THE MEANING OF RELEVANT SCIENCE IN TOWNSHIPS IN CAPE TOWN

MICHèLE STEARS

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Promoter: Professor Cliff Malcolm

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DECLARATION

I declare that "THE MEANING OF RELEVANT SCIENCE IN TOWNSHIPS IN CAPE TOWN" is my own work and that all the sources used or quoted have been indicated and acknowledged by means of references.

Signed..

Date. 7 April 2005 ....

University of KwaZulu-Natal

ABSTRACT

THE MEANING OF RELEVANT SCIENCE IN TOWNSHIPS IN CAPE TOWN

This study explores the meaning of relevant science in two townships in Cape Town. Reform in science education, both nationally and internationally has placed much emphasis on the fact that science education should be relevant. The research conducted in this study attempts to interpret different dimensions of relevance. This study explores not only how learners make meaning of their everyday lives, but what 'science' they deem to be relevant and worth learning within this context. It acknowledges the important role of teachers in establishing what learners perceive to be relevant.

The theory of social constructivism is suited to this investigation, in its recognition of the roles of children's knowledge, purposes, social groups and interactions in learning. The children in this study often have personal lives steeped in poverty, abuse and violence. The curriculum design is also guided by social constructivist theories. However, a second version of constructivism, critical constructivism, is used to frame the second phase of the study. A critical constructivist approach raises questions about the type of knowledge learners interact with. In critical constructivism, science and its methods, the curriculum and the classroom are opened up to critical inquiry.

Teachers' knowledge of their learners is used to design science lessons that

are more meaningful, relevant and personalised. The individual lessons, as well as the lesson series that are used in this study are designed as examples of relevant science, while the lesson series also serves as a tool to elicit deeper understandings of what learners in this particular context experience as relevant to their lives. Although the main focus of this research is the relevance of using everyday knowledge in the classroom, bringing everyday knowledge into the classroom allows for the inclusion of a number of dimensions of relevance. The different ways in which learners respond to the science lessons in both phases are discussed as five outcomes.

The findings of the research show that the essence of a relevant science curriculum lies in a particular design. This design accommodates many dimensions of relevance, such as relevant content, context and purposes. Such as design helps learners to negotiate the difficult border between the formal school environment and the informal home environment. A relevant curriculum acknowledges that science education is more than only science, but also recognises the implications for science curriculum development.

This study is part of a larger project which is a comprehensive evaluation of the Primary Science Programme (PSP). The PSP gave the research its full support as the investigation of relevance may have an influence on curriculum design.

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CHAPTER 1

PURPOSE, RATIONALE AND BACKGROUND

INTRODUCTION

With the advent of democracy in South Africa, many changes were implemented, including changes to the education system. The legacy of apartheid was most obvious in the education system implemented before 1994 and it was imperative that a democratically elected government was seen to eradicate the inequalities of the past. The introduction of Curriculum 2005 (DoE,1995), as a single national curriculum for everyone, heralded a different approach in education. This curriculum not only advocated the development of knowledge and skills, but also emphasised education for democracy and citizenship (including social justice).

South Africa is not the only country engaged in educational reform. Influential reform documents have recommended that science instruction be grounded in practical contexts and that science educators, at the school level, design curricula that are interesting and relevant to the everyday experiences of their students (Taylor, 2001). This is the case in South Africa. Curriculum 2005 (DoE,1995) is outcomes-based and learner-centred. It seeks to balance central control (and a single curriculum) with local design, by requiring educators to design curricula according to central guidelines and set outcomes. However, to design relevant curricula requires some understanding of what learners (and others) perceive to be relevant.

RATIONALE

The call for reform in science education has been especially strong because science is seen as a critical subject in economic and social development but, in many countries, learners' interest in science have decreased (Teppo and Rannikmäe, 2004) with drop-out rates increasing.

The situation in South Africa is particularly serious, because during the years of apartheid the science curriculum was content-centred, based on a positivist world-view and had very little connection to the lives of black South Africans. Given that policy makers claimed that science was not meant for black people, black education was poorly resourced. The result was that participation in science was low, with low achievement rates persisting.

Although the pressures of globalisation make educators aware that effective schooling must be able to prepare future generations with the knowledge, skills and attitudes that will enable them to cope with rapid changes in the workplace (Thomas 1997), an increasing body of research calls for reform in science education, focusing on the inclusion of local aspects in the curriculum. This is particularly important in a country like South Africa with its diversity and differences between urban and rural communities. To accommodate these differences require local curricula, rather than a set curriculum that privileges some learners over others. South Africa cannot afford to sustain a universal science curriculum if it benefits only a handful of learners who wish to pursue a career in the sciences. Instead, what are required are science curricula that provide opportunities for differences in detail while allowing for the development of important skills such as problem-solving and critical and creative thinking. Peacock (1995), for instance, suggests a core curriculum with regional variations. Such a curriculum would be more relevant to learners. Relevance however, is a complex idea and includes many dimensions. Relevance may be viewed in both a pedagogic and a content sense. Relevance in a pedagogic sense refers to the different strategies implemented to help learners learn science. Relevance in a content sense allows learners to influence what will be learnt. The purpose of this research is relevance from a learner's perspective, a way of increasing interest in science and levels of achievement.

The ROSE (Relevance of Science Education) project is an international project researching science curricula. It regards the universal science and technology curriculum as having so little relevance, that it is a barrier to learning and capturing interest (Sjøberg, Schreiner and Stefánsson, 2004). The aim of ROSE is to promote relevance of content and context in science and technology curricula. Various approaches have been implemented to make the science curriculum more relevant. One of these is a move towards eliciting the views of learners as to what is interesting and valuable to learn (Osborne and Collins, 2001). Another suggestion is that the outcomes for science education, for primary science, should be different to the outcomes for secondary education (Fensham, 2004). There should be less focus on scientific knowledge as an outcome (especially in primary science). In studies set in classrooms and oriented to cognition, the concept of relevance is limited by the rules and norms of classroom science.

There seems to be a general assumption that students will learn if science is interesting, connected with everyday life and useful in their life and future development (Teppo and Rannikmäe, 2004). The theme of the ICASE (International Council of Associations for Science Education) conference held in Penang, Malaysia in 2003, was relevance in science education. The purpose was to encourage increased relevance through relevance to perceived needs and interests of the student, relevance to industry or student careers and relevance to the needs of society or culture. The conference suggested that science should relate more to social issues in order to promote an interest in science. All of these are important aspects of relevance and take cognisance that there may be other personal and social outcomes that need to be met to enable learners to benefit from schooling.

The challenge however, is how to promote local curricula that are relevant in specific contexts, without raising the spectre of differentiation as experienced during the apartheid era. A localised curriculum should be seen as meeting a broader range of outcomes than a generalised curriculum, without trapping people in their local community. The criticism that a localised curriculum does not afford the opportunity to develop the knowledge and skills required to allow escape from local circumstances, needs to be questioned. It may be, as Fensham (2004) suggests, that there are other outcomes that are as important and, in fact necessary, to achieve science knowledge outcomes in the longer term. A relevant curriculum should embrace a concept of relevance that serves the local needs of learners without denying them access to a universal science education.

The rationale here is to explore what learners experience as relevant in the science classroom that might serve them in their community, while at the same time enabling them to improve their levels of science achievement. In order to establish what learners regard as relevant, the knowledge that teachers have of their learners together with the knowledge that parents have of their children, was relied upon. It was important to explore the interaction of particular learners between school and home (and their personal lives).

This research attempts to determine how teachers use their intimate knowledge of learners to develop learning activities that are relevant and how they implement these learning activities in their classrooms. Collaboration with the teachers in designing strategies that allow for the interests and lives of learners to be brought into the science classroom is necessary.

Although a good deal of research has been conducted on how knowledge is constructed within a social context, the influence of deeply personal factors that may influence learning requires investigation. As a teacher educator, I have spent time in many primary school classrooms over the past 15 years. Most of the classrooms visited could be described as highly functional in that they were well resourced and well managed. However, it was obvious that very little attention was given to socio-cultural issues or personal dimensions in the learners' lives. Prior to the implementation of Curriculum 2005 (DoE,1995), teachers could argue that they were bound by a set syllabus. With the introduction of Curriculum 2005 (DoE,1995), teachers were free to design their own learning programmes and the expectation was that these learning programmes would be more relevant to the learners.

