography of auditing processes that this study seeks to understand, along with ways in which the undertaking of an audit shapes meaning-making interactions and gives rise to environmental learning processes.

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[2] This list of categories of audits does not claim to be comprehensive. As noted on page 3, there appears to be very little published research on educative dimensions of environmental auditing. Also, there may be substantial overlap between different categories, for example, in the instance of an audit that leads to environmental improvement and supports curriculum-based learning.

2.2.3.2 Auditing within "targeted messages" approaches

Taylor (1997) reflects critically on WESSA's early approaches to teacher professional development. Learning outcomes for teacher workshops and materials emphasized "getting the message across" and tended to elevate the profile of the Society, at the expense of more meaningful opportunities for participants' engagement and learning (Taylor, 1997:50). For example, when O'Donoghue's educational water audit kits were first developed, teachers, including WESSA education officers, initially used the kits with the objective of teaching moral lessons to cause appropriate social change in others. However, Taylor (1997:106) found that this approach failed to produce the expected results. The assumptions associated with this approach reflected a narrow view of learning and change which failed to take into account the social context within which the materials were being used. The evidence generated through researching the use of these materials in the field suggested that resource materials, in themselves, could not teach direct change. By acknowledging the significance of the social context in which the learning takes place, Taylor (1997) was able to see how resource materials might be used to support better learning. As he put it,

> In a supportive social context, however, where a teacher … is able to use a resource with participants to explore environmental issues, the resource materials may support better learning. When researching the use of resources in the field, we found that they could help provide data which in turn could raise the level of debate pertaining to an environmental topic or issue.
>
> (Taylor, 1997:106)

Gradually, an emerging understanding of the social realities faced by teachers and learners began to influence the way teacher workshops were conducted and the way in which learning and teaching support materials were developed by WESSA. As it became apparent that workshops needed to address the realities of South African education and become more responsive to teachers' concerns, learning outcomes for teacher workshops began to emphasize the need to equip teachers with the resources and ideas they needed, to address their specific professional development needs. Taylor (1997) reported that this new approach, of sharing ideas and materials with teachers, rather than trying to tell them what they needed to know in order to change them, seemed to contribute to more meaningful interactions with the teachers. Similarly, when teachers changed their expectations and used the water audits to find out about water quality jointly with others, rather than to change others, this led to richer field work experiences that appeared to be more meaningful to all involved (Taylor, 1997). Taylor's (1997:92) opinion was that low-cost water quality

kits have enormous potential to support better environmental education processes in South Africa. He warned, however, that they should not be used with manipulative intent. [3]

2.2.3.3 Auditing-as-measurement within curriculum-focused approaches

The benefits of monitoring and measurement activities, such as audits, for curriculum work have been emphasized by Krapfel (1999). He claims that environmental monitoring can help learners to understand the processes and concepts their teacher needs to teach them as part of their school curriculum (Krapfel, 1999). Environmental monitoring activities often focus on scientific methods of measuring the environment and on developing particular skills and concepts in areas such as science, literacy, map-skills and mathematics (Hart, 1997).

Krapfel (1999) emphasizes the importance of practising to look for changes and learning to measure rates of change in the environment. He claims that most environmental problems are rate problems. "The problem is often not the kind of change but the rate of change" (Krapfel, 1999:50), for example, human birth and death rates, the rate of climate change, the rate of production of toxic waste and the slow rate at which manufactured wastes break down. Learners are therefore encouraged to visit the same area repeatedly and to monitor their sites daily over a week or two. Normally, learners' awareness would be limited to changes that take place over a few seconds or minutes, but auditing and monitoring phenomena over a longer period makes learners aware of changes that take place over days or weeks (Krapfel, 1999).

One of his auditing techniques involves focusing learners' attention on something that is slowly changing, for example, by marking a growing flower with a piece of masking tape. The marking helps learners to notice how individual things are changing around them, such as, in this case, the life of an individual flower. His method of marking helps to make those changes a visual reality rather than remaining an abstraction. Other auditing activities may involve measuring and

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[3]For a more thorough overview of the origins of WESSA, and the development of environmental education initiatives from 1952 to 1997, refer to Jim Taylor's (1997) thesis, entitled *Share-Net: A case study of environmental education resource material development in a risk society.*

graphing changes taking place in the environment, particularly the rate of change (Krapfel, 1999).

Hart (1997:134) gives an example of a school where teachers invited children to monitor changes in their school environment, as part of a school greening project. Teachers encouraged learners to contribute to the school greening plan and to say what they would like to see in their school grounds. As plants and animals began to colonize the grounds, they provided children with new items of interest and new opportunities for play. Teachers began to use the school grounds as a site for scientific study, and were able to develop lessons using what was happening outdoors as a focus for their curriculum work. This provided children with opportunities to learn about ecological changes by observing and recording changes as they occurred and to report and compare their findings. Hart (1997:134) found that through these experiences, children came to understand the intimate relationship between wildlife and their habitat.

2.2.3.4 Auditing within socially critical, action-focused approaches

Environmental education is increasingly being characterized, in the literature, as socially critical in its intent. However, Greenall Gough and Robottom (1993:301) contend that most schools are not involved in socially transformative environmental education. They are primarily involved in integrating environmental education content into their existing curricula, rather than engaging in the kinds of social action advocated by socially critical pedagogy (Greenall Gough & Robottom, 1993:307).

Greenall Gough and Robottom (1993) claim that in many schools, water studies involve little more than activities in which learners collect water samples, carry out standard testing procedures and report the results in conventional scientific ways (Greenall Gough & Robottom, 1993:301). They argue that in such audits, teachers are translating the curriculum into conventional scientific studies of social issues, rather than into socially critical studies. They claim that such studies do little to empower the students to address the issues and resolve the problems in focus (Greenall Gough & Robottom, 1993:308). They advocate educational processes that engage society, social structures and social issues immediately, rather than merely preparing learners for later participation. They also recommend processes that give learners experience in working on social issues, critical reflection, social negotiation

and the organization of environmental action (Kemmis *et al.*, 1989, as cited in Greenall Gough & Robottom, 1993:305).

Hart sees this approach to auditing as a potentially useful strategy for obtaining useful scientific data that can contribute, in a meaningful way, to environmental improvement and community development (Hart, 1997:138). It seems that the idea of auditing-as-monitoring has been conflated with the idea of auditing as a critical engagement, which can lead to reflection and change (R. O'Donoghue, personal communication, December 14, 2005). What appears to be developing is an ideology of auditing within a reflexive pedagogy, which can lead to environmental transformation.

Greenall Gough and Robottom (1993:302) describe a case study that, in their view, expresses some of the characteristics of socially critical environmental education. In this case study, learners in Australia were engaged in the following processes of learning and action:

- Auditing and monitoring levels of bacteria in freshwater and marine water;
- Auditing sewage pollution at their nearby swimming and surfing beaches;
- Determining topographical and demographic patterns; and
- Reporting and sharing their findings in an international computer conference.

As a consequence of the learners' activities:

- Public interest in the issue increased;
- The State's Minister requested the local water board to make substantial improvements to their sewage treatment facility;
- Learners developed deeper understandings of environmental issues, the power relationships within society, the technical parameters of water quality, and of their own capacity to influence the outcomes of environmental issues.

According to Greenall Gough and Robottom (1993:310), the project provided learners with opportunities to appreciate their social reality as socially constructed and subject to reconstruction through historical, social and political processes in which they can be involved as agents of change.

Hart (1997:138) claims that auditing and monitoring activities can help learners to see how the knowledge and skills of school subjects such as geography,

mathematics and language can be put to good use for better management and development of their school or community. This point of view is particularly evident in whole school approaches to sustainability.

2.2.3.5 Auditing within whole school approaches to sustainability

In their review of whole school approaches to sustainability, Henderson and Tilbury (2004) found that environmental audits are being used by schools all over the world, including South Africa, New Zealand, China, Scotland, England, Wales and Europe. Environmental auditing has become one of the most common forms of participation, by learners and teachers, in whole school approaches to sustainability (Henderson & Tilbury, 2004). Audits have begun to appear within a startling array of environmental education projects, programmes and courses, both locally and internationally. Recently, perhaps as an offshoot from whole school approaches such as Eco-Schools, there has been a surge of interest in environmental auditing in school improvement programmes in South Africa. Surprisingly, despite this quickening enthusiasm, it appears that very little research has been done around environmental auditing in environmental education.

Environmental auditing at the school level can provide opportunities for children to contribute to assessing the state of their own environment. Schools usually undertake an environmental audit as one of the first steps towards a whole school development programme (Ashwell, 2003:15; Henderson & Tilbury, 2004). Undertaking an environmental audit can provide the school with a snapshot of the state of the environment, which can assist in identifying areas needing attention. The school may then use the findings of the audit to (1) inform the development of action plans (2) provide a set of baseline data for monitoring of the problem areas and (3) inform periodic reviews of the school's performance (Henderson & Tilbury, 2004).

Henderson and Tilbury (2004) reported that most of the environmental audits used within the programmes they reviewed focused primarily on environmental issues such as resource consumption and the state of the school grounds. They found little evidence of audits being used to consider other aspects of sustainability, such as "intercultural issues and evidence of citizenship, participation in decision-making and links to community" (Henderson & Tilbury, 2004:37). They expressed a concern that the undertaking of audits in this manner might reinforce a narrow interpretation of sustainability that considers only concerns related to the physical environment. This

could be problematic if audits remain the only process by which a school identifies areas for whole school action. In their view, programmes with an orientation towards education for sustainability ought to include a focus on other important issues such as consumerism and globalization, and a focus on principles such as respect for diversity, promotion of indigenous knowledge and intercultural understanding, peace and equity. Their observation raises questions about approaches to auditing in South African schools, since principles such as these, and this broader interpretation of sustainability, are reflected in the new curriculum.

2.3 Educational transformation in South Africa

2.3.1 The new curriculum

This research is being conducted at an interesting time in South Africa's history. South African society has undergone major transformations within the last decade, including transformation and revision of the school curriculum. New education policies, underpinned by the vision and values of the South African Constitution, have been developed to shape the new Outcomes Based Education (OBE) curriculum (South Africa, Department of Education, 2002).

Curriculum transformation has been closely linked to the broader goals of social transformation in South Africa. As explained in the overview to the Revised National Curriculum Statements grade R to nine for schools, "The curriculum can play a vital role in creating awareness of the relationship between human rights, a healthy environment, social justice and inclusivity" (South Africa, Department of Education, 2002:10). The Learning Area Statements have been designed to address these principles (South Africa, Department of Education, 2002). Many environmental issues are closely linked to human rights and social justice issues (NEEP-GET, 2005c:1). Access to clean water, for example, relates to human rights, because everyone has the right to have access to clean and safe water sources. It also relates to social justice, because the injustices of the past contributed to the current unequal distribution of water resources. Teachers are expected to be able to interpret the social goal and to design, adapt and use appropriate lesson plans and learning activities, which reflect the principles of the new curriculum (NEEP-GET, 2005c).

2.3.2 Teachers' roles

Historically, teachers were seen as people who could transmit required knowledge and skills to learners. Education transformation in South Africa has brought about changes in the roles of teachers. According to Parker (2004), the state sees teachers as agents of transformation and has embarked on a major political project to train teachers to be able to implement these transformational ideals.

An important emerging challenge for teacher education is the development of curricula capable of producing teachers who fit this new image. Increasingly therefore, teacher educators are exploring ways to make professional development more critical, reflective and reflexive (NEEP-GET, 2005a).

2.3.3 Learning and teaching support materials (LTSM)

One of the challenges faced by teachers in implementing the new curriculum in South Africa has been the lack or inadequacy of LTSM (NEEP-GET, 2005b). Learning and teaching support materials play an important role in scaffolding and supporting learning activities (NEEP-GET, 2005b) and carefully designed LTSM can support teachers in bringing about curriculum change (Czerniewicz, Murray & Probyn, 2000).

Research undertaken as part of the National Environmental Education Programme for the General Education and Training band (NEEP-GET) suggested that poor use of learning and teaching support materials in schools was impeding successful implementation of Curriculum 2005 (NEEP-GET, 2005b). The research recommended that more attention needs to be paid to:
- The way in which teachers use environmental LTSM when planning lessons;
- Access to LTSM;
- Over-use of LTSM;
- The relationship between LTSM and teaching methods;
- Ways in which language and literacy affect the use of LTSM.

Czerniewicz *et al.* (2000) concluded that of the six roles set out in the Norms and Standards for Educators (1998), the competence of teachers as interpreters and

designers of learning programmes and materials was the weakest. Their research indicates that little work has been done on learning support materials other than textbooks and there is a need to understand learning support materials from a social constructivist point of view (Czerniewicz *et al.*, 2000, as cited in Russo 2003:13). This appears to support my assertion that there is a need for more research to be done on environmental auditing in environmental education.

2.4 Environmental risk

2.4.1 The notion of risk

Riechard (1993) defines a hazard as "an act, event, or phenomenon that has the potential for causing harm" and the magnitude of the hazard as "the amount of harm that might result if the act, event, or phenomenon actually occurred" (Riechard, 1993:9). The notion of risk takes into account both the potential magnitude of the hazard and the likelihood that the act, event, or phenomenon will occur (Riechard, 1993). In this sense, risk represents a future that is to be prevented.

2.4.2 Risks and hazards in the teachers' contexts

The teachers participating in the *Schools and Sustainability* course are faced with many challenges, including environmental and health issues within their school contexts. Some prominent examples from the *Schools and Sustainability* 2004 evaluation report (Hoffmann, 2004) are listed below:

- The teachers work at relatively poor schools, with a scarcity of learning support materials. Many parents are unable to pay school fees, and schools are deprived of the financial resources they need;
- Many children suffer from malnutrition, which affects their performance at school. Some arrive at school without any food and without having had any breakfast;
- Many children attending these schools live in informal settlements without proper water and sanitation. Some children have inadequate standards of personal hygiene. Children often damage toilets and taps at school because some children do not seem to know how to use them appropriately;

- Many teachers are struggling to adapt to the new curriculum;

- In some schools, there is very little co-operation among teachers;

- In many cases, teachers have very large classes to teach;

- Some school grounds are unattractive and have few flowers and trees. Opportunities to use the school grounds for learning are under-utilized;

- Schools cannot afford to send children on excursions;

- School resources such as electricity and water are poorly managed, for example, water leaks are common;

- Some schools are not adequately secure places for teachers and children to work and play in;

- Many children come from broken homes. Some suffer from child abuse, while others are exposed to drugs and alcohol abuse;

- Some schools are subjected to high levels of littering and vandalism;

- Some schools are located in areas with high levels of air pollution;

- In most schools, there is little support from parents, and very little interaction with the community;

- There is a general lack of environmental awareness among the learners, teachers, parents and community.

2.4.3 Risk perception

Risks associated with modernity, such as pollutants in water, air and food, chemical contamination and radioactivity, often escape human detection. Evidence from my interactions with the teachers prior to this study indicated that while they were able to identify and describe many risks in their contexts associated with poverty, they were less likely to identify other, less obvious, invisible risks generated by modern society.

Often, it is only those with access to scientific information or scientific tools of enquiry, usually experts, who are able to perceive these risks (Beck, 1992). People therefore become dependent on experts to save them. The danger is that the general population begins to believe that the experts have everything under control and that risk management is their responsibility alone.

People do not always think clearly about risk. People often demonstrate unrealistic views and behaviours towards hazards and risks (Riechard, 1993). According to

Riechard (1993:10), a person's perception of a hazard can be influenced by factors such as "myth, hearsay, superstition, experience, or precise scientific data." For example, when Membiela, Nogueiras and Suárez (1993) examined students' preconceptions about environmental problems in a city in Spain, they found that there were important differences between the students' perceptions of environmental problems and the actual environmental problems in the city. In the authors' view, the principal problem in the city was contamination of the River Barbaña through waste disposal from the city and from the industrial areas. However, students identified the presence of refuse as the principal environmental problem in the city. Students did not perceive that the real problem lay with those processes that lead to accumulation of refuse. They focused on the presence of refuse in the city as the principal problem.

Other findings of their study included the following points:

- Students had a limited grasp of the complexity of the problems surrounding urban solid waste. Although they equated the presence of refuse in the city with pollution, they seemed unaware of the more serious problem of pollution resulting from solid waste.
- Students generally considered only limited aspects of environmental problems. They usually considered only those aspects that they perceived in their immediate environment.
- They did not grasp the close relationship between consumerism and refuse.
- Although students identified changes in personal conduct as an important solution to environmental problems, very few of them were prepared to take any kind of action for environmental improvement.

This example illustrates the need for pedagogical processes which can mediate a close engagement with reality, to help learners to perceive the risks in their environment in a form that is congruent with reality (see section 2.7). Riechard (1993) claims that education is the primary contributor to an individual's perception of risk. He notes, however, that education has tended to take a reactive role, rather than a proactive role, in dealing with risk. Most teachers who are interested in environmental risk must draw on an unorganized mixture of available technical information and find ways to relate it to their existing curricula (Riechard, 1993).

Understanding a person's risk-taking behaviour also requires an understanding of their social location. As Riechard (1993) points out, a person may display irrational

behaviour in the face of danger, despite possessing the cognitive ability to perceive the risk and to plan against it. Hannigan (1995) explains that perceptions of risk often differ across populations facing different life chances. The choices people make are often directly related to their social location and the power differences among different groups of people. Individual perception of risk is powerfully influenced by the social institution to which an individual belongs, for example, family, friends, colleagues, the media and their culturally-embedded perspectives.

As life becomes increasingly characterized by socio-ecological risk, it becomes more important than ever for environmental educators to develop appropriate responses to risk. In the next section, I discuss a range of objectives of environmental education, as well as the notion of risk literacy and the ideology of education for sustainability.

2.5 Objectives of environmental education

2.5.1 A range of objectives

Much has been written about the kind of environmental education that is needed to achieve a sustainable society. The Tbilisi definition and objectives of environmental education provides an often-cited list of specific abilities that environmental education should help learners to obtain or strengthen, including awareness, concern, knowledge, attitudes, motivations, commitments and skills (UNESCO, 1980, as cited in De Young & Monroe, 1996:171). Of course, different kinds of environmental education programmes, curricula and materials specialize in developing different abilities (De Young & Monroe, 1996). Examples of objectives follow:

- Environmental education should promote the development of critical independent thinking (Robottom & Hart, 1995);
- Environmental education should seek to build up students' abilities to take action towards solving environmental problems, that is, their action competence (Jensen & Schnack, 1997);
- Environmental education should prepare children to be able to live with and negotiate risk (Le Grange, 2003) and contribute to a risk-literate society (Riechard, 1993). This objective is probed further in the next section.

2.5.2 Risk literacy as an objective

O'Donoghue (2001) notes that present approaches to environmental education have developed in response to emerging socio-ecological risks. In his view, environmental education processes should provide opportunities for learners to engage with information 'about' environmental risks, to explore these risks through encounter experiences 'in' the environment and to take action 'for' an improved environment. This approach emphasizes the importance of providing a balanced mix of educational processes of cultural induction, encounter experiences and critical reflection, with a view to fostering meaningful environmental learning and better environmental management and lifestyle choices (O'Donoghue, 2001).

Riechard (1993) suggests that a person's ability to perceive risk is partly developmental in nature – it depends on their stage of cognitive and psychosocial development. He argues that risk perception is related, in part, to a person's ability to think logically and to understand cause-and-effect relationships. He defines risk literacy as follows:

> Risk literate people have the knowledge, objectivity, and inquiry skills that make it possible for them to interpret … [risk-related] information presented in the popular media … they are critical thinkers and decision-makers – they ask questions, seek answers, study consequences, and act on the basis of the best information available.

> (Riechard, 1985:110, as cited in Riechard, 1993:9)

O'Donoghue's (2001) and Riechard's (1993) ideas provide useful models of process for the kinds of environmental education advanced in the ideology of "education for sustainability."

2.5.3 Education for sustainability

Since the United Nations Conference on Environment and Development in 1992, there has been a popularizing of the notion of sustainability within environmental education, internationally. Education for sustainability (E*f*S) seeks to engage learners in critical reflection about lifestyles, to help them make informed decisions about their decisions and actions, and to work towards a more sustainable environment (Henderson & Tilbury, 2004). E*f*S requires learners to develop special skills, including

critical enquiry, systemic thinking and problem solving, and the competencies needed for effective partnerships, participation and action. Similarly, Mayer (2002, as cited in Henderson & Tilbury, 2004:29) identifies the need for learners to develop critical thinking and questioning skills, and the ability to uncover the root causes of environmental problems and the values and assumptions that are dominant in society.

Within the transformation 'agenda' of E*f*S, teachers are seen as agents of change (Janse van Rensburg & Lotz-Sisitka, 2000). This has significant implications for the professional development of teachers, as teachers require new modes of teaching and learning. Teachers need to be supported to develop skills of participatory teaching and learning approaches. These include student-centred learning, action learning and co-operative learning (Henderson & Tilbury, 2004), as well as "action research, experiential and inquiry learning, the use of critical and reflective thinking and engagement in real issues and contexts related to children's lives" (Wilson-Hill, 2003:i, as cited in Henderson & Tilbury, 2004:22).

2.6 The uneasy relationship between science and environmental education in the *Schools and Sustainability* course

One of the challenges I have grappled with as a tutor on the *Schools and Sustainability* course, has been to find ways of drawing on science to help teachers develop insight into environmental risks, while remaining critical of the cultural assumptions associated with the dominant view of science. This view is still largely influenced by logical positivism, reductionism and the 'value-free' approach to research (Ashley, 2000:275).

2.6.1 Cultural biases underlying 'Western' science-oriented education systems

Science and technology have long been associated, in the "Western world", with the cutting edge of progress. Scientific knowledge is given high status, compared with other forms of knowledge, and is widely regarded as a source of empowerment. The

post-war period of 1945-1965 has been described as "the heyday of deference to the scientific expert … The scientific expert was the person who could tell us what to do and shape and guide our behaviour in all circumstances" (Ashley, 2000:270). In many respects, this appears to be the dominant outlook of eThekwini Municipality, a key partner in the development and implementation of the *Schools and Sustainability* course. Many of the teachers on the course, with their particular capital of ideas about environmental issues, seem to view environmental problems from a developmentalist perspective.

Some of the current cultural biases (De Young & Monroe, 1996) associated with the 'Western' education model include:

- A mechanistic or scientific explanation of environmental processes;
- The domination of raw facts and declarative knowledge over narrative or historical explanations;
- The use of factual, objective and information-intensive texts as its main educational tools;
- Rational and objective problem-solving processes;
- Faith in the 'issue comprehension' behaviour change model, which predicts that "as soon as people are fully aware of the facts and understand the logical causes and consequences of their environmentally destructive behaviours, they will take immediate and appropriate actions to improve matters" (De Young & Monroe, 1996).

Until recently, much of the literature on risk has reflected the assumption that risks can be objectively determined. Because of this assumption and the cultural biases outlined above, risk determination has been regarded, almost uniformly, as "exclusively the province of engineers, scientists and other experts" (Hannigan, 1995:92). In Riechard's (1993) view, the role of environmental education is to create conditions for the shaping of an individual's risk perceptions to be near or equal to 'computed risks', and to facilitate the translation of these perceptions into behaviours that eliminate or reduce those risks. This perspective of environmental risks assumes that there is a single objective reality, which can be measured and understood, if the right instruments and methods are used to perceive it. This perspective resonates with Elias's (1987) concept of reality-congruence, as explained in section 2.7.

In Riechard's (1993:12) words: "Accurate perceptions of risks are necessary for the attainment of a risk-literate society". This view has been popular in Western and industrialized nations, who are accustomed to perceiving reality through the lenses of scientific progress (Marsonet, 1995:22). According to Marsonet (1995), it was Popper's view that it is only within science that we can get a true knowledge of reality. Neopositivists endorse a scientistic (logical positivist) outlook that every type of knowledge must be reduced to the scientific one. This strongly empirical view is that reality is constituted, simply and only, by what we can experience from the sensory viewpoint (Marsonet, 1995:30).

Ashley (2000:275) warns that many environmental problems are a consequence of the irresponsible way in which the public has embraced science and its technological products. It has been suggested that public responsibility for the management of environmental risks is an essential step in the transition of society from modernism to reflexive modernity (Beck, 1992; Ashley, 2000). In Ashley's (2000) view, one of the key aims of environmental education ought to be a scientific education that contributes to an understanding of risk and scientific uncertainty. Environmental education should promote public attitudes towards science that are more responsible.

2.6.2 Critiques of science-oriented approaches to environmental education

Recent environmental education research has been quite critical of traditional science-oriented approaches to environmental education. Although such methods may be commendable, some have been criticized.

- Some methods misrepresent environmental problems as objectively existing physical or technical phenomena that can be reliably diagnosed and solved through better data collection, the development of regulatory legislation, personal behaviour changes, or the development of institutional practices that reduce environmental impacts (Robottom & Hart, 1995).

- Some methods seem to advance the ideologies of behaviourism and individualization (Robottom & Hart, 1995; Jensen & Schnack, 1997). Behaviourist approaches to environmental education tend to individualize the responsibility for environmentalism. Such environmental education

programmes aim to show individuals the error of their behaviours, and to urge them to make better choices. Jensen and Schnack (1997) recommend that environmental education should aim to make present and future citizens capable of acting on a societal as well as a personal level. Because environmental problems are usually political in nature, collective action is, in many instances, more productive than individual action (Robottom & Hart, 1995).

- Some methods emphasize only scientific approaches to analyzing and solving environmental problems (Smith & Williams, 1999). Robottom and Hart (1995) stress that environmental issues are social constructions, which only have meaning within their particular historical, social and political context.

- Some methods neglect the deeper cultural transformations required to shift to more ecologically sustainable ways of living (Smith & Williams, 1999).

These critiques raise questions about the kinds of research that environmental education should be engaging in. The implication for environmental auditing is that educators need to find appropriate and effective ways of using audits to develop insights into environmental risks.

2.6.3 The need for a "science of reflexive modernity"

Latour (1999) suggests that in the debate between science and anti-science, researchers can choose a third option, which is free from the so-called "science wars". Scientists need to recognize that the more connected scientific research is to the social world, including society, psychology, ideology and people, the more accurate, verifiable and solid it will be. Scientific research of this kind is uncertain, open-ended, both objective and subjective and lacks the coldness, aloofness and certainty of science.

Ashley (2000:275) advocates the notion of "the science of reflexive modernity" which:

- Responds to the challenges of living in a risk society;
- Promotes an understanding of the limits of science;
- Reflects appropriate responses to the limits of science;
- Leads to a "scientific action competence founded in an understanding of the limits of science" (Ashley, 2000:269);

- Prepares learners for "responsible participation in a democracy in which public competence in ethical reasoning and moral responsibility complement the public understanding of science" (Ashley, 2000:276).

Auditing may be a useful way for learners to develop the skills and values of "the science of reflexive modernity". However, educators need to be aware of the critiques of science-oriented approaches, the assumptions associated with developmentalist perspectives, and the cultural biases that may be reflected in their audits.

2.7 Reality-congruence

As I reviewed the literature on environmental auditing and reflected on my experiences of different audits, it became evident that different kinds and ways of undertaking audits can be associated with particular ontologies. Compliance auditing (see section 2.2.1) and environmental monitoring (see section 2.2.3.1) approaches seem to assume that there is a single objective reality, which can be measured and understood, if the right instruments and methods are used to perceive it. These approaches insist on close encounters with the "real world" in their attempts to perceive risks and make meaning from those encounters, reaching, as it were, for reality-congruent accounts of the world. Other kinds of audits seem to place less emphasis on the closeness of the engagement with reality. This latter approach may have emerged as a result of growing recognition that our perceptions of the world, including our perceptions of risks, are socially constructed, as explained in section 2.4.3.

The notion of reality-congruence is of central importance in understanding the emergent dimensions of audit-centred learning interactions in this study. According to O'Donoghue (personal communication, April 14, 2005), "attempts at meaning-making … are weak or good according to the extent to which they are reality-congruent and constructed within a close engagement with and in the real world and amongst the realities that we hold and share". Reality-congruent knowledge can be understood as knowledge which "consistently 'works' with a high degree of certainty" (Elias, 1983, as quoted in Mennell, 1992:161). The degree of certainty becomes important when we consider that audits are often undertaken as a first step towards taking environmental action.

Elias (1987) points out that reality-congruent knowledge of non-human nature is growing very rapidly (Elias, 1987). He explains that the scientific approach to nature coincides with a high level of self-regulation that goes hand in hand with a high level of object-control. This has enabled humankind to extend control over nature to diminish the threats to society from nature (Elias, 1987).

Recalling a passage from one of his earlier works, Elias wrote:

> High exposure to the dangers of a process tends to heighten the emotivity of human responses. High emotivity of responses lessens the chance of a realistic assessment of the critical process, hence of realistic practice in relation to it. Relatively unrealistic practice, under the pressure of strong affects, lessens the chance of bringing the critical process under control.

<div align="right">(Elias, 1981, as quoted in Elias, 1987)</div>

Elias (1987) claims that as the dangers that non-human nature poses to humans have seemingly diminished, particularly in more advanced, industrialized societies, our knowledge of nature has become more and more detached. In contrast, dangers posed to humans by other humans have remained comparatively high and less controllable, so that people's knowledge of society continues to be characterized by a high level of fear and involvement, and even what Elias terms a "fantasy-orientation" (Elias, 1987:xxix).

I tentatively suggest that these comments may shed some light on the significance of auditing processes in which a close engagement with reality, coupled with a measure of detachment, can lead to the construction of a more reality-congruent account and a more realistic assessment of the environmental issue in focus. The importance of reality-congruence, and the interacting processes of involvement and detachment within audit-centred attempts at meaning making are further elaborated in section 2.9.2.

2.8 The social construction of reality and the problem of relativism

2.8.1 Constructivism

The *Schools and Sustainability* course has a constructivist approach to learning. Key assumptions of this theory are that reality is socially constructed, and that reality and knowledge are relative to social context (Berger & Luckmann, 1966). "Constructivist perspectives allowed researchers to probe how human realities are socially constructed and are thus provisional and relative within socio-cultural context" (R. O'Donoghue, personal communication, April 14, 2005). This theory allows us to recognize that risks that seem 'real' to a Foundation Phase teacher at a school in the Durban South Industrial Basin may not seem 'real,' in the same way, to a high-powered businessman at the oil refinery down the road. Naïve interpretations of constructivism are reflected in educational activities that focus predominantly on the individual and his/her prior knowledge, experience of the world and construction of knowledge, and that treat the world as provisional, personal and relative (R. O'Donoghue, personal communication, April 15, 2005). This orientation is reflected in auditing activities on the course such as the 'scoping exercise' (Appendix 2), which is designed to capture learners' impressions of their environment as a basis for environmental learning and action. This activity seems to take for granted the validity of knowledge constructed through the mobilization of learners' impressions. The tools used in the auditing process do not necessarily support an objective assessment of environmental concerns. The limitations of this orientation become clearer when we consider the significance and power of the "habitus".

2.8.2 Habitus

The theory of social constructivism recognizes that the reality of everyday life is an intersubjective world. "There is an ongoing correspondence between *my* meanings and *their* meanings in this world, that we share a common sense about its reality" (Berger & Luckmann, 1966:37). This sense of reality is maintained through each individual's ongoing interactions with others. Other people we encounter serve to

reaffirm our subjective reality (Berger & Luckmann, 1966:169). These affirming social encounters and routines contribute to the development of a "habitus" (Berger & Luckmann, 1966) or "natural attitude" (Bauman, as cited in Rhodes University lecture notes, 2002), which consists of the background knowledge we hold of all the things we take for granted. Habitus refers to the knowledge, lifestyle, values, dispositions and expectations that we have, without being aware that we have them – in other words, the non-reflected-upon-truths, or naïve knowledge that we hold (Rhodes University lecture notes, 2002).

According to May (1996), "the habitus is inculcated as much by experience as by teaching, whilst its power is seen to derive from the lack of thought which informs its manifestations." This view echoes that of Berger and Luckmann (1966) who claimed that "The validity of my knowledge of everyday life is taken for granted by myself and by others until further notice, that is, until a problem arises that cannot be solved in terms of it" (Berger & Luckmann, 1966:58). This concept sheds light on the significance of auditing processes that allow us to engage critically with the naïve knowledge we hold, and on the power of auditing processes that enable us to pause and reflect on the validity of our knowledge of everyday life.

Constructivist learning theory explains that people learn through encountering incongruities and misunderstandings, in other words, deviations from our expectations and habitual knowledge (Kintsch, 1980; Bauman, as cited by Rhodes University lecture notes, 2002:18). This is what makes us pause and think, and triggers the processes of knowledge-building and learning. This seems to tell us something about how audits might contribute to learning. They can provide a means of making learners pause to check the reality-congruence of their perceptions. Learners may then be prompted to engage with any discontinuities that become apparent in the data, and to explore and reflect on the questions that arise.

As O'Donoghue suggests:

> Auditing is perhaps a useful process for engaging the way we see things and actual effects that there are in the world. In such a process we review what we know about a particular topic or concern before going out to have a look at the way things are playing out and, in so doing, collect evidence of the effects and graph these to help our grasp of a process and to inform discussion and actions towards doing these things in ways that are less problematic.
>
> (R. O'Donoghue, personal communication, April 15, 2005)

2.8.3 The postmodern trend of relativism

The constructivist approach of the *Schools and Sustainability* course emphasizes learning processes in which teachers can actively construct knowledge. Tutors try to avoid assuming an authoritarian position from which we can share our "expert knowledge". Janse van Rensburg and Lotz-Sisitka (2000) explain how a situation like this can easily lead to relativism.

Radical forms of constructivism are problematic because of the dilemmas they create of relativism, generalizability, accountability and social responsibility (Muller, 2000:162). Anti-realists claim that there is no reality beyond constructive description, and that nothing exists that is not a product of human representation (Muller, 2000:151). The world of phenomenology is not concerned with what things are, in and for themselves, but only in human intentions and human experiences of the world (Latour, 1999). For this reason, phenomenology can never tell us what the world is really like – it can only help us understand what the world is like for human consciousness (Latour, 1999). According to Bourdieu (1991, as cited in May, 1996), "most people are statistically bound to encounter circumstances that tend to agree with those that originally fashioned their habitus".

These ideas tell us something about the limits of auditing processes which emphasize the mobilizing of prior knowledge, story-line approaches, photographs and field observations, in contrast to baseline measures-based approaches. The constructivist perspective foregrounds the perspective of the individual and the personal meanings s/he has made of the world (R. O'Donoghue, personal communication, April 17, 2005).

Realists, on the other hand, claim that scientific concepts and enquiry processes can show us the real world as it is (e.g. Latour, 1999; Archer, 2002). American pragmatists might dismiss this claim, however, and argue that scientific knowledge is merely one of many available forms of knowledge. The implication of this view is that science takes its place as a human activity of equal epistemological status to all other human activities. Scientific knowledge is merely one kind of knowledge among all other kinds of knowledge that are all worthy in their own way. "Science is in this gesture 'dethroned' as a producer of privileged statements about the world" (Muller, 2000:151).

"In a relativistic world where the beliefs of the scientific community may come into conflict with the beliefs of alternative social groups … a power struggle for the authority on which claims for the rightness of action are based might be inevitable" (Ashley, 2000:272). A consequence of this is that teachers tend to foreground individual constructs of reality and knowledge and environmental education is "subverted by constructs about propositions [about reality] and humans engage in processes of personalising self validating…" (R. O'Donoghue, personal communication, April 14, 2005).

Muller (2000) proposes that to avoid these dilemmas, the constructivist position should be tempered with a moderate social realism in order to acknowledge the possibility of epistemic and cognitive gain.

2.9 Critical realism and the tools of science

2.9.1 Relative certainties

> *… why burden this solitary mind with the impossible task of finding absolute certainty instead of plugging into the connections that would provide it with all the relative certainties it needed to know and act?*

> *(Latour, 1999, as quoted in Gough & Price, 2004:30)*

The realist view, according to Marsonet (1995:61), recognizes that while science can gives us insights into a reality outside of human experience and representation, it is incapable of giving us the true and perfect picture of reality.

As Nicholas Rescher puts it:

> Our scientific conceptions aim at what exists in the world but only hit it imperfectly and "well off the mark." The fit between our scientific ideas and reality itself is loose and well short of accurate representation. But there indeed is some sort of rough consonance … The realism it espouses is one of intent rather than achievement – a realism that views science not as actually *describing* reality but as merely *estimating* its character.

> (Nicholas Rescher, as quoted by Marsonet, 1995:70)

Hannigan (1995) recommends that when scientific evidence is uncertain or ambiguous, it should be bolstered by moral arguments to help us to make judgments

about risks. This view accords well with Beck's (1992) suggestion that risks can only be understood if research is a combination of Natural Science and Social Science, everyday and expert rationality, interest and fact.

According to Latour (1999:4), science offers us a way of being *relatively* sure of many things with which we are engaged in our daily lives, through the mediation of the tools of science and the practice of our science laboratories. His views resonate well with those of Haack:

> … what is special about science is not that it has a unique method for getting at the truth, but that it has done rather well, by and large, at meeting the criteria – experiential anchoring and explanatory integration – by which we appraise the well-foundedness of any empirical beliefs. Science, in my view, is not *privileged* epistemically; it is only rather *distinguished* from an epistemic point of view.

> (Haack, 1992:10, as cited in Muller, 2000:152)

One of the implications of a critical realist approach to auditing is that audits should draw on scientific practices that are capable of giving us insights into a reality outside of human experience. As explained in the next section, many of these practices involve a detour via detachment.

2.9.2 Learning from a detour via detachment

According to Elias (1987), science involves a detour via detachment. He claims that detour behaviour has played a significant role in the growth of human knowledge. "Not all detour behaviour amounts to what we have come to call 'science', but all scientific knowledge involves an element of detour behaviour" (Mennell, 1992:164).

> If it proves possible for people to observe the relations of elements in the process with a measure of detachment, relatively unimpeded by emotional fantasies and in a realistic manner, they may be able to form a symbolic representation – a 'theory', a 'model' – of their situation and, by means of actions based on that representation, change the situation.

> (Mennell, 1992:164)

Latour (1999) uses an example of a soil study to explain how science allows us to make meaning of the world, through the mediation of scientific instruments and practices that allow us to reach for greater reality-congruence. In his example, researchers collect soil samples from a forest. The samples provide information that

the researchers use to draw a soil profile onto a piece of paper. In this process, information from a variety of sources, and collected at different times, is captured into one diagram, using graphical 'language'. The diagram makes it possible for the scientists to see features that were impossible to see in the real forest. It allows the researchers to label and annotate their representations of the world, which cannot easily be done in the 'real' world.