Although many learning programmes that address cultural differences have seen the light, the personal circumstances of learners need to be taken into account when learning programmes are designed. The aim is to establish how learners experience science when engaged in activities that bring their personal experiences into the classroom. Most science curricula address different cultural aspects in a superficial way, but do not address the personal circumstances. These aspects of the curriculum will be included in curriculum design. This will mean using different content and teaching strategies to accommodate the personal and social dimensions of learners' lives.

While my study will try to determine what constitutes relevant science for learners in a particular context, I believe that this research will enable a better understanding of the different ways in which learners experience what is relevant to their lives.

BACKGROUND

The Primary Science Programme

This study is part of a comprehensive evaluation of the Primary Science Programme (PSP) of the Western Cape. PSP is a programme of school and teacher support that includes the development of teachers as curriculum designers and the provision of modules that teachers can adapt as part of Curriculum 2005 (DoE,1995). PSP operates in disadvantaged urban townships and the rural areas of the Western Cape, so conceptions of relevance are important to both pedagogy and the choice of content. The purpose of the evaluation programme is to inform and guide PSP practice and describe the PSP's impact and effectiveness, in the context of curriculum change in

South Africa (Malcolm and Kowlas, 2002). The evaluation includes various aspects of teaching and learning such as school and classroom management, materials development and assessment.

The evaluation consists of two strands. The first is a large-scale study to gather data on the PSP through questionnaires and pupil assessment from a representative sample of schools together with descriptive data from the PSP office (Malcolm and Kowlas, 2002). The second strand explores, in depth, various aspects within the PSP itself and a small selection of schools and classes. A pilot study was conducted in 2001 to guide detailed planning and I joined the team in 2002 to become involved in detailed classroom studies and curriculum design.

The PSP works mainly in historically disadvantaged schools, as this is where the need is greatest in terms of development and support. The study was therefore conducted in schools that are socially and economically disadvantaged and where the PSP has intervened. The teachers in the selected classrooms had all been trained through the Primary Science Programme (PSP). The pilot study showed that these classrooms were well-managed and effective in terms of learner participation in class activities. It was for this reason that they were defined as effective classrooms. This implied that the teachers involved were highly committed to effective science education and to the children in their classes – teachers who could work as partners in the research.

Although the teachers use materials developed by the PSP, resources are fairly limited and teachers are often required to improvise. Most learners come from environments where poverty dominates their lives and they often lack writing materials. The classes are large, with 40 – 55 learners in each. An added complication is the fact that children have to learn through a language, which is not their mother tongue.

The choice of teachers and their classes was carefully considered and teachers who were defined as effective by the PSP management as well as the evaluation team, were selected. These teachers would be able to introduce lessons that included dimensions of relevance to these particular children.

The PSP gave the research its full support as the investigation of relevance impacts on curriculum design. As one of the foci of the PSP is curriculum, they saw possible benefits from the research. My research benefited from the fact that, as part of a larger evaluation, links to the PSP made access easier to schools and allowed for interaction with members of the PSP who run workshops and write curriculum material. It (the research) also benefited by having links to other members on the evaluation team and insight into various other dimensions of the evaluation. On the other hand, the fact that this research was part of a larger study meant that there was no options in the choice of schools and the decisions as to which grades would be part of the study. The fact that the study was conducted some distance away required careful planning with regard to data collection.

Relevance

This study investigated the meaning of relevant science and what learning the learners perceived to be relevant in their lives. It explored ways of including dimensions of relevance in learning programmes to see how learners responded. To accomplish this, my research had to understand the lives of the learners in these classes better. What were their interests, experiences and circumstances? Three teachers who live in the area and teach at schools in the area acted as collaborators in the study. They provided valuable input with regard to the children in their classes. The input from these teachers was relied on heavily because of their knowledge and their ability to communicate intimately with the learners. Language constraints made it difficult to communicate with the learners in their mother tongue (isiXhosa). The learners were not proficient enough in the language of instruction (English) to allow deep interaction with them without the support of the teachers. Parents also provided insight into the lives of their children and the communities they lived in through meetings facilitated by the teachers. Children, of course, provided valuable information about their lives as well. This gave three perspectives on what constituted relevance - teachers, parents and the children.

This knowledge was used to design conventional lessons, taught by the teachers. Dimensions of relevance were built into these lessons. This enabled knowledge of how learners responded. The lessons provided a basis for interviews to investigate deeper dimensions of relevance.

The next step involved working with learners to establish a list of relevant 'topics', including questions and ideas that made these topics relevant. From the list, one topic was chosen and developed as a series of lessons that were regarded as relevant, both in content and in ideas and methods built into the module. The children and the teachers were active in the design of these lessons. As well as being based on learners' interests, the lessons were founded on the principles and guidelines of the Revised National Curriculum Statement (RNCS), (DoE,2002).

PURPOSE

The purpose of this study was to gain a deeper understanding of what constitutes relevant science for a group of learners in a particular context. The following critical questions will guide my study:

- What do learners regard as a relevant science curriculum?
- How do learners respond to a relevant science curriculum in a conventional setting?
- How do teachers use the knowledge they have to teach relevant science?
- How do learners respond to a relevant science curriculum in an arranged setting?

This study sought answers to the critical questions by involving teachers as collaborators and learners as co-participants in the study.

This study should be useful for the following reasons.

- It will inform theory with regard to relevant science in that it will broaden the concept to include more dimensions of relevance.
- It will inform theory about curriculum design that may influence policy on curriculum design, pointing to the importance of including teachers as

participants in curriculum design, as well as the importance of designing localised curricula.

- As the PSP collaborates with teachers to explore ways of improving learner performance, this study may also benefit the project.

The study was conducted in three schools located on the Cape Flats in two different townships. One that consists mostly of informal housing and the second is one of the older, more established townships on the Cape Flats. Even the established township is surrounded by an informal settlement. The schools are,

- Luzuko Primary in Guguletu.
- Isikhokelo Primary in Khayelitsha.
- Chumisa Primary in Khayelitsha.

All three schools are located in areas with severe socio-economic problems. Many children have recently moved into the area from the former Transkei and face the challenge of having to adapt to an urban environment as well as the many other social and personal challenges that children in these communities face. It is for these reasons that this area was chosen for the study. The current science curriculum is perhaps less relevant to these learners than any other community of learners.

DIFFICULTIES

A central difficulty was communicating with the participants due to language difficulties. This raised the issue of translation. Waldrip and Taylor (1999) argue that important information can be lost in translations and responses should be reported verbatim. The fact that I relied heavily on translation, raises the question as to how accurate the translations were and for this reason an inability to converse with the participants in their mother tongue was a limitation. The limitation was overcome by data being obtained from a variety of sources.

Nespor (1998) raises the issue of researching children. He wonders if children react in a certain way to the researcher, especially in their reactions to interviews. He warns that interviewing learners could be problematic, as his research indicates that children see interviews as opportunities to give the 'right' answers - the answer the researcher wants. He suggests that the researcher should try to be an atypical adult as this might elicit responses from learners that they would not normally give to teachers. As I spent a number of days teaching learners whom I also interviewed, this strategy was not appropriate. The fact that learners were interviewed a number of times reduced the possibility of them providing responses they thought were expected. Other forms of data, such as observation, work sheets, tests and interviews with teachers and parents could be viewed as forms of triangulation to support the evidence from learner interviews.

OUTLINE

The report consists of nine chapters, including this chapter. In this chapter, attempts have been made to place the study in context by providing some background. The rationale gives personal reasons for wanting to conduct this study, based on the experience of primary science classrooms together with the importance of this research in the context of global science education reform. The research questions provide a framework for the study.

In chapter 2, the theoretical framework is discussed and an overview given of the literature that relates to the teaching and learning of relevant science. Although social constructivism is the theoretical framework that underpins the study, other forms of constructivism are elaborated upon. Social constructivism does not only explore how learners make meaning, but looks at the socio-cultural environment in which meaning is made. In the context of this study, this is a crucial element. Special attention was paid to critical constructivism and the second phase of the study is also informed by elements of critical constructivism. Social constructivism and critical constructivism provide the basis for defining relevance. The literature discusses learning and teaching from a social constructivist perspective. The influence of the socio-cultural background of learners on learning, including the subculture of poverty, is discussed, as well as the issue of learning through a second language.

As part of my study involves curriculum design, the theories that guide the design of curricula are explored. Critical constructivist, learner-centred approaches based on problem solving, guide the curriculum design in this research. Various approaches to the design of relevant curricula are discussed, pointing to the complexity of the concept of relevance.

The research was conceived in two phases, which differ with regard to theoretical and methodological frameworks and are therefore presented separately. Chapters 3 to 5 cover phase 1, and chapters 6 to 8 cover phase 2. Phase 1 investigated learners' perceptions of relevance and how they might be incorporated into a conventional setting (that is, as part of the teachers' programme). In phase 2 the children, teachers and I worked together to create, implement and evaluate a module that sought to be relevant. It was, in this sense, an arranged setting.

Phase 1

Chapter 3 sets out the methodological framework applied in phase 1. This methodology is essentially interpretive as it enabled me to interpret and give meaning to the children's social world and school experience. This chapter sets out the methods and instruments that allow exploration of the first three research questions. Various issues related to the methodology, such as ethical considerations, validity, reliability and generalisability are also discussed in Chapter 3.

Chapter 4 presents a descriptive analysis of the results of phase 1. This analysis is presented as three narrative accounts, one of a teacher and two of learners. While the teacher's narrative is a composite of the three teachers, the narratives of the learners represent two groups of learners who experience the science lessons differently. The teacher's narrative provides insight into the lives of the learners in these classes and how she perceives their responses to the different lessons. It also gives an account of how the parents of these learners view their children, their communities and school. The learners' narratives reveal their responses to the lessons taught.

In chapter 5 the results reported in chapter 4 are discussed. From the narratives, a number of categories of relevance are defined and discussed from the teacher's perspective as well as from the responses of the two groups of learners.

Phase 2

Chapter 6 describes the methodology of Phase 2. Phase 2 is an arranged setting, in which my role changed from outsider to insider, working with the children and teachers as researcher, curriculum designer and teacher. Thus the methodology was participative. As the teacher in the classroom it became necessary to interpret what happens in the classroom in a broader context, hence the critical constructivist approach. The research in phase 2 included a pilot study.

This chapter also sets out the methods implemented that allowed the exploration of the fourth research question. The lesson series served as a research instrument as it enabled an exploration of the different dimensions of relevance, as well as developing a deeper understanding of how learners perceived relevance. Methodological issues that emerged (that were not present in phase 1) are discussed, including language and issues of power.

In chapter 7 the findings of phase 2 are presented as three narrative accounts of the same teacher and two learners. The teacher gives an account as an observer in a classroom in which I taught her learners. She interprets her learners' actions in response to the lesson series. The learners' narratives provide insight into their responses to the lessons. This chapter also gives a brief description of the tests that were written after completion of the lesson series.

In chapter 8 a number of categories that emerge from the narratives of chapter 7 are identified and discussed. The categories are presented as propositions about relevance.

In chapter 9, the findings from phase 1 and phase 2 are brought together, examining the ways in which learners responded to the different aspects of relevance and possible reasons for their responses. The implications of the research for science curriculum development are discussed in the light of the findings.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

IINTRODUCTION

The South African Education System has undergone major transformation over the last ten years. The introduction of Curriculum 2005 (DoE, 1995), including a new science curriculum, was central to this transformation. The curriculum was hailed as a paradigm shift, providing a single national curriculum for all schools, based on common outcomes, learner-centeredness and a devolution of curriculum design to schools and teachers. Its outcomes and guidelines were strongly transformative, socially and economically. Even so, themes of the Natural Science Learning Area - Life and Living, Energy and Change, Matter and Materials and Earth and Beyond - drew on traditional science content, similar to that in the old curriculum and still central to curricula such as in the UK National Curriculum, the Australian Profiles and the USA Benchmarks. In 2002, Curriculum 2005 (DoE,1995) was 'streamlined' to form the Revised National Curriculum Statement (RNCS), (DoE, 2002), which, while retaining the basic principles of Curriculum 2005 (DoE,1995), is more prescriptive in suggesting content while at the same time encouraging the inclusion of indigenous knowledge (African experience, knowledge and ways of knowing) and local content (RNCS, DoE, 2002). The policies thus provided a considerable scope for the localisation of learning programmes and pursuit of content and methods that are relevant to the lives and purposes of the children. The question thus arises, how relevant the experienced science curriculum is to the learners and how it can be made more relevant and more effective? An attempt to understand what learners regard as relevant and how they respond to this relevance, was made. This required some discussion of what is meant by relevant science and the type of curriculum that facilitates the delivery of relevant science.

The theory of social constructivism is suited to this investigation, in its recognition of the roles of children's knowledge, purposes, social groups and interactions in learning. The children in this study often have personal lives steeped in poverty, abuse and violence. The curriculum design was guided by social constructivist theories. Much of the literature in science education concerning relevant science defines relevance in terms of enhancing learning of traditional science content with a view to various adult roles. Less literature exists covering the broader dimensions of relevance from the learners' perspective. This study explores not only how learners make meaning of their everyday lives, but also what 'science' they deem to be relevant and worth learning within this context. The literature reviewed in this chapter focuses on relevance with regard to science learning. However, aspects of relevance and learning outcomes in the science classroom that go beyond science learning were kept open. This idea of learning through science (as well as learning about science) is part of the Curriculum 2005 policy, with its concerns for social transformation and broad competences such as problem-solving, critical thinking, personal management and teamwork (DoE, 1995).

THEORETICAL FRAMEWORK

Although social constructivism provided the lens through which the study was conducted, some discussion of the various definitions and views of constructivism is necessary. This is important as two different versions of constructivism are used to frame the two phases.

Individual or Personal Constructivism

Constructivism as a learning theory has been widely accepted throughout the science education research community as an alternative to a behaviourist view that learning is the absorption and reproduction of knowledge. The notion that the learner actively constructs understanding is well supported by research and has appeal as a foundation for child-centred pedagogies. Personal constructivism emphasises the individual's learning and views knowledge primarily as something stored in the individual mental system, as mental models of the world outside (Duit and Treagust, 1998). Students' come to class with a multitude of unique experiences, beliefs and knowledge about how the world works – they have lots of scientific ideas (Colburn, 2000). Since the mid 1980s, an extraordinary amount of research has been done to record children's existing knowledge on a wide range of subjects, it indicates how that knowledge is often firmly held and proposes ways of shifting children's understanding effectively (e.g. Duit and Treagust, 1998).

Personal constructivism, as a force in science education, has its roots in Piaget's structuralism (O'Loughlin, 1992). Piaget's interest lay in isolating universals of cognitive development. His particular approach points to a model of cognitive development characterised by reasoning that is ahistorical, value-free and abstract. However, this rational approach does not account adequately for patterns of cognitive development and this paved the way for social and cultural approaches to cognitive development. O'Loughlin, for example, is extremely critical of personal constructivism. He argues that it can be disempowering because

> This lack of dialectical interchange between the individual and the world belies the constructivist image of an active learner firmly in control of her or his destiny. Instead the suggestion is that because of its emphasis on decontextualised intellectualism and decentration from experience, constructivism detaches people from their reality and teaches them to intellectualise and rationalise their relationship with the world rather than come to grips with the possibilities for personal and social transformation (O'Loughlin, 1992, p802).

On the other hand, von Glasersfeld (1995) argues for individual constructivism because knowledge construction – rational or not – occurs ultimately in individual minds. He is critical of social constructivism and its emphases on language and social interaction. In his view,

> The crucial aspect of the 'negotiating' procedure is that its result - the accommodated knowledge - is still a subjective construction, no matter how mutually compatible the knowledge of the negotiators may have become in the process. (von Glasersfeld, 1995, p191).

Clearly there is more at stake here than learning theory, including the nature of 'knowledge', the prospect of shared knowledge and the nature of reality itself. Should knowledge be defined as 'residing' in individual minds, or collective minds, as an entity capable of residing 'somewhere' and being passed one from one place to another (albeit imperfectly), or as a discourse having point only in the act of communication (with people or objects)? The review focuses on learning theories, but keeps in mind the different conceptions of knowledge in different theories.