As Latour (1999) explains:

> … thanks to inscriptions, we are able to oversee and control a situation in which we are submerged, we becomes superior to that which is greater than us, and we are able to gather synoptically all the actions that occurred over the many days and that we have since forgotten.

(Latour, 1999:65)

He says, "The sciences do not speak of the world but, rather, construct representations that seem always to push it away, but also to bring it closer" (Latour, 1999:30). When we capture evidence from the real world and move out of the situation from which the evidence was gathered, we are able to (1) examine the evidence in comfort and at our leisure (2) compare it with similar evidence gathered at a different time or from a different place and (3) control, sort and rearrange the evidence to look for patterns. This would be more difficult or impossible to do in the confusion of the real world. In this way, we gain knowledge about the world by becoming detached from the world.

The ideas discussed in this section highlight the value of auditing processes that involve baseline measures-based approaches, data gathering and graphing, which are the some of the key strengths of auditing (R. O'Donoghue, personal communication, April 17, 2005). These ideas may be able to help us to understand how learners can make meaning of the world, through auditing processes that reach for greater reality-congruence, through the mediation of tools and practices involving the gathering of data and the construction of representations, to provide learners with the relative certainties they need to know and to act.

2.10 Conclusion

In this chapter, I have clarified the context of the study, reviewed a range of relevant literature and drawn on theory to provide vantage points from which to examine

auditing processes in the *Schools and Sustainability* course. This has prepared the way for a discussion, in the next chapter, of the research design decisions I made in this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research design decisions I made to achieve the aims and goals of this study (see section 1.5). It attempts to clarify my methodological perspectives, describes and justifies my research methods and explains how these choices relate to the research question and context presented in Chapter Two. It also describes how I identified categories, how I analyzed the data, and how I dealt with issues of validity, trustworthiness, and research ethics.

Research design decisions in this study were based on my research question and what I hoped to achieve. They were influenced by my views about research, reality and knowledge. I needed a research design that would allow me to observe teachers' and learners' learning processes and actions while undertaking environmental audits in their natural setting. It had to allow me to gather information on contextual factors influencing those learning processes and actions. I needed to be able to elicit teachers' and learners' perspectives on the learning processes and actions taking place during audits. I needed a research design that would not impose on the teachers' time too much and that would fit in it well with the flow of activities of the professional development course in which they were engaged.

I therefore chose to design this study as an interpretive case study of the choreography and use of environmental audits by teachers participating in the *Schools and Sustainability* course. These choices are discussed further in the sections that follow.

3.2 Research orientation

3.2.1 Interpretivist research

From an interpretive perspective, human action is seen as an outcome of external influences and all human actions have reasons (Connole, 1998). As Connole (1998) explains, human actions take place within a structure of social rules within which they have meaning. These actions often have intentions and may be accompanied by reflection. Meanings are generated, negotiated and shared through language and other forms of symbolism. The task of the interpretive researcher is to understand these processes and the context within which they take place (Connole, 1998).

Interpretive approaches to research have particular assumptions about reality and knowledge, including the following:

• People can only understand the world as it appears to them and cannot know with absolute certainty how it 'really' is (Berger & Luckmann, 1966; Bassey, 1999; Janse van Rensburg, 2001);

• There are different ways of understanding what is real, and researchers therefore require multiple methods for understanding them (Connole, 1998; Bassey, 1999);

• Human meanings and knowledge generated through research are constructed by individuals and groups in interaction with each other and through language (Bassey, 1999; Janse van Rensburg, 2001).

Given these assumptions, the purpose of interpretive research is to advance knowledge by describing and interpreting the meanings which people make of the world. It also seeks to understand the context within which those meanings are generated (Connole, 1998; Bassey, 1999; Janse van Rensburg, 2001). The interpretive approach to research allows the researcher to work closely with the people s/he is studying and to try to understand people's subjective experiences (Cohen, Manion & Morrison, 2000:22). This kind of research requires "rich, detailed information of a qualitative nature" (Janse van Rensburg, 2001), which may be obtained through methods such as "in-depth interviews, observations or interpretation of documents" (Janse van Rensburg, 2001).

One of the limitations of this kind of research is its potential to promote a relativist view, in which all subjective experiences are accorded the same degree of validity (Muller, 2000; Janse van Rensburg, 2001). Interpretive researchers frequently assume that the best data about the world can be obtained through the self-report of the people being researched (Muller, 2000). In radical forms of constructivism, researchers may even treat these accounts as the only reality worth examining (Muller, 2000). This approach also implies that the people 'being researched' are able to articulate a sociologically-meaningful account of their own situation and actions. But Muller (2000) rejects the assumption that research informants have privileged insight into the way they construct their world. His proposal, that constructivism should be tempered with a dose of realism, seems to agree with May's (1996) recommendation, that while research should accord validity to people's interpretations of the world, it should not necessarily take those accounts at face value.

My stance as a researcher is therefore not that of a radical constructivist. I heeded Muller's (2000) advice and tempered the assumptions of constructivism with a dose of realism. Considering the study from this perspective allowed me to recognize that some kinds of research can tell us more about the world than others and that some claims to knowledge may be less valid than others (Muller, 2000). I recognized that basing my research assertions exclusively on data drawn from the teachers' interpretations of the world would be problematic. Therefore, I did not rely solely on the teachers' perspectives, but also generated data using other methods, wherever possible. In addition to interviews, I also used field observations and photographs, document analysis, and group interviews with learners. Maxwell (1992:290) advises that in order to construct valid accounts or explanations of a social situation, researchers need to respect the perspectives of the actors in that situation. He cautions, however, that those accounts need not be centered on those perspectives. Adopting a moderate realist stance has allowed me to move beyond relativism, without having to make claims about the absolute certainty and truth of my research assertions (Muller, 2000).

My task, in this study, has been to develop a deeper understanding of how teachers are adapting and using environmental audits as a strategy for lesson planning. I have also sought to understand how audits are shaping meaning-making interactions and environmental learning processes in their contexts. This has led me to focus my attention on understanding teachers' and learners' subjective experiences of reality,

as well as the contextual and social factors which influence meaning making and learning. As explained in Chapter One, there is also a "practical knowledge interest" (Habermas, as cited in Janse van Rensburg, 2001) inherent in this study. This research may be useful to inform the future development and use of environmental audits for environmental education processes, and may inform the future development and implementation of resource-based professional development courses for teachers.

The perspectives outlined above have influenced the way in which I selected informants, the techniques I used to generate data and my interpretations of it. They have also influenced my relationship with the informants, and my assumptions about the generalizability of the study.

3.2.2 Case study research

Bassey (1999:47) defines a case study as the "study of a singularity conducted in depth in natural settings". In his view, key features of the case study are (1) that it must be conducted mainly within its natural context and (2) that sufficient data must be collected for the researcher to be able to understand significant features of the case, and propose interpretations for what has been observed. I chose the case study approach so that I would be able to learn about the undertaking of environmental audits within their real-life context. This became important, because my initial survey of data from teachers' lesson plans was deficient in contextual information and could not provide the depth of insight I needed. I quickly realised that the processes taking place in the audit were more important than the products of the audit. I needed to generate richer evidence of those processes and their context.

I chose the case study approach because it would be able to provide me with data about significant features of an audit-based approach to lesson planning, such as: the teachers' intentions and expectations for the lesson; teacher knowledge; teaching and learning interactions; language and meaning making; and how materials were being used. In order to probe how teachers in the case study were adapting and using environmental audits, I needed to generate "thick descriptions" of the reality of teachers' practice. According to Geertz (1974, as cited in Maxwell, 1992:288), thick description "is *meaningful* description – that is, the description embedded in the cultural framework of the actors; the term does not refer to the richness or detail of

the account". Thick descriptions are generated by drawing on the participants' own meanings, largely from the words they have themselves used. Nevertheless, accounts of participants' meanings are ultimately constructed by the researcher, based on participants' own accounts as well as other evidence (Maxwell, 1992).

The case study approach provides an appropriate method with which to generate such data, since "case studies strive to portray 'what it is like' to be in a particular situation, to catch the close-up reality and 'thick description' (Cohen *et al.*, 2000, citing Geertz, 1973) of participants' lived experience of, thoughts about and feelings for a situation" (Cohen *et al.*, 2000:182). This became important as I probed the questions embedded within my second research goal, which was to explore ways in which the use of audits shapes meaning-making interactions and environmental learning processes.

This case study can be categorized, loosely, as a theoretical case study (Bassey, 1999). Initially, my research questions were framed in evaluative terms, reflecting my interest in evaluating the use of audits in environmental education. Later, I became more interested in understanding how teachers can use different kinds of auditing processes to help learners make meaning of the world and to strengthen environmental learning within their contexts. There are, however, elements of evaluation in the research, given my role as a tutor and assessor on the course in which the teachers were participating. Because data from case studies are "strong in reality" (Cohen *et al.*, 2000:184), the insights gained through this case study of auditing in the *Schools and Sustainability* course may be useful to inform my own practice and that of others. As Bassey (1999:51) puts it "the role of educational research is to inform professional discourse, and to be informed by it. Research should contribute to the maelstrom of ideas, theories, facts and judgements about education".

Generalizability of the study

According to Maxwell (1992:293), "qualitative studies are usually not designed to allow systematic generalization to some wider population". However, the theories which emerge from such studies may be useful in helping others to make sense of similar situations. In keeping with this, I do not intend to make explicit claims about the external generalizability of my accounts. Nevertheless, I do hope that this study will help other environmental educators and researchers to develop their own

understandings of how the undertaking of environmental audits can shape learning processes in similar or different contexts.

Selection of research informants

In 2005, three clusters of teachers from Durban participated in the *Schools and Sustainability* course. Teachers attended workshops to work through course materials, and then returned to their schools to complete work-place based tasks. One of the tasks in their first assignment included adapting and using an environmental audit with their learners. All of the teachers undertook an audit for their first assignment, and several of the teachers undertook a second audit, voluntarily, for their second or third assignment. After completing their school-based assignments for the course, teachers attended a reporting workshop at which they reported and reflected on the work they had done.

The proposed research timeline was intended to be fully integrated with the implementation plan of the *Schools and Sustainability* course. My intention was to use the opportunities presented by the course to interact with teachers in useful ways for this research. In practice, however, it did not work out precisely as planned. Although the research timeline correlated well with the timing of workshops and assignments for the first two clusters of teachers, the third cluster started the course later than anticipated. By this time the fieldwork for this study was already underway. Twelve of the fifteen teachers in the first two clusters agreed to participate in this research. Although I have not used any data from the work of the third cluster of teachers, they are part of the same case. I have been able to informally test the emerging ideas about audits by comparing them with these teachers' lesson plans and portfolios. Also, as the lead tutor on the course, I had intended to visit all of the teachers at their schools at least twice during the year to support them as they worked on their assignments. For reasons outlined in section 3.3.5.1, I was able to visit only two of the teachers. These two teachers, Ayanda Ngwenya and Ntsiki Ndzingwa, became the focus of more in-depth individual case stories, as explained in section 3.3.5. The names of the teachers who contributed directly to this research can be found in Appendix 3, along with the names of their schools and the grades they teach.

Because case studies are usually carried out over an extended period of time, they allow the researcher to get to know the people s/he is studying quite well (Maxwell, 1992). I worked with the two clusters of teachers on the course from 18 February

2005 to 9 September 2005. We worked together, intensively, at nine separate workshops during the period of the research – a total of three full days and six half days per cluster. In addition, I spent two half days visiting Ayanda and Ntsiki at their schools to observe their auditing lessons, conduct interviews and do group interviews with their learners.

How I gained access and consent to do the research

After negotiating access with the teachers at our first workshop of the course, I obtained permission from the Kwazulu-Natal Department of Education to conduct the research. I also obtained written consent from the Principals to visit their schools during school hours. I was very careful to explain that the school visits would not affect my assessment of the teachers' competence on the course, and that the visits were necessary for research purposes only. This was important, because some teachers seemed nervous at first about having me there to observe their lessons.

My relationship with the research informants

As I have indicated, this research was not the main focus of my relationship with the teachers. My relationship with the teachers was also that of a tutor working with participants on a professional development course. At first, I was concerned that this relationship might play out as a hierarchical one in which teachers regarded me primarily as an expert and as their assessor. Despite these concerns, it seemed to me that a relationship of trust developed between us during the seven months of the course. I explained that our mutual participation in the course and in the research was as much a learning experience for me as it was for them, and in this sense, we developed a reciprocal relationship.

In the first module of the *Schools and Sustainability* course, teachers do an assignment in which they are expected to undertake an audit within a lesson. At first I was concerned that if I observed lessons undertaken as part of the Module One assignment that teachers might feel anxious about being observed by the same person who would assess their assignment. Coincidentally, however, all three of the audits that I drew on for the development of the case stories were undertaken as part of the assignments for Modules Two and Three. Hence, the teachers' use of audits in those lessons was voluntary.

As the course proceeded, teachers seemed to become more confident about sharing their experiences, successes and challenges with me. The conversations we had at

workshops and during school visits focused on more than just information about their auditing lessons. This helped me to gain a more accurate sense of the reality of the teachers' practice. Also, as their tutor, I had to engage with samples of teachers' work that were not directly relevant to this research. This, too, helped me to construct a broader picture of their context and practice.

The teachers' participation in the research seemed to have been of benefit to them, too. Learning processes on the *Schools and Sustainability* course emphasize the development of teachers' abilities to interrogate their context, and to reflect critically on their own practice. Teachers were supported throughout the course to improve their competence in these skills and as the year progressed they became more skilled at articulating educationally meaningful accounts of their own practice. In this sense, the teachers' participation in the research provided additional opportunities for them to practise these skills.

3.3 Research techniques and data analysis

As indicated in section 3.2.1, interpretive research is concerned with what the described objects, events and behaviours mean to people, not only on the basis of the researcher's perspective and categories, but also on those of the participants (Maxwell, 1992). For this reason, I designed research instruments that would be able to provide me with data about the participants' perspectives on auditing, such as the teacher's intentions, feelings, evaluations and learners' cognition. According to Maxwell (1992), this aspect of understanding is central to interpretive research. The methods I used to generate thick descriptions were: document analysis of teachers' portfolios, research journaling, field observations and photographs, semi-structured interviews, and group interviews.

Analysis of the data was undertaken in two phases. In the first phase, I differentiated the twenty-seven audits in this case study into three broad categories, based on the auditing methodologies that had been used. In the second phase, I developed an in-depth case story for each of the three auditing methodologies. This enabled me to probe, in more depth, how audits were shaping meaning-making interactions and giving rise to environmental learning processes in this case study.

3.3.1 Analysis of teachers' portfolios

While they worked through the three Learning Units of the *Schools and Sustainability* course, teachers produced portfolios of evidence of the work they had done. These portfolios included their lesson plans, copies of resources used, examples of learners' work and reflections on their lessons. As their tutor, I collected and assessed their portfolios after each Learning Unit. This provided me with opportunities to study their lesson plans, resources, learners' work and reflections, and to collect evidence to answer my research questions. This evidence was particularly useful in making progress towards achieving the first goal of the study. It gave me information about the focus of the audits, auditing processes, materials used in the audit and findings of the audit.

As I assessed teachers' portfolios, I summarized what I read in their lesson plans, activities and reflections. These summaries provided a rich source of data for phase one of data analysis (section 3.3.4).This technique helped me to decide what additional information I would need to obtain through the other research methods.

3.3.2 Keeping a research journal

I intended maintaining a research journal to record information from observations and interactions with the teachers during workshops, reporting sessions, telephonic communications, school visits, observations and portfolio assessments throughout the course. I did not use this technique as extensively as planned, however, probably because my role as a tutor tended to dominate over my role as a researcher during workshops. At reporting workshops, I took notes while teachers reported, which helped me to understand their contexts better and some of the challenges they faced. It also helped me to gauge their levels of understanding of the course content. These notes provided me with a way of checking the information I had gathered from their portfolios. These journal entries were most useful in providing information for the second goal of the study. They consisted largely of teachers' impromptu comments about the value of the auditing processes and how learners responded to them.

3.3.3 The general comparative method

The general comparative method is a strategic method of generating theory from data in a purposeful way. That theory can then be used to explain the data, and has been termed "grounded theory" (Glaser & Strauss, 1967). According to Coffey and Atkinson:

> … there is now a widespread view that theory building and theory testing are developed primarily out of the categorization of data through coding procedures, and the construction of systematic, hierarchical relationships among the categories …

> (Coffey & Atkinson, 1996:142, cited by Hodgkinson, 2004)

3.3.4 Phase one of data analysis

After examining my research question and goals carefully, I decided to code the data from teachers' portfolios using the codes outlined in Table 1. By the end of this phase of analysis, I had access to twenty-seven audits from twelve teachers' portfolios. I chose not to code the original portfolios, as this would have generated a very large amount of paperwork. Instead, I coded the summaries I had made (section 3.3.1) of teachers' portfolios using coloured stickers. To check whether the summary of a portfolio would yield the same data as the original portfolio, I coded Ntsiki's original lesson plan too, treating it as a 'control' or method check. I found that there were very few incidents which were sourced from Ntsiki's original portfolio which I was unable to find in the summary of her portfolio. I am therefore satisfied that the decision to code the summaries was probably an adequate strategy for managing the data without compromising its quality.

Table 1 showing categories and codes used in phase one of data analysis.

Category	Code
Ways in which audits are used by teachers and learners (e.g. auditing methodology; adoption of learning support materials)	BLUE
Ways in which auditing LTSM are adapted by teachers (e.g. adaptation of learning and teaching support materials)	YELLOW
Ways in which audits shape meaning-making interactions (e.g. what learners make of the audit and of the issue being investigated) and give rise to environmental learning processes (e.g. active learning processes, learning outcomes and environmental action)	RED

3.3.4.1 Outcomes of phase one of data analysis

The codes used in phase one of the data analysis allowed me to differentiate the twenty-seven audits in the case study into three broad categories, according to the auditing methodology that was used. The use of the term 'auditing methodology' throughout this study refers to:

- The environmental focus of the audit;
- The auditing methods and instruments which were used;
- The kinds of data that were collected or generated;
- The auditing sites that were used.

I chose to refer to these three broad methodologies as (1) an "impression-based" methodology (2) an "evidence-generating" methodology and (3) an "actualizing" methodology. This unexpected and useful outcome of phase one helped me to refine my strategy for further data generation and analysis.

The findings of this phase of analysis are presented in section 4.2.1 for impression-based audits, section 4.2.2 for evidence-generating audits, and section 4.2.3 for actualizing audits.

3.3.4.2 Strategy for further data generation and analysis

To achieve my first research goal, I decided to use evidence from the twenty-seven audits in the teachers' portfolios to develop an overview of how audits were being used for lessons in the case study. My analysis of the twelve teachers' portfolios and journal entries would provide data for this overview.

Now that I was able to differentiate three kinds of auditing methodologies in the case study, I decided to develop an in-depth case story for each of the three methodologies. Methods used to generate data for the case stories would involve observations of auditing lessons, an interview with each teacher before and/or after the auditing lesson, and a group interview with a small group of learners after the lesson. During each lesson, I would take photographs and record some of the verbal interactions with a tape recorder. I would record the interview with each teacher and the group interview with the learners. The evidence gathered in this way would be analyzed with the aim of probing, in more depth, how audits were shaping meaning-making interactions and giving rise to environmental learning processes in the case study. In addition, once I had identified the dominant methodology in each of the

twenty-seven audits in my overview, I would be able to draw evidence from this larger pool of data to strengthen my analysis of each case story. This would enable me to achieve the second research goal.

A preliminary analysis of the data suggested that each auditing methodology could be characterized by (1) particular ways of undertaking audits (2) particular kinds of teaching and learning interactions and experiences and (3) particular kinds of audit findings and meaning-making processes. These early insights would be probed further in phase two of the analysis (section 3.3.6).

3.3.5 Construction of case stories

3.3.5.1 Selection of teachers for the case stories

My selection of teachers for the case stories was influenced mainly by logistical factors. Considering how busy the teachers' schedules were, it was difficult to find a mutually convenient time in which to observe a lesson and conduct interviews without causing too much disruption to the school timetable. My own work pressures meant that I was often unavailable on the days when teachers planned to undertake environmental audits, and I was reluctant to ask teachers to change their week plans for the sake of this research. Also, inaccessibility and a lack of security posed a risk at some schools. I was advised by teachers at a particular school not to visit them during the fieldwork period of this research because of recent hijackings in their area.

Fortunately, both Ayanda and Ntsiki indicated that their time was more flexible than most, and that they would be able to accommodate me in their programmes. I was therefore able to travel to their schools to observe their auditing lessons and conduct the interviews. Ayanda Ngwenya is an Intermediate Phase (grade seven) teacher from a township school in Umlazi. He conducted a waste audit in an Economic and Management Sciences lesson. My analysis of the data from his case story differentiated his waste audit as an "evidence-generating audit". Ntsiki Ndzingwa is a Foundation Phase teacher (grade three) from a rural school in Molweni. She undertook a sanitation audit in a Life Skills lesson. My analysis of the data from her case story differentiated her sanitation audit as an "actualizing audit".

3.3.5.2 Field observations and photographs

My observations of auditing lessons during my visits to Ayanda and Ntsiki's schools were "semi-structured" (Cohen *et al.*, 2000). In other words, the observations were guided by, but not limited to, an observation checklist that I prepared before undertaking the field observations. I knew that I would need information on issues such as the physical features of the classroom, characteristics of the group of children being observed, interactions taking place between the teacher and learners and among learners, activities and auditing processes, the teaching style, and resources used. However, my observations were not pre-determined nor done in a strictly systematic way. This was an appropriate strategy, because the purpose of gathering observational data in this study was not to test hypotheses. Rather, the observations were intended to help me to generate hypotheses (Cohen *et al.*, 2000) about how the undertaking of environmental audits can shape environmental education processes in school contexts. This enabled me to be responsive to the situation within each case story. My role was that of an observer-as-participant (Cohen *et al.*, 2000). Refer to Appendix 4 to see the observation schedule I used to guide my observations.

3.3.5.3 Semi-structured interviews

The strength of interviews, as a research method, is that they allow informants to discuss their own interpretations of the world in which they live, and to explain their own perspectives (Cohen at al., 2000). I chose to make use of a less formal approach to interviewing, in which I would be free to modify the order of the questions, change the wording, ask follow-up questions to probe the informant's answer and add new questions as the need arose. This approach to interviewing has been categorized as "semi-structured" (Bogdan & Biklen, 1992, as cited in Cohen *et al.*, 2000) or as an "interview guide" approach (Patton, 1980, as cited in Cohen *et al.*, 2000). I wanted the informants to be able to answer the questions in their own way and in their own words. The advantages of this approach are that (1) data collection can be fairly systematic because the topics and issues to be covered are specified in advance, and (2) the interview remains conversational and situational. A disadvantage of this approach is that important questions can easily be omitted, inadvertently (Patton, 1980, as cited in Cohen *et al.*, 2000). I attempted to guard against this possibility by preparing an outline of key topics to be discussed and ticking them off as they arose during the interview. Refer to Appendix 5 to see the interview schedule I used to guide the interviews with the teachers and learners.

3.3.5.4 Group interviews

In one sense, the group interviews were the least successful of all of the research methods in the study, because the aim of these interviews was not satisfactorily achieved. I had intended to use group interviews to find out what the children had learnt through the auditing processes and what sense they had made of their findings. Cohen at al. (2000) outlined some of the difficulties in interviewing children. The primary challenge in this study was my inability to converse with the children in Zulu. Although Ntsiki and Lihle assisted me by interpreting, I did not succeed is establishing a good rapport with the learners and they did not seem comfortable enough to talk freely about their experiences. In both instances, there was little or no interaction among the learners and all interactions were limited to linear interactions between the interpreter, the learners and me. In Ntsiki's case story, her presence in the group interview seemed to have a strong influence on the learners' responses and she prompted them frequently. I have therefore used the data from her group interview with caution. It is also possible that the learners felt shy or intimidated in the presence of a stranger. On the other hand, the group interviews did provide me with some insights into how learners perceived water and waste issues at school. The interviews gave me a sense of how well learners had understood the auditing processes they had been involved in and the interviews a sense of what the children had *not* learnt during the lesson! Despite these challenges, there were a few instances in which the group interviews provided me with insights that would probably not have come to light without them.

3.3.5.5 Ntsiki's case story

I visited Ntsiki Ndzingwa on 11 May 2005 at her school in Molweni, outside of Durban, to observe a lesson on sanitation. This lesson was conducted as part of her Learning Unit Two assignment, and her use of an audit as a strategy for lesson planning was voluntary. Before she began her lesson I interviewed her to find out what her intentions for the lesson were, what the focus of her audit would be, what materials she planned to use, and what results she expected to get from the audit. The interview took approximately ten minutes.

I sat in her classroom and observed while she conducted the lesson. I used a digital camera to capture pictures of key aspects of the lesson and made field notes to record my observations. I used an observation schedule as a guide, throughout the lesson, to direct my attention towards key contextual factors, teaching and learning

processes, and interactions between teachers and learners, and among learners. Although the lesson was presented entirely in Zulu, I was able to follow most of the lesson, despite being unable to understand the exact words that were being used. Ntsiki assisted me by providing brief explanations in English whenever she could and I asked her detailed questions about the lesson in the interview afterwards.

After the lesson, I asked Ntsiki to select five learners for a group interview. Ntsiki sat with us throughout the interview and interpreted my questions into Zulu, and the learners' responses into English. The aim of the group interview was to find out what sense the learners had made of the auditing lesson, what results they were expecting and what they had learnt. The interview took approximately thirty minutes.

I then interviewed Ntsiki again, to find out what she thought of the auditing lesson and what results she had expected. I asked her what she thought had been learnt and gave her an opportunity to justify her choice of materials and activities. We talked about specific aspects of the lesson that I needed to have clarified. I also asked her a few questions about a previous audit that she had conducted, to check whether the information I had gathered from her portfolio had been accurate. This interview took approximately twenty-five minutes.

Later, at our next *Schools and Sustainability* workshop, Ntsiki submitted her completed portfolio which included her lesson plan, examples of learners' work and her reflections on the lesson I had observed. Ntsiki's case story (Case Story Three) is presented in section 4.3.5.

3.3.5.6 Ayanda's case story

I visited Ayanda Ngwenya on 1 August 2005 at his school in Umlazi, Durban, to observe a lesson on waste. This lesson was conducted as part of his Learning Unit Two assignment, and his use of an audit as a strategy for lesson planning was voluntary. I sat in his classroom and observed while he conducted the lesson.

I used a digital camera to capture pictures of key aspects of the lesson and made field notes to record my observations. I used a tape recorder to capture some of the verbal interactions between the teacher and his learners and among learners. I used an observation schedule as a guide, throughout the lesson, to direct my attention towards key contextual factors, teaching and learning processes, and interactions

between teachers and learners, and among learners. The one-and-a-half hour lesson was presented partly in Zulu and partly in English.

At the end of the lesson, Lihle Nxumalo, one of the co-tutors on the course, presented a lesson on water to the class, while I interviewed Ayanda in the staff room. During this lesson, Lihle presented a talk and video focusing on water and saving water. She showed the learners how to measure water consumption in the home, how to detect leaks and how to save water.

The purpose of my interview with Ayanda was to find out what he thought of the lesson and what he thought had been learnt during the lesson. It gave him an opportunity to justify why he had chosen this particular topic as the focus of his audit, his choice of materials, to explain how he had adapted the lesson, and what his expectations had been. We also talked about the findings of the audit and how the audit related to previous and future lessons. The interview took approximately thirty minutes.

After the interview, I asked Ayanda to select six learners for a group interview. As Ayanda had to return to his class, Lihle sat with us and assisted with interpretation when required. The purpose of the group interview was to find out what sense the learners had made of the lesson and what they had learnt. We talked about the issue of waste in their school, how they felt about it and how they thought it should be dealt with.

Later, at our next *Schools and Sustainability* workshop, Ayanda submitted his completed portfolio which included his lesson plan, examples of learners' work and his reflections on the lesson I had observed. Ayanda's case story (Case Story Two) is presented in section 4.3.3.

3.3.5.7 Kay's case story

While I was analysing the data from the first two case stories, I realized that I still needed data for a case story of an "impression-based audit". I also needed stronger data on what had been learnt during the auditing lessons. I realized that evidence of learning could be found in the examples of learners' work included in teachers' portfolios, and in a teacher's detailed reflections on the lesson. I purposively scanned all twelve of the teachers' original portfolios again to find one that could provide

examples of learners' work and good quality teacher's reflections. I selected Kay Sagadavan's Learning Unit Two portfolio in which she documented a series of lessons and an audit focusing on sanitation. Kay is a grade five Life Orientation teacher from Dr Macken Mistry Primary School in Durban. The sanitation audits she undertook with her learners contained characteristics of "impression-based" audits. Although I was unable to visit her school to observe a lesson and conduct interviews, her portfolio and reflections were sufficiently rich in detail to enable me to construct a case story of her "impression-based" sanitation audit. Kay's case story (Case Story One) is presented in section 4.3.1.

3.3.6 Phase two of data analysis

3.3.6.1 Codes and categories

In phase two of the data analysis, I analyzed the evidence from the three case stories with the aim of probing, in more depth, how audits were shaping meaning-making interactions and giving rise to environmental learning processes in the case study.

To add rigour to my analysis of the three methodological approaches to auditing, I drew evidence from all twenty-seven of the audits at my disposal. For example, the portfolio submitted by Ayanda did not include many examples of learners' work or sufficiently detailed teacher's reflections. When I realized that I lacked adequate evidence of learners' developing problem definitions and accounts of the issue, I decided to strengthen the data with evidence from the larger pool of portfolios. Mbatho's portfolio provided a rich source of data on how learners' perspectives on sanitation emerged and broadened through the "evidence-generating" audit she undertook as part of a Geography lesson.

I initiated phase two of the data analysis, by colour-coding the data generated through the field observations, semi-structured interviews, group interviews and research journal entries using a refined set of codes (Table 2). I chose to use the photographs as a memory aid rather than as a source of data.

Table 2 showing refined categories and codes used in phase two of data analysis.

Category	Code
Environmental focus: • issues and risks in school context identified by the teacher • focus of audits • how decisions are made about the environmental focus of the audit • findings of the audit (include a record of inaccurate data, absence of findings, weak interpretations etc here)	• RED • BLUE • BLUE • BLUE OR RED
Use of materials: • how materials are used in audits • selection of materials for auditing, adaptation or adoption of materials	• GREEN • GREEN
Teaching and learning interactions and meaning making: • how the audits are conducted • teacher knowledge (include lack of knowledge, inaccurate knowledge etc here) • teaching and learning interactions [T-L, T-L-L, T-E-L, E-T, T-E) (L-T, L-L, L-L-T, L-E, E-L, E-L-T, E-L-L) • active learning processes (learners) • language and meaning making (learners)	• PURPLE • PURPLE • PURPLE • YELLOW • YELLOW
Evidence of learning: • teacher intentions and intended learning outcomes • actual outcomes • environmental learning	• GOLD • GOLD • GOLD

3.3.6.2 Development of analytic memoranda

I generated analytical memoranda by examining the coded data closely, in repeated readings, until I was able to identify similar instances that could be grouped together in coherent categories. Each category I generated came to represent a "theoretical abstraction" (Glaser & Strauss, 1967), which seemed to have something to say about what was occurring in the auditing lessons. Some categories contained several sub-categories. I kept my research question in the forefront of my mind, to ensure that the categories I was generating would be able to help me answer the research question (see Appendix 6 for analytic memoranda). In this way, categories and sub-categories were rearranged and refined in a creative process that lasted several weeks.

I then looked at each category to see if I could detect any specific conditions under which that category existed. This involved a process of "constant comparison" (Glaser & Strauss, 1967), which required an intimate and thorough knowledge of the

data. To achieve this, I compared all the data within each auditing lesson and also compared data across different auditing lessons. The insights gained from this process of constant comparison were used in two ways: (1) to further refine the analytic memoranda and (2) to inform the construction of reflective comments, which I would later draw on to interpret and explain the findings.[4]

3.3.6.3 Outcomes of phase two of data analysis

Auditing choreography

The system of codes and analytic memoranda that emerged in phase two of the data analysis allowed me to describe the choreography of the audits in the case stories and supplementary portfolios using a set of descriptors (see Appendix 7 for the complete list of descriptors). The use of the term 'auditing choreography' throughout this study refers to:

- Intended learning outcomes and moral lessons;
- How the audit was contextualized;
- How LTSM were used in the audit;
- Processes of teacher and learner participation;
- Teachers' and learners' roles and learning interactions;
- How learners were supported to acquire the language of the lesson.

The findings of this phase of analysis are presented in sections 4.3.2.1 to 4.3.2.4 for the impression-based audits, sections 4.3.4.1 to 4.3.4.4 for the evidence-generating audits, and sections 4.3.6.1 to 4.3.6.4 for the actualizing audits.

Knowledge construction and meaning making

I was also able to draw on the coded evidence to describe the teachers' and learners' attempts at knowledge construction and meaning making in the various auditing lessons. I described knowledge construction and meaning making in the auditing lessons using the following set of descriptors (see Appendix 7 for the full list of descriptors):

- Nature of the learners' experiences;
- Teachers' skills, knowledge and experience;
- Findings of the audit;
- Teachers' and learners' developing definitions of the problem;

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[4] Some of these reflective comments were of direct benefit to my practice as a tutor on the course and were fed back to teachers via my assessment reports on their portfolio work.

- Processes of involvement and detachment;
- Teachers' and learners' accounts of reality;
- Evidence of learning and meaning making.

The findings of this phase of analysis are presented in sections 4.3.2.5 to 4.3.2.8 for the impression-based audits, sections 4.3.4.5 to 4.3.4.8 for the evidence-generating audits, and sections 4.3.6.5 to 4.3.6.8 for the actualizing audits.

3.3.7 Development of analytic statements

Eventually, as the analytic memoranda evolved and stabilized, I began to detect thematic categories emerging from the data. I tentatively wrote up a series of analytic statements and sought to illustrate and test them with data from the analytic memoranda. Another cycle of constant comparison began as these analytic statements were refined. See Appendix 8 for the complete set of analytic statements that emerged from the data.

In order to establish the generality of an analytic statement, I looked for instances in the data where the statements were true and where they were not. I looked for similarities and differences within data sets and across data sets. I identified instances in which the statements seemed to be an accurate description and instances in which they were not accurate. This process of checking the generality of each analytic statement helped me to establish the applicability of the emerging "grounded theory" (Glaser & Strauss, 1967).

3.4 Validity and trustworthiness

Validity refers to the relationship between a researcher's account and the reality external to that account, regardless of whether that reality is considered an objective reality, or a human construction (Maxwell, 1992:283). Denzin and Lincoln (1994) remind us that the methods chosen should maximize internal and external validity, minimize the researcher's impact and support interpretations that are consistent with the informants' lived experiences.

It is important to acknowledge that this research is value-laden:

- As an educational researcher, I have particular ideas and theories about how people learn and about what constitutes good education practice.
- As a tutor on the *Schools and Sustainability* course, I have particular ideas and expectations about how assignments should be done, including how lessons should be planned.

3.4.1 Descriptive validity

According to Maxwell (1992), this category of validity concerns the actual accuracy of the researcher's accounts of the things that were heard or seen. It is not concerned with the meanings people make of their actions, but rather with how accurately the researcher has reported what happened.

According to Maxwell (1992), researchers can easily resolve threats to descriptive validity by collecting and checking appropriate data. I attempted to ensure the accuracy of the data in the following ways:

- I used a tape-recorder to capture the interviews and classroom speech and transcribed the recordings word for word. I double-checked the script while playing back the tapes.
- I made field notes and took photographs during the lessons and cross-checked these with the tape recordings.
- I also compared the field notes, photographs and tape recordings with the teacher's lesson plan, where possible, and with the portfolio produced as part of the professional development course.

I checked the accuracy and generality of the analytic statements by returning frequently to the original data to verify my interpretations. This gave me confidence that the data had probably not been inappropriately distorted during the complex process of analysis.

3.4.2 Interpretive validity

According to Maxwell (1992), this category of validity is concerned with what the described objects, events and behaviours mean to people. It is concerned, not only with the researcher's perspective and categories, but also with those of the participants, for example, teacher's intentions, learners' cognition, feelings, beliefs, and evaluations. "Interpretive validity is inherently a matter of inference from the words and actions of participants in the situations studied" (Maxwell, 1992:290). For this reason, I have chosen to quote the respondents' actual words wherever possible in Chapter Four, to report their meaning as faithfully as I can.

I recognize the limitations of a research design that hinges on the research participants' abilities to articulate their individual accounts of the world. This is particularly important considering that most of the teachers were Zulu-speaking, and that the course and the research were conducted largely in English. From an empirical perspective, I acknowledge that this could be regarded as a potential weakness of the study. It therefore became important to consider the extent to which my accounts and thick descriptions were "experience-near" (Geertz, 1974, as cited in Maxwell, 1992). In other words, I needed to ensure that the accounts I constructed were as accurate as possible and consistent with the teachers' own accounts of their experiences. I found that my accounts seemed to approach greater congruence with teachers' accounts of their experiences, when I (1) listened to their self-reports, which were self-structured verbal accounts, and asked them clarifying questions, which helped to generate shared meanings at reporting workshops (2) read their written portfolio work, which consisted of written accounts structured by questions in the workbook and (3) interviewed them, which provided verbal accounts that were semi-structured through the promptings.

In the analysis phase, I triangulated these data, wherever possible, with data generated from the field observations and photographs, group interviews with learners and from the research journal, to establish how accurate the teachers' accounts were. In other words, I collected and then checked the data using multiple sources of information and multiple modes of generating data (Denzin & Lincoln, 1994).

3.4.3 Theoretical validity

According to Maxwell (1992), theoretical validity is concerned with the theoretical constructions and explanations that the researcher brings to or develops during the study. Its purpose goes beyond simply describing the participants' perspectives.

It concerns (1) the categories that were generated from the data, that is, construct validity and (2) the relationships that are postulated to exist between those categories, that is, internal or causal validity.

Maxwell (1992) explains that threats to theoretical validity may remain, even if the facts are shown to be accurate. I attempted to deal with this by drawing on a large number of teachers' portfolios to construct the analytic categories. I then wrote up the three case stories and analyzed them in terms of the relationships between these categories. I then checked the validity of those relationships by triangulating the findings within the case stories with instances from the larger set of portfolios.

As mentioned above, I was aware, throughout the research, that my personal interests and my role as a tutor in the *Schools and Sustainability* course might influence my interpretation of the data. Following the advice of Denzin and Lincoln (1994), I sought to avoid bias by searching for contrasting findings, outliers and extreme instances. I attempted to replicate key findings, examined rival explanations and also looked for negative evidence.