Social Constructivism

The way in which a learner constructs reality and makes meaning or 'mental models' is influenced by social and cultural factors as well as physical and personal ones. Making learning meaningful for learners has to take into account social and cultural environments. Vygotsky's theory is influential in this regard. Where Piaget views the direction of the development of thinking from the individual to the social, Vygotsky views the direction of development from the social to the individual ((Vygotsky, 1986). Meacham (2001) supports Vygotsky's view that learning does not take place in cognitive isolation, but within the context of activities and social interaction informed by the day-to-day contingencies of culture. School learning is largely informed by the interaction between the conceptual domains of the home/community and school. Vygotsky (1986) saw the connection between the 'spontaneous ' (often unstructured) conceptual domain and the 'schooled' (formal) domain as essential if school learning is to be effective, irrespective of the cultural background of the learner. Vygotsky's view is that learners do not grasp concepts learned at school directly, but through conceptual frameworks taught in the home. If children have difficulty connecting the spontaneous conceptual domain of the home to the conceptual domain of the school, this could have serious implications for learning. A relevant curriculum can facilitate these connections. Such a curriculum may well help learners to reach the stage referred to as 'generalisation' by Meachum (2001). Generalisation occurs when the learner is able to separate conceptual understanding gained in the home environment from that specific context and connect it to more general concepts in other contexts. Moll (2001) is of the view that in the South African context, Vygotsky's view of the relationship between school learning and everyday life may be misinterpreted. The two are not versions of each other, as is implied (Moll argues) in the documents from the Department of Education. The two types of knowledge are constructed differently, with the informal knowledge providing a foundation on which formal structured knowledge is constructed.

From a social constructivist viewpoint, learning occurs best in a social environment that is mutually and actively created by the teacher and learners. In that social setting, effective learning will be influenced, especially by more 'capable' others, in the learners' immediate environment. Learners contribute to the group knowledge, but in turn take knowledge from the group. Chak (2001) refers to the co-constructivist's perspective and the active roles of adults and children in that co-construction. Vygotsky (1986) argues that each child has a Zone of Proximal Development (ZPD), beyond the child's current knowledge, but within reach. If this ZPD is not actualised in the home environment, it may be more difficult to actualise in the school environment. Disjunction between the home/ community setting and the school setting may make actualisation more difficult. Smagorinsky and O'Donnell-Allen (2000) refer to the importance of the home environment in preparing learners for the school environment. However, the interaction is two-way. The home environment might be adjusted to better fit with the school programme or the school programme might be adjusted to better fit the home experience.

Many researchers have expanded the theories developed by Vygotsky. For example, Mc Robbie and Tobin (1997) point to the importance of the personal, subjective as well as the social. There are multiple ways in which individuals may construct their meaning from a given context.

> Social constructivism recognises the social and personal aspects of learning. In a personal sense the individual constructs meaning as new information interacts with extant knowledge (Mc Robbie and Tobin, 1997, p194).

Duschl and Hamilton (1998) turn attention from learners and learning to science, pointing to social influences on the development of science knowledge, beyond individual psychological influences. While knowledge is personally constructed, this knowledge and its construction are socially mediated as a result of an individual's interaction with others in that culture. This is supported by Lauzon (1999) who sees learning as an active experience that requires learners to become actively involved and participate in a community. This community is 'a community of practice' – whether the classroom, the peer group, the home or an interest group. Whether expressed in face-to-face interaction or via books and the Internet. In that community, learning and knowledge are tacit and covert as well as overt arising from experience, norms, assumptions and behaviours in the community as well as from overt instruction and dialogue. Lauzon refers to situated cognition - the idea that cognition is shaped by purposes, physical and social settings and is far from an individual process of abstraction. (This is discussed in more detail later). Theories of situated cognition suggest that learning is more effective when it occurs in a context in which knowledge is both created and used. They also suggest that learning occurs in different ways and with different characteristics in different communities.

To what extent are learners able to link spontaneous and formal science knowledge if the communities in which spontaneous knowledge develops (such as home, peer group, etc.) are limited in scope by poverty and the demands of physical and social survival? Does it follow that schools must provide opportunities for spontaneous knowledge to develop as part of their development of formal knowledge? Should schools emphasise formal knowledge related to the spontaneous knowledge that the children do have, on the basis of their particular lives and priorities? Chak (2001) refers to the importance of adult sensitivity to children's learning in the zone of proximal development. Many children in this study live in environments where there is little possibility for adult guidance or collaboration with capable peers, neither in the real needs of the children (and their families), nor in the topics of the school science curriculum. To understand which knowledge is useful to the children, what their concerns are and how they 'generalise' concepts, some understanding of their everyday lives is required.

Vygotsky gave much attention to 'mediation means' i.e. the ways in which tools appropriated from the social world shape human functioning. The tools and the skills in using them, derive from the various social worlds the learners inhabit. Tappan's (1998) view is these tools are made available through caring others – whether adults, siblings or peers. This may be thought of as a caring pedagogy. When the caring pedagogy is absent, achievement is affected. His view is that researchers working in communities of economically, socially or linguistically disadvantaged children should be sensitive to the possible absence of a caring pedagogy. Donald, Lazarus and Lolwana (2002) also emphasise the role of mediators that help learners to acquire the social constructions of knowledge through the ZPD. The requirement for the 'mediation' of someone who will help learners to make the connections between where they are in their understanding and the new knowledge, is critical. Learning will occur where the learner is challenged to alter their present understanding to a more advanced level. If the challenge is too far it will fail. Mediation (and the quality of that mediation) will help. This process of critical connection occurs more easily through familiar content or particular interest. Although Donald, Lazarus and Lolwana (2002) focus on cognition and the construction of knowledge, they point out that construction of the world includes values, social interaction and emotional adaptation. It is important to remember this in the context of science education, where the emphasis is towards the construction of abstract knowledge and rational thought. The broader perspective may be especially important in the study, where the focus of construction of the world for many learners may be much more in the practical and procedural domains of knowledge than the formal domain.

A strong feature of Vygotsky's view of social constructivism is situated cognition. Situated cognition focuses on learning as participation in a socially constructed world (Agee, 2002; Rodriguez, 1998; Lave and Wenger, 1991). Learning is a situated activity (situated cognition) that occurs in communities of practitioners. Newcomers move to full participation in the socio-cultural practices of the community by acquiring skills and knowledge. Lave and Wenger (1991) describe the first step in the relationship between newcomers to the community of practice and established, experienced members of the community as 'legitimate peripheral participation' and from here deeper relationships and fuller participation develop. Theories on situated cognition emerged from work that examined the relationships among learning and thought processes in particular social and cultural contexts. Situated cognition is an important idea in the research. The focus is on children who live in particular communities and particular situations, quite different from the situations that are usually assumed. For example, in curriculum policies and materials and international tests of science achievement.

McCaslin and Hickey (2001) use the term socio-historic constructivism to describe the work of Vygotsky. They view learning as

> ...increasingly meaningful participation in knowledgeable sociophysical contexts. (McCaslin and Hickey, 2001,p 137).

They give considerable attention to 'scaffolding' as a way of guiding construction, and place great emphasis on context. Essential to their approach of scaffolding are the relationships between co-participants, a requirement reminiscent of communities of practice. Learning is closely bound to context and participation in a community where learning is practised and valued.

Critical Constructivism

Where social constructivism is a theory of learning, critical constructivism is concerned also with educational purposes and the nature of the classroom community. Following theorists such as Foucault (1974), Giroux (1988) and Freire (1990), critical constructivism points to the politics of knowledge and discourse and the ways politics define and express a 'community of practice'. The science curriculum, as a vehicle for social and personal development, can seek to reproduce society or to transform it in particular ways. In critical constructivism, science and its methods, the curriculum and the classroom are opened up to critical inquiry. A critical constructivist approach raises questions about the type of knowledge learners interact with. It requires that educators and their learners take cognisance of social, political and historical issues in the practice of education in the context of the community in which they practise (Kincheloe, 1991).

Aldridge, Fraser, Taylor and Chen (2000) raise the issue of a critical voice within a critical constructivist framework. The teacher is in a privileged and responsible position. To what extent do students question the teacher's pedagogical plans, methods and knowledge and voice their concerns about impediments to learning? While students might question the degrees of shared control, competition and negotiation, can they also question the nature of the curriculum and its implications for personal interests and relevance (such as, for example, a preference for practical action over critical discussion)? Critical constructivism recognises the power issues and learning issues as constraints on learners whose culture is different from that which 'produced' the knowledge the learner is expected to construct. For example, O'Loughlin's (1992) socio-cultural model contains elements of critical constructivism. Knowing is viewed as a process of examining current reality and constructing critical visions of other possible realities as a step towards social transformation. In somewhat similar vein, Rodrigues (1998) offers a socio-transformative constructivist model that links social constructivist theoretical frameworks to multicultural education. As multicultural education is largely concerned with empowering learners and acknowledging different cultural experiences and ways of knowing, it has a strong critical constructivist slant.

CONCEPTIONS OF RELEVANCE

Various members of the science education community such as policy makers and curriculum designers regularly make calls for a science curriculum that is more relevant. This raises the question of what is meant by relevance? (Malcolm, Kowlas, Stears and Gopal, 2004). Various researchers have explored the meaning of relevance. Relevance is a complex notion with many dimensions. A fundamental question was raised by Campbell, Lubben and Dlamini (2000) in their research when they asked 'relevant to whom?' and 'relevant to what?"

As a goal for science education, relevance is usually interpreted in terms of contextualised science content (Campbell et al 2000), the assumption being that this will enhance science learning leading to an increase in science enrolment and more students choosing science as a career. Members of the science education community and the general public expect a curriculum to deliver students who have scientific knowledge and skills and if the curriculum is relevant, will allow them to apply these in their everyday lives. It is interesting to note that most research on relevant science curricula focus on what content may be relevant (Gaskell, 1992) and is usually conducted with students in secondary schools.

The main focus of my research is 'relevant to whom', as it explores what the learner experiences as relevant science. This may promote an understanding of which dimensions of relevance the learners respond to, including the relevance of context, purpose and method.

Social constructivism as a learning theory may be helpful in interpreting relevance to learners as it acknowledges that the ways in which learners construct knowledge depend on how they view the knowledge to be constructed. This raises issues of relevance, as learners will respond to different dimensions of relevance differently. Bloom's (1995) framework of 'contexts of meaning' shows that learners bring multiple interests, meanings and understandings to learning. He categorised meanings according to different contexts, using 'context maps' to uncover the "richness of learners' multiple understandings." Bloom states that

> …research on learners' conceptions in science has missed important facets of the construction of meaning. (Bloom 1995, p.180).

He argues that emotion-values-aesthetics, interpretive frameworks and personal experiences have considerable impact on the way children make inferences and construct knowledge and have been ignored by previous research. Notions of relevance have to go beyond the rational-cognitive and include criteria such as Posner's 'plausible, fruitful, feasible'(1992). If teachers understand the socio-cultural background of their learners they may be better equipped to understand, not only how learners learn but also what the interests and intentions of their learners are (Osborne and Freyberg, 1985). This knowledge will allow teachers to plan learning experiences that might be relevant to learners with regard to their purposes, context and meaning. Context is a very important aspect of relevance as relevance depends on context. How do we determine what learners find relevant? (Malcolm, 2004). When the context changes, what was previously regarded as relevant might become irrelevant. Campbell et al (2000) places great emphasis on the importance of relevant contexts. Context was a crucial aspect of relevance in the research as the topics used in the lessons were relevant to that particular environment.

Relevant science should also be characterised by relevance with regard to purpose and methods. For example, relevance could refer to society, employment or everyday life, to a distant future or immediate needs, to fantasies and curiosities or practical requirements. Building all these dimensions of relevance into the curriculum requires a view of relevance in both a pedagogic and content sense. This means including a variety of strategies when designing learning programmes as well as allowing learners to influence what will be learnt. Relevance is not only about instrumental purposes (practical, usable). Exotic and curious topics, far removed from the context, might be relevant because they are interesting. This presents a dilemma of sorts – whether what is referred to as relevance in fact means interesting (Malcolm, 2004). This debate is beyond this study. Relevance is used in the same way as it is used extensively in science education research. However, it is conceded that the dimensions of relevance that learners respond to is, in fact, that which interests them. The view is that learners experience something as relevant precisely because it interests them. Even when a topic is deemed irrelevant in a certain context but interesting, it is relevant to the learner in a personal and developmental way. In the broader research community there seems to be an understanding that there is a relationship between relevance and interest as many research papers talk about what learners find interesting (Kim and Fisher,1999; Hobden, 2004). The report of Teppo and Rannikmae (2004), on the ROSE project, equate relevance for students with interest.

The dimensions of relevance explored in this study were those topics and experiences that learners were interested in. Sometimes they were interested because it related to their everyday lives and sometimes they were interested because they had knowledge to share. At other times they were interested because activities were fun. Sometimes they were interested in 'irrelevant' events and phenomena. There is less concern with the notion of relevance as defined by policy makers in science education than with relevance that might be interesting.

SOCIAL CONSTRUCTIVISM IN CURRICULUM AND TEACHIING

A number of issues are raised when social constructivism is applied to designing curricula, as such curricula have to take cognisance of the different ways in which different learners construct knowledge in a socially interactive way. It also has implications for teaching, as a constructivist classroom requires particular pedagogical approaches.

Social constructivism in action

Power sharing

An important aspect of classroom practice is a move towards an active classroom, structured in ways that promote learning. An active classroom will create a different classroom landscape by enhancing social interaction and power sharing, as well as giving learners opportunities to set their own goals and select the kinds of activities required to achieve these goals. Malcolm and Keane's (2001) definition of learner-centeredness includes power sharing. This has implications for the way in which teachers view their roles in the classroom as it requires teachers to be willing to share power. This is not always easy and may result in confusion of the role of the teacher and to what extent power can be shared with learners. Bencze (2000) criticises constructivism as not being egalitarian because students' conceptions are denigrated, their experiences regulated and their conclusions restricted. He believes that instead of accepting ideas put forward by learners, little opportunity exists for them to develop their own ideas in accordance with their own needs. Another aspect that needs to be considered is the fact that some cultures regard the notion of adults 'listening' to children as foreign. Many teachers therefore believe that, as adults they need not create opportunities for sharing ideas. Does this mean that power sharing is an illusion, with some individuals always taking the lead or some ideas getting more attention than others? Critical pedagogy requires the critique of criteria for knowledge claims, but this is not an easy task for many children. Just as teachers have difficulty in defining their role in power sharing, learners have similar problems. While they are willing to take control in a limited way, they view ultimate authority as residing with the teacher. A similar situation resulted in the classroom in this study. Learners viewed the teacher as the ultimate authority. A change in their view would require a longer period of exposure to such practice.

Learner diversity

When learners are allowed to set their own learning goals in a learner-centred classroom these goals will be different for different learners. This raises the issue of classroom diversity – learners bring different worldviews, purposes and interests into the classroom. Thus other outcomes, over and above science learning outcomes, may be important as well. Learner diversity requires an alignment of learners' abilities and backgrounds with the types of tasks they are given and linking learning content to their everyday lives. Elementary school learners have alternative concepts of scientific phenomena (Lederman, 1993) and teachers need to take cognisance of this fact facilitating the various means of conceptual change that may occur as a knowledge of learners' ideas will enable a teacher to help them change or modify their cognitive structures or 'conceptions' (Hendry and King,1994). This is often seen as adding to the burden of teachers' work, the argument being that teachers do not have the time to learn so much about their learners. It would be very difficult, in a South African context, for a teacher to have detailed knowledge of every learner, as most classes are large. However, teachers should endeavour to at least have some knowledge of the background of their learners as a group.