3.5 Ethical considerations

The kind of data I generated was non-controversial. Teachers and children were aware of my presence during observations and I made it clear what I was there to achieve. Photographs of teachers and children depicted typical, non-controversial, daily classroom scenes. I obtained permission from the school principals, teachers and the Kwazulu-Natal Department of Education to conduct research in the schools. I chose to inform the teachers of my intentions and to obtain their permission before involving them in the research.

I did encounter an ethical dilemma while observing Ntsiki's lesson, when she began to set up a sanitation experiment incorrectly. Although observers often strive to be neutral and non-interventionalist (Cohen *et al*., 2000), I decided to quietly assist her, with as little disruption to the flow of the lesson as possible. If I had not intervened, the experiment would have been done incorrectly and the results of the audit would have been invalid. My intervention was appropriate, as Ntsiki and I had a relationship within the professional development course, in which I was expected to support her use of educational resources. As an observer, I was more interested in the fact that the intervention was necessary, than I was in observing the consequences of Ntsiki's error for the lesson.

3.6 Concluding summary

In this chapter I have discussed the research design decisions I made to achieve the aims and objectives of the study. I have sought to clarify my methodological perspectives, and described and justified my research methods. Some of these decisions were made prior to the generation of data, and others were informed by the analysis of data generated in the initial stages of the research. This is clarified further, in Chapter Four, which presents the findings of the research.

CHAPTER 4: FINDINGS OF THE STUDY

4.1 Introduction to the chapter

In this chapter, I present the data I generated through the research methods described in Chapter Three. As explained in Chapter Two, the aim of this research is to understand how the undertaking of environmental audits can shape environmental education processes in school contexts. In seeking to answer this question, this chapter presents a review of ways in which audits in the study were choreographed and used by teachers for lessons within school contexts. It also presents my reading of the meaning-making interactions and environmental learning processes that took place.

As explained in section 3.3.4.1, the first phase of data analysis suggested that the audits undertaken by teachers in this case study could be differentiated into three broad types. These three auditing types had particular characteristics, outlined in sections 4.2.1, 4.2.2 and 4.2.3. Because of those characteristics, they tended to lead to particular kinds of teaching and learning interactions and encounters with the environment. All of these interacting processes seemed to influence the findings of the audit, the ways in which learners constructed knowledge through the audit and the reality-congruence of their accounts. As explained in section 3.3.5, these phenomena were analyzed further in the second phase of data analysis, when I developed an in-depth case story for each of the three auditing methodologies.

Section 4.3 presents three case stories that illustrate and provide thick descriptions of the three approaches to auditing. It probes the relationships, in each of these case stories, between auditing approach, teaching and learning interactions, the kinds of encounters learners had with the environment, and the ways in which knowledge was constructed through the audit. It also probes the relationships, in each of these case stories, between auditing approach, the findings of the audit and the reality-congruence of the accounts that were constructed.

4.2 Findings of phase one of data analysis

As explained in Chapter Three (section 3.3.4.1), the lesson-planning decisions teachers made seemed to have implications for auditing methodology. [5] Of the twenty-seven audits I examined in this case study eight shared characteristics that set them apart as a group, which I chose to call "impression-based audits". These were: Prem's school grounds audit, Busi and Lungi's water quality audits, Mbatho, Ishmael, Kay and Ramona's school sanitation audits and Thenjiwe's air quality audit (Analytic Memorandum [AM] 1.1). Sixteen audits shared characteristics that led me to identify them as "evidence-generating audits". These were: Ntsiki, Thenjiwe, Mbatho, King, Ayanda and Kay's water consumption audits, Busi and Lungi's turbidity tests, Ishmael, Kay and Ramona's water quality audits, Tom's water pollution audit, Mbatho's community toilet survey, Ishmael and Kay's hand-washing survey, and Ayanda's waste audit (AM1.2). Four audits shared unique characteristics that set them apart from the first two groups. I chose to call these "actualizing audits." These were: Ntsiki's, Thenjiwe's, Ramona's and Kay's *E. coli* testing sanitation audits (AM1.3).

Although there is some overlap between the characteristics of these three groups of audits, they can be distinguished, fairly consistently, according to
- The ontological interest that is embodied;
- The methods used to mobilize / generate information;
- The source of information used in knowledge construction (AM1).

Sections 4.2.1, 4.2.2 and 4.2.3 present data that illustrate similarities and differences between the methodologies of the three approaches.

4.2.1 Methodologies of "impression-based audits"

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[5] My use of the term 'auditing methodology' throughout this case study refers to:
- The environmental focus of the audit;
- The auditing methods and instruments which were used;
- The kinds of data which were collected or generated;
- The auditing sites.

The audits that belong to the group called "impression-based audits" were designed to construct knowledge about an issue using information sourced from informants' (inter)subjective impressions (AM1; AM2.4). This information was mobilized through methods such as opinion polls, observations, multiple-choice questions and checklists (Analytic Statement (AS) 1.1, AM1).

Auditing instruments were designed as lists of 'closed' questions about specific phenomena – none of the instruments I examined required learners to do any tests or follow prescribed procedures in order to generate data. The learning and teaching support materials that were used provided general guidelines for the documentation of learners' impressions of the state of the environment (AM11.2.3). Data were predominantly qualitative (AM2.2). The questions led learners to observe and subjectively assess phenomena of interest. Data were recorded in checklists, templates or questionnaires primarily requiring one-word answers (AM4.4). Learners answered the questions by recording or selecting responses that coincided with their impressions and/or prior knowledge. Because the data were strongly contextual, there was no need to analyse and interpret the data. The learners' responses, just as they were, were treated as the findings of the audit (AM4.15). This is not to say that they should not have been evaluated, however. This is discussed further in Chapter 5, section 5.4.1.

4.2.1.1 Summary of impression-based auditing activities in the case study

- Prem's class audited learners' impressions of the state of their school grounds. Learners responded to a series of questions about the school grounds by supplying a "happy face/good/yes" symbol or a "sad face/bad/no" symbol.
- Busi and Lungi's classes audited learners' impressions of the quality of water in a river near the school. Learners made subjective judgements about water quality (e.g. water supply, health risk, catchment conservation, river site quality and water life) by supplying a "bad", "not so good" or "OK" judgement to each of the above elements. They did not have to do any tests or provide any evidence to support these impressions.
- Mbatho, Ishmael, Kay and Ramona's classes audited learners' impressions of the state of their school toilets. Learners answered questions in a checklist about the state of the school toilets by supplying a "yes" or "no" or other one-word response. They were not required to provide evidence to support their impressions.

- Thenjiwe's class audited learners' impressions of the quality of the air at their homes. Learners made subjective judgements about air quality by answering a series of closed questions. After answering the questions they concluded whether the air quality was "good", "bad" or "OK." They did not do any tests to verify their impressions.

These data are presented in AM1.1.

4.2.1.2 Auditing sites

All of the impression-based audits in the case study focused on local issues, in or nearby the school (AM5.1.1). Some audits involved an 'exploration', by learners, of issues outside the classroom, but within the school grounds (AM3.2.2). Some audits were conducted outside the school (AM3.2.3). Some audits were conducted (or repeated) in the learners' homes (AM3.2.4). None of the impression-based audits were conducted inside the classroom (AM3.2.1).

4.2.2 Methodologies of "evidence-generating audits"

The audits that belong to the group called "evidence-generating audits" were designed to construct knowledge about an issue using information which was sourced from informants' interpretations of empirical-experiential data (AM2.5). This information was generated through methods such as counting, measuring, describing, categorizing, and supporting impressions with observational evidence (AS2; AM2).

Many of the auditing instruments in this group, or their accompanying learning support materials, gave learners instructions regarding appropriate procedures for collecting data (AM11.2.3). These instructions went beyond telling learners to document their impressions of the phenomenon of interest. Both qualitative and quantitative data were generated (AM2.1, AM2.3). The design of the evidence-generating audits seemed, therefore, to encourage a greater degree of objectivity than the impression-mobilizing methods of the first group of audits. Data were commonly recorded in audit sheets requiring learners to write descriptions, answer questions and/or provide evidence of their observations. Some data were recorded in tables, graphs or interview schedules (AM4.4). In all instances, but to varying

degrees, data were decontextualized. For this reason, data needed to be synthesized or analyzed and interpreted in order to generate meaningful findings. This was not always done (AM4.3, AM4.7, 2.4.9, 2.4.15). In all instances, data were limited to observable evidence. This group of audits did not make use of instruments that were capable of studying the effects of unobserved phenomena. In some instances, however, teachers and learners drew conclusions about unobserved phenomena that were not supported by empirical evidence, as discussed in section 4.3.4.7.

4.2.2.1 Summary of evidence-generating auditing activities in the case study

- Ntsiki and Thenjiwe's classes assessed the severity of water wastage at school without actually measuring water volumes. Learners counted the number of toilets, taps, basins etc throughout the school and indicated which ones were leaking and/or broken.

- Ntsiki, King, Mbatho, Ayanda and Kay's classes measured daily water consumption at school. Ntsiki, King and Ayanda's learners simply recorded daily meter readings. Mbatho and Kay's learners measured and estimated water consumption of various water use activities in the school and home.

- Mbatho's class conducted an interview-based survey of the state of the toilets in neighbouring communities. Learners visited a rural area, an informal settlement and a 'township' to conduct the survey. They identified which types of toilets were used in different areas, interviewed residents and described sanitation problems they encountered. Mbatho's community sanitation survey differed from the impression-based sanitation audits in section 4.2.1. Learners were expected to support their impressions of the toilets, in their reports, with descriptions of specific problems encountered and information from their interviews with residents. They also drew on technical information, from a resource they had been given, about the advantages and disadvantages of different kinds of toilet systems.

- Ishmael, Kay and Ramona's classes each conducted a guided investigation of the quality of water in a river near their schools. In these water quality audits, learners made subjective judgements about water quality, for example, water colour, smell, vegetation, water life, speed and impacts, by responding to multiple choice questions. They also had to measure stream depth and speed of flow and determine whether animals present were sensitive to pollution or hardy.

- Mbatho and Kay's classes did a survey of hand-washing practices of learners at school. Learners observed and counted how many and what percentage of girls and boys washed their hands after visiting toilets.

- Tom's class did a guided investigation of water pollution in a river near their school. Learners counted and categorized items of litter they found at the river and tried to identify where they had come from.

- Ayanda's class did a survey of the school rubbish bins. Learners sorted and counted rubbish from rubbish bags in different zones within the school.

- Busi and Lungi's classes each assessed turbidity levels in a river near their school. Learners assigned a turbidity class to the river water by comparing the water to turbidity classes on a turbidity disc.

These data can be found in AM1.2.

Ishmael, Kay and Ramona's water quality audits differed from the impression-based water quality audits described in section 4.2.1.1 in the following ways:

(1) These audits were designed to capture learners' impressions of water quality, but in a more directed and structured way than in Busi and Lungi's audits. The evidence-generating audits drew learners' attention to things they might not normally have paid attention to.

(2) Learners were required to support their judgements by providing evidence, for example, by describing which animals were found, by measuring how deep the river was, or by selecting the checklist option that corresponded most closely with the evidence they had seen at the site. Note that all five of these teachers used the Schools Water Action Project (SWAP) Water Quality audit to support the learning, but Busi and Lungi chose to use only parts of the resource. This decision had consequences for the way in which data were generated and affected the accuracy of the learners' findings (see section 4.3.2.5 for more detail).

4.2.2.2 Auditing sites

All of the evidence-generating audits in the case study focused on local issues, in or nearby the school (AM5.1.1). Only one of the evidence-generating audits was conducted entirely in the classroom (AM3.2.1). Some audits involved an exploration of issues outside the classroom, but within the school grounds (AM3.2.2). Some audits were conducted outside the school (AM3.2.3).

4.2.3 Methodologies of "actualizing audits"

Audits that belong to the group I have called "actualizing audits" were designed to construct information about an issue based on evidence of the effects of unobservable phenomena (AM2.6). This evidence was generated through the mediation of scientific instruments and scientific practices (AS1.3, AM1.3).

Only one auditing instrument of this type was used in this case study and it was used by three different teachers. The instrument (the MicroLife *E. coli* test kit, produced by Somerset Educational), is accompanied by methodological instructions which have to be followed precisely (AM11.2.3). The audit involves a scientific experiment to test whether coliform bacteria are present in water sample. The kit is not accompanied by any resource for recording data, so some teachers chose to record their findings in the form of a traditional scientific report (AM4.4). The method is designed to demonstrate the presence of coliform bacteria in a water sample through a colour change. Although it is impossible to see the actual bacteria in the water sample, it is possible to demonstrate that they are present through a chemical reaction that causes a positive sample to change from clear to yellow. The apparatus in the kit includes a torch with an ultraviolet light, which is used to check positive samples for the presence of *E. coli* bacteria. The ultraviolet light causes samples containing *E. coli* bacteria to fluoresce (see Appendix 9 for a copy of the instructions). The data in this experiment are thus highly decontextualized and the results need to be interpreted in terms of the method before meaningful findings can be generated.

4.2.3.1 Auditing sites

All of the actualizing audits in the case study focused on the issue of invisible germs on learners' hands. All of the audits were conducted in or very near to the classroom (AM3.2). Some teachers allowed their learners to repeat the experiment at home.

4.3 Findings of phase two of data analysis

In this section, I present and analyse each of the three case stories that was developed. Each case story represents one of the three auditing methodologies that were differentiated in this case study. Case Story One (section 4.3.1) provides thick

description of an impression-based audit. Case Story Two (section 4.3.3) describes an evidence-generating audit. Case Story Three (section 4.3.5) describes an actualizing audit. Each case story is analyzed to explore ways in which audits were choreographed and used by teachers for lessons, and to explore ways in which audits shaped meaning-making interactions and gave rise to environmental learning processes.

In the first part of the analysis of each case story, I explore relationships between choreography of the audits and subsequent teaching and learning (inter)actions and reality encounters (AS 2). As explained in Chapter Three (section 3.3.6.2) the use of the term 'auditing choreography' throughout this study refers to:

- Intended learning outcomes and moral lessons;

- How the audit was contextualized;

- How LTSM were used in the audit;

- Processes of teacher and learner participation;

- Teachers' and learners' roles and learning interactions;

- How learners were supported to acquire the language of the lesson.

In the second part of the analysis of each case story, I explore relationships between choreography of the audits and knowledge construction (AS 3). As explained in Chapter Three (section 3.3.6.2), the use of the terms 'knowledge construction' and 'meaning making' throughout the study refer to:

- Nature of the learners' experiences;

- Teachers' skills, knowledge and experience;

- Findings of the audit;

- Teachers' and learners' developing definitions of the problem;

- Processes of involvement and detachment;

- The teachers' and learners' accounts of reality;

- Evidence of learning and meaning making.

4.3.1 Case Story One: an "impression-based" audit

.3.1.1 Introduction

Kay Sagadavan (t11) is the Deputy Principal and a grade five teacher at Dr Macken Mistry Primary School, in Sea Cow Lake, Durban. She joined the *Schools and Sustainability* course in February 2005. The environmental focus of the second learning unit of the course was sanitation and all participating teachers received a resource-based learning (RBL) pack of materials to support teaching and learning about sanitation. Kay chose to include a focus on sanitation in her grade five Life Orientation work schedule, and to use some of the materials and audits from the RBL pack provided. Kay's Learning Unit Two portfolio (p2) provided data for this case study. It included her lesson plan, examples of learning support materials used, examples of learners' work and her reflections on the lesson. In addition, Kay reported on her lesson at a reporting workshop (10 June 2005), during which I made notes in my research journal.

4.3.1.2 Teacher's intentions

According to Kay, the purpose of her series of lessons on sanitation was as follows: "Learners will investigate the cleanliness, facilities available and the correct use of the school toilets and plan a strategy to address the problem" (p2t11).

Kay chose the following learning outcomes for her lesson plan (p2t11):
- The learner will be able to make informed decisions regarding personal, community and environmental health;
- The learner will be able to demonstrate understanding of and commitment to constitutional rights / responsibilities and show understanding of diverse cultures / religions;
- The learner will be able to use acquired life skills to achieve and extend personal potential to respond effectively to challenges in his/her world.

4.3.1.3 Kay's lesson plan

(1)   Kay started the lesson by showing her learners two posters illustrating correct and incorrect use of sewage systems. She prompted a class discussion by asking learners to describe what they noticed in the charts. She used a guided questioning approach to steer the discussion towards a focus on healthy and unhealthy sanitation practices. Learners voiced their opinions about how they thought toilets were being misused in their communities and in their school.

Kay reported that while looking at the posters, "The learners were observant, commenting that they have rights, they have to be treated with dignity. They felt that they have a right to clean toilets, clean environment …" She said: "We moved onto discussing our own school toilets. You should have heard them. Their complaints were many" (p2t11).

(2)   Kay then gave the learners a school sanitation audit (Appendix 10), adapted from the "Sanitation Works" Series of Learning Support Materials for Rural Health and Sanitation (Share-Net, 2003). The purpose of this audit was to help them collect data to verify the opinions they had expressed in the classroom, and to help them find out more about the state of their school toilets. The audit was designed to guide learners' observations. It elicited "yes" or "no" responses to questions about the toilets in the school, regarding availability of toilet paper, soap and hand towels, and the condition of the toilets. Some of the questions required a value judgement, but in most cases, the answer was obvious. I noticed, however, that two girls who had audited the same toilets had given different responses to some of the questions.

(3)   On returning to class, learners gave feedback on what they had observed in the school toilets. Kay commented that, after conducting the audit, "Learners were vociferous. They voiced their grievances, outlook, opinions, their observations quite strongly" (p2t11).

(4)   According to Kay:

> The audit … revealed that the toilets were not clean and hygienic at all times … Boys were not flushing the urinal. Bad odour. No bins available. Litter in the toilets. Toilet paper not available. Girls were leaving their sanitary wear not disposing of them in the correct manner. The floors were wet. There was poo on the toilet seat / floor … Many of these girls come from rural backgrounds. Were not aware that flushing the pads can cause blockages … Learners especially the smaller ones were peeing on the floor, making poo on the sides of the toilets, not carrying toilet paper, not cleaning themselves properly, not washing their hands with soap ... the bigger girls were not disposing of their pads in the correct manner … boys were peeing on the floor, not using the urinal properly, not flushing … [the cleaner] hoses [the floor] and leaves water standing around … boys were banging and kicking the doors open – no privacy.

(p2t11)

(5)   Learners indicated that they wanted to do something to improve their school toilets. The class discussed the problems and what needed to be done to resolve them. When learners asked their teacher if they could audit their toilets at home, too, she prepared an audit for them to use at home. She also talked to them about different kinds of toilets and sanitary practices in different cultures and religions. The findings of the audit revealed that most of the learners in her class had flush toilets at home, but that one learner shared a communal toilet with fifteen other people. She had not been aware of this.

(6)   She provided her learners with information, from the RBL pack, on different kinds of toilet systems. She also gave them a gridword activity and a wordsearch containing a variety of terms relating to health and sanitation, to help them become familiar with the terminology. Both resources were drawn from the "Sanitation Works" Series (Share-Net, 2003).

(7)   In order to resolve the sanitation problems in their school, learners needed to find out which groups of learners were responsible for each of the problems identified. Each of the problems was discussed and they realized that they needed more specific information. For example, were learners failing to flush toilets or were the toilets broken? Which toilets could not be flushed? Which doors needed locks to prevent boys from kicking them open?

(8)   To help the class to answer some of these questions, the teacher prepared an observation sheet on which learners could record specific observations about

problems and make suggestions for action-taking. Appendix 11 shows an example of a learner's findings (Nqobile Hopwell's observation sheet).

(9)   Learners also conducted a survey of the hand-washing behaviours of other learners to find out who was and who wasn't washing hands. This was drawn from the "Sanitation Works" Series (Share-Net, 2003).

Selvana (a grade five learner) wrote on her recording sheet:

> I sat at the platform near the J.P. assembly area. Had a sheet [for observing] 12 boys and 12 girls. I ticked on the sheet. I observed the boys runing [*sic*] into the toilet. Many washed their hands quite a few did not. I observed the girls, talking and reading the signs, posters. They went into the toilets. Almost all the girls used the soap from the soap bottle to wash their hands. A small number did not wash.

(Learner's Work [lw] t11)

(10)   After reporting the findings of their hand-washing survey, the class did an experiment to find out whether *E. coli* bacteria were present on the children's hands. This was intended to help them understand the importance of washing hands, to prevent the spread of germs and diseases.

(11)   The findings of their audits and observations helped learners to identify which groups of learners should be 'targeted' in their action plan and how each of these groups should be addressed. For example, Vianka addressed the older girls regarding proper disposal of sanitary pads. Khaye addressed the boys about using the urinals properly. A nurse was invited to talk about personal hygiene. Some of the grade five learners agreed to 'adopt' a class of Foundation Phase learners to teach them how to sit properly on the toilets and how to clean themselves and wash their hands.

(12)   The grade five learners developed the following action plan:
- They started with a toilet clean-up campaign;
- They made posters with health messages and instructions on how to use the toilets properly and stuck them on the walls;
- They placed water in buckets near toilets to remind learners to wash their hands;
- Some of the grade five learners each adopted a Foundation Phase class to teach them how to use the toilets properly;

- The teacher addressed the school cleaner about not leaving the toilet floors wet;
- Children brought tissue paper for the toilets;
- They made bins for disposal of sanitary towels in the girls' toilets.

Some of the learners did a talk in assembly about respecting the school toilets. For example, Gift, a grade five boy, did a talk in assembly to share what he had learnt and his message with the rest of the school. He said:

> Today I am here to talk to you on how to use the toilet. Firstly, a toilet should be kept clean and tidy at all times. A school toilet should be kept as clean as it is at home. Some children use the floor instead of the pan. After the toilet has been used it should be flushed. When using the toilet, we must always wipe the pan before use. The toilet should not be messed with water on the floor. Some children have a 'don't care' attitude; they treat the toilet as if it is a pigsty. In conclusion I would like to say that if we don't keep our toilets clean we will pick up germs and infection. Thank you.

(lwt11)

Individual learners addressed specific groups of boys and girls about specific problems they had identified. For example, Vianka, a grade five girl, addressed the grade six and seven girls. In her speech she said:

> Do not use newspaper, chips papers ect [*sic*] [as toilet paper] … and put into pans. As this will damage the toilet system. Eventually this waste ends up in the Northern Treatment Works. The workers have to physically remove the papers which donot [*sic*] disintegrate …

(lwt11)

- The learners drew up a school hygiene policy and personal hygiene policies;
- The teacher planned for future lessons to focus on diseases associated with sanitation, symptoms and causes of locally occurring diseases and prevention strategies.

(13) Learners monitored the toilets for three weeks, after which they gave feedback on the improvements they had observed.

4.3.2 Analysis of the case story

In sections 4.3.2.1 to 4.3.2.4, I analyse relationships between choreography of the impression-based audits and subsequent teaching and learning (inter)actions and reality encounters (AS 2).

4.3.2.1 Teachers' intentions

Several teachers commented on how much their learners had enjoyed the learner-centred, hands-on, practical activities (AM14.1). For example, after undertaking an audit very similar to Kay's, Ramona said: "From the response of the learners to the audit, it can be noted that learning is learner-centred, practical and adopts a hands-on approach" (p2t12). Several teachers said that they valued the audit because they thought the practical activities had helped learners to remember the lesson better (AM14.12). Kay said "It has to be [a] practical, hands-on experience that learners remember" (p2t11).

Some teachers who used the impression-based approach to auditing seemed to value the message behind the audit more highly than the auditing process itself (AM14.3). For example, Busi described the aim of her water quality audit as follows: "To enable them to remember in a later stage … to pass information to another; to change attitudes" (p1t5). Even though some of her auditing methods were flawed (section 4.3.2.5), she seemed to be satisfied that her 'environmental message' has been transmitted via the auditing activities and received by the learners.

Other teachers seemed to value the learning processes as much as, or more than, the environmental message of the audit (AM14.5). Prem thought that her auditing activities had contributed to learners' personal development and life skills. She said:

> [Auditing is] a positive method of identifying needs and further investigation into environmental issues. Learners demonstrated enthusiasm for outdoor, practical lessons… [It is] relevant to learners in terms of their personal development, a life skill as it concerns nutrition. It allows the learner to explore and investigate environmental issues and risks.
>
> (p1t3)

Almost all auditing lessons in this case study included information or a discussion on ways to take action to solve or prevent environmental problems. The degree of participation by learners and the amount of attention given to action varied (AM5.2.5). For example, in Prem's auditing lesson, the school improvement plans she described as emerging from the audit appeared to be teacher-driven (AM6.4.2) and the learners probably did not contribute in any significant way to decision-making, because they were so young. Some teachers, however, valued the audit because it enabled important issues to be addressed, not just talked about, but actually resolved (AM14.6) as part of the lesson plan. In Kay's series of auditing lessons, learners were able to make a valuable contribution to improving the cleanliness of their school toilets during the three-week period in which they were learning about sanitation (AM7).

4.3.2.2 Teacher and learner participation

In Kay's case story, the focus of the audit was directly relevant to learners' immediate needs and interests. The learning processes were contextualized and situated. Learners were given the opportunity to take the initiative in responding to their findings. Follow-up activities were responsive to the learners' suggestions. Learning actions were closely related to environmental actions and learners could see how their activities impacted on the problem.

The impression-based audits in this case study required few resources (LTSM and equipment) and were safe and easy to implement. Because the methods simply involved documenting learners' impressions, there was probably less pressure on the teachers to supervise and manage the minutiae of the research process. Perhaps this explains why it was usually possible for the whole class to participate in these audits (AM3.1.7). Prem's was the only impression-based audit in which the whole class could not participate. This was due to staff shortages (AM3.1.1). As explained in sections 4.3.4.2 and 4.3.6.2, full participation was not always possible in the evidence-generating and actualizing audits.

All of the impression-based audits were pre-planned by the teachers (AM3.1.3). Although learners did not contribute to the development of the auditing instruments, in some instances, follow-up activities were suggested, planned and implemented by the learners (AM3.1.5). Kay said she appreciated the fact that the audit had enabled her to be part of the learners' learning experience (p2t11).

4.3.2.3 Learning and teaching support materials (LTSM)

All of the teachers who undertook impression-based audits chose to use learning support materials or resources during their auditing lesson (AM11.2.9; see Appendix 12 for a summary).

Some teachers adopted an existing audit and used it 'as is' (AM10.1.1), such as Kay's first school sanitation audit. Some teachers adapted an existing audit (AM10.1.2). For example, Kay customized an existing school sanitation audit by inserting instructions for learners at the top of the page and adding a section where learners could record their observations, suggestions and proposed actions. Only one teacher, Prem, designed her own impression-based audit (AM10.1.3).

Role of the LTSM in the learning

The way in which resources were used influenced the kinds of learning processes taking place in the impression-based auditing lessons of this case study (AM11; AM17). Some LTSM were used to mobilize learners' prior knowledge, for example, Kay's sanitation posters (AM11.2.1). Other LTSM were used as a source of information for learners (AM11.2.2). Some LTSM were used to guide the investigation phase of the audit, by providing general guidelines for documenting learners' impressions, for example, Kay's school sanitation audit and her audit of toilets at home (AM11.2.3). All of the impression-based audits were accompanied by LTSM which were used to record the findings of the audit (AM11.2.4). Some LTSM were used as a means of reporting on the investigation and findings, for example, Kay's sanitation audits were accompanied by templates for reporting observations, suggestions and proposed actions (AM11.2.6). Other LTSM were used in multiple roles, for example, the posters showing healthy and unhealthy environments were used to mobilize prior knowledge and provide new information (AM11.2.7). Finally, some LTSM were used to help learners become more familiar with new terminology. For example, several teachers gave their learners gridwords and wordsearches featuring sanitation-related terms and an activity requiring learners to write sentences using the terms (AM11.2.8).

Who used the LTSM?

Some LTSM were used by the learners themselves within the lesson (AM11.3.3). For example, Kay's learners used two sanitation audits, a school sanitation survey with space provided for writing observations, suggestions and actions, a gridword and a

wordsearch. Other LTSM were used by both the teacher and the learners. They used the materials together (AM11.3.4). For example, Kay and her learners used an information sheet on different kinds of toilets, as well as two sanitation posters.

4.3.2.4 Teaching and learning interactions among teachers, learners, resources and environment

Teachers' roles (AM16.1)

Some teachers shared their knowledge of the topic with their learners. For example, Kay shared her knowledge of different sanitary practices in different cultures and religions with her learners. She explained the causes of sanitation problems and how they affect the community. All of the teachers provided learners with LTSM to support learning during the auditing lesson, as well as the equipment and resources learners needed for the audit. They all gave their learners instructions regarding the audit.

Some teachers accompanied their learners to their auditing sites, while other teachers chose not to. Some teachers organized meetings with knowledgeable people who could provide more information and answer the learners' questions.

Some teachers assessed their learners' work. Kay assessed her learners' observation reports, suggestions and proposed actions. Some teachers supported the learners' suggestions for action and helped them implement them. For example, Kay addressed the school caretaker about how the learners would like their toilets to be managed (p2t11).

Teacher-teacher interactions (AM16.2)

All of the teachers reflected on their first audits at a professional development workshop. Some teachers worked together to support each other's auditing lessons, for example, Kay worked closely with her colleague, Ramona.

Learners' roles (AM16.4, AM16.7)

Many teachers invited their learners to share their existing knowledge of the issue with the rest of the class. For example, Kay's learners had an opportunity to share their knowledge about sanitation and their concerns about the state of their school toilets (p2t11). Learners participating in the various audits in the case study worked either singly or in groups to observe and describe their impressions. They used the LTSM provided by the teacher to guide their observations. Some teachers gave their

learners opportunities to shape their own learning by stating what they would still like to know about the issue in focus. For example, Kay's learners told her that they wanted to audit their home toilets too. In most auditing lessons, learners were invited to suggest and implement solutions to the problems they had identified. Kay's learners developed an action plan, took action, reported on their action and monitored the problem for three weeks. Some learners had an opportunity to speak to experts about the problem and to contact the authorities to voice their concerns.

Learner-learner interactions (AM16.5)

Several of the audits provided opportunities for learners to work cooperatively and to share what they had learnt with other learners in their school. Kay's learners worked cooperatively to develop an action plan, told other learners that they should look after the toilets, adopted younger learners to show them how to use the toilets properly, presented speeches to other classes on hygiene, and reported to other learners on the implementation of their action plan through a drama and a talk in assembly. Some learners in the school reacted badly to their action initiatives by tearing down their posters. Despite this, Kay's learners showed commitment to spreading their 'environmental message' (p2t11).

Learners' interactions with the environment (AM16.6)

Audits provided opportunities for learners to explore their school and community contexts. Learners participating in the various audits identified problems in their environment; made judgements about the state of their environment based on their impressions; suggested causes of environmental problems; and took action to improve their environment.

Language (AM13)

Some teachers made an effort to support learners' acquisition of new terminology through specifically chosen activities. Kay used activities such as gridwords, wordsearches, poster-making and preparation of speeches to help learners practise using the new terms. She said she felt confident that her learners coped with the language and that the materials she used were suitable for grade five (p2t11).

In sections 4.3.2.5 to 4.3.2.8 I analyse relationships between choreography of the audit and knowledge construction (AS 3).

4.3.2.5 Nature of the learners' experiences, including problems with the way the audit was conducted

Teacher knowledge and skills (AM8)

Some teachers seemed to understand the moral lesson or message of the audit, but had trouble following the correct procedure (AM8.4). Some audits, adapted or designed by teachers were not well structured and seemed to lack a clear focus, aim and educational value (AM18.3).

Ishmael described in reporting workshops how he had struggled to make curriculum links between the environmental issues associated with sanitation and his learning area, Geography (Reporting Workshop [rw] t7). His struggles illustrate the tensions that seem to exist between the need to achieve the learning outcomes of the curriculum and the need to choreograph audits in ways that enable learners to 'get to grips' with reality. Although he was pleased that the moral lessons of the audit had been learnt, he had some doubts about whether he had choreographed the audit appropriately to achieve the learning outcomes of his Geography lesson. This tension was evident in several other teachers' lesson plans where teachers measured the success of their lessons against how effectively their environmental message had been transmitted. A number of teachers claimed that their lessons had been very successful, but they were unable to provide convincing evidence that the intended learning outcomes had been achieved (AM21.14). They seemed to interpret the learning outcomes superficially, and were satisfied, as long as the learners could remember the environmental message of the lesson.

Busi and Lungi took their learners down to a river near their school to assess water quality. This was the first time that either of the teachers had undertaken an audit. They instructed their learners to decide whether the water quality in the river was 'OK', 'bad' or 'not so good' in each of the following categories: water supply, health risk, catchment conservation, river site quality, water life and turbidity (p1t5; p1t10). Although they used the SWAP water quality booklet for the audit, they chose not to follow the guidelines provided for assessing water quality in each of those categories. They did not do any tests, other than a turbidity test to determine water clarity. They merely judged the quality of the water based on their subjective impressions, and recorded their assessments in a table provided in the SWAP booklet. According to Busi, her class learnt through this auditing activity how to assess how clean river water is. She claims that "chemicals inhibits [*sic*] water life with a result of plant loss

and animal loss." She says "learners were able to observe the amount of dirt in water that cause[s] some different kind of disease like cholerah [*sic*]." She says "they have evidence because they visited the site and discovered that water is polluted" (p1t5). Lungi claims that her learners identified the type of chemical that was present in the water as mercury (p1t10)! Both groups of learners concluded that the nearby factories must be responsible for the pollution in the river. Busi's learners even wrote a letter to the community leader "asking for a meeting to solve the community problem about the factory polluting the area" (p1t5).

It is my view that the learners in Busi and Lungi's classes did not use appropriate water quality auditing methods for the questions they were asking about water quality. A turbidity test alone cannot tell us what kinds of pollution are in the water. It cannot prove that the nearby industries are responsible for the alleged water pollution. It can tell us very little about the health hazards associated with water pollution. Busi's group did not test the water for the presence of chemicals, nor did they look for biological indicators of river health. Clearly, the teacher was not well-informed about the effects of factory effluent on plant life in the river, or she would have known that many kinds of pollutants actually encourage algal growth (Begon, Harper & Townsend, 1990). Her statement about cholera is worrying. My interpretation is that the chosen auditing method restricted both groups of learners to using what they already knew to try to make sense of what they were experiencing on the excursion.

4.3.2.6 Teachers' and learners' accounts

Learners' developing definition of the problem
The way the audits were choreographed, and the range of perspectives learners were exposed to (AM5.2), seemed to influence the learners' developing definition of the problem in focus. This is clearly illustrated in Kay's series of auditing lessons. Initially, the sanitation problems in Kay's case story were defined by learners, primarily in personalized terms. These definitions reflected a strong concern for the social effects of poor sanitation. After listing some of the problems she had observed in the toilets, Vianka summarized the problem as follows: "It is unhygienic and not a pleasant sight" (lwt11). Although the audit was designed in a way that allowed learners to construct personalized definitions of the problem, there seemed to be general consensus about which behaviours and conditions they felt were part of the problem and needed to be addressed. This intersubjective defining of the problem

probably took shape during the feedback session when learners reported what they had observed in the school toilets.

If Kay had concluded her lesson at this point, the impression-based audit may merely have succeeded in eliciting learners' individual impressions about the unpleasant sights and smells associated with dirty or poorly-equipped school toilets. However, she went on to introduce health-related definitions of the problem through the hand-washing audit, the gridword and wordsearch activities, the *E. coli* experiment, and by inviting a nurse to speak to the learners about personal hygiene (p2t11). Gift's comments illustrate how health-related concerns were added to the group's growing definition of the problem. He said: "… if we don't keep our toilets clean we will pick up germs and infection" (lwt11). His suggestion for action was to "Teach the pupils how to use the toilets properly not to mess it" (lwt11).

Kay's perspectives on sanitation issues extended beyond a concern about the individual learner's practices. She was also aware of social and structural factors in the school that influenced the individual learner's habits. This was reflected in her learners' reports, which indicated that the bathrooms lacked soap, bins and toilet paper, and that the youngest children had not been taught how to wash their hands after visiting the toilet (lwt11). Learners' work suggested that they understood that the solution to the problem was more complex than merely changing individual practices. One child illustrated that resolution of the problem would require a combined effort by members of the school community:

> There should be prefects at the toilets during breaks … Teachers should check if prefects are doing there [*sic*] duties … Bigger children should teach the smaller children how to use the toilet properly … Children should help the caretakers by keeping the toilets clean.

> (lwt11)

Kay also introduced the learners to different kinds of toilet systems and reminded them about their earlier visit to the Northern Treatment Works where they had learnt about how wastewater is treated. The learners' definition of the problem thus expanded further to include a concern for how inappropriate use of toilets could damage the infrastructure. As Vianka explained to the other girls, certain items should not be flushed down the toilet because "this will damage the toilet system. Eventually this waste ends up in the Northern Treatment Works. The workers have to physically remove the papers which donot [*sic*] disintegrate" (lwt11).

Several of the auditing lessons in the case study included a focus on human rights and a concern for how environmental issues affect quality of life, human health and safety (AM5.2.1; AM13.6). Of all the impression-based audits in this case study, only Prem's included a focus on biodiversity, and there is a brief reference to threats to biodiversity in Busi's water quality audit (AM5.2.3). There is no evidence that Kay's lesson considered the impacts of issues associated with sanitation on the physical environment. For example, the appropriateness of waterborne sewage systems for water-scarce South African conditions was not questioned. Surprisingly, Prem's auditing lesson failed to consider the causes of environmental problems – she simply audited them (AM5.2.6).

Processes of involvement and detachment, and the reality-congruence of accounts

The information for Kay's sanitation audit was gathered by school children who regularly used the toilets in the school. Many of the children's reports were emotionally-laden, particularly in the case of learners who had audited dirty, poorly-managed toilets. Kay's lesson provided a useful balance between processes of involvement and detachment, however. She included opportunities for learners to step back from the emotivity of the situation, so they could assess the issue with a greater measure of objectivity.

Very few of the instruments in the impression-based audits of this case study seemed to offer a useful balance between involvement and detachment. Perhaps this explains why some of the accounts that learners developed reflected an understanding of environmental issues as personal problems, for which learners were expected to take individual responsibility. This relationship between emotionally-involved auditing processes and accounts of environmental issues as personal problems is illustrated in the following example. Ishmael's learners had a very emotional reaction to the findings of their school sanitation audit and seemed to have been shocked into changing their personal sanitary practices. As Ishmael reported:

> Although what the learners discovered when they did the audit survey of the toilets seemed to shock them, they seemed to be motivated when we discuss[ed] them and come [*sic*] up with [a] positive action campaign to remedy the present scenario … They seemed to be shocked after discovering how risky their health is by not following proper hygienic procedures but nevertheless their planned programme of action gave them relief in knowing that they can still do something about the health

hazard of their toilets. In particular, the audit, therefore, became the eye opener.