The subculture of school science

Although it is acknowledged that inclusion of everyday knowledge in the curriculum is important, there appears to be a reluctance to implement this kind of curriculum (Taylor, 2001) as this places great demands on the teacher. The fact is that although teachers acknowledge the importance of allowing learners to make their own meaning, Hendry and King (1994) are of the view that teachers practice a kind of double think in which they believe that teaching is the transmission of knowledge, while learning is a process of change to the learners' ideas. The implication is that teachers seem to regard learners' own ideas as largely irrelevant. Most teachers appear to hold a traditional view of teaching and learning science and teach accordingly (Tsai, 2002). Their views of the nature of science, that science is a body of established facts that need to be transmitted while learning is a process of knowledge production, may well stem from their own school experience. It would certainly appear that the belief system of the teacher has a major influence on the way they teach (Tiberius, 2001). Cobb, Wood and Yackel (1990), in their work on classrooms as learning environments, mention the necessity of a teacher reconceptualising their role in order to facilitate constructivist learning.

The Learner-centred classroom

Constructivism underpins ideas of 'learner-centeredness' in that it allows for learners to construct knowledge individually. However, a learner-centred education is much more than this as it provides opportunities for learners to learn, engage in activities that they regard as useful and influence the process whereby learning takes place. It also means caring for learners. A caring pedagogy encourages academic growth (Brown, 2003) and allows for the learners' other needs to be met as well. These include cultural, social and emotional needs (Daniels and Perry, 2003) as well as other learner-centred outcomes that may be more difficult to define (Malcolm and Keane, 2001). A caring approach was evident in the classes of the teachers who collaborated in this research. They focused on smaller groups in the class to gain a deeper understanding of the learners' everyday lives, caring for their learners and gaining knowledge of these learners' personal lives. This enabled them to contribute meaningfully to the design of a relevant curriculum. Their PSP training equipped them with the skills to apply a learner-centred pedagogy when implementing the designed curriculum.

Developing learner-centred, critical constructivist approaches is not always easy. Although teachers may acknowledge the importance of learners' constructing knowledge, they have a problem facilitating this, for in order for a teacher to be able to facilitate the construction of knowledge for learners, they must find out what learners' ideas are and must have a clear understanding of what their role in the classroom is. On the other hand, learners often struggle to understand their own as well as their teachers' roles. Tsai, (2000) showed that the learners in his study had constructivist-orientated epistemological beliefs - that is they enjoyed the opportunity to air their views and to find answers in different ways, but still preferred the teacher to have authority in lesson planning. In this study, learners also enjoyed sharing ideas with each other but it was clear that the teacher's authority was acknowledged.

A learner-centred classroom may be described as a classroom that allows for learners to be actively engaged in purposeful activities. However, these activities must be carefully selected, taking into account the learners' own ideas, background, interests, learning styles and the social environment in which the learner operates. The role of the teacher is crucial in this type of classroom, in spite of the fact that a perception exists that the teacher's role has become less important as they act only as a facilitator in an active learning environment. The teacher decides on the strategies that will be implemented and these strategies should be based on a sound knowledge of the learners in that classroom.

Co-operative learning

While individual work accommodates divergence, another important strategy of learner-centred education is group work also referred to as co-operative or collaborative learning which provides opportunities for convergence expressed as group products. Although the literature reveals different schools of thought regarding the value of this approach in terms of enhancing learning ability, the value of co-operative learning lies in the possibility of achieving other outcomes besides conceptual development. Co-operative learning is an important characteristic of learner-centred classrooms as it assumes that learners take more responsibility for their learning and that peer interaction creates a more conducive atmosphere for the exchange of ideas. Social interaction amongst peers might provide opportunities for engendering a much stronger commitment to new ideas, instead of holding on to ideas that might be regarded as non-science ideas. This resonates with Vygotsky's thinking on 'mediation' (Moll, 1990) and the collaborative nature of teaching and learning within a social constructivist framework (Wells, 2000). Small groups enable learners to engage more readily in verbal interactions and this may give them the opportunity to make sense of the world in a meaningful way. It also encourages individualisation as it accommodates different learning styles, as well as allowing learners to progress at their own pace. A third advantage of co-operative learning is the fact that the teacher interacts with smaller groups and this may make it easier for them to 'listen' to their learners.

In spite of much research supporting co-operative learning, some research expresses reservations as to the value of this approach. Problems may be encountered if all group members are not on the same cognitive level (Bradbury and Zingel1998; Tudge, 1993) as learners with poorer conceptual understanding do not share their ideas willingly with their peers. The same applies to second language learners who are put in groups with first language learners. This is in conflict with the notion of a more 'capable' peer mediating learning as described by Vygotsky (Moll, 1990). The level of interaction between group members is also brought into doubt (Kempa and Ayob, 1991) as it seems to be mostly factual information that is shared between learners in groups. Little exchange at higher cognitive levels, for example problem solving, occurs. The solution here may lie in the design of the tasks learners are required to do. Tasks should be designed in such a way that each learner is required to engage in higher order thinking.

Nevertheless, a large body of research indicates the value of co-operative learning, as students' learning within a peer context is enhanced (Lazarowitz and Hertz-Lazarowitz, 1998). It is for this reason that emphasis is placed on this approach in science education (Hogan, 1999). However, the value of co-operative learning lies in the quality of the task designed for the group activity and not in the group activity per se. Curriculum 2005 (DoE,1995) encourages the use of group work to facilitate learning for most of the reasons listed above. However, the question arises whether this is the best strategy for all learners. The teachers participating in this study use this strategy often and it works well when learners are engaged in practical activities. Co-operative learning may well facilitate the achievement of a range of outcomes, not only outcomes related to learning science.

The socio-cultural background of learners

The learners who were participants were from a non-western culture, although they were taught science from a western perspective. The socio-cultural background of these learners shapes their worldview and causes them to hold different views of science as well. It may be difficult for these learners to demonstrate understanding of concepts learnt at school while not believing them if they are in conflict with beliefs held in 'out of school' science. If students have good reason to believe what they believe, particularly in the light of everyday experiences, they would be reluctant to change their beliefs about scientific knowledge. (Desautels and LaRochelle, 1998) Gao agrees that,

> ...culture, as a contextual lens through which people view and understand the world has direct influences on students' cognitive processes and understanding of science (Gao, 1998 p3).

He sees different cultural groups as holding different views regarding science because they have a different worldview. Duschl and Hamilton support this view when they state that,

> A learner's epistemological framework is a factor in changes in knowledge representation (Duschl and Hamilton, 1998 p1059).

Their wordview may also cause them to place less value on what is being taught in the science class. The purpose of the curriculum is then called into question. If the learners in a class are from a non-western culture and the focus is on western science, this raises the issue of how this focus should be handled. One possibility is to emphasise the learning of science in a cultural milieu and to view science and education as cultural enterprises, which form part of a wider cultural matrix of society. Culture has an influence on the learning of science and learning results from the organic interaction among the personal orientations of a learner, the subculture of a student's family, peers, community, tribe, school and media, the culture of his or her country or nation and the subculture of science and school science (Cobern and Aikenhead, 1998). Science should not be treated as a 'superior' way of knowing but as a culture and, specifically a foreign culture, with a language that has to be translated into the informal language of the learner. The problem of course, is that the language of the learner does not always have words that are equivalent (Quicke2001). Learners' alternative ideas might be highly resilient to more 'rational' considerations. There is evidence that involvement of socio-cultural views about science concepts in science instruction develop positive attitudes towards the study of science (Baker and Taylor1995).

Lubben, Netshisaulo and Campbell (1999) studied the use of cultural metaphors by learners and their scientific understanding of certain scientific concepts. They were of the opinion that the use of cultural metaphors may influence science conceptual understanding and this influence may be positive. Most studies on the views that different cultural groups hold of science seem to suggest that children see science as compartmentalised and partial and they feel that they have better and fuller explanations for 'scientific' phenomena. The notion that learners can make automatic switches from one context to another and operate without any hindrance in the new context, is seriously questioned by researchers such as George (1999). She states that education in science should be viewed as the process of crossing the boundary between the subculture of the learner and the subculture of science.

> Boundary crossing between two worlds, the traditional and the world of science may be difficult or even hazardous for some people (George, 1999, p77).

George identifies four 'categories' which describe the extent to which a learner's cultural knowledge is included in 'western science'. In the first category no conflict exists as western science has an explanation for indigenous science, in the second category, western science could have an explanation of the indigenous science, in the third category western science cannot explain indigenous science and the two are therefore in conflict and in the fourth category, indigenous beliefs lie outside the domain of western science. It is when the science studied at school falls into the last two categories that the difficult boundary crossing referred to, occurs.