<div align="right">(p2t7)</div>

This may also explain why so many of the impression-based audits led to problem definitions and accounts of the issue that referred to a narrow segment of reality only – the social reality. As discussed above, many of the auditing lessons reflected a concern for the social effects of environmental issues, and seemed to neglect other important effects, such as the impacts of environmental problems on the physical environment and the economy.

4.3.2.7 Findings of the audit

I do not have much data on what teachers expected to emerge from their impression-based audits. It is likely that teachers chose to undertake these particular audits because they had already identified that there might be problems that were 'worth auditing' in these focus areas. In Kay's case, she did have some preconceived ideas about what the findings of the school sanitation audit would be. But she had not been fully aware of the severity of the problem prior to the audit, and admitted surprise at the severity of the problem (AM19.1).

Validity of findings (AM19.2)

In some of the impression-based audits undertaken in this study, the accuracy and trustworthiness of the findings were influenced by the teachers' knowledge (AM18.1) and experience of auditing, and by the way in which they used the LTSM (AM11.2.4, AM10.1.2).

In Busi and Lungi's audits, learners had to rely solely on their prior knowledge to make sense of the encounters, because of the lack of teacher knowledge and experience of water testing, and the poor use of materials to support the learning. I do not have any evidence that these audits challenged the learners' assumptions or extended their prior knowledge in any way. The chosen auditing method did not really help the learners to perceive and understand the invisible risks associated with the alleged water pollution that appeared to be the teachers' main concern. The evidence suggests that the auditing methods they used were flawed and the knowledge they constructed during the experience was questionable. Consequently, the accounts of the world that learners constructed through these auditing processes

were not congruent with reality. In my view, Busi and Lungi did not really use their audits as a way of checking up on reality. They seemed to use the audits as a way of affirming their own beliefs and teaching predetermined moral lessons about water pollution.

Working with the findings

In some of the audits, learners were given an opportunity to work with their findings (AM4.2). Kay's learners wrote down the findings (AM4.4), discussed them and interpreted them together. When the learners presented their audit findings in class, the teacher allowed them to express their emotions. The learners had very strong feelings about the state of the school toilets because it affected them in a direct and personal way (AM6.4.1). Kay discussed the findings of the audit with the learners in a meaningful manner (AM4.8). She responded to their need for more information by giving them an additional audit, by providing more information, and by inviting a nurse to talk about issues of hygiene relevant to the audit findings. She encouraged them to suggest ways of taking action to resolve the issues they raised, and supported them to implement and strengthen their plans. It appears that all of the learners' concerns, identified through the audit, were addressed in follow-up activities and lessons.

In several audits, learners reported their findings to other learners in the school to share what they had learnt (AM4.12). In one instance, a teacher expressed his intention to use the findings of his audit to revise the school policy (AM4.13). In most of the audits, however, data were collected and then 'abandoned' (AM4.7). Although many teachers carried forward the ideas which emerged from the audit into subsequent lessons, in most cases, teachers did nothing with the actual findings once they had been generated. Busi, for example, used the water quality audit as a motivation for calling a meeting with the community leader, but it appears that the actual data were of no further use once they had been generated.

4.3.2.8 Evidence of learning and meaning making in impression-based audits

When teachers were asked to provide evidence of what had been learnt through the audit, most of them responded in one of two ways. They either provided evidence of learning against the intended outcomes of the lesson, or they provided evidence that the moral lessons of the audit had been learnt (AM21).

Kay reflected on the learning as follows:

> [Regarding] Learning Outcome (LO) 1: Looking at the discussion /
> feedback after the audit, one realises that there is evidence of learning.
> They were able to make informed decisions concerning the cleanliness of
> the toilets using the questionnaire. [Regarding] LO 2: At the feedback
> discussion, learners were able to understand that they have rights. With
> rights comes responsibilities … Learners were able to identify problems,
> record accurately, carry out the audit correctly and record their
> observations leading onto corrective measures / strategies.

> (p2t11)

Kay felt that the learning outcomes of her lesson had been adequately achieved at
the level required by the assessment standards.

Her reflections suggest that the moral lessons of the audit had been learnt, too. She
said: "The learners pointed out that cleanliness is an important issue, we must be
responsible, respect our environment …" (p2t11). Learners persevered when they
encountered opposition from other learners and remained dedicated until the
cleanliness of the toilets improved (AM21.12). She felt that learners had become
aware of their responsibility to put litter in the bin, wash hands, as so on, and felt
confident that learners would now behave responsibly towards the environment
(AM21.14).

In my view, an enormous amount of implicit learning took place during some of the
auditing lessons (AM21.14). In addition to the moral lessons and the curriculum-
linked learning, Kay valued the audit because she found that it encouraged active
participation by learners and enabled her to be part of their learning experience
(AM14.10). She said: "There is so much scope for active participation by learners
through auditing, observing, recording, reporting and planning strategies to overcome
problems" (p2t11). Busi said: "I have realised that learners liked to do things
themselves, doing water audit" (p1t5).

Kay thought that auditing activities had the potential to teach learners to solve
environmental problems themselves (AM14.2), stimulate behaviour change
(AM14.4), and provide opportunities for active learning (AM14.5). Kay commented
that her learners were highly motivated during the auditing lessons. She said:

The learners are working with something that is of interest to them, at the same time
using their powers of thinking, making decisions, exerting their rights, responsibilities,

acquiring skills, knowledge, attitudes and values. …Taking action also contributed to reflexive competence in the context of sanitation problem-solving.

(p2t11)

4.3.3 Case Story Two: an "evidence-generating" audit

4.3.3.1 Introduction

Ayanda Ngwenya (AN) is a grade seven teacher at Phila Combined School in Umlazi, Durban. He joined the *School and Sustainability* course in February 2005. The environmental focus of the third learning unit of the course was waste and participating teachers received resource-based learning packs of materials to support teaching and learning about waste. Ayanda chose to include a focus on waste in his grade seven Economic and Management Sciences work schedule, and to use some of the materials from the RBL pack provided. My data sources for this case story were: Ayanda's lesson plan, my observations of his lesson, my semi-structured interview with a group of Ayanda's learners after the lesson, and my semi-structured interview with Ayanda.

4.3.3.2 Teacher's intentions

According to Ayanda, the aim of his lesson was for learners to audit the school bins and discuss different sources of waste. Ayanda chose the following learning outcome and assessment standard for his lesson plan (p3t9):

- LO1: The learner will be able to demonstrate knowledge and understanding of the economic cycle within the context of 'the economic problem';

- Assessment Standard (ASS) 1: The learner will be able to explain needs and wants and how the differences between them impact on communities and the environment.

4.3.3.3 Ayanda's lesson plan

(1)   Ayanda introduced his lesson by explaining that the class would audit the school bins. He said: "I want us to see what kinds of waste we have in the school and what we can do" (Observation [o] t9). He gave each learner a handout entitled "Sources of Waste," produced by Durban Solid Waste (ltsmt9). He read the handout

aloud, interspersing the reading with his own explanations and examples to help the learners see how the information related to their own lives. After summarizing the reading, Ayanda asked three boys to fetch three bins from around the school and bring them to the classroom.

(2)   Ayanda used a guided questioning approach to find out what the learners already knew about waste and waste management. For example:

> AN: What can we do with waste after we have collected it?
> Boy: We fire it.
>
> AN: Is it OK to burn waste?
> Boy: Can pollute air.
>
> AN: Smoke and fumes pollute air – not right to our health. What else?
> Girl: Can recycle.
>
> AN: What does it mean to recycle?
> Boy: Re-use.
>
> AN: How can we reuse waste? How can we recycle?
>
> (ot9)

Learners were hesitant to respond to Ayanda's questions and seemed reluctant to speak in English except when the answer to a question was obvious. Ayanda helped them with clues, speaking more and more in Zulu as the lesson progressed.

(3)   Ayanda reminded the learners about their Technology projects in which they had made objects from paper and plastic, such as paper maché bowls and mats. He emphasized that waste can be used to make money or to save money, for example, by making recycled paper.

(4)   Next, Ayanda divided the class into three groups of seventeen learners and assigned a group to each bin. He tipped the rubbish on the floor of the classroom and the learners scrambled around the piles, sorting it according to type of material – plastic, paper, etc. Ayanda and the learners were not sure how some of the items should be categorized. For example, at first they separated chip packets from other types of plastic until Lihle instructed them to group chip packets with other plastic items. They counted the items of rubbish in each category and wrote their numbers down. Ayanda, however, seemed a bit confused about how best to record the findings. The worksheet he had designed (Appendix 13) was not perfectly compatible

with the types of rubbish they happened to find on this day. Therefore, he devised a new categorizing system and wrote the new set of categories on the board. The children continued counting the items and confirming with each other that they had counted correctly. There was not enough work to keep everyone occupied at this point and the learners began to get restless. Some children began dancing and singing in the back corner

(5)   Once the sorting and counting was over, the children cleaned the classroom and put the rubbish back into the black plastic bags. Different kinds of waste were placed in separate bags. The children smiled, laughed and played as they cleaned.

(6)   Next, Ayanda explained how to record the findings on the audit sheet he had designed (ltsmt9). "In zone one they are going to write the number of photocopy papers. In zone two they are going to write the number of newspapers and tissues" (ot9). Originally, the zones numbers had represented different parts of the school, but Ayanda decided to use these spaces to record the different kinds of waste they had counted. The learners were confused about how to fill in the recording sheet and needed intervention. Lihle and Ayanda helped them to fill in the numbers to complete the worksheets. Ayanda walked around, checking that they had filled in the worksheets in the way he expected.

Commenting on the audit sheet he had designed, he said:

> I thought it's relevant to the lesson. Although I have to give myself time to do some changes because it was for the first time. I didn't even know what I'm going to get from these bins. So … [in] the next sheet I have to include all these things that you get from the bins.

(it9)

(7)   Ayanda asked each group to hand him their worksheets. He copied the total number of items of each type of waste onto the board and then added them together. He chose not to write the data in tabular form with row and column headings, but used an informal, fairly unorganized form of presenting the data. He did all of the calculations himself, although I noticed one of the boys voluntarily checking his sums. There was nothing for the learners to do at this point and some of the learners were not paying attention at all. They found the following items in the three rubbish bins: 1179 plastic items (including sweet wrappers, chips, plastic bags and icicle packets),

488 paper items (including newspapers, boxes and used tissues), ten tins, eight pieces of foil, 45 scraps of food, and six pieces of polystyrene.

(8)   Once the totals had been recorded on the board, Ayanda talked to the learners about ways of putting waste to good use, instead of discarding it.

He said:

> These are the findings. What can we do with this waste? I think there are a lot of things we can do with this waste. We can use foil. Especially in Technology projects foil can be used. Making solar cooker, making solar system. We can still use that foil, it can help us. Food – you can make compost. Dig a hole, put food there, cover with soil … Then what else? When the pit is full, can plant some vegetables. It can help us. Papers – paper and boxes. We had something that we made out of boxes [in a previous Technology lesson]. The project was making a lunch box that will have a window so that we can see what is inside without opening. And it should be waterproof. It should be able to protect the food. What else? Plastic - should include these hard ones. We've got this thin one and this hard one – like two litre bottles.

(ot9)

(9)   Finally, Ayanda introduced the focus of the next lesson, which would be paper-making.

He said:

> We have to make a paper. Must recycle because we can see – although we don't have much today (Monday) we usually have more papers. We are going to make papers. These papers that are used for writing invitations and Christmas cards. They use these beautiful recycled papers.

(ot9)

4.3.4 Analysis of the case story

In sections 4.3.4.1 to 4.3.4.4 I analyze relationships between choreography of the evidence-based audits and subsequent teaching and learning (inter)actions and reality encounters (AS2).

4.3.4.1 Teachers' intentions

Ayanda recognized that the waste audit sheet he had designed needed some improvements (it9). In my opinion, the auditing method itself was not well structured

and did not have a clear focus or purpose. He did not seem to put enough thought into the auditing activities the learners would be doing (AM8.3). The learners I interviewed could not tell me what the purpose of the audit was or why they had counted the litter. According to Ayanda's lesson plan, the aim of his lesson was to teach learners about the importance of a healthy and clean environment. I observed that the emphasis of his environmental 'message' changed during the course of the lesson from 'not littering,' to 'correct disposal of waste,' to 'saving money by recycling,' to one of 'healthy eating and saving money'!

Ayanda was satisfied with what the children had learnt, even though he acknowledged the weaknesses of the audit design. He explained that the audit had made learners aware of their unhealthy eating habits. The lesson had taught learners that "out of waste you can get some things that can be re-used. Not that everything should be disposed. And again they were aware that if you burn papers you are causing pollution" (it9). Commenting on which skills learners might have gained through the lesson, Ayanda said: "[They learnt] skills of identifying types of waste and something that can be used again, and … things that could be put in a pit to be used as compost." Ayanda felt confident that with repetition, learners would become accustomed to picking up litter at school and that they would learn the importance of keeping the school clean. Clearly, Ayanda hoped that his lesson would lead to behaviour changes amongst the learners (AM14.4). This is reminiscent of the targeted messages approach introduced in Chapter Two (section 2.2.3.2).

Ayanda was not the only teacher who seemed to be satisfied with the lesson, as long as the moral lesson had been taught - even if the auditing process itself was faulty. Several other teachers, who used the evidence-generating approach to auditing, seemed to value the message, or moral lesson, behind their audits more highly than the auditing process itself (AM14.3). Some teachers seemed to value their moral lessons more highly, even, than their curriculum-required learning outcomes (AM21.14). Mbatho, a Geography teacher, felt that her lesson was a success despite the fact that her intended learning outcomes had not been fully achieved. She said: "It is a pity we started the lesson late during the third quarter … so we could not thoroughly do the lesson to achieve our learning outcomes … but at least they are aware of important point of disease" (p2t6).

Other teachers valued their evidence-generating audits for different reasons (AM14). For example, Ramona noted that her learners developed research skills through their

water quality audit. She said: "Learners studied questions in the audit and were able to find and locate and interpret information" (p1t12).

Thenjiwe said:

> Audit has assist[ed] learners to be aware of different ways of saving water and also [to be] able to identify areas that use more water daily. [Learners] have also developed skills of controlling and monitoring the usage of water; have also learnt that water is money and need[s] to be saved.
>
> (p1t2)

Tom valued the water pollution audit because his learners developed action-taking skills. He said: "The learners found that action had to be taken immediately and they devised an action clean-up campaign as the best alternative to put an end or minimize pollution" (p1t8).

Several teachers commented on how much their learners had enjoyed the learner-centred, hands-on, practical activities.

After her water audit, Mbatho said:

> They became excited to see that they have find [*sic*] out the important information themselves and went out to tell the school about their findings and their parents … It makes them more responsible and be confident that they are involved in their learning processes.
>
> (p1t6)

Some teachers seemed to value the participatory nature of their auditing activities (AM14.10), even if they recognized that some of the activities had not been well thought through (AM14.1). After her community toilet audit, Mbatho said: "Even though our learning outcome was not fully achieved … I really feel by making them active in performing their research made a great difference" (p2t6).

A number of teachers said they valued the audit because they thought the practical activities would help learners to remember the lesson better (AM14.12). As Mbatho said: "It becomes easy to remember for their examinations" (p1t6).

Thenjiwe said:

> Learners were so excited and they are the ones whose [*sic*] been taking the lead throughout the lesson. That if you involve your learners and make them active it easy for them to remember and they come out with ideas you never thought of them … Learners has to gain experience, be active participants. They have to feel ownership for the findings and solutions. Have to learn new things and new skills.

(p1t2)

Tom valued the auditing activities because he could use them to support active learning processes (AM14.5). During the *Schools and Sustainability* course, Tom developed a lesson-planning strategy for himself based on the steering questions of the active learning framework (O'Donoghue, 2001). His strategy was to start the lesson planning process by drafting a series of "essential questions for project work" (p1t8). For example, his lesson on water pollution was shaped around the following questions:

- What is pollution?
- How does a stream get polluted?
- What are the possible sources of the pollution?
- What pollution 'stuff' is in the stream?
- Who can we contact for help?
- What alternative action is there to solve the problem?
- What is our action plan?

(p1t8)

He then developed a pack of worksheets and activities, including an audit, to guide learners as they sought to answer each of the questions (ltsmt8). Subsequent learning actions depended on learners' responses to the questions, and the results of the audit in particular. At the end of the lesson, learners reported their findings against the essential questions that had initiated and guided the process. Tom's reflections suggest that for him, the actual topic of the lesson and the environmental messages learnt were of less importance than the active learning processes taking place in the lesson (AM14.5). He seemed to prioritize the learning of knowledge and skills as required by the Natural Science curriculum (p1t8).

Almost all of the lessons incorporating evidence-generating audits included information or a discussion on ways to take action to solve or prevent environmental problems. However, the degree of participation by learners and the amount of attention given to action, varied. Tom and other teachers said that they valued learning processes that enabled learners "to do something to solve problems in their

local community" (p1t8, AM14.2). A number of teachers said that they hoped learners would go home and teach their families what they had learnt and apply what they had learnt at home (AM6.4.7).

Ayanda, and some other teachers, did not consider the causes of environmental problems in their lessons. They merely identified and audited the problems and then discussed possible solutions (AM5.2.6).

4.3.4.2 Teacher and learner participation

In Ayanda's waste audit, the whole class participated in the audit but there were not really enough resources or tasks to allow everyone to get involved (ot9). In some of the other evidence-generating audits undertaken in this case study, only part of the class was able to participate in the audit because of constraints such as time, space, group management or limited resources (AM3.1.1).

Ayanda's audit, like most of the other audits, was pre-planned and managed throughout by the teacher (AM3.1.3). Learners participated in pre-planned activities and were not required or invited to contribute to the planning of the audit, or to make any research decisions during the lesson. The teacher gave instructions for the learners to follow and made all required research decisions on behalf of the learners (AM3.1.4). Tom, however, provided a framework for his water pollution audit, then supported learners to plan aspects of the audit themselves (AM3.1.6).

4.3.4.3 Learning and teaching support materials

All of the teachers who undertook evidence-generating audits chose to use learning support materials or resources during their auditing lesson (AM11.2.9; see Appendix 12 for a summary).

Some teachers adopted an existing audit and used it 'as is' (AM10.1.1). This happened in Ishmael and Kay's water quality audits, Busi and Lungi's turbidity tests, and Kay and King's water consumption audits. Some teachers designed their own audits, entirely, and made their own LTSM for the lesson (AM10.1.3). For example, Ntsiki and Thenjiwe each designed a simple worksheet to record the findings of their water audits. Tom made his own resources because he did not find the resources in the RBL pack suitable for grade eight. Mbatho and her learners designed interview

schedules for their community toilet survey. Many teachers seemed to find the process of adapting and designing audits very challenging.

Role of the LTSM in the learning (AM11.2)

The ways in which resources were used influenced the kinds of learning processes that took place in the evidence-generating audits of this case study (AM17). Some LTSM were used to mobilize learners' prior knowledge (AM11.2.1). Some were used as a source of information for learners. For example, Ayanda gave his learners an information pamphlet on sources of waste (AM11.2.2). Other LTSM were used to guide the investigation phase of the audit (AM11.2.3). All of the evidence-generating audits were accompanied by LTSM which were designed to record the findings of the audit (AM11.2.4). Some LTSM were used to guide the development of an action plan (AM11.2.5). Others were used as a means of reporting on the investigation and findings, for example, Tom's pack of worksheets and activities and Ishmael's SWAP water quality booklet (AM11.2.6). Finally, some LTSM were used in multiple roles, for example, the SWAP water use audit was used to guide investigations and to record findings (AM11.2.7).

Who used the LTSM?

Some LTSM were used only by the teacher (AM11.3.1). For example, Ntsiki used a worksheet to help her calculate and record volumes of water used at school. She also used information about auditing from the course notes to prepare for her lesson (AM11.3.2). Tom used Enviro Fact Sheets (Share-Net, 1999b) to prepare for his audit. Other LTSM were used by the learners themselves within the lesson (AM11.3.3). For example, learners used Tom's portfolio boards for reporting on their investigation. Some LTSM were used by the teacher and the learners together, for example Ayanda's waste audit recording sheet (AM11.3.4).

4.3.4.4 Teaching and learning interactions among teachers, learners, resources and environment

Teachers' roles (AM16.1)

All of the teachers introduced the topic to their learners in some way. Ayanda first explained the purpose of the lesson to the class and then used guided questioning to assess the learners' prior knowledge. Ntsiki introduced her learners to the topic of water wastage by telling a story and asking questions about water.

Teachers provided information on the topic in different ways. Ayanda shared his own knowledge on the topic, and then read an information pamphlet to the class. He explained concepts to the learners and gave examples to help them relate the new information to what they already knew. He used code-switching to help learners understand new concepts and English terminology. Mbatho discussed the causes and effects of sanitation problems with her learners. All teachers provided learners with LTSM such as posters, photographs, worksheets, readings and gridwords, as well as the equipment, resources and instructions learners needed for the audit. Ayanda did not use his auditing worksheet as he originally intended, but made decisions about how to use it during the lesson itself.

Most teachers accompanied their learners to the auditing sites. Other teachers chose not to accompany their learners while they undertook their audits. Some teachers helped their learners to collect and record evidence. For example, Ayanda checked that the audit was being done correctly and intervened when learners struggled with the task or concepts. In some lessons, it seemed that the teacher did not supervise the learners adequately during the audit.

Some teachers supported the learners' suggestions for action and helped them implement them. For example, Tom assisted in making the logistical arrangements for learners to implement their action plan.

Teacher-teacher interactions (AM16.2)
All of the teachers reflected on their first audits at a professional development workshop. Some teachers worked together on their evidence-generating audits.

Learners' roles (AM16.4, AM16.7)
In Ayanda's lesson, I observed learners listening to the teacher as he shared information with them. They answered his questions, and obeyed his instructions. They did not voluntarily offer information or ask their own questions. In some other audits, learners were given more opportunities to take the initiative. Learners in the various audits used LTSM provided by the teacher, followed instructions, conducted tests or collected evidence using other methods. They recorded observations or measurements, reported findings and took action to reduce or solve the problem.

Learner-learner interactions (AM16.5)

Several of the audits provided opportunities for learners to work in groups to do class activities and conduct the audit. In Ayanda's lesson learners helped each other to sort and count waste and confirmed their accuracy with each other. They talked to each other about their findings. Ntsiki's and Kay's learners observed the behaviour of other learners in the school as part of their audit, and told other learners how to behave in more appropriate ways. Tom's learners worked together to develop an action plan and reported to other learners on the implementation of it.

Learners' interactions with the environment (AM16.6)

Audits provided opportunities for learners to explore their school and community contexts. For example, Ayanda's learners investigated what kinds and amounts of waste can be found in the school bins. Learners participating in the various audits in this case study identified problems and made judgements about the state of the environment. They measured the severity of the problems through various methods of counting, categorizing, describing, measuring and testing, identified causes of environmental problems based on their data, and took action to improve their environment.

Language (AM13)

As noted in the case story, Ayanda's learners were not confident about speaking in English. They struggled to understand terms and concepts such as waste, polystyrene, decomposing and recycling. For example, one learner demonstrated that he was confused by the dual usage of the word "waste" in the contexts of litter and water consumption. Ayanda was aware of this and therefore used code-switching in the lesson. Although the lesson was meant to be in English, he used more Zulu than English.

In sections 4.3.4.5 to 4.3.4.8, I analyse relationships between choreography of the evidence-generating audits and knowledge construction (AS 3).

4.3.4.5 Nature of the learners' experiences, including problems with the way the audit was conducted

Teacher knowledge and skills (AM8)

Some teachers seemed confident about the moral lesson or message they wanted to convey to learners through the audit, but the purpose of the chosen auditing method was not always clear (AM8.3). For example, the learners in Ayanda's class learnt that waste can be recycled and reused, but they did not seem to know why they had to sort and count items of rubbish as part of their lesson. Perhaps this is because his audit was not well-designed and did not seem have a clear focus.

Similarly, some teachers understood the message of the audit, but had some difficulty understanding and following the correct procedure (AM8.4). There were methodological problems with the way these teachers conducted their audits. For example, Thenjiwe was unable to devise a suitable method of monitoring toilet use at school and did not understand how to use the meter readings to calculate daily water consumption. King's water use audit was incomplete. He told his learners to write down the meter readings for five consecutive days, but did not use the readings to calculate water consumption.

In some audits, the stated aim did not match the methods used or the data collected (AM8.5). In some audits, the lesson the teacher thought had been learnt did not seem to relate to the purpose or method of the audit. For example, the stated aim of Ntsiki's water wastage audit was to find how much water was being wasted in the school and how it could be saved. What really happened in the audit was that learners counted the number of leaks in the school and read the water meter for a week. No calculations were done to determine water volumes.

Some teachers understood the auditing procedure and followed it correctly, but seemed to have difficulty interpreting the findings. Some seemed to have come to invalid conclusions (AM8.6). For example, Ishmael followed the instructions in the SWAP water quality audit, but his learners' findings were transferred inaccurately onto the summary page of the audit book. The conclusions they came to were therefore inaccurate. Some teachers were not familiar with concepts in the LTSM, lesson or audit (AM8.7).

Busi and Lungi's learners may have learnt how to use a turbidity disc, but I question whether they were able to make much sense of the results. They had nothing to compare the results with. This turbidity test did not appear to help them to understand water pollution better. It seemed to be a non-sensical activity that had little impact on the learners' ability to make sense of the experience. I think that the way in which the audit was choreographed merely affirmed what the teachers and learners already suspected. That is, that the factories were polluting the water.

Learners' skills (AM18.2)

Some learners had difficulty conducting the audit or using the LTSM correctly. For example, Ntsiki's learners did not know how to read the water meter. They were confused by the numbers six and nine and did not know which side of the meter to stand on.

4.3.4.6 Teachers' and learners' accounts of the issue

Learners' developing definition of the problem

The comparative table in Appendix 14 compares two very different evidence-generating audits. Both audits focused on waste and used evidence-generating methods, but they differed in many other respects. The comparative table illustrates how the auditing methodology, teacher's intentions and perspectives engaged with in the lesson influenced the accounts of the problem that developed through the audit.

Many of the evidence-generating audits in the case study emphasized concerns about human health, saving money and reducing consumption of resources (AM5.2). Very few lessons included a focus on ecosystems and biodiversity, or the impact of environmental issues on the physical environment. The learners' developing definition of the problem in focus seemed to be influenced by the ways in which the audits were choreographed and by the range of perspectives learners were exposed to. This is clearly illustrated in the series of auditing lessons developed by Kwa-Mathanda High School colleagues, Mbatho and Ishmael. The first perspective, developed in Mbatho's classroom-based activities, focused on how poor sanitation can affect human health. Next, she developed an audit which required learners to visit three different communities near the school, to find out about the different kinds of toilets being used. The interview sheets and reports written by Mbatho's learners contained descriptions of the problems associated with different kinds of toilets observed in their community. Based on their impressions of the state of the toilets

they visited, learners seemed to develop the perspective that pit toilets were bad and that flush toilets were good. This early, narrow, definition of the issue is illustrated by a learner's comments: "I think that [the pit toilet] is bad for comminity [*sic*] because it can also cause iliness [*sic*] to people." In contrast, another learner described a flush toilet as follows: "The house that I visited yesterday I had a great time, because I saw a clean toilet. It was a flashing [*sic*] toilet … I didn't see any problem about the toilet coz it was clean. I didn't see even any fly."

If Mbatho's audit had been limited to a process of documenting learners' impressions of different toilets, learners might have developed a one-sided or narrow view of sanitation issues. However, the evidence-generating design of Mbatho's audit enabled learners to investigate the sanitation issue from different perspectives. By interviewing a range of residents, they discovered that solutions were more complex than simply replacing pit toilets with flush toilets. As they discovered, the problem with flush toilets was that if a family failed to pay their water bill, their water supply would be cut off and they would be unable to flush their toilet. Mbatho encouraged her learners to think critically about the issue and any proposed solutions to the problems they encountered. As she assessed her learners' work, she challenged suggestions that failed to consider different dimensions of the problem. For example, when one learner wrote: "They must ask the government or the Municipality to not switch [off] the [water supply] for unemployed people because they can't pay," Mbatho responded by asking: "And where would the government get the money from because they are not paying the bills?"

Later, Mbatho's colleague Ishmael used her learners' reports as a source of information for his own learners. His learners pursued questions about the health risks associated with poor sanitation by conducting a survey of the state of the school toilets and learners' hand-washing habits. He described the learners' reactions to what they learnt as follows:

> For learners, they seemed to be shocked after discovering how risky their health is by not following proper hygiene procedures but nevertheless their planned programme of action gave them relief in knowing that they can still do something about the health hazard of their toilets in particular – therefore the audit became an eye-opener.

(p2t7)

Ayanda's learners engaged with a very limited range of perspectives during his waste audit. The way in which Ayanda's learners defined the problem is illustrated by the following comments from the learners, as translated by Lihle:

> (1) The problem that is caused by litter is that the school looks untidy and anybody who visits the school will see the untidiness of the school. It's not only inside the school, it's also outside the school. It's not only affecting the school only – it's also the people around the school.
> (2) In the informal settlement there's a lot of dirt. There's a lot of waste that is not monitored or not collected. It's lying around from people dumping.
> (3) Food leftovers from the nutrition scheme it's not ever dumped properly. It's just dumped in the open space. It makes flies. It smells.

<div align="right">(Group interview [g] t9)</div>

It is difficult to see from these accounts how the auditing lesson Ayanda conducted extended or challenged the learners' definition of the issue. His learners engaged with a narrow range of perspectives on the issue and subsequently developed accounts of the issue that referred to a very limited segment of reality.

Processes of involvement and detachment

The information for Mbatho's audit was elicited from residents who used different types of toilets. Several of the reports were emotionally-laden, particularly when learners had visited residents in informal settlements who still used pit toilets or the bucket system. One learner quoted a resident as saying: "… the government was the people to be blamed for this situation. They have to build us a flush toilet" (lwt7). Emotional excerpts from learners' reports follow (the emphasis in each case is mine):

> (1) That toilet was **very bad** … it is affect them to get sick … so it is **very dangerous** to use a pit toilet.
> (2) She told me … how **horrible** the toilet[s] in shacks [are].
> (3) When one toilet is smelly, the diseases that come out **spreads everywhere**.

<div align="right">(lwt7)</div>

This activity seemed to bring the learners into a close emotional involvement with the issue they were auditing. This might have affected the objectivity of their assessment of the sanitation issue. Mbatho's lesson, however, seemed to provide a useful balance between processes of involvement and detachment. She gave the learners opportunities to step back from the emotivity of the situation, so they could assess the issue with a greater measure of objectivity.

This was also true for some of the other evidence-generating audits of the case study. Tom's water pollution audit illustrates the correlation that seems to exist between auditing processes that find a balance between involvement and detachment, and greater reality-congruence of learners' accounts. The accounts of the issue that Tom's learners developed reflect an understanding of environmental issues as being more complex than personal problems for which learners are expected to take individual responsibility. Learners understood that successful resolution of the problem required cooperation from government, local business and the general public, as well as from individuals. His auditing lessons led to problem definitions and accounts of the issue that referred to a broader segment of reality than those of the majority of impression-based audits. For example, learners understood that pollution affects plants, animals and people, and that there were political, economic, social and biophysical dimensions to the problem.

Reality-congruence of learners' accounts

In some instances, teachers' own accounts seemed to be inaccurate and these misconceptions seemed to have been passed on to the learners. Mbatho said she taught her learners about "diseases associated with bad air from toilet" (p2t7). In her view, the highlight of the lesson was "how to try and decrease the rate of disease caused by bad air from toilet" (p2t7). Commenting on what the children learnt through the lesson, she said: "…they did not know that rash in the body can be cause by bad smell from the toilet and they did not know how flies spread disease from one dirt[y] place to [the] community" (p2t7). One of her learners described the bucket system as follows: "The hole get full of faeces and it smells and pollute air. That is why we get sick" (lwt7). Another learner thought that people could contract tuberculosis from dirty toilets. Although the teacher read these reports, she did not correct these misperceptions.

Learners' accounts also seemed to be influenced by the LTSM used. Teachers appreciated materials that contained information that was consistent with the learners' reality. As Mbatho said, the most useful LTSM were "those that have pictures of the real thing and what is exactly happening out their [*sic*] in their toilets … because [they] are like real what is at their homes." She was referring to resources which had information about different types of toilets and how they should and should not be used.

4.3.4.7 Findings of the audit

In some audits, the teacher seemed to know what the findings would be, even before the audit was done. In some instances, the audit was seemingly done to prove a point, or to get a predetermined message across. The findings were used merely to reinforce that message.

In some audits, the teacher had some preconceived ideas about what the findings would be, but was a bit surprised by the results. In Ayanda's waste audit, the learners found a large amount of plastic waste in the school bins. Ayanda had expected them to find more paper than any other kind of waste.

Validity of findings (AM19.2)

The findings of some evidence-generating audits were questionable. Even when teachers used well-designed, 'tried and tested' auditing methods, the accuracy of the findings was influenced by the teachers' knowledge and experience of auditing, and by the ways in which they used their LTSM. As explained in section 4.3.2.5, Busi and Lungi's impression-based water quality audits at the river included one evidence-generating activity - a turbidity test. This test is designed to assess the clarity of water. A high turbidity can be caused by silt from soil erosion, by sewage and industrial waste, or by excess microscopic life in the water (O'Donoghue, n.d.). The turbidity test cannot be used as proof of chemical pollution in the water. Nevertheless, Busi and her learners came to the conclusion that the river water was polluted by chemicals from factory effluent and was contaminated with cholera-causing bacteria. Lungi obtained a turbidity score between one and three, which her learners interpreted as "not so good" (O' Donoghue, n.d.). This interpretation has to be viewed with caution because the results of turbidity tests are difficult to interpret. Some rivers are naturally turbid. According to the guidelines in the SWAP water quality audit (O' Donoghue, n.d.), the key to interpreting the results of turbidity tests depends on knowing natural turbidity levels in the area where the tests are being conducted. In this sense, the turbidity test can only offer us 'relative certainty' about the quality (clarity) of the water. When reporting on the findings of her turbidity test, Lungi said: "Learners were able to discover the amount of dirt in water, and in dirty water there is no life that results to death." When I assessed her portfolio, I challenged this radical response by asking: "Isn't that a bit extreme?" It appears that even though the turbidity test is a well-established, 'tried and tested' method of assessing water quality, it can be used and interpreted in inappropriate ways.

Working with the findings

In some of the audits, learners were given an opportunity to work with their findings. In Tom's audit, learners wrote down the findings, worked with them, analyzed and interpreted them (AM4.2). Tom used the opportunity to develop learners' mathematical skills, such as graphing and tabulating. Specifically, learners listed items of litter found at the river, identified which materials they were made of, counted them and identified where the waste had come from. They made tables and graphs showing how many items of each kind of litter they had found. They inserted the names of waste items in a matrix of non-metals *versus* metals and recyclable *versus* non-recyclable categories. Learners engaged with the findings of the audit by answering questions about pollution in a series of worksheets, for example, what is pollution and how does a stream get polluted? They defined terms they had learnt, suggested who they could contact to help them solve the problems they had encountered, suggested solutions, chose the best alternative, developed and implemented an action plan, and reported on their projects.

In some of the audits, however, data were collected and then 'abandoned' (AM4.7). After writing up the findings of his waste audit on the board, Ayanda proceeded to give examples of what can be done to reuse or recycle or compost different types of waste. In my opinion, this could have been done without making the learners spend an entire lesson meticulously counting every piece of rubbish in the school bins! Ayanda did not take the opportunity to explore, with the learners, what the findings might mean. In a similar way, Ntsiki did not explore with her learners what the numbers in her water consumption audit might mean. She concluded the lesson by discussing ways of saving water, which could have been done without making the learners count leaks and take meter readings.

4.3.4.8 Evidence of learning and meaning making in evidence-generating audits

When teachers were asked to provide evidence of what had been learnt through the audit, most of them responded in one of two ways. They either provided evidence of learning against the intended outcomes of the lesson, or they provided evidence that the moral lessons of the audit had been learnt (AM21). For example, Mbatho and Tom were able to see close links between the intended outcomes of the lesson and what had been learnt through their audits.

Commenting on the success of his lesson, Ayanda said:

> I think they enjoyed the lesson, although I was doing the lesson for the first time. But it went well … They could even realize, maybe we eat much sweets, or much chips. They could even realize that we spend a lot of money buying sweets. They commented that we are spending a lot in buying sweets. It just that … I haven't done savings in Economic and Management Sciences (EMS) - the ways of saving money - that you can save rather than buying sweets. Because at times it's not really healthy.
>
> (it9)

I interviewed some of Ayanda's learners to find out what the findings of the audit meant to them. An excerpt from our ensuing dialogue follows:

> Pat Hoffmann (PH): Why do you think that your teacher wanted you to do this lesson today?
> Boy One: I don't know.
>
> PH: Why did you count the number of plastics, number of papers, and number of tins?
> Learners: We don't know.
> Boy Two: Because we want to know how many papers are around our school.
>
> PH: Why do you want to know that? [Long pause. Eventually, I read the audit findings to them to remind them what they had found in the bins.] What does that tell you? Which group had the most waste?
> Learners: Plastics. Chips, sweets, plastic bags.
>
> PH: Yes. Where did they come from?
> Boy Three: Lying [on the ground]. Some from the air. Come from outside. When I asked them why they thought the teacher had instructed them to separate the tins, plastics, paper, as so on, there was a long silence. So I prompted them.
>
> PH: What can you do with the papers?
> Boy Four: You can make dishes.
>
> (gt9)

I asked the children what they had learnt about waste during the lesson. Each time I asked a question about "waste" one of the boys insisted on talking about how water is wasted in the school and that he had learnt that they should save water. He could not seem to remember anything he had learnt from the lesson on waste. Other learners seemed to remember the 'message' of the lesson very well, but could not say much, if anything, about the auditing process itself. They said they had learnt that they should separate paper from the plastic and that they should throw their rubbish in the bins, rather than on the ground. One boy said: "And I learnt that we can reuse

it." Another boy said that he had learnt that "you have to put the dirt where it belongs. Put [it] in the plastic, put [it] in the bin." It is difficult to see, from this evidence, whether the lesson was able to teach the learners anything that they had not already known before the audit. When I asked the learners whether there was anything that they still wanted to know about waste that had not been covered in the lesson, a girl said she wanted to know more about how plastic can be recycled or reused. When I asked them how they thought they could contribute to solving the problem of waste in their school, the learners offered several ideas for managing existing waste better, but had no ideas for reducing waste.

Like Ayanda, Ntsiki's reflections on the learning were limited to a suggestion that the moral lessons of the audit had been learnt. She said: "[The learners] become aware of the importance of water and why we should save water …They change[d] their behaviour in water usage. Using cups when drinking water, keeping buckets in the classroom. Reporting leakage they found at school." She said: "The learners will no longer waste water because they are well equipped. That is they have knowledge and skills of saving water" (p1t1).

4.3.5 Case Story Three: an "actualizing audit"

4.3.5.1 Introduction

Ntsiki Ndzingwa is a grade three teacher at Kwadinabakubo Combined School, in Molweni, outside Durban. She joined the *Schools and Sustainability* course in February 2005. The environmental focus of the second learning unit of the course was sanitation and all participating teachers received a resource-based learning pack of materials to support teaching and learning about sanitation. Ntsiki chose to include a focus on sanitation in her grade three Life Skills work schedule, and to use some of the materials and audits from the RBL pack provided. Ntsiki's portfolio (p2) provided data for this case story. It included her lesson plan, examples of learning support materials, examples of learners' work, and her reflections on the lesson. I also drew on my observations of her lesson, my semi-structured interview with a group of Ntsiki's learners after the lesson, and my semi-structured interviews with Ntsiki before and after her lesson.

4.3.5.2 Teacher's intentions

Ntsiki's lesson plan listed the following aims and outcomes for her lesson on sanitation (p2t1):

- The learner will be able to describe sources of clean water and unclean water;
- The learner will learn how to conduct a simple experiment;
- The learner will be able to plan an investigation as part of a group;
- The learner will be able to participate in a planned activity;
- The learner will be able to show and explain what was intended and what was done.

The aim of the *E. coli* experiment was "to find out that our hands are not clean" and that "germs are all over the air." She said: "I've chosen to use this simple experiment for washing hands ... So that they can see that their hands are always dirty … There are lot of ways of getting the disease, so they must know it's very important to wash hands." Ntsiki hoped that the children would apply what they had learnt in the classroom, at home: "So, for them to see and do these things practically, they can do it after, at a later stage. Not to do it only in the classroom, but even when they are at home, in real life situation, they must apply these things, what they have learnt in the classroom." When I asked her what she thought the learners would gain through the lesson, she said: "… now their lifestyle will change – now they will no longer touch any food without washing their hands."

When I asked her why she had chosen to do this particular sanitation audit, Ntsiki said:

> I chose it because you know when you teach learners, and when you teach them by imagining things. Because you have to bring the real things in the classroom, do the practical thing, so they will know and they will remember when they are at home, what are they expected to do. So, it's better to do auditing because they easily remember and they know the rules, like this one of sanitation, which is very important. You know the learners when they go to the toilet, you can tell them to wash their hands, but they forget. And with this auditing thing, because we are going to do this little experiment with them, so it will help them to see that all around the earth there are germs. You see, even if you are staying in the classroom. Before you touch food, before you eat your fruit, you must wash your hands, you must wash your food …Usually we just tell the learners … you don't do things practically. We just take it for granted that they will understand what you are talking about and that becomes very

difficult for learners because some of them they haven't experienced
these things … So they see no reason – they don't understand what you
are talking about.

(Interview [i] 1t1)

4.3.5.3 Ntsiki's lesson plan

In this Life Skills lesson, Ntsiki taught an enormous class of 94 grade three learners. The experiment she conducted made use of the "MicroLife *E. coli* kit". She followed the instructions for the "Clean Hands Test" (Appendix 9) provided in the "Sanitation Works" Series (Share-Net, 2003).

(1)   Ntsiki introduced the lesson by reminding the learners about what they had learnt in a previous lesson. She drew their attention to a series of posters on the wall illustrating healthy and unhealthy environments and information about cholera. She asked them questions about the posters to find out how much they could remember. For example, Ntsiki asked the learners how to purify water using "Jik" and they responded. Many answers were limited to "Yes, teacher." There were some simultaneous answers from the whole class and also many questions directed at individual learners.

(2)   Next, Ntsiki read a story from a newspaper about a crèche that was about to receive piped water at their school and how this was expected to benefit the children. Commenting on the article, Ntsiki said:

There is water now in the crèche. Now they are happy because they will
be able now to encourage their learners to wash their hands. Yes. And
they want to be the exemplary in the community of cleanliness. Yes. So
in the school there was no water. So now they built the pipes for them to
get water in the school.

(i2t1)

(3)   Next, she selected sections of a cholera pamphlet and read them out aloud.

(4)   To introduce the *E. coli* experiment, Ntsiki asked the class how many of them had washed their hands before coming to class. They all held out their hands and answered "Yes, teacher". She told them that she would help them do an experiment to check how clean their hands were. Ntsiki provided step-by-step instructions for the learners throughout the experiment, following the instructions provided in the "Clean Hands Test."

(5)   First she passed three tubs of clean water around the class for all of the children to wash their hands in. The water became quite murky after all the hand-washing! Learners were very enthusiastic about the activity and Ntsiki frequently had to calm them down and keep them quiet. As I took photographs, the learners crowded in to try to be in the picture. My presence was clearly a source of distraction, but this did not seem to disrupt the lesson.

(6)   Ntsiki demonstrated how to fill the droppers with water. She used the term 'millilitres' but also showed them the level to which the droppers should be filled and how to dispense the liquid into what she called "test tubes" (actually vials). She handed out the vials and told the children to place them in the middle of each table. There were only enough vials for one or two per table of eight learners. There was a sense of great anticipation and suspense. She instructed the group leaders to fill up their bottles with colilert solution and contaminated water from the tubs in which they had washed their hands. The class 'hummed' with excitement as the children chatted to each other about the experiment.

(7)   Ntsiki explained that some bottles would be left on the warm windowsill overnight and that some would be incubated under the children's clothes and taken home overnight. She explained that the vials now contained germs and warned the children not to play with them. She showed them how to seal the vials in little plastic packets containing a drop of "Jik". She showed them how to incubate the vials in their underclothes and recommended that they put the vials into their armpits to keep them warm.

(8) Next, Ntsiki prepared the control. It appears that she did not fully understand the procedure, because when she was preparing the control, she impulsively put her hand into the jug of cooling boiled water to feel the temperature, thus contaminating the water. I had to intervene and help her make up a new control with water from the tap. This water was not boiled, unfortunately, but we hoped it was free of coliform bacteria. I noted that she kept calling the colilert solution "*E. coli*", which was incorrect. She explained to the class how she had made the control. She told the learners that she had put clean water and food for bacteria and colilert solution into the vial. In saying this, she confused the colilert with *E. coli* and apparently did not understand that the colilert was a bacterial growth medium. Finally, she took three of the vials, wrapped them in foil and put them onto the windowsill. The rest were

placed inside the children's clothes to incubate. When she asked for volunteers to do this she got an incredible response, of course!

According to Ntsiki, "The following day, up to their surprise, the solution change[d] the colour to yellow. So it was proved that their hands are not germ free" (p2t1). In subsequent lessons the learners wrote up a brief scientific report of the findings of the *E. coli* experiment. Ntsiki used pictures from the "Sanitation Works" Series to show learners how diseases such as diarrhoea and worm eggs are transferred from faeces to hands and to other people. They talked about how rivers become polluted, and learnt she how to purify water with "Jik." Finally, learners wrote up a series of personal, household and school hygiene policies.

4.3.6 Analysis of the case story

In sections 4.3.6.1 to 4.3.6.4, I analyze relationships between choreography of the actualizing audits and subsequent teaching and learning (inter)actions and reality encounters (AS 2).

4.3.6.1 Teachers' intentions

Ntsiki valued the *E. coli* clean hands experiment because she thought it could help learners to understand that there are invisible germs on their hands (AM14.9). She recognized that it might be difficult for very young learners to understand the invisible risks associated with poor sanitation or hygiene practices, especially when they have limited experience (AM14.8). Ntsiki hoped that the experience of the audit would help learners to understand the idea of germs, and remember the lesson, more easily than if she simply told them about germs. As she put it: "So it's better to do auditing because they easily remember and they know the rules" (i1t1).

Ntsiki also hoped that the experience and the learning would bring about certain behaviour changes. She wanted the learners to understand why they should wash their hands after going to the toilet and before eating their food. As she put it: "now their lifestyle will change – now they will no longer touch any food without washing their hands" (i1t1). Like Ntsiki, Thenjiwe decided to do the Clean Hands Test with her learners to "(1) understand *E. coli* bacteria (2) to see how *E. coli* bacteria spread through human contact and drinking dirty river water and (3) to understand that

whenever you come from the toilet you should wash your hands [to] free them from germs" (p2t2). Ntsiki also hoped the learners would go home and teach their families what they had learnt and hoped that they would apply what they had learnt at home (AM14.13).

Ntsiki was able to see close links between the curriculum requirements of the Life Skills learning area and what could be learnt through the *E. coli* audit. Although it was quite a complex experiment, she tried to pitch the lesson at a level suitable for grade three. As Ntsiki explained: "In grade three you know, you don't introduce much of concepts. Just start from the simple things – the basic things … just the washing of hands, all those things" (i2t1).

All three teachers who used the *E. coli* experiment included a focus in their lessons on ways to take action to solve or prevent sanitation problems (AM5.2.5).

4.3.6.2 Teacher and learner participation

In all three *E. coli* audits, only part of the class was able to participate in the experiment because the kits teachers used had a limited supply of reagents and equipment for the experiment (AM3.1.1).
In all three lessons, the audit was pre-planned and managed throughout, by the teacher. The learners participated in pre-planned activities and were not required or invited to contribute to the planning of the audit. All research decisions were made by the teacher (AM3.1.3). The teacher gave very explicit step-by-step instructions for the learners to follow throughout the audit (AM3.1.4).

4.3.6.3 Learning and teaching support materials

All three teachers adopted an existing method of testing water for the presence of *E. coli.* None of them tried to adapt it in any way (AM10.1.1). Although the test can be conducted in different ways, adaptation of the method requires a very good understanding of the experimental method.

Kay seemed to understand the method fully, but Ntsiki and Thenjiwe did not understand the method adequately, and made some mistakes while conducting the experiment (ot1).

Role of the LTSM in the learning

The way in which resources were used seemed to influence the kinds of learning processes taking place in the actualizing audits of this case study (AM11.2). Some LTSM were used to mobilize learners' prior knowledge, for example, Ntsiki's cholera posters (AM11.2.1). Some LTSM, such as the story in Ntsiki's newspaper article, were used as a source of information for learners (AM11.2.2). In all three auditing lessons, the MicroLife *E. coli* test kit and the Clean Hands Test instruction sheet (Share-Net, 2003) were used to guide the investigation phase of the audit (AM11.2.3).

Who used the LTSM? (AM11.3)

Some LTSM were used only by the teacher, such as the story Ntsiki read to the class (AM11.3.1). Some LTSM were used by the learners themselves in the lesson, such as Ntsiki's template for writing up a scientific report (AM11.3.3). The teacher and learners used the *E. coli* test kits together (AM11.3.4).

4.3.6.4 Teaching and learning interactions among teachers, learners, resources and environment

Teachers' roles (AM16)

The teachers shared their knowledge on the topic with their learners in various ways. Ntsiki used guided questioning to mobilize their prior knowledge. Teachers provided learners with LTSM such as posters and equipment for the experiment. They gave the learners step-by-step instructions and helped them to do the experiment.

Learners' roles (AM16)

Learners listened to the teacher as she provided information and gave them instructions. They reported their findings and in Kay's lesson, they suggested solutions.

Active learning processes (AM17)

Ntsiki used posters from a previous lesson to mobilize learners' prior knowledge (AM17.2). She provided opportunities for learners to build on their prior knowledge by sharing her knowledge on the topic, and by providing learners with LTSM (AM17.3). The *E. coli* experiment provided learners with an opportunity to investigate the issue of germs on hands (AM17.4). After incubating their vials overnight, learners reported the results of the experiment to their teacher (AM17.5). Kay's learners took action by

encouraging other learners to wash their hands after visiting the toilet. Ntsiki's learners took action by learning how to purify water with "Jik" before drinking it (AM17.6).

Language (AM13)

Although Ntsiki taught in the home language of the learners, they still struggled with some of the terminology used in the lesson. Ntsiki and Kay provided learners with a gridword and a wordsearch to help them become more familiar with sanitation-related terms.

In sections 4.3.6.5 to 4.3.6.8, I analyze relationships between choreography of the audit and knowledge construction (AS 3).

4.3.6.5 Nature of the learners' experiences, including problems with the way the audit was conducted

Teachers' and learners' knowledge and skills (AM8)

Ntsiki and Thenjiwe understood the moral lesson or message of the audit, but had some difficulty understanding and following the correct procedure. There were methodological problems with the way both of these teachers conducted their *E. coli* experiments (AM8.4). Ntsiki and Thenjiwe both confused *E. coli* with colilert, the bacterial growth medium necessary for the experiment. Examples of learners' work from Thenjiwe's portfolio showed that learners had developed the same misunderstanding. The learners wrote in their experimental report: "Apparatus: Two bottles, one with boiled water and *E. coli* and the other bottle with water from washing our hands and *E. coli* to test the presence of germs" (lwt2). Evidently, Thenjiwe did not understand the aim of the experiment. She treated the experiment as a demonstration that boiling a contaminated water sample will destroy *E. coli* bacteria. But her methods were not consistent with that purpose.

In my opinion, the *E. coli* experiment was too advanced for Ntsiki's grade three learners, and she did not understand the method well enough to be able to make the experiment sufficiently understandable for them. In the focus interview with her learners, I detected some serious misunderstandings about the experiment. Learners knew that if their water samples were contaminated with germs that they would turn yellow overnight, but they did not understand why. Some of them thought that the

reagents in the experiment were *E. coli* or cholera and "Jik". This must have been confusing because both the control and the experimental sample contained colilert, which they thought was *E. coli* or cholera. Both were placed in "Ziplock" packets containing "Jik."

4.3.6.6 Teachers' and learners' accounts of the issue

Teachers' and learners' developing definition of the problem

Like many of the other audits in this case study, the learners' developing definition of the problem in focus seemed to be influenced by the way the audits were choreographed, and by the range of perspectives learners were exposed to in the process.

All three teachers included their *E. coli* audits as part of a series of Life Orientation lessons on sanitation. Ntsiki and Thenjiwe contextualized their audits by linking the idea of germs to the idea of drinking dirty river water. Ntsiki's *E. coli* audit was followed by a demonstration of how to purify water using "Jik." Thenjiwe preceded her *E. coli* audit with a lesson on poor sanitation practices, waterborne diseases, and the dangers of drinking dirty river water. Kay contextualized her audit by linking it to the idea of washing hands properly after visiting the toilet. Her *E. coli* audit was done after conducting a survey of the hand-washing behaviours of other learners in the school and after an impression-based audit of the state of the school toilets.

Ntsiki and Thenjiwe's concerns seemed to lie primarily with the relationships between the individual learner's sanitary practices and human health (AM5.2.1). Consequently, their learners seemed to develop an understanding of sanitation issues as a personal problem for which they had to take individual responsibility. For example, after doing the *E. coli* audit, Thenjiwe's learners made posters "with the message warning others to be aware of dirty water usage and suggesting the cleansing of hands whenever you come from the toilets and before touching food" (p1t2). One of her learners wrote: "Dirty water can cause serious diseases by drinking dirty water and bathing in dirty water, dirty water is very dangerous" (lwt2). Ntsiki's concern for the sanitation practices of the individual was reflected in her conclusion to the experiment, which stated: "Germs are everywhere. It is important to wash our hands after going to the toilet or before we eat" (p2t1). When I asked the learners what they had learnt about sanitation during the lesson, Ntsiki translated their responses into English for me, as follows: "[Boy One] has learnt that every time

your hands must be clean … [Boy Two has learnt that] If he want[s] to make food, [he] must start by washing hands with water. Even if you come from the toilet – wash your hands" (gt1).

After doing the *E. coli* audit, Ntsiki taught her learners how to purify water before drinking it. The learners' developing definition of the sanitation issue was reflected in Ntsiki's comments when she said:

> They also like the idea of drinking water with a drop of "Jik" because they say that water is very clean and got no germs. They say even at home they taught others what they've learnt. Now they know that they should [put] one teaspoon of "Jik" in a ten litre bucket of water.
>
> (p2t1)

By the end of Ntsiki's series of lessons, the learners' definition of the issue seemed to have expanded a little, but was still lodged within the original perspective Ntsiki had introduced. This perspective centred on the relationships between individual sanitary practices and human health. One of her learners wrote a hygiene policy which stated: "I must wash my hands before I eat; wash hand[s] after going to toilet … not to eat in a plate, bowl or dish and not wash it … and use it again where flies have been sitting on it … [the school] must have clean toilets" (lwt1).

Although it seems that a diversity of perspectives on sanitation were developed through these audits, none of the *E. coli* auditing lessons undertaken in this case study considered or examined impacts of sanitation issues on ecosystems or biodiversity (AM5.2.4).

Processes of involvement and detachment

Unlike many of the impression-based and evidence-generating audits in the case study, the *E. coli* audit did not bring the learners into a close emotional involvement with the issue they were investigating. The learning appeared to be highly decontextualized and detached.

Reality-congruence of learners' accounts

After doing the *E. coli* experiment and learning about waterborne diseases, one of Thenjiwe's learners made a poster which said: "How non-purified water can cause serious disease: … When you drink dirt[y] water you can get a serious disease like malaria …" (lwt2). This was a misunderstanding that Thenjiwe did not correct when

she assessed the learner's work. Malaria is not a waterborne disease, but is transmitted by mosquitoes (Picker, Griffith & Weaving, 2002). Evidently, Thenjiwe's knowledge of waterborne diseases was limited or inaccurate. In my opinion, Ntsiki and Thenjiwe's learners did not understand the experiment as well as the teachers seemed to think they did.

4.3.6.7 Findings of the audit

Ntsiki knew what the findings of the *E. coli* experiment would be beforehand. Like her evidence-generating water wastage audit, this *E. coli* audit was done to prove or demonstrate a point or get a predetermined message across (AM19.1). She said: "I wanted to prove to the learners that their hands are always dirty, by testing the *E. coli* bacteria" (p2t1). The findings of the audit were used to reinforce that message. Ntsiki said: "Up to their surprise, the solution change the colour to yellow. It was proved that their hands are not germ free … Yellow colour is a positive test for the presence of coliform bacteria" (p2t1).

In all three teachers' cases, the experimental samples containing contaminated water tested positive for the presence of coliform bacteria on children's hands (AM19.1). None of the teachers used the torch provided with the kit to find out whether the coliform bacteria included *E. coli* bacteria. This may have been due to a lack of certainty about what a fluorescing sample should look like (rw).

Validity of findings

As explained above, Thenjiwe's understanding of the experimental method was incorrect. Although she got the same result as Ntsiki and Kay did in their experiments, her explanation for that result was wrong (AM19.2).

Working with the findings (AM4)

Given the way in which these experiments were conducted, the range of potential results was limited. The experimental sample could either test positive for the presence of coliform bacteria, or negative. There were no data, as such, to work with. Learners who participated in Ntsiki's experiment were given an opportunity to write down the findings, in a simple scientific report (AM4.4). All three teachers had plans to build on the learning. Kay planned to introduce the topic of disease in the next lesson, drawing on what had been learnt about germs.

4.3.6.8 Evidence of learning and meaning making in actualizing audits

Kay's experimental report indicates that she understood the experiment correctly. She said: "Bacteria test kit was very effective. Learners were fascinated with the bacteria test kit. It was hands on active participation … They enjoyed keeping the "babies" warm … Learners were curious … learners enjoyed the hands on experience" (p2t11). Examples of learners' work in Kay's portfolio suggest that her learners recognized that germs exist in contexts other that those suggested by the experiment. Examples of learners' comments include: "Bacteria is unhealthy"; "We cannot see germs with the naked eye"; "The basin has lots of bacteria in it"; and "If we don't keep our toilets clean we will pick up germs and infection" (lwt11).

When Ntsiki was asked to provide evidence of what had been learnt through the *E. coli* audit she said: "The lesson was of good help to the learners because they were not aware germs are all over air and they should always wash their hands before they eat anything and after going to the toilet" (p2t1). She had some doubts about whether the intended learning outcomes of the lesson had been achieved yet and said that she planned to go on with the series of lessons for the next two weeks (i2t1). She thought that the hand-washing test had helped the learners to understand the idea of germs, which would prepare them for the next lesson. She said: "That was a good start for me because it was easy now when I tell them about purifying water before they drink it especially water from rivers" (i2t1).

Thenjiwe reflected on the success of her lesson saying:

> After the hand test (*E. coli* bacteria) [learners] were … in a position of telling others / themselves also of washing their hands every time after … using the toilet and also taking care of any dirty water. It has also contributed to the good sanitation practices … Also that river water is not good for human drinking before purification.
>
> (p2t2)

So, despite the flaws in the audit, she was satisfied that her environmental message had been shared.

4.4 Concluding summary

This chapter has presented an overview of the evidence from the case study and the building blocks for the developing thesis. These findings are summarized below:

- In this study, three kinds of audits could be distinguished, according to the ontological interest that was embodied, the source of information for the knowledge that was constructed, and the methods that were used to mobilize / generate that information.

- The way in which an auditing lesson was choreographed influenced the nature of the subsequent teaching and learning processes and reality encounters.

- The choreography of the auditing lesson influenced the quality of subsequent processes of knowledge construction and meaning making, specifically, the teachers' and learners' findings, developing definitions of the problem, and subsequent accounts of reality.

- Teacher knowledge, skills and experience played an important role in shaping auditing methodology, choreography and meaning making.

The evidence presented in Chapter Four is discussed further in the next chapter, in greater depth, and in relation to the literature reviewed in Chapter Two.

CHAPTER 5: DISCUSSION OF THE FINDINGS

The world is a vast accumulation of fascinating stories. Through careful observation and sharing with others, we can learn to read these stories for ourselves… If you don't learn how to read the world, then you will be dependent on others to tell you the stories, and you will live your life according to their stories. But learning to read the stories for yourself will allow you to choose your own course.

(Krapfel, 1999:62)

5.1 Introduction to the chapter

In Chapter Four, I presented and analyzed evidence of ways in which auditing processes played out in the case of the *Schools and Sustainability* professional development course. Particular attention was given to how audits were choreographed and used by teachers for lessons within their school contexts. My first interpretation of the data differentiated three approaches to auditing from among the twenty-seven audits in this case study. I chose to refer to these three approaches as (1) an impression-based methodology (2) an evidence-generating methodology and (3) an actualizing methodology. The descriptors I used to describe and differentiate the audits in this case study are presented in Appendix 7 and in the footnotes to this Chapter. My developing interpretations were then examined in more depth within three individual case stories. Further analysis and interpretation of the data revealed some of the relationships between auditing methodology, the choreography of auditing lessons, and knowledge construction and meaning-making processes associated with these.

In this chapter, I revisit the evidence in relation to the literature reviewed in Chapter Two. I draw on theory to broaden my perspectives on the key findings and synthesize what I have learnt about how the undertaking of environmental audits shaped learning processes in this case study.

5.2 Auditing methodology [6]

In Chapter Four I probed the significance of teachers' choices from among the range of possible methodological alternatives as I analyzed a series of case stories. I found that the teacher's methodological choices seemed to have implications for (1) the ontological interest that was embodied in the audit (2) the methods that were used to mobilize / generate information through the audit and (3) the source of information that was used in knowledge construction. I also found that teachers and learners in the case study tended to have a reactive orientation towards environmental risks. These findings are discussed in the paragraphs that follow.

Auditing methodology, the kinds of environmental risks audited and types of evidence generated

All of the environmental audits in this case study enabled teachers and learners to explore their local contexts and investigate environmental risks in or near their schools and communities. Some kinds of audits, however, seemed to be more effective at auditing certain kinds of risks than others. The impression-based audits appeared to be better suited to auditing visible risks, such as air pollution, poor waste management and state of the school toilets (section 4.2.1). They were less effective at auditing risks that were difficult to detect by sight or other senses. Impression-based audits recorded evidence in the form of opinions, impressions and observations (Appendix 15). The evidence-generating and actualizing audits in the study were not limited to gathering evidence on visible risks, but were also effective at auditing risks that were less apparent, such as the presence of coliform bacteria on hands, wasteful water consumption practices at school and water pollution in the local river. This was made possible through the use of methodological tools and practices such as experiments, measurements, calculations and ecological studies (sections 4.2.2 and 4.2.3; Appendix 15). Actualizing audits, it could be argued, are a subset of the evidence-generating type of audit. The actualizing audits in this case study were particularly suited to gathering evidence on the effects of invisible

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[6] As explained in Chapter Four (section 4.2), my use of the term 'auditing methodology' throughout this study refers to:

- The environmental focus of the audit;
- The auditing methods and instruments which were used;
- The kinds of data that were collected or generated;
- The auditing sites that were used.

phenomena. These differentiating characteristics are discussed further in section 5.4.3.1.

The tendency for teachers and learners to have a reactive orientation in response to risk

As discussed in Chapter Two, many of the risks of modernity are imperceptible, and yet the significance of environmental risk is becoming increasingly apparent in daily life. In the light of these concerns, it is becoming more important than ever for environmental educators to support pedagogical processes which can mediate a proactive engagement with the imperceptible risks in our environment in a manner that is congruent with reality.

It is interesting, therefore, that teachers' use of environmental audits in dealing with risk in this case study, tended to be reactive. Most audits were set up in ways that enabled learners to document their impressions and/or collect evidence on manifest, perceptible hazards, while placing less emphasis on hazards that were not yet manifest, or imperceptible (Appendix 15). Information about potential hazards seemed to occupy a central place in many auditing lessons, and a concern for such hazards provided a context for the moral lessons that were taught. There was little evidence, however, of auditing processes that allowed learners to audit imperceptible hazards through processes in which they could proactively engage with the focus of concern through data gathering and in-depth deliberation. This finding supports Riechard's (1993) assertion that education tends to have a reactive orientation in response to environmental risk.

While the identification of issues and the mobilization of learners' impressions may be a useful starting point, auditing in environmental education needs to go beyond the documenting of impressions followed by emotive reactions. Audits need to be carefully structured by teachers to mediate proactive engagement with risk and appropriate responses. The choreography of auditing lessons therefore requires further discussion.

5.3 Auditing choreography: teaching and learning interactions, and reality encounters [7]

The second key finding of this study is that the way in which auditing lessons were choreographed seemed to play an important role in shaping the teaching and learning interactions in the lesson and the nature of the learners' encounters with the focus of concern (AS 2). While auditing methodology played an important role in directing the focus of the audit, as argued in section 5.2, it appears that auditing choreography played a stronger role in shaping possibilities for learning in the auditing lessons in this case study. This is illustrated in Appendix 14, which compares two methodologically-similar waste audits. Although some teachers in the case study made similar choices from among the range of possible methodological alternatives for their audits, it was their decisions about auditing choreography that seemed to have a stronger shaping role in their lessons.

Audits choreographed within outcomes-based learning perspectives
As discussed in Chapter Two, teachers in South Africa are faced with a great deal of uncertainty as a result of current ongoing processes of educational and political transformation. As a consequence, teachers in this case study seemed to be grasping for resources and activities that could ease their transition to an outcomes-based approach to education. The *Schools and Sustainability* course offered teachers an opportunity to use new resources and try new activities, such as audits, aligned with an outcomes-based approach. They seemed to feel good about teaching the moral lessons associated with environmental education, and to be impressed by the notion that they could be 'agents of change' for a more sustainable environment.

In this case study, a point of tension became evident in the way some teachers seemed to value the moral lesson or 'message' of the audit or the practical,

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[7] As explained in Chapters Three and Four, the use of the term 'auditing choreography' throughout this study refers to:

- Intended learning outcomes and moral lessons;
- How the audit was contextualized;
- How LTSM were used in the audit;
- Processes of teacher and learner participation;
- Teachers' and learners' roles and learning interactions;
- How learners were supported to acquire the language of the lesson.

participatory, learner-centred and enjoyable elements of the auditing activities more highly than the intended learning outcomes of the lesson. A preoccupation with teaching moral lessons that are aligned to varying degrees with learning outcomes seemed to over-shadow some teachers' intentions to provide opportunities for meaning making and in-depth engagement with the focus of concern. This was reflected in those lesson plans that were set up to 'preach' predetermined environmental messages and that gave nominal attention to the learning processes themselves. Some teachers measured the success of their lessons against criteria such as how well the moral lesson had been learnt and how enjoyable the activities were, and paid less attention to evidence of learning and achievement of learning outcomes. This seems to indicate that an unquestioning embracing of the practical and participatory dimensions in the design of audits could give teachers a false confidence that they are enabling their learners to engage meaningfully with environmental concerns.

This case study has shown that a wide range of curriculum-linked concepts and skills can potentially be learnt through auditing. In general, the evidence-generating audits provided more opportunities for the development of curriculum-linked knowledge and skills, while the impression-based audits provided opportunities, primarily, for the teaching of moral lessons. This should not be taken as a rule, however, since some teachers were able to contextualize and choreograph their impression-based audits in ways that provided rich opportunities for the development of curriculum-linked skills and knowledge. Most teachers used audits as opportunities for learners to develop and practise investigative skills and life skills. Some teachers were able to contextualize and choreograph audits in creative ways that related to a wider range of learning areas and learning outcomes.

Audits choreographed within behaviourist perspectives
In the literature review I mentioned my surprise at the teachers' enthusiasm for environmental auditing (section 1.4). I observed that some teachers developed an almost religious zeal for teaching moral lessons associated with environmental education. This is consistent with the findings of Jensen and Schnack (1997), who noted a tendency in Danish schools for teachers to be preoccupied with changing learners' attitudes or behaviours, or with inculcating better habits in them. They criticized the tendency for teachers to neglect the cognitive aspects of environmental education. Although the teachers on the course knew that they needed to do activities that would support the development of curriculum-linked skills, many of

them still seemed to value activities that they thought would help learners to remember the facts needed for their examinations. This phenomenon is reminiscent of the idea of auditing within a 'targeted messages approach', which was described in Chapter Two (section 2.2.3.2).

Another point of tension became evident in the way some teachers in the case study seemed to value the moral lessons that emerged through their auditing lessons more highly than the need to 'get to grips' with reality. This is discussed further in sections 5.4.1 and 5.4.2. Some teachers appeared to value these moral lessons more than the actual auditing processes and their potential to support learning and knowledge construction. In some instances, teachers appeared to be unconcerned about the quality of the auditing methodology, experience and findings. They appeared to be satisfied with the learning, as long as the moral lesson had been taught. It seems that behaviourist assumptions and intentions can easily be camouflaged within techniques borrowed from popular contemporary theories such as the active learning framework and outcomes-based education.

Audits choreographed within individualistic perspectives

Some teachers in the case study seemed to elevate moral lessons that focused on the responsibility of individuals to take action in relation to environmental and social problems. However, as argued in Chapter Two (section 2.6.2), behaviour change is no longer endorsed as an appropriate goal for environmental education. Heck (2004) and others (e.g. Robottom & Hart, 1995; Jensen & Schnack, 1997) have challenged the idea that individual behaviour changes can address the root of environmental problems, since many problems require collective action and changes at a social and societal level. This approach to environmental education has also been criticized for neglecting the deeper cultural transformations required for a shift to more ecologically sustainable ways of living (Smith & Williams, 1999). My interpretation of the data is that the tendency of some teachers to individualize responsibility for environmental action was more a function of the ways in which their auditing lessons were choreographed, than a function of the methodological features of the audits and the auditing materials that were used.

Audits choreographed within socially critical perspectives

Audits embedded in a socially critical ideology should be characterized by processes of critical engagement for social and environmental transformation (R. O'Donoghue, personal communication, December 14, 2005). Most of the audits in this case study

seemed to fall into the category described by Greenall Gough and Robottom (1993) as scientific studies of social issues, rather than socially critical studies. Unlike Hart (1997), very few of the teachers seemed to see children's participation in environmental investigations as a potentially useful strategy for obtaining useful scientific data that could contribute, in a meaningful way, to environmental improvement and community development. Possibly, only Kay's series of auditing lessons (sections 4.3.1 and 4.3.2) could be confidently characterized as socially critical in its intent, although some of the other audits in the case study had certain socially critical elements.

Teachers' opinions about the extent to which the auditing processes had contributed to environmental action and problem-solving differed from mine, in several instances. My opinions correspond to some extent with those of Greenall Gough and Robottom (1993), who argued that many auditing processes do not engage learners in the kinds of social action advocated by socially critical pedagogy. In most cases, they asserted, "Little is done to empower the students to address the issues and resolve the problems" (Greenall Gough & Robottom, 1993:308). Commonly in this case study, teachers seemed to conflate the idea of teaching children about issues and about potential solutions to problems, with the idea of involving children in processes of "critical engagement which can lead to reflection and change" (R. O'Donoghue, personal communication, December 14, 2005). There was little evidence in this case study of auditing processes that allowed learners to engage proactively with the focus of concern through data gathering, in-depth deliberation and problem-solving (also see section 5.2). When I discussed this observation with one of the teachers, Thenjiwe Zulu, she argued that her lessons on sanitation, which provided learners with the knowledge of how to take action, were part of her strategy for solving the problem of sanitation in her school. She claimed that such lessons could in fact lead to reflection and change. Rogoff's (1990) work on guided participation in socio-cultural activity provides a useful additional perspective on this debate. She claims that the problems people face and the solutions that are considered appropriate are culturally defined (Rogoff, 1990).

As she explains:

> The structure of problems that humans attempt to solve, the knowledge base that provides resources, and the strategies for solutions that are considered more or less effective or sophisticated are situated in a social matrix of purposes and values. The problems that are posed, the tools that are available to solve them, and the tactics that are favored build on the sociocultural definitions and available technologies with which an individual functions. Further, the solution to problems often occurs in social situations that define the problems and provide opportunities for learning from social transactions.

(Rogoff, 1990:6)

Rogoff's (1990) words reflect her confidence in the ability of children to appropriate the cognitive tools and perspectives of the surrounding cultural community as they engage with teachers and peers in everyday activities. Rogoff (1990) goes on to explain that this appropriation of problem-solving skills happens most effectively through processes of guided participation in sociocultural activity. This involves (1) building bridges between what children already know and can do, and new information and skills to be learnt (2) arranging, structuring and supporting children's participation in activities (3) and transferring to children increasing responsibility, as they become more skilled at managing problem solving, themselves. She says that the degree of responsibility that should be given to the learner for achieving the overall goal depends on the skill and experience of the learner (Rogoff, 1990).

Drawing from Rogoff's (1990) perspectives, my tentative recommendation to Thenjiwe and to other teachers who use environmental audits in their lessons would be this: children need to be supported to develop the skills to use the available tools for problem-solving. Teachers therefore need to arrange and structure their learning activities, and regulate the difficulty of tasks in ways that support the development of problem-solving skills. As Rogoff (1990) explains, effective structuring of learning activities involves maintaining children's involvement with the purpose of the activity, in a manageable and supported form. If the overall goal of environmental auditing is to help learners to engage in critical reflection about environmental risks and to make informed decisions that will contribute to a more sustainable environment, then auditing processes should be structured in ways that support learners to participate in and manage problem-solving activities themselves. This suggests that audits need to go beyond the mere identification of environmental issues and learning about issues. However, identification of issues by the learners themselves, rather than by the teacher, can be a useful starting point.

When I viewed the data from this perspective, it seemed that some of the practical and participatory activities teachers had implemented had not been adequately structured or supported. It seems that teachers on the course may need additional support to arrange and structure their auditing lessons in creative and effective ways. It is useful, therefore, to discuss learning and teaching support materials in the section that follows.

Learning and teaching support materials

I have observed that an extensive range of LTSM is available to teachers for environmental auditing. These materials vary in focus, approach and methods, as well as in quality and educational value. All teachers in this case study used LTSM in their auditing lessons and they played a central role in many of the lessons.

When planning their auditing lessons, teachers in the case study made decisions about how teaching and learning processes would be supported through the use of materials. Teachers made decisions about which materials would be used, whether they would adopt, adapt, or design their own materials, the centrality and role of the materials in the lesson, and who would use them.

Czerniewicz *et al.* (2000) and the NEEP-GET (NEEP-GET, 2005b) found that poor use of LTSM in schools was impeding successful implementation of Curriculum 2005. While some teachers in the case study were able to select, design or adapt and use LTSM in appropriate and reflexive ways, others seemed to make comparatively poor use of available materials. The evidence from the case study was consistent with the findings of an evaluation of the *Schools and Sustainability* course of 2004 (Hoffmann, 2004), which found that some teachers appeared to adopt 'blindly' the materials that had been provided on the course and to use them without the necessary adaptations for their grade, learning area and context. Some teachers seemed to select LTSM without considering whether the materials would help learners to become more competent in the learning outcomes intended for the lesson. A few teachers designed their own auditing materials for their lessons, but this seemed to be more challenging than adopting or adapting existing materials. In general, teachers on the course seemed to need more support to develop their ability to select and adapt materials, and to reflect critically on their use of LTSM.

As reported in Chapter Four, LTSM were used in a variety of ways in the audits in this case study. The ways in which they were used influenced the kinds of learning

processes that took place in the auditing lessons. Generally, the impression-based audits in this case study required fewer LTSM than the evidence-generating and actualizing audits. My interpretation of the evidence is that the use of well-designed auditing methodologies and 'tried-and-tested' LTSM does not guarantee the quality of the teaching and learning processes that will take place in an auditing lesson. Nor does it guarantee the effectiveness of attempts at knowledge construction and meaning making. The skills and knowledge of the teacher seem to be key requirements for the successful undertaking of an audit. The role of the teacher's knowledge, skills and experience in using LTSM is discussed further in section 5.5. Where LTSM were used effectively, however, they seemed to play an important role in scaffolding and supporting learning activities and in assisting learners to acquire the language of the lesson.

Teacher and learner participation [8]

According to Lotz-Sisitka and O'Donoghue (2004), there has been growing interest in participation in education, in South Africa, since the 1990s. This interest is linked to the advent of democracy in post-apartheid South Africa, changes in social structure and a need to re-define patterns of practice. This 'participatory turn' may also explain why environmental auditing has become so popular in environmental education, and why there has been a shift from auditing as an activity exclusively for experts to auditing as an activity in which the public, including school children, can participate. School environmental education has been defined by Wals (as quoted in Heck, 2004:1) as "the process that enables students and teachers to participate in the planning, implementation, and evaluation of educational activities aimed at resolving an environmental issue that they themselves have identified."