The work of Jegede and Okebukola (1991) also seem to suggest that the African world view clashes with western science and the stronger the learner's belief in traditional African cosmology, the more difficult it becomes to learn western science through a process approach. This has implications for inquiry-based science programmes in African classrooms, as they rely heavily on observation skills. Luthuli (1985) even goes as far as to suggest that although he regarded segregated education systems as totally unacceptable, there should be an education system that is shaped by a black worldview for black learners. Fakudze (2003) uses the 'African Learner Model' that combines three theoretical models - Border Crossing, Collateral Learning and Contiguity Learning to explain how African learners succeed at cognitive tasks. According to this model, the mind of the African learner functions within the traditional socio-cultural environment. Successful learning is dependent on mediating structures or processes embedded in the socio-cultural environment. Peacock (1995) has a different explanation for the fact that children in rural Africa often have problems with learning science. He ascribes it to the fact that traditional African pedagogy is so different from the current approach to science teaching. He sees African pedagogy of observation, imitation and explanation as being in conflict with the 'process' approach, which is designed to develop the skills and processes of scientific thinking. The problem is exacerbated by the fact that many teachers do not identify with this approach and often do not understand the underlying philosophy of a 'process' approach. This is certainly not the case in this study where the teachers have embraced the principles of Curriculum 2005 (DoE,1995). Peacock argues for a science curriculum that contains the essential elements of science learning, which are seen to be essential in all countries and cultures, as well as a curriculum that is locally relevant and will link knowledge to children's experience. Ninnes (1995) obtained similar results to those of Peacock from his work in the Solomon Islands. For him the contrast between knowledge as a personal construct and knowledge as object/commodity, is problematic. It may be easier to assimilate western science into traditional culture if science is viewed as an element of western culture, rather than the only truth (Ogawa, 1986). This research suggests that border crossing should be facilitated, but to what extent can the problem be addressed by including the African worldview in science teaching and setting the two worldviews up in opposition to each other? Is it possible to set the western and the African worldview up in relation to each other? Such a curriculum that reflects 'science professionals' thinking while retaining sensitivity to local viewpoints, would be more accessible for learners who hold non-western worldviews.

In spite of extensive research on the importance of viewing science as a cultural activity, it continues to be represented aculturally and as truth (Krugly-Smolska, 1995). Science is never identified as part of the cultural fabric of society. Extensive research in the field has built a strong argument for culturally relevant science where the rules of science connect to the out of school lives of children. School science should value ways of knowing brought to school by students, such as caring, cooperation, holistic approaches and out of school activities. It should reflect the lives and cultures of children through narrative and story telling. If science is open to multiple ways of doing, knowing and communicating then those learners whose lives are not mirrored in traditional school science will find connections more easily (Barton, 1998). Thomas (1997) refers to a culture sensitive pedagogy that reflects cultural and psychological universals as part of globalisation, while maintaining certain key contextual values and culture specific features that are part of the cultural context of both learners and teachers. A culturally sensitive pedagogy will actively reflect and clearly prescribe culture-specific knowledge, behaviours, attitudes and skills. These culture-specific attributes should complement the basic learning requirements common to all schooling.

Do children's sayings and beliefs actually compete with scientific knowledge, and if they do, to what extent? Hills (1989) is of the opinion that learners' "untutored" beliefs do not compete with scientific knowledge as they do not fit into a scientific framework and may be operating under the auspices of some alternative to the scientific framework without competing at all with scientific concepts. It is when the norms and values of the everyday lives of children differ from those of the school that it becomes difficult to switch from one context to another. Contextualising school science might make it easier for the switch to occur (Peacock, 1995) Contextualising school science means that learners are able to use their everyday knowledge in the school context, but the opposite does not occur easily as everyday contexts and school knowledge are far removed (Campbell et al, 2000; Moll, 2001). Although it may not be easy to use school knowledge in everyday contexts, the degree to which this is possible, depends on how difficult learners perceive this form of border crossing to be. For many learners it is very difficult to link the informal, spontaneous, everyday knowledge with formal, structured, science knowledge. This form of border crossing may be facilitated by carefully considering what should be included in the curriculum.

To be able to design science activities that are more contextualised, it is essential to understand the everyday lives of the learners involved in this study. It is for this reason that the class teachers collaborated by bringing their knowledge and deep understanding of their learners' everyday lives to the study. As part of the research, this knowledge was tapped into by working with teachers in designing a series of science lessons for these learners. In the design of this lesson series, the purpose of science education was carefully considered as it was the intention to strike a balance between 'learning science' as described in the Natural Science Learning Outcomes of the RNCS (2002) and 'learning through science' as espoused by the Critical and Developmental Outcomes of Curriculum 2005 (DoE,1995). As the learning outcomes are supposed to serve the critical outcomes, there is a strong relationship between them. It would, however, seem that there are more complex issues involved that influence science learning and that the nature of the everyday environment has a strong influence in determining whether learning will occur, as well as deciding what is worth learning. The lack of adult involvement, which provides very little opportunity to imitate a more competent person, as well as the absence of collaborative learning place a limit on the development of the potential of the child. When the child goes to school, the teacher is not able to fulfil this role alone. The home environment is essential. If the child does not learn to do through collaboration today, he will not be able to do it independently to-morrow (Vygotsky, 1986). While most of the research in science education has been directed at facilitating border crossing to enhance science learning, the possibility has largely been ignored that there may be other outcomes besides science learning outcomes that are important in the science classroom. Many learners may have purposes other than improving their science knowledge and these purposes may not be particular to a specific culture, although acknowledgement of culture may facilitate the achievement of these outcomes.

The subculture of poverty

For many communities, cultures other than ethnicity influence their lives. One of such subcultures is the subculture of poverty. For communities that have been exposed to Western science and technology, poverty may be a great factor. Poverty has an impact on individuals as well as on communities, threatening their survival in many ways. Poverty affects communities physically, psychologically and socially when they are deprived of basic facilities such as health care, recreational facilities and libraries. An aspect that has been researched extensively, is the effect of poverty on the performance of learners as well as the value they place on what is learnt. There is evidence to suggest that poverty has such a profound influence on the worldviews of children, that it alienates them from school. Hence the reference to a subculture of poverty as introduced by Oscar Lewis (cited in Haralambos and Holborn, 1995). Lewis argues that the culture of poverty is a 'design for living' with its own norms and values, transmitted from one generation to the next. In his view poverty is perpetuated and there is very little opportunity to escape from it.

Poverty and lack of parental support are regarded as the most important barriers to learning (Merina, 1992; Farkas, 1969). Arguably a lack of parental support is often a result of poverty. Roseberry-McKibbin (2001) argues that to fully understand the problem, it is essential to view poverty as a subculture and not merely one aspect of a child's life. The collaborative efforts of parents, learners and teachers could contribute to a more conducive learning environment for children who grow up in a subculture of poverty (Gregory, 2002). The fact is, that under poverty conditions, parents are involved in a daily struggle for survival, leaving very little time for 'challenging conversations' or for reading. In addition, many parents from poor socio-economic backgrounds believe it is the school's duty to educate their children and are reluctant to engage in activities with their children that support learning. Such parents regard the education of their children as the responsibility of the 'experts' and do not regard their involvement as important. Another reason may be that formal schooling is not an integral part of the culture of poverty and often parents do not view schooling as an important aspect of their children's development. Responses from parents of learners in this study stress the importance of schooling, but the reality is that these parents are often not in a position to support and motivate their children at school. The views of the parents regarding the value and purpose of schooling have an effect on the learners' perception of school and this perception in turn may impact on learning.

Most of the research regarding poverty agrees that it may be viewed as such a strong factor in the lives of people, that reference to a sub-culture is justified.