The methodology and choreography of environmental audits seemed to influence the possibilities for learner participation in lessons and in problem-solving. The lesson

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[8] During phase two of the data analysis, I developed the following set of descriptors for processes of participation in an auditing lesson:

- The extent to which learners were able to contribute towards planning the audit;
- The extent to which all learners could be directly involved in the auditing activities;
- The extent to which learners could contribute towards planning follow-up activities;
- How learners engaged with the findings;
- The extent to which learners could contribute to the development of a plan of action to respond to the identified risks.

planning decisions the teacher made had implications for processes of participation in the auditing lesson. It appears that very few teachers in this case study invited their learners to contribute to planning the learning or environmental actions in any way, even though several of the intended learning outcomes highlighted the importance of learner participation in planning and making decisions. Rogoff's (1990) work on guided participation, discussed in section 5.3, emphasizes the active role of children as participants in their own learning and development. Her ideas help us to understand how, through guided participation, children are able to make links between their previous experience and competence, and the skills and information needed to solve new problems. There was little evidence in this case study of learners planning, implementing and evaluating educational activities aimed at resolving hazards they themselves had identified. In most cases, the focus of the audit and the auditing methods were pre-determined by the teacher.

Most teachers seemed to give little attention to auditing processes in which learners could proactively engage with the focus of concern through data gathering and in-depth deliberation around the findings. This is discussed further in section 5.4.1. There was little evidence that the teachers and learners took time to reflect on the accuracy of their impressions, and on the representations of the world they constructed through their involvement in the audit.

My tentative argument, based on the evidence presented in Chapter Four, is that possibilities for participation seemed to be limited when teachers and learners took up a reactive response to environmental issues and an uncritical view of their findings. This was particularly evident when auditing processes were characterized by close emotional involvement and impassioned responses. Some teachers seemed to feel very strongly about the issues being audited, and this may have led them to value the predetermined message or outcome of the audit more highly than the learning processes in the audit. In such cases, the accuracy of the teacher's accounts seems to have been taken for granted, and the findings of the audit, as long as they seemed to affirm the teacher's beliefs, were not challenged. In this way, some learners were denied opportunities to interrogate the findings themselves.

The quotation at the beginning of Chapter Five highlights the value of pedagogical processes such as audits that can teach learners to read the stories of the world for themselves. As Krapfel (1999:62) puts it: "If you don't learn how to read the world, then you will be dependent on others to tell you the stories, and you will live your life

according to their stories." This seems to have implications for the development of agency, because learners may fall into a pattern of receiving and repeating the teacher's stories of the world, without developing the skills to read and construct these stories for themselves.

5.4 Knowledge construction and meaning making [9]

The third key finding in this case study is that the choreography of the auditing lessons influenced the quality of subsequent processes of knowledge construction and meaning making, specifically, the teacher's and learners' findings, developing definitions of the problem, and subsequent accounts of reality (AS 3). The evidence from this study seems to support the views of Rogoff (1990), who argued that the greatest influence of the social world on cognitive development is the determination

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[9] During phase two of the data analysis, I developed the following set of questions to help me explore the processes of knowledge construction and meaning-making in the auditing lessons:

Findings of the audit:
- Were the findings accurate and valid?
- Did teachers and learners engage critically with the findings?

Teachers' and learners' developing definitions of the problem:
- What range of perspectives did teachers and learners engage with in the lesson?
- How critical was that engagement?
- How did the balance between processes of involvement and detachment affect meaning-making?
- How well did learners manage to acquire the language of the auditing lesson?
- What kinds of knowledge were constructed e.g. propositional learning of scientific concepts only or situated knowledge?

The teachers' and learners' accounts of reality:
- Which segment of reality was audited?
- How did the teachers' and learners' accounts of the problem represent that segment of reality that was audited?
- Were the accounts of that segment of reality reality-congruent?

of which activities are available for children to observe and participate in, and which companions are available to provide support and challenge to them.

5.4.1 Critical engagement with the findings

As shown in Chapter Four, some teachers and learners did not engage critically with the findings of the audit. In some cases, there seemed to be tensions between the teacher's concern for what the data were saying and his/her preoccupation with teaching moral lessons. As discussed in section 5.3, these moral lessons sometimes came to represent what the teacher really wanted to say to the learners through the experience of the auditing lesson. It was notable that some teachers did not work with the findings at all but abandoned the data and fell back to the moral lessons that they intended to teach.

There is no evidence that any of the teachers encouraged their learners to critically work with and evaluate their data and the methods they had used to generate their data, or to debate the validity of their findings. I suggest that this should be an essential step in the undertaking of audits, particularly in the undertaking of impression-based audits. If auditing processes are to reflect the values of "the science of reflexive modernity" Ashley (2000:275), then they also need to promote an understanding of the limits of science and help learners to formulate appropriate responses to those limits.

There seems to be a need to make auditing processes more meaningful. This may be achieved, in part, when teachers structure auditing activities in ways that provide opportunities for learners to engage critically with their findings, and with the definitions they develop of the problem in focus. Audits need to do more than merely direct learners towards the achievement of fixed outcomes and the acquisition of pre-determined environmental messages. Teachers need to choreograph audits in ways that open up possibilities for participation by learners, by transferring increasing responsibility to learners for developing their own evidence-based accounts of the world, and for reflecting critically on their findings.

5.4.2 Teacher's and learners' developing definitions of the problem

5.4.2.1 Critical engagement with a range of perspectives

According to Monroe and Kaplan (1988), learners come to the classroom with preconceived notions of reality. Some of these notions can be supported by scientific fact and others cannot. They argue that learners should be given opportunities to engage repeatedly with various experiences that confront their original notions, to help them replace their original notions with new processes and ideas. This case study has shown that teachers can choreograph audits towards that purpose. The evidence suggests that the most successful audits, in terms of knowledge construction and meaning making, may have been those that were undertaken within a series of lessons progressively focusing on different dimensions of the same issue and supported by a range of learning and teaching support materials.

The teacher's perspectives appeared to play an important role in shaping learners' developing definitions of the problem being audited. Some teachers seemed to view the issue from only one perspective, using one method of gathering data. Other teachers undertook a series of different audits of the same issue. This provided learners with a diversity of learning opportunities and seemed to help them to develop broader definitions of the problem. It seems that auditing processes that provided learners with a diversity of perspectives on the issues of concern may have been more effective in helping learners to construct problem definitions "and act on the basis of the best information available" (Riechard, 1993:9).

In some audits, there was no evidence of teachers helping learners to uncover the root causes of environmental problems. Learners merely audited symptoms of the problem. It appears that when the range of perspectives was narrow, or based only on an individual's impressions, or when the teacher's need to teach a moral lesson was uppermost, learners were more likely to develop radical, unrealistic accounts of the issue in focus.

In many instances, teachers and learners did not seem to grasp the complexity of the environmental problems audited and therefore studied them from a narrow range of perspectives. As Riechard (1993) claimed, people do not always think clearly about risks and may demonstrate unrealistic views. My findings (from Ayanda's case story)

are in accordance with those of Membiela *et al.* (1993), who found that students did not perceive that the real problem with waste lay with those processes which lead to accumulation of refuse. The students focused on the presence of refuse in the city as the principal problem. Ayanda's learners, too, appeared to have a limited grasp of the complexity of the waste problem, and did not seem to recognize the relationships between consumerism and waste. Although his learners agreed that they ought to pick up their own litter and should not contribute to the creation of more litter, they admitted that they felt negative about picking up other people's litter.

In their international review of whole school approaches to sustainability, Henderson and Tilbury (2004) found that most audits focused primarily on environmental issues such as resource consumption and state of the school grounds. They expressed a concern that undertaking audits in this manner might reinforce a narrow interpretation of sustainability, which considers only concerns related to the physical environment. My findings in this South African case study were not fully consistent with theirs. I found that there seemed to be a preoccupation with the social effects of environmental issues and comparatively little concern for impacts on the physical environment. Although the course assignments guided teachers' choice of issues to audit and most of these related to physical aspects of the environment, it seems that teachers were more concerned with the social effects of environmental issues and tended to focus their audits on these.

A perspective that was conspicuously absent from the audits in this case study was a socially critical perspective which questions the way society has embraced lifestyles and technologies that ultimately harm the environment. Drawing from Jensen and Schnack's (1997) understanding of socially critical education, I suggest that a socially critical approach to auditing should prioritize the following processes:

- Exploration of different dimensions of the issue;
- Careful consideration of any conflicts of interest or conflicting views;
- Deliberation around why people choose to act or not to act in particular ways;
- Investigation of structural, contextual, cultural and societal forces that constrain individual action.

It is also worth noting that Jensen and Schnack (1997) have cautioned against taking a narrow approach, which focuses only on local issues, as learners also need to develop global understandings of environmental problems. This suggests that audits of local issues need to be linked in some way to global issues, and ought to lead to a

broader understanding of wider issues. Teachers therefore need to pay careful attention to the way in which they contextualize their auditing activities. Building on the point made earlier, in section 5.4.1, I recommend that teachers need to provide opportunities for learners to engage critically with their findings and to consider the significance of their findings from a broader range of perspectives.

5.4.2.2 The balance between processes of involvement and detachment

The evidence presented in Chapter Four suggests that some of the impression-based audits in this case study may not have created opportunities for learners to work with sufficient detachment to construct a realistic assessment of the issue in focus. This was particularly evident when learners audited issues that provoked emotive responses. Emotive responses, exaggerated accounts and extreme views associated with these were notable in many audits where processes of detachment were not well developed. As Elias (1981, as quoted in Elias, 1987) explains: "High exposure to the dangers of a process tends to heighten the emotivity of human responses. High emotivity of responses lessens the chance of a realistic assessment of the critical process, hence of realistic practice in relation to it."

According to Latour (1999:4), the tools and practices of science offer us ways of putting aside our emotive responses, temporarily, thus enabling us to pursue our investigations with a measure of detachment. Instead of setting up ways of looking at and representing the world that give rise to emotive and radical responses, audits may be set up to achieve a calm, detached measuring of what is really happening.

The data from this case study leads me to suggest that most of the impression-based audits by-passed the detour via detachment that may have helped learners to achieve a calm and reality-congruent grasp of the focus of concern. They seemed to allow and possibly encourage participants in the audit to engage in impassioned ways with the issue in focus. The emerging accounts of the issue tended to be rich in contextual details and assertively written, reflecting fervent concern for the environment. Some of these accounts seemed to be characterized by a "fantasy orientation" (Elias, 1987). In contrast, some evidence-generating audits in the study enabled learners to 'take a step back' from direct emotive engagement with the focus of concern. This seems to have been achieved towards the construction a more accurate representation of reality. In the process of tabulating, graphing and

analysing the data, for example, information about the issue becomes deconstructed, in a sense, before being reconstructed into a new representation of reality.

The "fantasy-orientation" (Elias, 1987) characterizing some teachers' and learners' accounts was not limited to impression-based audits, however. It also surfaced in those evidence-generating audits which did not employ the various tools and practices needed to achieve the necessary measure of detachment. Processes such as these appeared to be a consequence of the way in which the auditing lesson was choreographed, and a function of teacher knowledge and skill, rather than an outcome of the auditing methodology in itself.

5.4.3 The teachers' and learners' accounts of reality

> *The finger pointing at the moon is not the moon.*
> *(Krapfel, 1999, quoting a Zen saying)*

The theory of social constructivism describes the reality of everyday life as an intersubjective world. In this world, our subjective sense of reality is maintained through ongoing interactions with other people, who constantly reaffirm or challenge our sense of reality (Berger & Luckmann, 1966:169). The theory of critical realism allows us to distinguish between the world and our experience of it. It allows us to escape from the preoccupation of social constructivism with the finger pointing at the moon, and allows us to marvel at the moon itself! Critical realism acknowledges that some real entities are unobservable. This view of reality recognizes that even though some phenomena cannot be seen or experienced, they can be detected (or actualized) through scientific methods.

5.4.3.1 Which 'segment' of reality was audited?

Impression-based audits

The impression-based audits in this study were interested, predominantly, in the visible empirical-experiential 'segment' of reality. They documented learners' impressions of the state of the environment as it presented itself to them. As discussed previously, knowledge construction in these impression-based audits seemed to be based, primarily, on the mobilization of prior knowledge and learners' impressions. These audits seemed to be an effective method of documenting what learners thought they knew about the world (their transient realities). When used on

their own, however, these audits did not engage critically with, or challenge, the way learners saw or represented the world. It seems to me that incautious use of this methodology reflects a naïve interpretation of constructivism, which focuses predominantly on the individual and his/her prior knowledge, experience of the world and knowledge construction.

The impression-based audits in this study seemed to be less insistent on close encounters with the real world than the evidence-generating audits were. Some of the school sanitation audits, for example, could have been completed insider the classroom, without any need to go and look at the state of the toilets. Although they were often constituted by practical, hands-on, out-of-doors activities, these audits tended to be superficial. Auditing methods relied on empirical-experiential evidence and seemed to be less effective at helping learners to perceive and understand invisible risks, or the effects of those risks.

Evidence-generating audits

The evidence-generating audits in this study were also interested in empirical reality. However, they seemed to be less dependent than impression-based audits on learners' abilities to see (or detect in some other physical sense) the phenomenon or process of interest. They too were used to document learners' impressions of the state of the environment, but differed from impression-based audits in that they required learners to provide evidence to support those impressions. As discussed earlier, evidence was generated through techniques such as counting, measuring, categorizing, describing and interviewing. This helped learners to become aware of less-than-obvious processes that were occurring. As explained above, the evidence generated through these techniques was deconstructed, in a sense, when it was analyzed, and then reconstructed to produce a representation of reality.

Like compliance auditing (see section 2.2.1) and environmental monitoring (see section 2.2.3.1), some evidence-generating approaches seemed to reflect the assumption that there is a single objective reality, which can be measured and understood, if the right instruments and methods are used to perceive it. These approaches insisted on close encounters with the real world in their attempts to perceive risks and make meaning from those encounters, reaching, as it were, for the most accurate accounts of the world. While it may not be possible to know all that is happening in the environment with absolute certainty, the evidence from this case

study suggests that some auditing methods can tell us more about the world than others.

Actualizing audits

The actualizing audits in this study were interested in the effects of invisible phenomena. They documented the results of an experiment that demonstrated the existence of those invisible phenomena. Audits that belong to this group were characterized by their ability to make the 'invisible' effects of phenomena 'visible' through methods that actualized those effects.

The design of the actualizing audits in the study made them suitable for discovering emergent properties, that is, things learners could not observe or experience. I suggest that other actualizing techniques, not explored in this case study, might include the practices of mapping and graphing data to show patterns that would otherwise be impossible to see. Some of the audits in the previous two groups could possibly be adapted to take on characteristics of actualizing audits. For example, if Busi and Lungi had done a series of turbidity tests at different points along the river and at different times, they might have been able to map and graph these data to look for spatial and temporal changes in turbidity. Such patterns would not be visible to the observer undertaking a once-off impression-based or evidence-generating audit. Such data, obtainable only through the mediation of instruments that can transform reality into representations, might lead to important insights into the causes of the pollution in the river. In this sense, actualizing methods seem to be able to re-research the way we see things and help us to engage critically with what we think we know and experience.

5.4.3.2 How did the teachers' and learners' accounts of the problem represent that segment of reality that was audited?

In Riechard's (1993:12) words: "Accurate perceptions of risks are necessary for the attainment of a risk-literate society," and according to O'Donoghue, "attempts at meaning-making … are weak or good according to the extent to which they are reality-congruent and constructed within a close engagement with and in the real world and amongst the realities that we hold and share" (R. O'Donoghue, personal communication, April 14, 2005).

The limitation of some of the impression-based audits in this study is hinted at in the concept of the *habitus.* According to May (1996), "the habitus is inculcated as much by experience as by teaching, whilst its power is seen to derive from the lack of thought which informs its manifestations." According to Bourdieu (1991, as cited in May, 1996), "most people are statistically bound to encounter circumstances that tend to agree with those that originally fashioned their habitus." It could be argued that some impression-based approaches reflect an unquestioned faith in teachers' and learners' knowledge of everyday life. When learners were not given a chance to engage critically with their findings, subsequent accounts tended to mirror the teachers' and learners' expectations, or habitus. My tentative recommendation is that accounts of the world derived from audits ought to be appraised, according to the extent to which they are personal expressions or reality-congruent representations of reality.

In my study, the accuracy of learners' accounts seemed to depend less on the auditing methodology and LTSM used, and more on the teacher's intentions, knowledge and skills, the choreography of the audit, and on the way in which teachers and learners engaged with the findings. The reality-congruence of learners' accounts seemed to be improved when learners were given opportunities to generate data using different methods and when they engaged with a range of different perspectives on the issue. This is illustrated in Kay's series of lessons on sanitation. Kay's learners initiated their investigation by gathering data on their impressions of the state of the toilets. Later, they generated empirical data on learners' hand-washing practices through their evidence-generating audit. Finally, they undertook an actualizing audit to detect the presence of invisible bacteria on learners' hands. In this way, they were able to investigate different 'segments' of their reality and to construct reality-congruent accounts of their world.

As Latour (1999) suggests, scientists need to recognize that the more connected scientific research is to the social world (society, psychology, ideology, people etc.), the more accurate, verifiable and solid it will be. This view is in accordance with Beck's (1992) suggestion that risks can only be understood if research is a combination of Natural Science and Social Science, everyday and expert rationality, interest and fact. These recommendations have implications for professional development of teachers and other educators involved in the undertaking of environmental audits. They seem to imply that teachers need to be able to engage in

research at a fairly sophisticated level. The role of teacher knowledge, skills and experience in the undertaking of audits is discussed in the next section.

5.5 Teacher knowledge, skills and experience

The fourth key finding of this study is that teacher knowledge, skills and experience seemed to play an important role in shaping auditing methodology, choreography, knowledge construction and meaning making (AS 4). My findings are consistent with those of the NEEP-GET (2005b), which found that many South African teachers have a limited knowledge and understanding of local environmental issues. Krapfel (1999), too, found that most of the teachers he worked with lacked knowledge of the environment around their schools, partly because many were teaching in an area that was different to the area they had grown up in.

The skills and knowledge of the teachers in this case study seemed to be a key requirement for the successful undertaking of these audits. Some teachers were able to choreograph auditing lessons in creative and effective ways that seemed to promote and support good learning, almost regardless of the auditing methodology or the LTSM they chose to use. Conversely, other teachers seemed to struggle to make effective use of environmental audits as a strategy for lesson planning. It appears from the evidence that well-designed auditing methodologies and tried-and-tested LTSM cannot guarantee the quality of the teaching and learning processes that will take place, nor the success of attempts at knowledge construction and meaning making in an auditing lesson.

Where teachers seemed to lack adequate knowledge and experience of auditing methods, and when poor use was made of materials to support and extend the learning, teachers and learners tended to rely on the mobilization of prior knowledge to make sense of encounters. Some teachers seemed to over-value activities which mobilized learners' prior knowledge. Such practices have a limited capacity to support the construction of new knowledge and may not provide adequate opportunities for teachers and learners to confront their assumptions and misconceptions about an issue. According to Bartlett (1932, as cited in De Young & Monroe 1996:177), when prior knowledge is deficient, learners tend to reorganize the new materials they are reading to fit into whatever their existing expectations and interpretations are.

As I probed the role of the teacher's knowledge, skills and experience in an auditing lesson, I found the following set of descriptors helpful in understanding why the audits in this case study played out in the ways they did:

- The teacher's ability to implement an appropriate auditing method e.g. how well the auditing methods were followed and how this affected meaning making;
- The teacher's lesson planning skills e.g. the ability to make appropriate links to curriculum and how well the teacher contextualized the audit;
- The teacher's ability to select / adapt / design and use LTSM e.g. how well LTSM were used and how they supported the learning;
- The teacher's familiarity with and understanding of the topic and concepts;
- The teacher's assessment skills e.g. how carefully the teacher assessed learners' work and corrected misunderstandings;
- The teacher's ability to reflect critically on the method, the learning processes and the findings.

Professional development courses, such as *Schools and Sustainability*, may be able to contribute to teachers' continued development of these skills.

5.6 Conclusion

In this chapter, I have sought to answer my research question, by discussing what I have learnt about how the undertaking of environmental audits can shape environmental education processes in school contexts. I have presented a synthesis of the key findings of the case study and discussed them in the light of a range of educational ideas.

I have also presented a framework of descriptors that emerged from the data. I found them very useful in interrogating the evidence for this discussion. This framework has provided some starting points for conclusions and recommendations that will be developed further in the final chapter. The framework has also helped me develop insights into the professional development needs of teachers on the *Schools and Sustainability* course.

CHAPTER 6: CONCLUSION

6.1 Introduction

In Chapter Six I present a summary of the findings of the research, and draw conclusions based on my interpretation of the evidence. I offer some recommendations relating to the undertaking of environmental audits, the implementation of professional development courses for teachers, and the development of materials to support teaching and learning through auditing.

6.2 Summary of the key findings of this study

Four key findings emerged from the study. They are listed and briefly discussed below.

(1) The first key finding was that the audits undertaken by teachers on the *Schools and Sustainability* course were differentiated into three broad types. They were distinguished according to:

- The ontological interest that was embodied;
- The methods that were used to mobilize or generate information;
- The source of information that was used in knowledge construction.

The audits that belong to the group called "impression-based audits" were designed to construct knowledge about an issue using information sourced from informants' (inter)subjective impressions. This information was mobilized through methods such as opinion polls, observations, multiple choice questions and checklists.

The audits that belong to the group called "evidence-generating audits" were designed to construct knowledge about an issue using information which was sourced from informants' interpretations of empirical-experiential data. This data was generated through methods such as counting, measuring, describing, categorizing, and supporting impressions with observational evidence.

Audits that belong to the group called "actualizing audits" were designed to construct information about an issue based on evidence of the effects of unobservable phenomena. This evidence was generated through the mediation of scientific instruments and practices.

(2) The second key finding of this study was that the way in which an auditing lesson was choreographed influenced the nature of subsequent teaching and learning processes and reality encounters.

(3) The third key finding was that the choreography of the auditing lesson influenced the quality of subsequent processes of knowledge construction and meaning making, specifically, the teacher's and learners' findings, developing definitions of the problem, and subsequent accounts of reality.

(4) The fourth key finding was that teacher knowledge, skills and experience played an important role in shaping auditing methodology, choreography and meaning making.

These findings are discussed in detail in Chapter Five.

6.3 Educational implications of the findings

6.3.1 Auditing processes which over-emphasize processes of involvement

Some auditing activities in this case study seemed to bring learners into a close emotional involvement with the issue they were auditing, and this appears to have affected the objectivity of the learners' assessment of the issue. It seems that when learning processes are characterized by emotive responses, the tendency is for educators to have a reactive orientation in response to environmental risk. In the impression-based audits in this study, the kinds of risks audited tended to be those that were visible and about which teachers and learners had or could develop strong opinions. When learners' impressions or opinions were treated as data, there tended to be limited interrogation or analysis of the findings, and the accuracy of subsequent

accounts of the world was taken for granted. Documenting of learners' impressions may be a useful starting point if it leads to gathering of evidence and reflection on the findings. However, this approach alone may not be able to teach learners the empirical-analytical and reflexive skills required to construct reality-congruent accounts of the world.

The evidence suggests that when the balance between involvement and detachment in the methodology and choreography of the audit was tilted in favour of involvement, auditing processes were prone to emotivity. There was a tendency for learners to construct accounts of environmental issues as personal problems that are best dealt with at a personal level. If the lesson included a focus on possibilities for action, these tended to be personalized solutions, did not always relate to the findings of the audit, and sometimes amounted to lists of good habits that the teacher had provided. Although it is important for learners to make informed decisions about their personal lifestyles and choices, it is also necessary for them to understand environmental problems within their global and social contexts. Instead of encouraging learners to react to the visible symptoms of environmental problems, such as litter, audits should help learners achieve the detachment needed to find out what is really happening and to formulate appropriate responses.

6.3.2 The value of auditing processes characterized by a balanced interplay between processes of involvement and detachment

The evidence suggests that when auditing lessons provided opportunities for learners to step back from the emotivity of the situation, learners may have been able to assess the issue with a greater measure of objectivity. My recommendation is that the choreography and methodology of audits should be characterized by a balanced interplay between processes of involvement and detachment. Learning processes may be strengthened when audits are characterized by a calm measuring of what is happening in the world accompanied and assisted by a detour via detachment. It appears that the tools and practices of science can help learners to construct reality-congruent representations of the world. In the evidence-generating audits in this case study, the documenting of learners' impressions was not considered adequate. Evidence-generating methods required learners to justify their impressions or to interrogate and refine them through measuring, describing of evidence, testing and

analysis of data. It seems to be important to work with the findings in evidence-generating audits, since the accuracy of teachers' and learners' impressions prior to the audit is not taken for granted.

6.3.3 Auditing processes choreographed to affirm the teacher's beliefs

When teachers had very strong feelings about the issue being audited, there was a tendency for them to value the predetermined message or outcome of the audit more highly than the learning process itself. When the accuracy of the teacher's message was taken for granted, and the findings seemed to affirm the teacher's beliefs, learners tended not to challenge or interrogate their findings critically. In some cases, learners were not be given adequate opportunities to work with the findings and the data were abandoned once they had done their job of affirming the teacher's message or account of the problem.

Possibilities for participation seemed to be limited when little attention was given to the representations of the world that were constructed and to the learners' ability to debate and deliberate what they thought they knew about the issue. In some cases, learners were not given a voice and seemed to be expected, merely, to echo the teacher's voice. This seems to have implications for the development of agency. When learners fall into a pattern of receiving and repeating the teacher's stories of the world, they may be denied opportunities to develop the skills needed to read and construct the stories of the world for themselves. I tentatively suggest that this pattern may be encouraged by OBE because the products of the learning process are determined beforehand and learners are expected to demonstrate that they have achieved those intended outcomes. In order to be declared competent, learners must produce whatever the teacher and the curriculum demands.

The evidence suggests that the range of perspectives to which learners were exposed influenced the learners' developing definition of the problem in focus. When the emphasis in an auditing lesson was on affirming the teacher's beliefs, learners tended to engage with a narrower range of perspectives and consequently developed superficial representations of the problem in focus.

6.3.4 The value of auditing processes in which risks are examined critically from a range of different perspectives

It has been argued that when learners are allowed to engage with the world and to read its stories for themselves, space is provided for the development of agency. Giving learners a voice of their own opens up more possibilities for participation. The evidence suggests that when the message of the audit was not predetermined, learners could be encouraged to consider the problem from different perspectives. When auditing methods did not rely on the risks being visible, learners were able to learn about risks in their environment that were less apparent. It seems that when opportunities were provided for intersubjective negotiation of problem definitions, learners were better able to develop broader and deeper understandings of the problem in focus and more reality-congruent definitions of the problem.

When auditing lessons led to problem definitions and accounts of the issue that referred to a broader 'segment' of reality, these accounts reflected an understanding of environmental issues as being more complex than personal problems for which learners were expected to take individual responsibility. For example, Tom's learners discovered that successful resolution of the waste problem they were investigating required cooperation from government, local business, and the general public, as well as from individuals.

6.3.5 The significance of teacher knowledge, skills and experience

The evidence from this study suggests that some teachers lacked the knowledge, skills and experience to undertake environmental audits in effective and creative ways. This is cause for concern. When auditing procedures were not followed correctly, the accounts of the world that were constructed did not seem to be reality-congruent. When teacher knowledge and experience of auditing was limited, and poor use was made of materials to support the learning, auditing activities tended to rely, primarily, on mobilizing prior knowledge to make sense of the encounters. Effective structuring of auditing activities seemed to be achieved when teachers were able to build bridges between learners' prior knowledge and new information and experiences. When learners were restricted to using what they already knew to try to make sense of what they were experiencing, the potential to learn anything new and

to challenge the validity of what they already knew was limited, and possibly inadequate for making good sense of new experiences. The evidence suggests that some audits were less effective than others at challenging learners' assumptions and extending their prior knowledge. When auditing methods were flawed, seemingly as a result of inadequate teacher knowledge, the knowledge learners constructed during the experience seemed to be questionable. Consequently, some of the accounts of the world that learners constructed through these auditing processes were not reality-congruent.

6.4 Significance of the findings

I suggest that the findings of this study are significant when considered in the light of the escalating global environmental crisis and heightened interest in the notion of education for sustainability, particularly at this time as we move into the UN Decade of Education for Sustainability. The advent of democracy in South Africa seems to have been accompanied by a growing interest in understanding participation in education. The decentralization of empirical-analytical practices in environmental education may be linked to this interest. Activities that were previously assigned exclusively to the domain of experts or teachers are now becoming accessible to the public and to learners. This seems to be evidenced in the proliferation of activities such as auditing in environmental education in South Africa.

The development of OBE in the South African education system has been accompanied by the emergence of a number of tensions and a corresponding need for new approaches to professional development. For example, the role of the teacher has been reconceptualized. In particular, the transformational role of the teacher is being emphasized. Also, the roles of learning and teaching support materials and resource-based approaches to learning have been foregrounded. Implementation of the new curriculum seems to have been impeded by naïve interpretations of constructivism, and a number of challenges associated with a view of reality as socially constructed and relative. A further important tension is the uneasy relationship that seems to have developed between the ideologies and practices of a curriculum oriented towards outcomes and ideas about a socially critical curriculum.

6.5 Recommendations

The evidence from this case study suggests that the educational value of auditing may be strengthened through processes of data gathering and critical engagement with the findings that are choreographed in ways that lead to reflection and change. These recommendations are discussed further in the sections that follow.

6.5.1 Data gathering

As discussed in sections 6.3.1 and 6.3.2, some auditing processes in this case study did not seem to employ a useful balance between processes of involvement and detachment. I suggest that a "fantasy-orientation" (Elias, 1987) characterizing teachers' and learners' accounts may surface in those audits which do not employ the various tools and practices for gathering data and constructing representations that help to achieve the necessary measure of detachment.

My recommendation is that a useful balance between processes of involvement and detachment should be sought. Teachers should make use of auditing instruments that enable learners to 'take a step back' from direct emotive engagement with the focus of concern. This may be achieved through methods in which the evidence becomes somewhat decontextualized in the process of constructing a more accurate representation of reality. Auditing processes which enable a close engagement with reality, coupled with a measure of detachment, may lead to the construction of a more reality-congruent account and a more realistic assessment of the environmental issue in focus. For these reasons, baseline measures-based approaches, data gathering and graphing seem to be some of the key strengths of auditing.

6.5.2 Critical engagement with the findings

As discussed in sections 6.3.3 and 6.3.4, the findings of this study emphasized the limits of auditing processes in which accounts of the world relied heavily on the mobilizing of prior knowledge and field observations, in contrast to evidence-based approaches. Auditing methods such as these seemed to have a limited capacity to support the construction of reality-congruent accounts of the world, and may have

succeeded merely in affirming the teachers' and learners' previously held beliefs. In addition, they did not seem to be effective in helping learners to perceive and understand the invisible risks in their environment.

The value of audits seemed to be limited when teachers carried forward only the message which emerged from the audit into subsequent lessons, and when they did nothing with the actual findings once they had been generated. In some audits in this study, data were collected and then 'abandoned' and some teachers and learners did not seem to engage critically with the findings of the audit.

Conversely, when audits enabled learners to investigate the issue from different perspectives, they encountered incongruities and inconsistencies between their previously held beliefs and the situations they encountered. My recommendation is that auditing processes should provide a means of making learners pause to check the reality-congruence of their perceptions and engage with the discontinuities that become apparent in the data. Learners should be supported to pursue the questions they are prompted to explore and to reflect on. When learners are provided with opportunities to engage critically with the findings, for example, by writing them down, working with them, analysing, interpreting and evaluating them, they may be able to engage critically with the naïve knowledge they hold (*habitus*), and to pause and reflect on the accuracy of their knowledge of everyday life.

Auditing processes should provide learners with experiences in which they construct interpretations of the world that do not necessarily agree with their previous stories or the teacher's stories of the world. When teachers give learners the space to deliberate these conflicting or alternative explanations or interpretations, possibilities for the development of agency may be extended.

6.5.3 Reflection and change

Some kinds of auditing processes in this case study provided learners with information about issues, but lacked empirical-analytical data to compare with that acquired information. In some audits in this study, the message of the audit was not supported by the data and the teacher did not seem to allow the learners space to deliberate the differences. Some audits were not used as a way of checking up on reality. Rather, they seemed to be used as a way of teaching predetermined moral

lessons. Some kinds of audits in the case study seemed to do the converse. They provided learners with the experience of generating empirical-analytical data, but did not seem to support the learners with sufficient information to help them make sense of that data. It seems that in both scenarios, learners were denied opportunities to exercise their agency.

Audits need to move beyond the affirmation of teachers' perspectives. They need to open up possibilities for learner participation and the development of agency. This may be achieved when learners are given a chance to engage with a broader range of perspectives and opportunities to reflect on their previously held beliefs. Teachers therefore need to support learners to interrogate and work with the findings of their audits, to debate and deliberate what they think they know, and thereby to develop more reality congruent accounts of the world.

My recommendation is that auditing processes that reach for greater reality-congruence, through the mediation of tools and practices involving the gathering of data and the construction of representations, may be able to help learners make meaning of the world, and provide them with the relative certainties they need to know and to act. Audits should provide opportunities for the development of learners' agency, for example, by enabling learners to construct and deliberate problem definitions based on research from multiple perspectives, and to participate in planning and implementing action and monitoring of the environment.

6.5.4 Professional development

All of these findings have implications for professional development courses such as *Schools and Sustainability.* In my view, teachers need to be given opportunities to learn about auditing by undertaking audits. It is not be adequate merely to learn propositions about auditing. Similarly, teachers need to be given opportunities to engage with their concerns about the world, and not only with propositions about the world.

6.6 Tensions that emerged in the study and suggestions for further related research

A number of tensions have emerged, which require careful consideration and further research. A few of these have been selected and highlighted below because of their implications for curriculum and professional development.

- There seemed to be a point of tension between the need to achieve the learning outcomes of the curriculum and the need to choreograph audits in ways that enabled learners to 'get to grips' with reality. This tension needs to be probed further as it has implications for the development of environmentally-focused LTSM and lesson plans.

- Some kinds of auditing processes seemed to provide learners with experiences that merely affirmed the teacher's own interpretation or story of the world. This approach appeared to correspond with naïve interpretations of OBE in which the product of the lesson or audit became the goal of the lesson. I tentatively suggest that, in this sense, the curriculum may come to represent a dictator, if it is implemented in ways that discourage learners from disagreeing with the teacher when they encounter inconsistencies between alternative explanations. This tension needs to be understood better, for the benefit of professional development courses such as *Schools and Sustainability*.

- Naïve interpretations of constructivism tend to foreground the perspective of the individual and the personal meanings s/he has made of the world. When learners engaged with a very limited range of perspectives, auditing lessons appeared to be less effective at extending or challenging learners' perspectives. Impression-based audits tended to develop accounts of the issue that refer to a very limited 'segment' of reality – usually the social reality. Most auditing lessons in this case study were preoccupied with the social effects of environmental issues, and neglected other important effects, such as the impacts of environmental problems on the physical environment and the economy. This tension, too, needs to be better understood, as it has implications for the development of LTSM and lesson plans.

6.7 Conclusion

This case study has explored the use of environmental audits by teachers participating in the *Schools and Sustainability* course. It has reviewed ways in which audits were choreographed and used by teachers for lessons within their school contexts. It has explored ways in which audits shaped meaning-making interactions and gave rise to environmental learning processes within these contexts.

This study has highlighted the value of auditing processes in which attempts at meaning making were reality-congruent and constructed within a close engagement with the real world. The effectiveness of environmental auditing as a pedagogical process seemed to depend less on the auditing methodology and LTSM used, and more on the teacher's intentions, knowledge and skills, the choreography of the audit, the nature of the teaching and learning interactions and on the ways in which teachers and learners engaged with the findings of the audit.

As life becomes increasingly characterized by risk, it becomes more important than ever for pedagogical processes such as environmental auditing to mediate the development of competences needed to:
- Perceive environmental risks in the midst of the realities people hold and share;
- Develop the discipline to be able to construct reality-congruent representations of the world within a close engagement with the world and through a balanced interplay of processes of involvement and detachment;
- To engage in critical reflection about environmental risks and lifestyles;
- To make informed decisions in deliberation with others; and
- To act in ways that will contribute to a more sustainable environment.

The findings of this case study describe the potential of environmental auditing, as a teaching methodology, to develop these competences, by involving people in processes of data gathering and critical engagement which can lead to reflection and change. It has shown that auditing activities need to be carefully structured and mediated by teachers to be meaningful and to enable learners to identify environmental issues, engage in critical reflection and deliberate appropriate responses for social and environmental transformation.

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APPENDICES

Appendix 1: Outline of the *Schools and Sustainability* course

PART ONE: ORIENTATION

Introduction

Welcome to an exciting new stage on your ongoing lifelong journey of learning! Enrolling on the *Schools and Sustainability* Course will open up many opportunities for your further professional development as a teacher. This course is designed to help you find opportunities for environmental learning in your curriculum and translate these into learning actions that not only provide excellent educational experiences for your learners but also start to contribute towards an improvement in your whole school. You will be learning how to conduct an environmental audit of your school and how to translate your findings into a school environmental policy and management plan. As you progress through the course, you will discover that more and more, you will be required to work closely with your colleagues, school governing board, community and school management staff to bring about some of the changes you will identify as important with your learners.

The *Schools and Sustainability* course will help you develop lesson plans for environmental learning in the curriculum. You will learn about active learning processes involving information gathering/enquiry, taking action, reflection and reporting. You will be introduced to a range of learning support materials for five environmental topics (air, water, waste, sanitation and energy) and will be asked to use and adapt these in your learning activities. You will engage with a variety of educational methodologies and learn how to adapt these to your own context. Lastly, you will learn more about assessment of learning and also be asked to evaluate your own learning and work throughout the course.

Like most things in life, what you put in is what you will get out. This course is certainly not about an expert telling you "how to do" or "about" environmental learning. You will not be a passive learner soaking up information. This course will only be meaningful with your full engagement as an active learner. As teachers, we often find it strange or difficult to see ourselves as learners; after all, we spend so much time teaching others! It is time to change that, for the duration of this course and onwards, you are a learner and a teacher at the same time. We hope that you will participate fully on this course, both during the contact time and by dedicating time to your work-place assignments.

Accreditation

This course will be recognised as a full 12 credit module towards an Advanced Certificate: Environmental Education (ACE) and is accredited through Rhodes University. The course is designed as one of the modules of the Environmental Education ACE offered at Rhodes University but it will also allow you to apply for Recognition of Prior Learning (RPL) towards other ACE's. The number of credits that would be recognised as RPL will differ depending on how similar the ACE you will be studying is to the Rhodes EE ACE. For teachers in formal education, this is the accreditation option that is most meaningful.

While the course has been designed specifically for teachers, it is also useful to educators working in non-formal education such as environmental educators, community development workers, agricultural extension staff, etc. To cater for this potential user group, the course has been carefully aligned to two unit standards from the Bachelor of Environmental Education, Training and Development Practice

Degree (NQF level 6). Non-formal educators who complete the course may apply for assessment against unit standards 13620 and 13621 and will receive a 14 credit skills programme certificate.

Course Outline

You will be required to participate in three learning units in order to make up the full 12 credit module. The three learning units are based on a progression of learning and increase in skills and competency on your part as you progress through each learning unit.

You will be able to choose from five environmental topics as you progress through the three learning units. The five topics are:
- Water
- Sanitation
- Air
- Waste
- Energy

These topics will be used to contextualise your learning on each learning unit. After completing the course you will have worked with three of the five environmental topics.

You will be given a pre-course assignment that you must complete before attending each learning unit (see page 14). Each learning unit is based on 40 hours of learning of which 16 hours will take the form of contact workshops and 24 hours will be in the form of work-place tasks and assignments. Contact workshops will take place over weekends (Friday 13h00 – 17h00 and Saturday 08h00 – 17h00) and a report-back contact workshop after two weeks on a Friday (13h00 – 17h00). The full cycle of contact workshops, topics and learning units are given in the table below …

Learning Unit 1: Environmental learning in the Revised National Curriculum Statement & developing school environmental policy

Before attending this unit you will need to complete a pre-course assignment where you will find a reading that identifies an environmental issue related to the environmental topic for this learning unit (see the table above to see which environmental topic you will be focusing on for your learning unit 1). The assignment guidelines are found in Section 2 of this document. This reading is to get you started on thinking about the environmental topic and how the issue relates to your school.

The first part of each Learning Unit will focus on the particular environmental focus for that unit (See table above) i.e. if you are participating on the first semester your environmental topic for Learning Unit 1 is "water". You will explore this topic briefly from a socio-ecological historical perspective, studying various local, regional and international issues regarding this topic. You will be provided with a resource-based learning (RBL) pack containing a diversity of Learning Support Materials (LTSM's) that you can use and adapt both for your own learning with regard to the topic and also for learning actions with your learners in your curriculum. The materials pack also has notes and ideas for various methods and approaches you can use in your lessons and learning actions.

You will then spend time identifying Learning Outcomes in your Learning Area(s) that you can use to plan a lesson(s) for environmental learning with a focus on the environmental topic. You will discuss methods and activities that will engage your learners and other school role-players in developing an environmental policy for this and other environmental components in your school. You will then take one aspect of your school environmental policy and develop and implement an action plan.

You will then have one month to implement the ideas and plans you develop on the course, keep evidence of this work and then present it at a portfolio presentation workshop. After the presentation workshop, you will then have a month to work on your pre-course assignment for Learning Unit 2.

Learning Unit 2: Active learning supporting whole school development

Your pre-course assignment for this learning unit will focus on working with your colleagues, school governing body, school management staff and community members to craft your school environmental policies into an integrated and holistic development plan for your school.

Once again you will start off exploring your environmental topic in detail. You will then be introduced to active learning processes and be tasked with developing lessons and learning actions using active learning processes that will contribute to your holistic school development plan.

After a month you will present your work through a portfolio of evidence and then start work on your pre-course assignment for Learning Unit 3.

Learning Unit 3: Assessment of learning and evaluation of whole school development plan and actions

Your pre-course assignment for this learning unit is to take your school environmental policies and whole school development plan and write up a critical reflection on them. You will critically discuss the processes involved in their development (who and how), the concerns and issues they were designed to address (why), how your lessons and learning actions contributed to these processes and vice versa.

After studying the environmental topic for this learning unit, you will explore assessment of learning. You will be introduced to methods and techniques you can use as well as a variety of approaches to assessment. You will also evaluate the learning and activities you engaged in on learning units 1 and 2, learning to critically reflect on your work and bring this habit into your work.

You will develop lesson plans and learning actions, conduct assessment and write up critical reflection notes on these activities as your workplace task. Finally, you will incorporate these activities into your now substantial portfolio of evidence, present this portfolio and then submit it for assessment.

Appendix 2: Scoping exercise from the *Schools and Sustainability* course

AN ENVIRONMENTAL PROBLEM OR CONCERN IN MY SCHOOL OR COMMUNITY
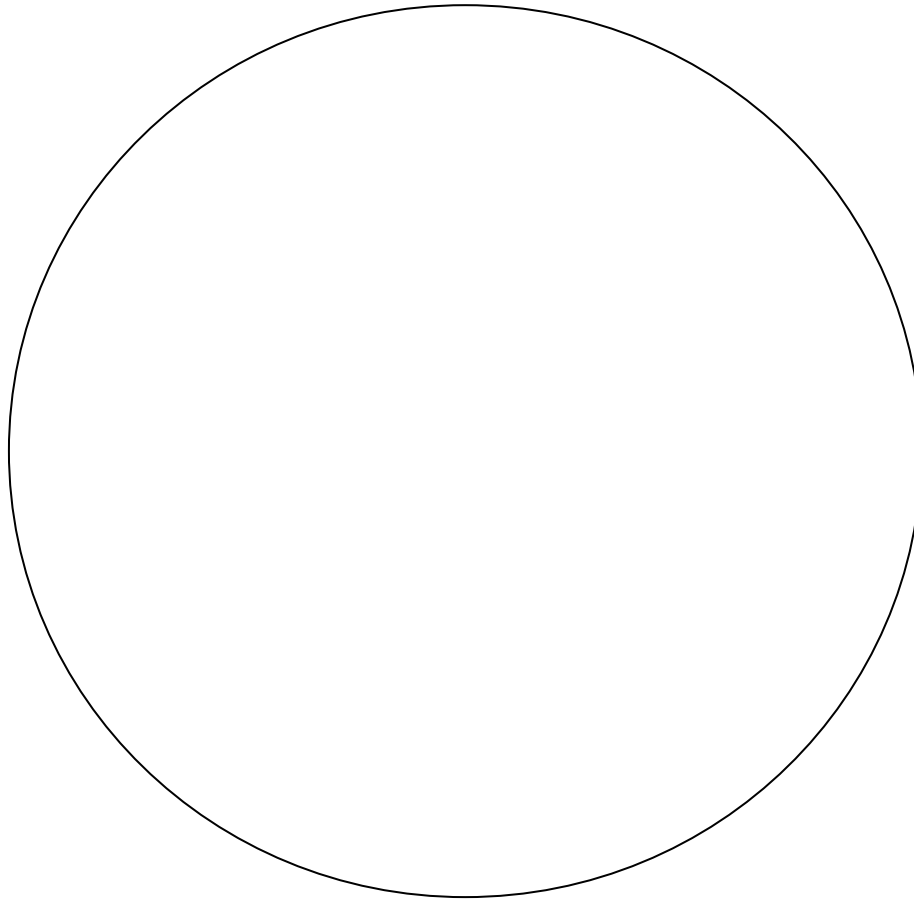
Describe your picture here…

ACTIVITY: Sketching scope

Help learners to make a 'sketching scope' out of a rolled up piece of paper and ask them to walk around the school or community. Allow them to select and draw an environmental problem or concern that they see through the scope (higher grades might be asked to write a paragraph/essay of the most pressing environmental concern to them. Copy this page for your learners to do their drawings on. Make a poster in your school of all the learners' pictures. In the space below summarize the issues highlighted by your environmental working group and your learners.

Appendix 3: Details of teachers who contributed to the research

Teacher's name	Code	School	Grade taught
Ms Ntsiki Ndzingwa	t1	Kwadinabakubo Combined School	3
Ms Thenjiwe Zulu	t2	Saphinda Primary School	6
Ms Prem Reddy	t3	Esayidi Pre-Primary School	R
Mr King Hlophe	t4	Kalipha Primary School	6
Ms Busi Blose	t5	Imisebe CP School	6
Ms Mbatho Shandu	t6	Kwa-Mathanda High School	9
Mr Ishmael Nzuza	t7	Kwa-Mathanda High School	8
Mr Tom Jafta	t8	Newlands East Secondary	9
Mr Ayanda Ngwenya	t9	Phila Combined School	7
Ms Lungelo Goba	t10	Imisebe CP School	6
Ms Kay Sagadavan	t11	Dr Macken Mistry Primary	6
Ms Ramona Ramdas	t12	Dr Macken Mistry Primary	4

Appendix 4: Observation schedule

Guidelines for observations

Social processes: What interactions are taking place?
- What does the teacher do?
- How does the teacher introduce the audit?
- What does the teacher do during the audit? What is her/his role?
- Are any LTSM used by the teacher? If so, which ones, and how are they used?
- How does the teacher interact with the learners?

How do learners use the audit?
E.g. Do learners work individually or in groups?
- How do they prepare themselves before actually going out and conducting the audit?
- How do learners interact with each other?
- How is the work distributed amongst the learners and what are the different roles?
- Where do the learners go and how do they decide where to go to conduct the audit?
- How do they find the answers to the questions on the audit?
- How do they record their findings?
- How do they react to their findings?
- How do they make sense of their findings?
- How do learners interact with the teacher?
- Are any other LTSM used by the learners? If so, which ones, and how are they used?

Context and environment*:*
- What LTSM / classroom resources are present?
- How available, visible, accessible are resources to learners?
- Are the environmental issues being audited obvious or hidden?
- What are the routines / rituals that characterize the setting?
- Other contextual factors of relevance

Appendix 5: Interview schedule

Guidelines for interviews:

First interview with the teacher:
- Which audit have you chosen to use in the lesson, and why?
- Have you adapted the audit in any way? If so, how and why?
- How do you intend to use the audit?
- Do you intend to use the findings of the audit in any way? If so, how?
- What do you think the findings of the audit will be?
- What are you hoping the learners will learn through doing the audit?
- Do you intend to assess the learning that takes place during the audit? If so, how?

Group interview with the learners:
- Describe what happened during the audit.
- How do you feel about the audit?
- What were your findings?
- What did you learnt through doing the audit?

Second interview with the teacher:
- What happened during the audit?
- How do you feel about the audit?
- What were the main findings of the audit?
- What did the learners learn through doing the audit?
- How successful do you think the audit was?

Appendix 6: Analytic memoranda

AM1 Types of audits

1.1 Impression-based audits were designed to construct information about an issue sourced from informants' (inter)subjective impressions. This information was mobilized through methods such as opinion polls, observations, multiple choice questions and checklists	p1t3; rwt3; ltsmt3; p2t11; lwt11; ltsmt11; lwt6; lwt7; lwt12; p1t5; p1t10; p3t2.
1.2 Evidence-generating audits were designed to construct information about an issue sourced from interpretations of empirical-experiential data generated through methods such as counting, measuring, describing, categorizing, and supporting impressions with observational evidence	p1t1; lpt1; p1t2; p1t5; p1t10; p1t6; p1t11; p2t6; lwt6; p1t8; ot9; ltsmt9; p1t1; ltsm1t1; p1t2; p1t4; p1t6; p1t9; p1t11; p2t11; ltsmt11; lp1t7; lwt8; p1t11; p1t12; p1t7.
1.3 "Actualizing-audits" designed to construct information about an issue based on evidence of the effects of unobservable phenomena generated through the mediation of scientific instruments and scientific practices.	i1t1; ot1; i2t1; p2t2; p2t11; lwt11, ltsmt11; p2t12.

AM2 Kinds of data generated

2.1 QUANTITATIVE data turbidity disc workbooks and activities the eThekwini Water Consumption Log SWAP kit water use audit sheet	 p1t5; p1t10; p1t8; p1t4; p1t7.
2.2 QUALITATIVE data Somerset bacteria test kit school sanitation audit audit of toilets at home SWAP kit water quality audit framework	 p2t11; ot1; p1t5; p1t7.
2.3 MIXED data 'Water and the Environment' audit; Water Field Studies water quality Survey	p1t11.
2.4 Data are based on learners' impressions – observations	ltsmt3; ltsmt11; lwt6; lwt7; lwt12.p1t5; p1t10; p3t2.
2.5 Data are based on empirical-experiential data i.e. evidence that supports learners' impressions of (the effects of) observable phenomena	ltsmt1; p1t2; ltsm1t5; ltsm1t10; p1t6; p1t11; lwt6; lwt8; ltsmt9; p1t4; p1t9; lwt11; p2t7; p1t12; p1t7.
2.6 Data are based on evidence of the effects of an unobservable phenomenon	p2t1; p2t2; p2t11.

AM3 What teachers and learners actually do to generate data
AM3.1 Learner participation in generating data

3.1.1 Only part of the class was able to participate in the audit because of constraints such as time, space, group management, limited resources	p1t1; p1t3 p1t6; p1t7; i1t1; ot1.
3.1.2 The whole class participated in the audit but there were not really enough resources or things to do, to allow everyone to get involved	ot9.
3.1.3 The audit was pre-planned and managed throughout, by the teacher	p1t3; p2t11; p1t6; p1t7; p2t12; p1t5; p1t10; p3t2; p1t1; i1t1; i1t1; ot1.
3.1.4 The teacher gave very explicit instructions for the learners to follow throughout the audit — the teacher made all required research decisions	p1t1; i1t1; i2t1; ot9; ot1.
3.1.5 The audit itself was pre-planned by the	p2t11; p2t11; p2t11.

teacher but follow-up activities were suggested and planned and implemented by the learners	
3.1.6 Teacher provided a framework for the audit, and supported learners to plan aspects of the audit themselves	p1t8.
3.1.7 The whole class was able to participate in the audit	p2t11; p2t6; p2t7; p2t12; p1t5; p1t10; p3t2; p1t11; p2t6; p1t8; p3t8; p2t11; p2t7; p1t12; p1t7.

AM3.2 Auditing sites

3.2.1 The audit was conducted entirely in the classroom	ot1; ot9; p2t2; p2t11; p2t12.
3.2.2 The audit involved an 'exploration', by learners, of issues outside the classroom, but within the school grounds	lpt1; p1t1; p1t3; i1t1; p1t2; p1t4; p1t6; p1t7; p2t6; p2t7; p1t9; p2t11; p2t11; p2t12; p1t11.
3.2.3 The audit was conducted outside the school	p1t5; p1t7; p1t8; p1t10; p1t11; p1t12.
3.2.4 The audit was conducted (or will be repeated) in the learners' homes	p2t11; p3t2.

AM4 Working with the findings

4.1 The teacher was the one who worked with the findings and interpreted / tried to make sense of them	ot9.
4.2 Learners were given an opportunity to work with the findings e.g. analyse and interpret them	p1t8; p2t11; p2t1.
4.3 Findings were not recorded at all	p1t5; p1t10.
4.4 Findings were recorded in an organized way	ot9; ltsmt1; ltsmt3; ltsmt2; lwt5; lwt6; lwt7; lwt10; lwt11; lwt12; ltsmt7; p2t11; p1t1; lwt8; ltsmt4; ltsmt11; lwt6; ot1.
4.5 Findings were recorded, but not in a very organized way	lpt1.
4.6 Teacher checked whether learners were recording data correctly and helped them do it correctly	ot9; p1t11; lwt8.
4.7 Once the data were gathered and reported, they were abandoned	lpt1; p1t7; p2t1; p1t5; p1t10.
4.8 The teacher discussed the findings of the audit with the learners in a meaningful way that relates to the auditing question and method	p2t11.
4.9 The teacher discussed the findings of the audit with the learners, but in a way that does not relate well to the auditing question and method used	ot9; p1t1.
4.10 Learners engaged with the findings of the audit in follow-up activities and lessons	lwt8; p1t8.
4.11 The teacher plans to use the findings of the audit in a later lesson	i2t1; it9; it9; p2t11.
4.12 Learners reported their findings to other learners in the school to share what they had learnt	p2t7; p2t2.
4.13 The teacher plans to use the findings of the audit to revisit the school policy	p2t7.
4.14 Findings were kept for use as a source of information for another class	p2t6.
4.15 Findings were recorded, but were not really analyzed and interpreted or evaluated	p1t3; p1t5; p1t10; p3t2; p1t1; ot9.

AM5 Environmental focus and perspectives
AM5.1 Environmental focus of audits

5.1.1 Contextual-relevance of the environmental focus	p1t1; ot1; p1t2; p2t2; p3t2; p1t3; p1t4; p1t5; p1t6; p2t6; p1t7; p2t7; p1t8; p1t9; p3t9; p1t10; p1t11; p1t11 ; p2t11; p1t12; p2t12.
5.1.2 Focus on audits of water consumption	p1t1; gt1; i2t1; lpt1; p1t2; p1t4; p1t6; p1t7.
5.1.3 Focus of school grounds audits included the following foci	p1t3.
5.1.4 Focus of audits of river water quality	p1t8; lwt8; p1t11; p1t12. p1t5; p1t7; lwt8; p1t10.
5.1.5 Focus of sanitation audits	p2t1; p2t2; p2t11.
5.1.6 Focus of waste audits	it9; ot9; p1t8; lwt8.
5.1.7 Multiple focuses	p1t8.

AM5.2 Environmental perspectives / dimensions / 'Lenses' used to examine environmental issues

5.2.1 Human rights	p1t1; lpt1; i1t1; p2t11; p1t3; p1t5; p1t10; p1t12.
5.2.2 Economic perspective	p1t2; p1t2; p1t6; it9; ot9.
5.2.3 Lessons which included a focus on ecosystems and biodiversity	p1t3; p1t11; p1t12; p1t5.
5.2.4 Audits which did not consider or examine impacts on ecosystems, biodiversity	p1t1; lpt1; i1t1; i1t1; gt1; p1t2, p1t4; p1t6; p1t8; ot9; it9; p1t10; p2t11.
5.2.5 Lessons which included information or a discussion on ways to take action to solve or prevent environmental problems	p1t1; lpt1; gt1; i2t1; p1t2; p1t3; p1t5; p1t6; p1t8; ot9; it9; p1t10; p2t11; i2t1.
5.2.6 Lessons which did not consider causes of environmental problems – just audited them	p1t3; p1t4; ot9; it9; ot9.

AM6 How decisions were made about audit design
AM6.1 Decision making

In response to formal teacher reflection	p2t11; p1t8.
The teacher makes some decisions about how to conduct the audit during the lesson itself	i1t1; ot9.
The teachers considered community members' sensitivity e.g. about the school's water debt when planning the water use audit	p1t6.
Decisions about content are based on the learners' level / grade	i1t1; i2t1; p2t11.
Decisions are based on the teacher's teaching priorities	i2t1.
Decisions are based on how logistically difficult it will be to conduct the audit	i2t1.
Decisions are based on which teaching methods the teacher thinks will help the learner to remember the lesson	i1t1.
Framework for the lesson was planned roughly around the active learning framework	p2t11; p1t8.

AM6.2 Environmental risks affecting schools

MANAGERIAL ISSUES: management challenges e.g. principal being absent for long periods shortage of classrooms	ot1
limited resources for teaching & learning; large classes platoon system	ot1; it9; ot9; ot1
inadequate waste management systems e.g. no bins on the grounds air pollution through burning rubbish at school	ot9; it9; gt9 it9; gt9.
SOCIAL: e.g lack of empowerment & poverty	p1t1.

INFRASTRUCTURAL: Water is wasted through inappropriate use of infrastructure (e.g. urinals); wasteful water use practices (e.g. drinking water using hands, flushing toilets for nothing, cleaning classes using a hosepipe, leaving taps running); and water leaks from broken pipes, broken taps, cisterns etc.	p1t1; lpt1; p1t2; p1t3; p1t6; i2t1
There are inadequate water and sanitation facilities in some homes and schools – teachers recognize that people have the right to have access to clean water	p1t1; it21; lpt1; p2t11
Some schools are in a bad state of repair e.g. poor quality school buildings, cracking walls, broken toilets, untidy school grounds	p1t6; it9; gt9.
ECONOMIC: high water bills at school; teachers want learners to understand that water is not free	p1t1; p1t6,
Many learners waste their money and eat unhealthily by buying junk food regularly at school	it9.
BIOPHYSICAL: Many rivers near schools are polluted with factory effluent, litter and other sources of pollution	p1t1; p1t5; p1t8; p1t10
Some teachers recognize that water pollution can lead to loss of biodiversity and animal habitat	p1t3; p1t5; p1t8
The potential for future water shortages in South Africa	i2t1; i2t1.
HEALTH water of poor quality can be a source of waterborne diseases e.g. cholera	p1t5; i1t1
bad sanitation in community and exposure to germs and disease (p2t6; / cleanliness of the school toilets (p2t11;); poor sanitation and personal hygiene practices among learners e.g. not washing hands after toilets and before eating, thus spreading germs.	p2t11; i2t1; i1t1
spread of contagious diseases, e.g. cholera, among school children through physical contact, sharing of food and the presence of germs in contaminated litter.	gt9
learners have unhealthy eating patterns – they buy junk food regularly at school	p1t3; it9
teachers recognize the importance of good nutrition / eating a healthy diet	it9.
SECURITY Teachers recognize the importance of having a safe environment at school. There is a shortage of safe places to play and playground equipment in some school grounds	p1t3
Some schools experience theft and security problems	p1t1; it9; p1t1.
BEHAVIOURAL Schools experience land / air pollution through littering by learners at school / burning rubbish; irresponsible use of school toilets.	p1t1; p1t8; it9; gt9; p2t11.

AM6.3 Sources / nature of the problems

Sources of some problems lie outside of the school, but schools have to deal with them e.g. litter blowing in from neighbouring informal settlements.	gt9.
Environmental problems are persistent (e.g. water taps and pipes are broken repeatedly), littering is a perpetual problem	i2t1; it9.
Many environmental problems at school are similar to problems at home	p3t9; lpt1; i1t1; i2t1; p1t8.

AM6.4 Responses to environmental issues / environmental action

6.4.1 Learners have very strong feelings about the issue	p2t11.
6.4.2 Teacher-enforced solutions	it9; gt9.

6.4.3 Possible reasons for lack of environmental action in schools include: lack of awareness, knowledge, skills, resources or will to take action; various obstacles that get in the way of action taking. Ntsiki's learners reported that they always see that water is wasted, that they knew that something had to be done about water wastage at school, but that they did not know what could be done (gt1)	i2t1; p1t8; gt9.
6.4.4 Teachers think that learners don't really think about these issues as problems – they just accept them	i2t1; gt1.
6.4.5 Teachers and learners tend to focus on treating the symptoms of the problem instead of dealing with the causes	i2t1; it9; gt1; gt9.
6.4.6 Teachers recognize the importance of a healthy and clean environment and consider it the learners' responsibility to keep their school clean; and to save water and to keep the toilets clean	it9; p1t1; i1t1; p2t11.
6.4.7 Teachers encourage learners to (or assume that they will) apply what is learnt at school to their home and community situation	p1t1; i1t1; p1t4; p1t8.

AM7 Teacher's intentions regarding using the findings

Purpose of the audit: to use the findings to actually improve management of the school / community environment and resources and thus learners' wellbeing / health	p2t11; p2t6.
Purpose of the audit: to learn about the issue and/or to use the findings to raise awareness in the school about the issue	ot9; p3t8; i2t1.
Purpose of the audit: to also achieve the requirements of the curriculum e.g. relating was is learnt about sanitation to life processes in biology	p2t11; i2t1; lwt8.
Learning was situated – relevant to learners' immediate needs and interests,	p2t11.
Teacher has no intentions to use the findings – the audit was an exercise only	i2t1.
Teacher values the audit because it enabled important issues to be addressed (not just talked about, but actually resolved)	p2t11.

AM8 Teacher's knowledge & skills

8.1 The teacher and learners in the case studies had done an audit together before	p2t1; ot1; ot9; it9; p2t11; p2t12; p3t2.
8.2 The teacher and learners in the case studies had never done an audit together before	lpt1; p1t5; p1t10.
8.3 The teacher knew what message s/he wished to convey to learners through the audit, but did not seem too clear about the purpose of the auditing method that was used	p1t3 ot9; p1t1.
8.4 The teacher understood the message of the audit, but had trouble understanding / following the correct procedure, there are methodological problems in the way the teacher conducts the audit	ot1; p1t2; i2t1; p1t5; p1t10; p1t7 i2t1; ot1; p1t7.
8.5 The stated aim of the audit did not match the methods used or data collected.	lpt1.
8.6 Teacher understood the auditing procedure and followed it correctly, but had trouble interpreting the findings or the findings are not valid	p1t5; p1t7; p1t10.
8.7 Teacher was not familiar with some of the concepts in the LTSM or the lesson or the audit	ot9; i2t1.

8.8 Reflections on teacher's understanding of the research process in an audit:
King conducted a water use audit with his grade six class. Each day, learners were supposed to read the meter at the agreed time: 07h30 – but sometimes learners arrived late. They did not always indicate the time at which the readings were taken. King was disappointed because he found that children used more water on some days than on others. Why did he think this was a problem?

Thenjiwe also said that some children arrive at school very early and use water before school starts – she was concerned that this water use would not be measured by the audit. I need to clarify why she thought this was a problem.

Lungi first showed her learners pictures of dirty rivers and they discussed in class what may be the cause of the pollution in the pictures and how this might affect the community. Then she took her grade six learners on an excursion to the nearest river, which has some factories nearby. Learners filled a bottle with water and determined the clarity of water using a turbidity disc. She says the learners did auditing using a turbidity disc. Then she arranged a meeting with local environmental health workers – learners interviewed the workers to get some information about health risks associated with water pollution and the impacts of water pollution on health. Then learners dramatized the results of using dirty water and ways to keep water clean. What evidence did she have to justify her view that the river was polluted?

AM9 Which materials were used in audits?

WATER CONSUMPTION –
pictures of wasteful vs 'good' water use practices (p1t5); worksheet for recording numbers of leaks (p1t1; p1t2); worksheets for recording water meter readings (p1t1); the eThekwini Water Consumption Log (p1t4); SWAP kit water use audit sheet (p1t6; p1t11); photographs taken at school (p1t1); information about auditing in course notes (p1t1).
WATER QUALITY –
SWAP kit water quality audit framework with instructions and tables to record data in (p1t5; p1t7),
"Water and the Environment' (p1t11); Water Field Studies water quality Survey (p1t11); Watties Fix-Its (p1t12); pictures of dirty rivers (p1t5; p1t10); turbidity disc (p1t5; p1t10).
SCHOOL GROUNDS –
Audit sheet: questions for learners about school grounds and a space to draw happy and sad faces (p1t3).
SANITATION –
Somerset bacteria test kit (ot1); cholera posters (ot1; p2t6); story in a newspaper article (i2t1); worksheet for writing up a scientific report (i2t1); audit / individualized questionnaire about state of the school toilets (p2t11); audit of toilets at home (p2t11); gridword on sanitation (p2t11); information on different types of toilets (p2t11; p2t6); interview schedule (p2t6); school survey focusing on toilets, bins and handwashing facilities at school with space for observations, suggestions and actions (p2t11); instructions for coliform testing and sanitation kit (p2t11);
chart depicting health and unhealthy environments (ot1; p2t11); pamphlets on diseases associated with sanitation (p2t6).
WASTE
workbooks with instructions, activities and space for writing down findings of the audit etc (made by the teacher) and portfolio boards for reporting on an investigation (p1t8); "Sources of Waste;' pamphlet produced by DSW (ot9); examples of products made from waste; a worksheet for recording number of items of each type of waste (ot9); Enviro Fact Sheets (p1t8).

AM10 Adaptation or adoption of materials
AM10.1 Ways in which LTSM are adapted and used by teachers for auditing lessons within school contexts

10.1.1 Some teachers adopted an existing audit – and used it as is – using materials provided by the course	p1t7; p1t5; p1t10; p1t4; i1t1; ot1; i2t1; p2t11.
10.1.2 Some teachers adapted existing audits to make them more suitable for their lessons	p2t11; p1t5; p1t10.
10.1.3 Some teachers designed their own audits, entirely, and made their own LTSM for the lesson	ot9; it9; p1t2; lpt1; p1t1; gt1; i2t1; lpt1; 1t1; i2t1; gt1; p1t3; p1t8.

AM10.2 Successful and appropriate use of materials

Some teachers were able to choose or design LTSM that were relevant to the lesson	ot9; ot1; p1t10; p2t11.
Some teachers understood the aims / message of the audit, the auditing procedure, the logic behind the procedure to be used, and	p1t8; p2t11.

how to interpret the findings	
Some teachers helped the learners when they struggled to use the LTSM	ot9; ot1.
Some teachers would not have been able to conduct any kind of audit without the information and guidance in the LTSM provided by the course	lpt1.
Some teachers used the LTSM flexibly and responsively – adapting it as s/he went along	ot9.
Some teachers have ideas for adapting and improving the LTSM in the future	it8.
Some teachers plan to use the LTSM or the audit findings in some way, in follow-up lessons	i2t1; it9; p2t11; p2t12; i2t1.

AM11 What role do LTSM play in the lesson?
AM11.1 Centrality of the LTSM

The LTSM (s) was a key part of the lesson, used throughout the lesson and the audit	ot1; p1t8; p1t5; ot9.
LTSM were used in only a limited part of the lesson and the audit	p1t1; p1t2; p1t3; p1t4.

AM11.2 Role of the LTSM in the learning

11.2.1 LTSM were used to mobilize learners' prior knowledge	p1t1; lpt1; i1t1; p1t10; ot1p1t1; lpt1; i1t1; ot9; p2t11.
11.2.2 LTSM were used as a source of information for learners	p1t10; lpt1; i1t1; ot1; i2t1; p1t1; gt1; ot9; i2t1; ot1; p1t10; p2t11.
11.2.3 LTSM were used to guide the investigation phase of the audit	p2t11; p2t6; p2t7; p2t12; p2t11
Provided general guidelines for documenting impressions	p1t5; p1t10; p1t8; p1t4; p1t6; p2t7
Provided instructions for generating evidence	p1t7; p1t11,
Provided strict instructions on how to conduct an experiment	ltsmt1; i1t1; i2t1; p2t2; p2t11.
11.2.4 LTSM were used to record the findings of the audit	p1t1; lpt1; gt1; i2t1; p1t3; p1t8; p1t2; ot9
Made by the teacher	p1t4; p1t7; p1t5; p1t10; p2t11; p2t6;
Pre-existing materials	p2t7; p2t12; p3t2.
11.2.5 LTSM were used to guide the development of an action plan	p1t8.
11.2.6 LTSM were used as a means of reporting on the investigation and findings	i2t1; p1t8; p2t11.
11.2.7 The same LTSM was used in a variety of roles	e.g. p1t10; p1t; ot1; p1t4; p1t8; p1t7.
11.2.8 Other roles e.g. supported language acquisition	p2t11.
11.2.9 Teacher did not use any learning support materials during the actual audit	none.

AM11.3 Who used the materials?

11.3.1 LTSM were used by the teacher in the lesson	i2t1; ot9.
11.3.2 LTSM were used by the teacher to understand the topic better and to prepare for the audit / lesson beforehand	p1t1; p1t8.
11.3.3 LTSM were used by the learners themselves in the lesson	p1t7; p1t5; p1t10; i2t1; p1t8; p1t2; p2t11.
11.3.4 The same materials were used by the teacher and learners / they used the materials together	p1t1; p1t10; p1t5; p1t7; p1t11; p1t12; p1t3; ot1; p2t1; p2t11.

AM13 Language

Learners were not confident about speaking in English and struggled to define concepts	ot9; it9.
Teacher taught in the home language of the learners	ot1.
Teacher used code-switching in the lesson	ot9.
Lesson was meant to be in English, but the teacher used more Zulu than English in the lesson	ot9.
Teacher is aware that learners were not familiar with some of the concepts in the LTSM or lesson or audit	ot9; it9.
Learner had difficulties with specific terminology	gt9.
Teacher made an effort to support learners' acquisition of new terminology	p2t11.

AM14 Teacher intentions regarding the learning

14.1 Teachers are aware of the value of practical, hands-on, participatory educational activities (such as audits) – but the activities are not always well thought out	lpt1; p3t9; p2t11; p2t12.
14.2 The teacher recognizes that children need to learn how to solve environmental problems themselves	lpt1; p2t11.
14.3 The teacher seems to value the message behind the audit more highly than the auditing process	t1t1; t9; t5; t10; p1t1.
14.4 Teacher hopes for behaviour change	i1t1; i1t1; i2t1; p2t11; t9; p1t1.
14.5 Teacher values the audit because s/he believes the practical activities help learners to understand the message of the lesson better	i1t1.
14.5 Teacher values the audit because of the active learning processes taking place in the lesson – the actual topic is of less importance to him/her	p2t11; p1t8.
14.6 Teacher values the audit because it enabled important issues to be addressed	p2t11.
14.7 Teacher emphasizes how the audit contributes to learners' engagement with issues of human rights and social justice and human dignity	p2t11.
14.8 The teacher recognizes that it is difficult for learners to understand certain risks when they have limited experience	i1t1.
14.9 Teacher values the audit because s/he believes that learners will be able to perceive invisible risks	i1t1.
14.10 Teacher values the audit because it encourages active participation by learners	p1t1; p1t2; p1t6; p2t11.
14.11 Teacher values the experience of the audit because children learn to do new things	p1t1; p1t2.
14.12 Teacher values the audit because s/he believes the practical activities help learners to remember the lesson better	p1t1; i1t1; p1t6; p1t5; p2t11.
14.13 Teacher intends for learners to go home and teach their families what they've learnt or hopes that they will apply what they've learnt in a personal capacity at home - Same as AM6.4.7	lpt1; i2t1; p1t6; p1t5; p3t9; p2t11.

AM16 Teaching and learning interactions

16.1 Teacher-Learner
–introduced learners to a topic or concept (p1t1; lpt1); used guided questioning to assess learners' prior knowledge (p1t8; ot9; (i2t1); shared his / her knowledge on the topic (it9(; ot9(; i2t1; p2t11); read a reading to the class aloud (ot9); explained concepts to learners and gave examples (ot9); used code-switching to help learners understand (ot9); discussed with the learners the causes of the problem and how it affects the community (p1t10; p2t11); provided learners with LTSM (p1t3) such as posters (i1t1; p2t11) and photographs (i1t1; lpt1); and worksheets (lpt1; gt1) and readings (ot9; and gridwords (p2t11); explained the purpose of the lesson (ot9);
teacher took learners to a nearby river to do water tests (p1t5; p1t10); gave learners instructions (ot1; ot9(; p1t8; p2t11); helped learners to read the water meter (p2t6); wrote down the learners' data (gt1; i2t1; checked that audit was being done correctly (ot9); intervened when learners' struggled with the task or concepts (ot9; it9); helped learners to work with the data (p1t8); organized a meeting with local environmental health workers to get more information (p1t10); assessed learners' work (p1t8; learners' reporting and action (p2t11); reported the findings of each group of learners to the whole class (i2t1); provided a framework for developing and implementing an action plan and reporting on the audit (p1t8); supported the learners' suggestions for action and helped them implement them teacher addressed the caretaker about how they would like their toilets to be managed (p2t11) (p2t11); introduced the next lesson (ot9); I think the teacher did not supervise the learners during the audit adequately (p1t4).

16.2 Teacher-Teacher
– teacher reflected on the audit and on the lesson at a professional development workshop (all p1 and p2 teachers).

16.3 Teacher-LTSM
– chose LTSM to use in the audit (i1t1; (i1t1; p2t11); teacher adapted LTSM before the lesson to suit the context / grade of learners (it9; p2t11); the teacher did not use the audit as s/he originally intended, but made decisions about how to use it in the lesson itself (i1t1; ot9); used resources from a previous lesson to mobilize prior knowledge (ot9); provided the materials to be used in the audit (i1t1; gt1; ot9; t5; t10; t6; t9; t11; t12; ot9; p2t11); teacher wrote down the learners' findings (lpt1; p1t3); T-L-LTSM – the teacher helped learners to record their findings correctly on the LTSM (ot9).

16.4 Learner-Teacher
learners listened to the teacher (ot1; ot9); learners told the teacher what they already knew about the topic (p2t11); learners answered teacher's questions (yes or no only) about problems in their environment (p1t3); learners struggled to respond to teacher's questions except where the answer was obvious (ot9); gave longer answers to teacher's questions (ot9); reported findings to the teacher (i2t1); told teacher what they would still like to find out (p1t8; gt9; p2t11) e.g. p2t11 learners wanted to audit their home toilets too; made posters for the teacher expressing what they had learnt (lpt1; checked the teachers' calculations (ot9); interviewed health workers (p1t10);
learners suggested solutions (i2t1; p1t8; p2t11); school nurse talked to learners about personal hygiene.

16.5 Learner-Learner
– learners worked in groups to do class activities (lpt1; and conduct the audit (ot9; p1t8; p1t11; p2t11); confirmed their measurements with each other (ot9); talked to each other (in their own class) about their interpretations of the findings (it9); observed behaviour of other learners in the school (lpt1; gt1; p2t11); told other learners that they should save water (lpt1; p1t1; and look after the toilets (p2t11); developed a action plan (p1t8; p2t11); reported on implementation of their action plan (p1t8; p2t11); performed a drama in groups (p1t10; p2t11); did an assembly talk to spread their message (p2t11); adopted younger learners to show them how to use toilets properly and presented speeches to other classes on hygiene (p2t11); other learners reacted badly to their action initiatives e.g. tearing down posters (p2t11); learners showed commitment to spreading their message (p2t11); dancing and singing in the corner because they have nothing to do (ot9; standing around doing nothing or playing (ot9); getting bored and restless (ot9); cleaned the classroom after the audit was complete (ot9).

16.6 Learner-Environment
– learners explored their context (e.g. looked for and counted 'good' and 'bad' plumbing in their environment, leaks (p1t1; p1t2); identified problems in their environment (p1t8; p2t11); took meter readings (p1t2); collected water samples and tested turbidity (p1t10); sorted rubbish into piles of different types (ot9); counted litter (p1t8);made judgements about the state of the environment; (p1t8; p2t11); identified causes of environmental problems (p1t8; p2t11); took action to improve their environment (no longer leave taps running, use cups to drink water, keep buckets in the classroom (p1t1; p1t2); puts bins in toilets for sanitary towels, taught younger children how to use toilets, put up posters with instructions on correct toilet use and hygiene, addressed other learners, put water in buckets near toilets to remind learners to wash hands(p2t11), made soap bottles, prepared tissue boxes, established a system of toilet monitors (p2t11); wrote to the community leader to solve the problem of water pollution (p1t5); learners now report leaks (p1t1; p1t2).
16.7 Learner-LTSM
– learners used learning support materials (p2t11); conducted an experiment / test using resources from an audit kit (gt1; p1t10; p2t11Ecoli); recorded observations / measurements in an audit sheet/book/worksheet (i2t1; p1t5; p1t7; ot9; p2t11; p2t11); found information in a LTSM (p1t12; followed instructions provided in a LTSM (p1t7; p2t11); Learners don't understand quite how to use the LTSM to gather valid data (p1t7; p1t10; and record their findings (ot9); Learners don't really understand the LTSM itself (e.g. gt1; Ntsiki's learners mis-identified the reagents in the experiment – cholera, E. coli, Jik), Ayanda's learners do not know what the purpose of the audit was or why they had to count the litter (gt9).

AM17 Active learning processes (Learners)

17.1 Participation	
Learners participated fully in the required activities	ot1; ot9; p2t11.
Teacher believes that learners were taking the lead throughout the auditing lesson – but I challenge that	p1t1.
Learners were taking the lead throughout the auditing lesson, with support and guidance from the teacher	p2t11.
Teacher believes that with repetition, learners have become used to picking up litter and that they know the importance of keeping the school clean (even before the audit)	it9.
Learners enjoyed the auditing activities	gt9; p1t5; p1t6; p2t11.
Learners showed curiosity about the issue being audited; and were highly motivated	p2t11; gt9.

17.2 Mobilizing prior knowledge	p1t8; ot9; ot1; p2t6; ot9; p2t11.
17.3 Finding and sharing new Information	it9; ot9; i2t1; p2t11; p1t3; i1t1; lpt1; gt1; p1t10.
17.4 Enquiries / encounters	p1t5; p1t10; ot9; p1t8; p1t1; p1t2; p1t8; p2t11; p1t2; lpt1; p1t10; ot9; p1t8; p2t11; p1t8; p2t11; p2t1.
17.5 Reporting	i2t1; p2t11; lpt1; p2t11; p1t8; p2t11.
17.6 Action	p1t8; lpt1; p1t8; p2t11; lpt1; p1t1; p2t11; p2t11; p1t8; p2t11; p1t1; p1t2; p2t11; p1t1; p1t2.
17.7 Better environmental management and lifestyle choices	p1t1; p2t11.

AM18 Nature of the learners' experiences / encounters
(Problems with the audit or the LTSM used)

18.1 TEACHER'S SKILLS e.g. audit conducted incorrectly, method incomplete, findings invalid	p1t2; i2t1; p1t7; p1t5; p1t4; p1t10.
18.2 LEARNER'S SKILLS: Some learners had difficulty conducting the audit or using the LTSM correctly	ot9; p1t4; i2t1; p1t7.
18.3 AUDIT DESIGN: Some teachers realized that the LTSM s/he had chosen /	ot9

designed was not quite correct but used it, as is, anyway	
In some cases, the audit designed by the teacher was not well-designed and did not have a clear focus, aims or educational value	lpt1; p1t3; ot9; gt9
In some cases, the instructions designed by the teacher were not clear enough for the learners to do the audit correctly	ot9
In some cases, the auditing method was not appropriate for the purpose of the audit – look again at teacher's intentions - not mine	p1t2; ot9
Some learners did not understand why they did the audit or the method that was used	gt1; i2t1; ot9; gt9
Some learners had difficulty using the LTSM because LTSM were not appropriate for the learners' grade or level of understanding	ot1.

AM19 Meaning making (learners)
AM19.1 Findings of the audit (include a record of inaccurate data, absence of findings, weak interpretations etc here)

Teacher knew what the findings would be beforehand. The audit was done to prove / demonstrate a point or get a predetermined message across.	lpt1; p1t1; i1t1; p2t1; i2t1.
Teacher had some preconceived ideas about what the findings would be, but was a bit surprised by the results	it9; p2t11.
WASTE - The findings of the waste audit were that school bins contain a lot of plastic and paper waste lots of junk food packaging: 1179 plastics (includes sweet wrappers, chips, plastic bags and ice lolly packets), 488 papers (includes newspapers, boxes and tissues), 10 tins, 8 foil, 45 food, 6 polystyrene	ot9; gt9.
SCHOOL GROUNDS - School grounds audit: grounds are not big enough for children to run on, there is no shade on the playground, learners did not see birds and insects in the grounds, children want more time to play on the swings, there is no place to sit and eat lunch, children would like to grow their own vegetables (these were 'Yes' and 'No' responses to the teacher's questions)	p1t3.
WATER CONSUMPTION - Determined daily water consumption from the water meter; Ntsiki's learners counted the number of toilets etc in the school and how many of them were leaking: cisterns (1/9), urinals (0/2), sinks (0/14), taps (7/12)	p1t4; p1t1; lpt1.
WATER QUALITY – Busi's learners concluded that their river is polluted with chemicals from factories … and ... "Learners were able to observe the amount of dirt in water that cause some different kind of disease like cholerah."	p1t5
Tom's learners concluded that the quality of the local river is not very good; the area has very little or no animal life; litter is a big problem	p1t8
Lungi's learners concluded that the river is polluted with mercury. This is questionable, since she used the turbidity test and the SWAP kit, which is unable to detect chemical pollution.	p1t10.
SANITATION AUDIT: all experimental samples tested positive for the presence of coliform bacteria on children's hands; school toilets were in a bad state because children were not using them	p2t1; p2t11.

AM19.2 Reflections on validity of findings

Busi's (t5) water audit involved only a turbidity test – so how did her learners assign water quality scores to the water quality tables (from the SWAP kit)? It looks like they made very subjective decisions about water quality – did not really use the audit as a reality check. Busi took her learners down to a nearby river where they tested turbidity. They filled in an audit sheet (really a summary of audit scores from the SWAP kit) to record the state of the water supply, health risk, catchment conservation, river site quality, water life and turbidity. It looks like they did not do any tests – so I don't know how they came to these conclusions about river quality. Busi also claims that "chemicals inhibits water life with a result of plant loss and

animal loss" – she did not test for presence of chemical or water life and obviously is not well-informed about the effects of factory effluent on plant life in the river. She says "learners were able to observe the amount of dirt in water that cause some different kind of disease like cholerah." She says "they have evidence because they visited the site and discovered that water is polluted. They wrote a letter addressed to the community leader asking for the meeting to solve the community problem about the factory polluting the area" (p1t5).

Lungi – almost identical to Busi's. Her water audit involved only a turbidity test – so how did her learners assign water quality scores to the water quality tables (from the SWAP kit)? It looks like they made very subjective decisions about water quality – did not really use the audit as a reality check. Lungi took her learners down to a nearby river where they tested turbidity. They filled in an audit sheet (really a summary of audit scores from the SWAP kit) to record the state of the water supply, health risk, catchment conservation, river site quality, water life and turbidity. It looks like they did not do any tests – so I don't know how they came to these conclusions about river quality. Lungi also claims that "Chemicals inhibits water life with a consequent loss of plants and animal diversity" … "Learners were able to discover the amount of dirt in water, an in dirty water there is no life that results to death" … isn't this a bit extreme?
"They have evidence because they visited the site and discovered that water is polluted. They also wrote a letter to the community leader asking for the meeting to solve the problem of the factory situation". … "They identified the type of chemical that polluted water which mercury" (p1t10). I have doubts about the validity of Lungi's data / or Busi's.

AM21 Learning outcomes

Stated / Intended / explicit learning outcomes	Teacher's opinion of what has been achieved in the lesson
21.1 p1t1 Life Skills LO2: "Discuss the role of acceptance, giving, forgiving and sharing in healthy social relationships (lpt1; Natural Science LO1: "Plans an investigation…" (lpt1) "Participates in a planned activity" (lpt1) Core knowledge: Sources of water (lpt1) Intended message: The importance of water and how to save water (lpt1) Content / information: Children's rights and responsibilities, how to save water (lpt1)	"they become aware of the importance of water and they should save water"; "they no longer leave taps running, they report leaks and damaged water pipes …"; "they come out with ideas you never thought of them." (p1t1) "The learners will no longer waste water because they are well equipped. That is they have knowledge and skills of saving water" (p1t1).
21.2 p2t1 Life Skills: Health Promotion – describes sources of clean and unclean water Learns how to conduct a simple experiment which demonstrates that there are germs on our hands and that's why we should wash hands after visiting the toilet and before eating Plans an investigation as part of a group Participates in a planned activity Will learn how to write up an experimental report Will find out how rivers get polluted The importance of washing hands (i1t1) Will learn how to purify water	The hand-washing test helped the learners to understand the next lesson more easily – which was about purifying water before they drink it – it helped them to understand the idea of germs. She says learners now prefer to drink water with a drop of Jik in it – because they believe it is very clean and has no germs. They know that to purify water, they must put a teaspoon of Jik in 10 litres of water. Learners know that germs can spread from one person to another and therefore if they are sick they should rather stay at home (p2t1).
21.3 p1t2 Learning outcomes: (1) Life Orientation LO1: Health Promotion. Assessment standard: "Participate in a problem-solving	"Audit has assisted learners to be aware of different ways of saving water and also able to identify areas that use more water daily. Have also developed skills of controlling and monitoring the usage of water. Have also

activity to address an environmental health issue" and (2) Life Orientation LO2: Social Development. Assessment standard: Children's rights to access water and responsibilities to save and value water (3) Life Orientation LO3: Personal Development. Assessment standards: Self-management skills, and Problem-solving skills in different contexts.	learnt that water is money and need to be saved" (p1t2). Thenjiwe says: "Audit has assisted learners to be aware of different ways of saving water and also able to identify areas that use more water daily. Have also developed skills of controlling and monitoring the usage of water. Have also learnt that water is money and need to be saved." She says lots of children come from informal settlements and don't know how to use taps and toilets properly e.g. They often leave taps running. Thenjiwe was able to see close connections between what they learnt and the intended learning outcomes. "Learners has to gain experience, be active participants. They have to feel ownership for the findings and solutions. Have to learn new things and new skills". " … they come out with ideas you never thought of them" (p1t2).
21.4 p1t3	"they were able to conclude that trees do attract birds for food and to build nests …"; "identify the need and importance for healthy eating habits …"; "became aware of water conservation by opening and closing taps correctly …"; "Identified the need for a healthy environmental in which to play in" (p1t3). – It is "relevant to learners in terms of their personal development, a life skill as it concerns nutrition. It allows the learner to explore and investigate environmental issues and risks e.g. trees are important for birds. Become aware of the partnership between learner and environment" (p1t3).
21.5 p1t5	Learners discovered that the water is polluted and wrote a letter to the community leader to arrange for a meeting to address the problem (p1t5). "To enable them to remember in a later stage; to think global; to act local; to pass information to another; to change attitudes" (p1t5).
21.6 p1t6	"… how wasteful we are at school …"; "Too much water is wasted, especially in the boys' toilet because of the urinals" (p1t6).
21.7 p2t6 NS: Planning investigations; Conducting investigations and collecting data; Evaluating ideas and communicating findings; Identifies challenges to societies and settlements associated with use and abuse of natural resources; Examines unequal distribution of and access to resources in different contexts; Makes suggestions to guide sustainable living practices …	"The tuning-in [activity] I used made them to be aware of how different toilets work other didn't know how toilets work, what blocks toilet, what causes sanitation problems, types of toilets e.g. pit system, bucket system, etc advantages and disadvantages of each and really it was an eye opener to them" (p2t6). "By sending learners out … and see different types of toilets ... getting first hand information … made them even more aware of the health risks they are exposed to" (p2t6).

Aims: To learn about risks and diseases associated with poor sanitation; Different toilet systems and their advantages and disadvantages; How to use different toilets correctly e.g. what causes blockages	"Even through our learning outcome was not fully achieved because of time factor but I really feel by making them active in performing their research made a great difference" (p2t6).
21.9 p1t8	Learners discovered that the water is polluted and that there is very little animal life. Devised a solution for litter problem at the river (p1t8) "To learn in class and then be able to use this learning to do something to solve problems in their local community" (p1t8).
21.10 p3t9 Intended message: The importance of a healthy and clean environment	Unintended outcome: Learners realized that they eat a lot of sweets and chips instead of healthy food (it9) Skills of identifying types of litter and knowing how to dispose of them or reuse / recycle them (it9).
21.11 p1t10	She believes they learnt how to assess how clean river water is. Practised interviewing health workers and dramatizing info about using dirty water and how to purify it (p1t10).
21.12 p2t11 Life Orientation: …able to make informed decisions regarding personal, community and environmental health … able to demonstrate understanding of and commitment to constitutional rights / responsibilities and show understanding of diverse cultures / religions …able to use acquired life skills to achieve and extend personal potential to respond effectively to challenges in his/her world Investigate the cleanliness and correct use of school toilets and plan a strategy to address the problem …	They were able to make informed decisions about the cleanliness of the toilets They recognized their rights and responsibilities They identified problems, recorded accurately, carried out the audit correctly, and recorded their observations. This lead to corrective measures being taken. They persevered – showed dedication. Cleanliness of toilets improved (p2t11).
21.13 p1t12	"were able to find, locate and interpret information"; identify plants and animals (p1t12).

AM21.14 Actual outcomes

Reflections or assessment focuses only on whether learners have acquired the environmental knowledge (message) which the teacher intended – learning outcomes not assessed at all	lpt1; ot9.
Teacher believes that learners have acquired the knowledge the teacher intended them to acquire and that they are aware of their environmental responsibilities	lpt1; p2t11.
Learners seem to remember the 'message' of the lesson very well, but can't say much (if anything) about the auditing process itself.	gt1; gt9.
The teacher is satisfied that the curriculum requirements have been met (that the lesson has provided opportunities for learners to achieve the learning outcomes and assessment standards), but I question that	i2t1.
Lots of implicit learning besides the intended outcomes	p2t11.
Teacher acknowledges that the lesson is incomplete and plans to go on with the lesson and build on the learning to help learners master the learning outcomes	i2t1; it9.
Learners intend to tell the people at home not to waste water etc	gt1; gt9.

Appendix 7: List of descriptors used to describe and differentiate audits undertaken in this case study

AUDITING METHODOLOGY:

- What is the environmental focus of the audit?
- Which auditing methods and instruments were used?
- What kinds of data were collected or generated?
- Which auditing sites will be used?

AUDITING CHOREOGRAPHY:

Curriculum processes:

- What are the intended learning outcomes and moral lessons?
- How was the audit contextualized?
- What is the nature of the teachers' and learners' roles and learning interactions in the lesson?
- How were learners supported to acquire the language of the lesson?

Learning and teaching support materials:

- Which LTSM were used?
- Did teachers adopt or adapt existing LTSM or design their own?
- What was role of the LTSM in the lesson?
- Who used the LTSM?

Processes of teacher and learner participation in the auditing lesson:

- To what extent could learners contribute towards planning the audit?
- To what extent could all learners be directly involved in the auditing activities?
- To what extent could learners contribute towards planning follow-up activities?
- Were there opportunities for learners to engage with the findings?
- To what extent could learners contribute to the development of a plan of action to respond to the identified risks?

KNOWLEDGE CONSTRUCTION AND MEANING MAKING IN AN AUDITING LESSON:

Findings of the audit:

- Were the findings accurate and valid?
- Did teachers and learners engage critically with the findings?

Teacher's and learners' developing definitions of the problem:

- What range of perspectives did teachers and learners engage with?
- How critical was that engagement?
- How did the balance between processes of involvement and detachment affect meaning making?
- How well did learners manage to acquire the language of the auditing lesson?
- What kinds of knowledge were constructed e.g. propositional learning of scientific concepts only or situated knowledge?

The teacher's and learners' accounts of reality:

- Which 'segment' of reality was audited?
- How did the teacher's and learners' accounts of the problem represent that 'segment' of reality that was audited?
- Were those accounts of that 'segment' of reality, reality-congruent?

The teacher's knowledge, skills and experience in an auditing lesson:

- The teacher's ability to implement an appropriate auditing method - e.g. how well were the auditing methods followed and how did this affected meaning making?
- The teacher's lesson planning skills - e.g. did the teacher have the ability to make appropriate links to curriculum and how effectively was the audit contextualized?
- The teacher's ability to select / adapt / design and use LTSM – e.g. how well were LTSM used in the lesson and how effectively did they support the learning?
- The teacher's familiarity with and understanding of the topic and concepts
- The teacher's assessment skills – e.g. how carefully did the teacher assess the learners' work and correct misunderstandings?
- The teacher's ability to reflect critically on the method, the learning processes and the findings.

Appendix 8: Analytic statements

ANALYTIC STATEMENT 1: AUDITING METHODOLOGY	Data sources	Sections in report
AS1: In this case study, three different approaches to auditing can be distinguished, according to: their ontological interest; the source of information for the knowledge they construct; and how that information is mobilized / generated. **Methodological choices teachers made included decisions about the following:** environmental focus of the audit auditing methods and instruments which were used kinds of data which were collected or generated auditing sites		
STATEMENT 1.1 **AS1.1 "Impression-mobilizing audits"** are designed to construct information about an issue which is sourced from informants' (inter)subjective impressions. This information was mobilized through methods such as opinion polls, observations, multiple choice questions and checklists.	AM 1.1 AM 2.2 AM 2.4 AM 3 AM 3.1.5 AM 3.1.7 AM 3.2.2 AM 3.2.4 AM 4 AM 5 AM 6 AM 7 AM 8 AM 9 AM 10 AM 11	Ch 4 4.2.1 4.3.1 4.3.2
STATEMENT 1.2 **AS1.2 "Evidence-generating audits"** are designed to construct information about an issue which is sourced from interpretations of empirical-experiential data which is generated through methods such as counting, measuring, describing, categorizing, and supporting impressions with observational evidence.	AM 1.2 AM 2.1 AM 2.2 AM 2.3 AM 2.5 AM 3.2.3 AM 3.1.1 AM 3.1.2 AM 3.1.3 AM 3.1.4 AM 3.1.6 AM 3.2.2 AM 4 AM 5 AM 6 AM 7 AM 8 AM 9 AM 10 AM 11	Ch 4 4.2.2 4.3.2 4.3.3 4.3.4

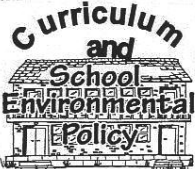| STATEMENT 1.3 **AS1.3 "Actualizing audits"** are designed to construct information about an issue which is based on evidence of the effects of unobservable phenomena which is generated through the mediation of scientific instruments and scientific practices.	AM 1.3 AM 2.2 AM 2.6 AM 3.1.1 AM 3.1.3 AM 3.1.4 AM 3.2.1 AM 4 AM 5 AM 6 AM 7 AM 8 AM 9 AM 10 AM 11	Ch 4 4.2.3 4.3.5 4.3.6

ANALYTIC STATEMENT 2: AUDITING CHOREOGRAPHY (TEACHING AND LEARNING PROCESSES AND REALITY ENCOUNTERS) **AS2: The way in which an auditing lesson is choreographed influences the nature of the subsequent teaching and learning processes and reality encounters.** **Choices teachers made about the choreography of the audit included decisions about the following:** intended learning outcomes; moral lesson of the audit; how the audit was contextualized; auditing methodology which LTSM were used; whether LTSM were adopted or adapted or designed by the teacher; the role of the LTSM in the lesson and who used them; teacher and learner participation; teachers' and learners' roles and learning interactions in the lesson; how learners were assisted to acquire the language / terminology of the auditing lesson.	Data sources AS1 AM 3.1 AM 3.2 AM 5.1 AM 6.2 AM 6.3 AM 6.4 AM 7 AM 8 AM 8.1 AM 8.2 AM 8.3 AM 9 AM 10.1 AM 10.2 AM 11.1 AM 11.2 AM 11.3 AM 13 AM 15 AM 16 AM 17 AM 18	Sections in report Ch 4 4.2.1 4.2.2 4.2.3 4.3.2.2 4.3.2.3 4.3.2.4 4.3.4.2 4.3.4.3 4.3.4.4 4.3.6.2 4.3.6.3 4.3.6.4

ANALYTIC STATEMENT 3: KNOWLEDGE CONSTRUCTION AND MEANING MAKING	Data sources	Sections in report
AS3: The way in which an auditing lesson is choreographed influences the quality of subsequent processes of knowledge construction and meaning making i.e. the teacher's and learners' findings, developing definitions of the problem, and subsequent accounts of reality. **Attempts at knowledge construction and meaning making can be evaluated according to the following criteria:** FINDINGS OF THE AUDIT: Were the findings accurate and valid? Did teachers and learners engage critically with the findings? TEACHER'S AND LEARNERS' DEVELOPING DEFINITIONS OF THE PROBLEM: What range of perspectives did teachers and learners engage with? How critical was that engagement? How did the balance between processes of involvement and detachment affect meaning making? How well did learners manage to acquire the language of the auditing lesson? What kinds of knowledge were constructed e.g. propositional learning of scientific concepts only or situated knowledge? THE TEACHER'S AND LEARNERS' ACCOUNTS OF REALITY: Which segment of reality was audited? How did the teacher's and learners' accounts of the problem represent that segment of reality that was audited? Were the accounts of that segment of reality reality-congruent?	AS 1 AS 2 AM 4 AM 5.2 AM 17 AM 18 AM 19 AM 19.1 AM 19.2 AM 21	Ch 4 4.3.2.6 4.3.2.7 4.3.2.8 4.3.4.6 4.3.4.7 4.3.4.8 4.3.6.6 4.3.6.7 4.3.6.8

ANALYTIC STATEMENT 4: TEACHER INTENTIONS, KNOWLEDGE, SKILLS AND EXPERIENCE	Data sources	Sections in report
Given the relationships between auditing methodology, choreography and meaning making, these processes were also shaped by the teacher's intentions, knowledge, skills and experience:		Ch 4 4.3.1.2 4.3.2.1 4.3.2.5
TEACHER'S INTENTIONS: intended learning outcomes intended moral lessons educational priorities and values	AM 6.1 AM 7 AM 14 AM 21	4.3.3.2 4.3.4.1 4.3.4.5
TEACHER'S KNOWLEDGE, SKILLS AND EXPERIENCE: ability to implement an appropriate auditing method - how well the auditing methods were followed and how this affected meaning making lesson planning skills e.g. ability to make appropriate links to curriculum and how well the teacher contextualized the audit; ability to select / adapt / design and use LTSM - how well LTSM were used – and how they supported the learning; familiarity with and understanding of the topic and concepts, assessment skills - how carefully the teacher assessed learners' work and corrected misunderstandings ability to reflect critically on the method, the learning processes and the findings	AM 8	4.3.5.2 4.3.6.1 4.3.6.5

Appendix 9: Instructions for the actualizing audit discussed in Case Story Three

This experiment, discussed and analyzed in Case Story Three, was drawn from the Sanitation Works Series of Learning Support Materials for Rural Health and Sanitation (Share-Net, 2003).

Curriculum and School Environmental Policy

Sanitation Works!

3 Are unwashed hands a problem?
Clean Hands Test

Intermediate phase: NS

Possible Learning Outcomes: Learners will learn
- How to conduct a simple experiment
- understand why it is important to wash hands after using the toilet
- how to determine the presence of Coliform Bacteria.

You will need:

- 4 bottles with Colilert solution
- 1 glass bottle
- 2 propettes
- 2 propettes with Jik
- Propette with spirit
- Matches
- Spirit burner
- Wire loop
- Ziplock bag
- Foil
- Tub
- cup

Testing for E.coli

This simple test investigates the importance of why we should wash our hands after going to the toilet. This experiment can be sued in variety of educational and fun ways to demonstrate the same point.

To receive a *'testing for E.coli bacteria'* kit, contact:

Share-Net on 033 330 3931 or

Ethekweni Environmental Education Centre 031 577 1605

Preparation and safe disposal
How to sterilise equipment and a working area
Notes on safe disposal of bacteria

Preparing a Control Test
A controlled experiment to 'check' that results will be reliable

2.1 How fast do bacteria grow?
An activity to explore exponential growth

2.2 Experiment 1: Are your hands clean?
Are they germ free?
Did you wash your hands after going to the toilet?

2.3 Experiment 2 : How to sterilise or purify water?
To find out how we can sterilise and purify water and see if it works.

2.4 Report Writing
Learners can write a brief report on the experiment using the following headings:
Aim; Apparatus; Method; Findings; Conclusion

Assessment
An acceptable demonstration of learning will be when learners are able to:
- express why, how and when it is important to wash hands
- identify after a simple experiment which bottles have the Coliform bacteria.
- write a simple report on conducting an experiment.

2.1 Experiment 1: Are your hands germ-free?

A. Preparing a Control Test *(a form of a 'check')*

1.

1. Fill the glass bottle almost full with clean water.
2. Replace the lid, but do not screw it on tightly.
3. Using tongs hold the bottle above the spirit burner 3. until it boils.

4. Allow to cool until it can be held comfortably.

5. Add 5 ml of boiled water to one of the plastic sample bottles with the **colilert** solution.

6. Tighten the lid and mark the bottle as the control (*C* on the lid).

5.

6.
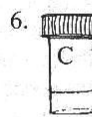
What is Colilert?
Colilert is the powder provided in the pack. It is a 'growth medium', which enables the bacteria to grow.
Think of the colilert as food for the bacteria.
Coli is for Coliform bacteria and lert is for alerting us that it is present.

B. Conducting the experiment

7. Pour water into a clean cup.
8. Get all children to dip their fingers in the water, rubbing index finger and thumb together.
9. Dispense 5 ml of this water into a plastic bottle with colilert solution.
10. Tighten and mark the bottle.

(Don't throw the water away - you will need this water in Experiment.2)

C. Incubating the samples

11. Put the control and sample bottles into the Ziplock bag.
12. Add one drop of Jik into the bag.
13. Place the Ziplock bag in a pocket to keep it warm for 18-24 hours. (it is essential for the bottles to be kept at body temperature in order to ensure the bacteria can grow). This is called incubation.

D. Assessing the results

14. Read the findings by observing colour change in each sample.
    A yellow colour will be a positive test for the presence of coliform bacteria!

Safety instructions:
Do not open either the ziplock bag or the bottle at any time during incubation.
Take the sealed bag to your science teacher for disposal in terms of the safety instructions in the pack.

Appendix 10: Example of an impression-based school sanitation audit from Case Story One

This is an example of an impression-based school sanitation audit, adapted from the Sanitation Works Series of Learning Support Materials for Rural Health and Sanitation (Share-Net, 2003). This audit sheet was completed by a grade five learner during Kay Sagadavan's school sanitation audit, as discussed in Case Story One.

Sanitation Audit Sheet

Grade 5 learners conducted an audit

Name Of School: Dr Macken Mistry   Name Of Learner: Christine

Date: 16 May 2005   Grade: 5

Please complete all sections of the questionaire

No. of learners in the school	620
No. of units in the school	16
No. of educators in the school	20

Section A Sanitation

	YES	NO
1) Is there sufficient water available for drinking and washing?	✓	
2) Which of the following toilets are used in your school. Mark with a tick ✓		
(a)Flush toilet – full water home sewerage	✓	
(b)Pit laterine – pit toilet with no vent pipe		✗
(c)VIP laterine		✗
(d)Bucket System		✗

	M	F
3) Number of toilets available for learners	9	13
4) Number of toilets available for educators	3	5

	YES	NO
5) Are there adequate toilet facilities for learners?		✗
6) Are there adequate toilet facilities for educators?		✗
7) Is there sufficient toilet paper available?		✗
8) Are there washing facilities available?	✓	
9) Are there rubbish bins in the toilet?		✗
10) Is there soap available for washing hands?		✗
11) Is there a towel available for drying hands?		✗
12) Are the toilets clean and hygienic at all times?		✗
13) Is there a smell problem?	✓	
14) Is there a fly problem?		✗
15) Are the floors clean?		✗
16) Are the floors wet?	✓	
17) Is there an overhead shelter?	✓	
18) Are there staff attending to the maintenance of the toilets?	✓	
19) BOYS Do you know how to use a urinal		
20) GIRLS Do you know about menstruation ?		✗
Are there sanitary bins in your toilet?		✗
Are there sanitary towels available at school?	✓	✗

Appendix 11: Example of a learner's work from Case Story One

This is an example of work produced by a learner during Kay Sagadavan's school sanitation audit, discussed in Case Story One. The learner used this data sheet to record evidence on the state of the school toilets.

Dr Macken Mistry Primary School
Name Of Learner: Nqobile Hopwell Date: 24 May 2005
Grade: 5 B

Observations:
I observed that the toilet seats had blood on it. I observed that the toilet walls had poo on them. I observed that the children pee on the floor. I observed that the children eat in the toilets. I observed that the toilet seats had poo and pee on them. I observed that the toilets were not flushed. I observed that the toilets cannot flush. I observed that the lunch box was in the toilet. I observed that the children write on the walls.

Suggestions:
I suggest that the girls who menstruate should wipe the toilet seats after using them. I suggest that the children should carry their own toilet paper instead of putting poo on the toilet walls. I suggest that the children should pee in the toilet. I suggest that the children should eat outside the toilet. I suggest suggest that the children should learn to sit properly on the seats.

Actions:
Make or bring a bin to keep in the toilets. Bring toilet papers tear them in half to keep in the toilets. I think that we should teach them how to sit properly on the seat. I think that we should teach them how to flush the toilet properly. We should also teach them not to eat in the toilet.

Activity:
Make them flush the toilet on their own, to see if they have learnt. Make them sit on the toilet seat on their own, to see if they have learnt.

Appendix 12: List of LTSM used by teachers for auditing lesson in the case study

Impression-based audits:

SCHOOL GROUNDS AUDIT
- Homemade audit sheet: questions for learners about school grounds with a space in which to draw happy and sad faces (p1t3)

WATER QUALITY AUDIT
- SWAP water quality audit framework (p1t5; p1t10)

SANITATION AUDIT
- Individualized questionnaire about state of the school toilets (p2t6; p2t7; p2t11)
- Audit of toilets at home (p2t11)
- Gridword on sanitation (p2t7; p2t11)
- Information on different types of toilets (p2t11)
- Chart depicting health and unhealthy environments (p2t6; p2t11)

AIR QUALITY AUDIT
- Individualized questionnaire made by a previous participant on the course and provided as an example in the course notes (p3t2)

Evidence-generating audits:

WATER CONSUMPTION AUDIT
- Pictures of wasteful vs 'good' water use practices (p1t1)
- Homemade worksheet for recording numbers of leaks (p1t1; p1t2)
- Homemade worksheets for recording water meter readings (p1t1)
- The eThekwini water consumption log (p1t4)
- SWAP kit water use audit sheet (p1t6; p1t11)
- Photographs taken at school (p1t1)

WATER QUALITY AUDIT
- SWAP kit water quality audit framework (p1t7)
- 'Water and the Environment' (p1t11)
- Water Field Studies Water Quality Survey (p1t11)
- Watties Fix-Its (p1t12)
- Pictures of dirty rivers (p1t5; p1t10)
- Turbidity disc (p1t5; p1t10)

SANITATION AUDIT
(1) Survey of toilets in community
- Information on types of toilets and wastewater treatment (p2t6)
- Cholera posters (p2t6)
- Information on diseases associated with sanitation (pamphlets) (p2t6)

(2) Survey of hand-washing practices in schools
- Observation sheet / school toilet survey with space to write down numbers of girls and boys who do and don't wash hands (p2t11)

WASTE AUDIT
- Homemade workbooks with instructions, activities and space for writing down findings of the audit etc (made by the teacher) and portfolio boards for reporting on an investigation (p1t8)
- "Domestic Waste' pamphlet produced by DSW (ot9)
- A homemade worksheet for recording number of items of each type of waste (ot9)
- Enviro Fact Sheets (p1t8)

Actualizing audits:

SANITATION AUDIT
- Somerset bacteria test kit (ot1)
- Cholera posters (ot1)
- Story in a newspaper article (i2t1)
- Worksheet for writing up a scientific report (i2t1)
- Instructions for coliform testing and sanitation kit (p2t11)
- Chart depicting health and unhealthy environments (ot1)

Appendix 13: Data sheet for the evidence-generating waste audit discussed in Case Story Two

This is the data recording sheet designed by Ayanda Ngwenya for his evidence-generating waste audit.

ZONE 1

Type of Waste	Bin 1	Bin 2	Bin 3
Paper			
Glass			
Tin			
Plastic			
Food			
Other			

ZONE 1

Type of Waste	Bin 1	Bin 2	Bin 3
Paper			
Glass			
Tin			
Plastic			
Food			
Other			

ZONE 1

Type of Waste	Bin 1	Bin 2	Bin 3
Paper			
Glass			
Tin			
Plastic			
Food			
Other			

Appendix 14: Table comparing two evidence-generating waste audits

	Ayanda's waste audit	Tom's water pollution / waste audit
Auditing methodology		
Focus of the audit	Waste.	Waste.
Auditing methods	Categorizing and counting waste.	Categorizing and counting waste; assessing health of the river.
Kinds of data	Quantitative evidence (numbers and types of waste).	Quantitative (numbers and types of waste) and qualitative (descriptions).
Auditing site	In classroom (AM 3.2.1).	At the river (AM 3.2.3).
Auditing choreography		
Teacher's intentions	To teach learners a moral lesson about waste – how they should use waste items to make money rather than disposing of it.	To achieve the learning outcomes of Natural Science; to promote active learning; to develop learners' problem-solving skills; to take action.
Teacher and learner participation	The teacher made all required research decisions for the audit and gave learners instructions (AM 3.1.4).	Teacher provided a framework for the audit, and supported learners to plan aspects of the audit themselves (AM 3.1.6).
LTSM	Data sheet made by the teacher – used to record data.	Pack of worksheets – used to guide the planning and implementation of the investigation, and to record, analyse and report the findings.
Findings of the audit	Numbers of items of plastic, paper, tins, etc.	River is in BAD condition, animal life is scarce, large quantities of waste are present, source of the problem is poor waste management by local business.
Opportunities to work with the findings	Findings were recorded on the blackboard only (AM 4.4) and were not worked with at all. The teacher abandoned them after talking to the learners, briefly, about them.	Items of litter were classified according to material and form of waste; learners identified sources of waste; results were tabulated, graphed and written into a matrix of non-metals vs metals, and recyclable vs non-recyclable (AM 4.2).
Perspectives engaged with in the lesson	Ways to use waste rather than throwing it away to save or make money; waste as evidence of unhealthy eating habits; individual responsibilities to take action. Very narrow view of the issue.	Impacts of waste on biodiversity; physical properties of waste materials; ways to reduce waste; responsibility of government, business, the public and individuals to take action. Broader view of the issue.
Processes of involvement and detachment	Counting and categorizing litter brought learners into close involvement with the issue. Learners felt negative about having to pick up litter. Learners' emotivity was more detached while reading the article on sources of waste.	Counting and categorizing litter and auditing the stream brought learners into close involvement with the issue. Learning was more detached while tabulating and graphing the findings, answering general questions about pollution and researching and planning for action.

Learners' accounts of the issue	"The problem that is caused by litter is that the school looks untidy" (gt9) Sources of waste were thought to be: children littering, the wind which blows litter in from neighbouring settlements, inappropriate disposal of kitchen waste.	"Pollution is an unwelcome concentration of substances that are beyond the environment's capacity to handle. [It is] bad for people and plants and animals." Sources of waste are "factory waste, local business, lack of bins" (lwt8).
Learners' proposed solutions	Learners are regarded as responsible for keeping the school clean. They must put litter in the bins and not throw it anywhere. They must pick up litter in the school every day. School must provide more bins (lwt9).	"teach the people" "polluters must pay a fine" "clean-up campaign" "council must clean up" "business must help us" (lwt8).

Appendix 15: Summary of environmental foci and auditing methods in this case study

(1) Impression-based audits

Type of audit	Environmental focus and auditing methods	Data sources
School grounds audit	Audit recorded learners' opinions on the size of playground, availability of shade, biodiversity, time available to play, availability of suitable places to sit and eat lunch, and whether learners would like to grow own vegetables	AM5.1.3 p1t3; pwt1; ltsmt3
Water quality audits	Audit recorded learners' observations of water supply, health risk, catchment conservation, river site quality, and water life	AM5.1.4 p1t5; p1t10
Sanitation audits	Audit recorded learners' impressions of the state of the school toilets – number of toilets, cleanliness, availability of soap/ toilet paper, state of the floor, and privacy	p2t6; lwt6; p2t7; lwt7; p2t11; lwt11; ltsmt11; p2t12; lwt12
Air quality audit	Audit recorded learners' impressions of the smell caused by pollution from factories, traffic, waste dumps etc	p3t2; ltsmt2

(2) Evidence-generating audits

Type of audit	Environmental focus and auditing methods	Data sources
Water consumption audits	Audit recorded the numbers of broken or leaking cisterns / taps / basins in the school; learners' observations of water use practices; wasteful water use practices; and suggestions regarding ways of saving water to save money learners' observations of water leaks at school water meter readings learners' observations about which areas in the school use excessive amounts of water	AM5.1.2 p1t1; gt1; i2t1; lpt1; p1t9; p1t11 p1t2 p1t4 p1t6
;Water quality audits	Audit recorded results of turbidity tests learners' observations and descriptions of water supply, health risk, catchment conservation, river site quality and water life, supported by evidence learners' observations of water colour, water smell, measurement or description of water speed, vegetation, observations and descriptions of animal life, alien plants and soil erosion learners' descriptions of the amounts and sources of pollution, the absence of waste management systems; problem-solving	AM5.1.4 p1t5; p1t10 p1t7 p1t11; p1t12 p1t8; lwt8
Water pollution audit	Audit recorded learners' descriptions of the types, amounts and sources of pollution; ideas for problem-solving	p1t8; lwt8
Sanitation audits	Audit recorded the numbers of girls and boys who do and don't wash their hands after visiting the toilets	AM5.1.5

Community toilet survey	Audit recorded the results of a survey in which learners visited neighbouring communities and interviewed residents to find out about the kinds of toilets they use; and residents' opinions of advantages and disadvantages of the different types of toilets	p2t6
Waste audit	Audit recorded learners' observations of the different types of waste and the amount of each kind of waste in the school bins	AM5.1.6 it9; ot9

(3) Actualizing audits

Type of audit	Environmental focus and auditing methods	Data sources
E. coli testing sanitation audit	Audit recorded evidence that there were invisible germs on learners' hands, e.g. coliform bacteria	AM5.1.5 ot1; i2t1; gt1; p2t2; p2t11; p2t12