Very often the low socio-economic position of their learners is accepted as a given by teachers and there is a tendency to teach children from poor backgrounds only basic knowledge and skills, the assumption being that they don't have the ability (Knapp, Shields and Turnbull,1995). Their research suggests that in classes where poverty is rife, instruction should be meaningful where learners are able to see connections with their everyday lives, as well the inclusion of activities that are aimed at enriching their learning experiences. Such a curriculum and change in teaching strategy could create more opportunities for achieving a broader range of outcomes. This view of poverty was developed in societies where the very poor are in the minority. Does research on poverty in minority groups also apply to developing countries where a large number of people are poor and socialised into a subculture of poverty? This may well be the case and as so many communities are involved, this is a broader social issue that cannot be resolved by schooling alone. This study views the culture of poverty as central to the lives of the children who are part of the study. The effect of poverty on the way these learners learn and what they value as worthwhile forms an integral part of the study. It may well be that to the communities from which these learners come, view poverty as more important than ethnicity. If learners do have problems moving from one subculture to another, this may seriously impact on their ability to engage with the type of science that is currently taught in those classrooms. If we wish to adhere to the principle of learner-centred education it is essential to acknowledge the importance of poverty in the lives of these learners. This aspect is often neglected.

The question that this study has attempted to answer is how learners respond to curricula that incorporate the needs and experiences of learners who live in poverty. Will a curriculum that is perceived to be more meaningful, enable conceptual development and the achievement of a broader range of outcomes? Would this kind of curriculum encourage the development of competences to move beyond a limiting environment, while at the same time assisting learners to make meaning of their lives? Does the influence of a subculture of poverty on learners prevent this kind of development in these learners? Furthermore, might a subculture of poverty cause learners to have a different interpretation of what is worth learning and knowing? Are we concentrating too much on conceptual development and ignoring other outcomes that may be achieved in the science classroom?

Language and learning

A substantial body of research has pointed to the importance of understanding cultural and linguistic influences within the learning process. As language is an expression of culture, the question arises how most South African learners learn science through a language which is not their mother tongue and how this impacts on learning and the socialisation process at school. If children are taught in a non-mother tongue language, a clash between the non-western worldview of the child and the western worldview of the science content is likely to occur. In order to reduce this friction, children should be encouraged to interact in their mother tongue and to engage in science 'content' that is perceived as culturally relevant. The development of thinking in terms of the importance of retaining proficiency in the mother tongue, has been recorded. The traditional view was that bilingual children, who did not perform academically, did so because they were ' linguistically confused' (Bankston and Zhou1995). Exposure to more than one language was seen as a disadvantage. The current view is that learning through a second language is less traumatic if it occurs gradually and the use of the mother tongue is retained.

Students who participated in the research of Krugly-smolska (1995) were from ethnic minorities, learning in a second language. Generally these learners performed poorly. An earlier held view was that the restricted language code could not deal with all the concepts and modes of thinking – referred to as 'cultural deficit' Cultural deficit theory has been largely replaced by the notion of cultural discontinuity or culture conflict. The relationship between language and concept development in science education is largely ignored The way in which learners construct meaning in science is related to their language background and to the compatibility between the learner's language and the language of science education (Baker and Taylor, 1995). South Africa is in a different position in that the communities that are required to learn through the medium of a second language, are not immigrants nor are they a minority. Nevertheless, the problems of learning through a medium other than the mother tongue are no less real. Research suggests that learners should start formal schooling in the mother tongue as the fostering of skills in a first language leads to cognitive development that can be transferred to other areas.

It would seem as if learning in a second language is made easier if learners are engaged in activities they relate to and that is connected to their own communities. In the South African context, a culturally relevant curriculum may well contribute to effective learning in a second language. This view is supported by the language policy of the South African Department of Education where it is referred to as additive bilingualism (Khan, 2001). However, her research indicates that secondary school learners feel that they are empowered by instruction in English. Rollnick (2000) brings the importance of language into perspective when she describes language as the mediator of the shared discourse between the more capable peer and the learner of Vygotsky's theory (1986). It is language that helps the learner to reach the ZPD. If language is thus the link between the learner who is learning to talk science and the teacher who mediates scientific thought within the ZPD, how will this process be influenced by a situation where more than one language is used? Rollnick (2000) is of the view that the problems encountered by learners learning science through a second language, cannot be tackled by a consideration of language issues alone. The social context in which the language is used needs to be considered. If the learner is learning science, they need to become participants in the social practice of science and become familiar with the style that is characteristic of the discipline. A culturally relevant curriculum combined with the use of the mother tongue should ease the way for learners to become participants in this social practice.

The lack of language skills (first and second language) is of concern to this study as it may cause learners to feel alienated in the science classroom and this would influence their perceptions of what might be worth learning and consequently what they perceive to be relevant to their lives. Most primary schools spend half the day developing language skills (Dickinson and Young, 1998). This implies that language should be developed across all disciplines. This is usually not a problem where teachers teach in their mother tongue, but what happens in classrooms where both the teacher and all the learners are required to use a language that is not their mother tongue? Does this result in some reluctance in both parties to engage in reading and writing activities? Science teachers may justify this by claiming that they are not language teachers, ignoring the approach that the main focus of the primary school is to develop language competence.

In summary, designing learning programmes is a complex task and curriculum designers need to take cognisance of the complexities of this process. The design of science curricula in which social constructivism is expressed adequately and learner-centred education principles are included, requires careful consideration.

CURRICULUM

As my research seeks to explore the meaning of relevant science for learners in a particular context the design of the lessons in both phases of the study, were guided by principles of learner-centred pedagogy. This section explores the different theories that underpin curriculum design and discuss the different interpretations of what a relevant science curriculum may mean.

Curriculum theory

What theory should underpin the design of a curriculum? There appears to be considerable disagreement as to what is meant by 'curriculum theory'. Kliebard attempts to explain curriculum theory by defining the meaning of theory,

> A theory may be construed as a way of seeing in a particular way: it is a way seeing one thing as if it were another (Kliebard, 1982, p13).

The use of curriculum theory as metaphor is advocated. To explain his point, he uses the analogy of a curriculum as a route over which one travels. Another view describes the function of a curriculum theory to define, describe and predict phenomena (Beauchamp, 2001). Curriculum theory may be used in helping teachers to organise and direct their practice. A more helpful way to understand curriculum is to look at the different types of curriculum theory. Walker (1982) describes four kinds of curriculum theory.

- A theory that rationalises curricular programmes; the focus being on systematic instruction.
- A theory that rationalises procedures for curriculum construction. These procedures should be guided by the questions: What purposes should the school seek to attain? How can learning experiences be selected to help attain these? How can learning experiences be organised for effective construction? How can learning experiences be evaluated?
- A theory that conceptualises curricular phenomena – it advises curriculum designers how to think about the work.
- A theory that attempts to explain curricular phenomena.

The second theory deals with curriculum planning, an aspect that is important in this study. This model of curriculum planning is referred to as the technical production perspective by Posner (2002). In contrast to this, Posner also discusses the critical perspective where he focuses on Paulo Freire's work. Freire (1990) urges a more democratic relationship between teacher and learner in planning the curriculum. It also describes an emancipatory approach, which emphasises 'critical reflection' on ones own 'concrete situation'. This perspective has a strong element of problem solving where teacher and learners are co-investigators. The curriculum design in this study is based on elements of the critical perspective, as learners are involved in selecting what they would like to have in the curriculum. It also allows for problem solving, as well as dialogue between teacher and learners.

Curriculum theory should also serve a traditional purpose, that is, being more helpful to teachers in planning and using the actual curriculum (Barone1987). This includes the notion that, if the curriculum is to have an impact on learners, learners should also have the opportunity to influence the curriculum. Curriculum theory should therefore develop from the critique of curricula as it is being taught. The theory underpinning the design of the curriculum in this study, assumes learner input into the design of the curriculum.

Stenhouse (2002) proposes the technical model as more appropriate to a curriculum that focuses on skills and information. As the curriculum module designed for this study does not focus on skills and information, but rather on the extent to which learners find the curriculum meaningful in their everyday lives, the critical perspective is more appropriate. Bernstein (2002), in his discussion of two types of curriculum, the collection type and the integrated type, makes the point that the type of curriculum chosen is ultimately a political choice. Do designers of curricula want to teach people how to think or do they want people to have a fundamental understanding of the disciplines included in the curriculum? Terwel (1999) raises the question of how constructivist theories impact on curriculum studies. What are the consequences for curriculum theory and practice if teachers and learners construct their own curricula? The constructivist movement re-emphasised the active role of the learner in acquiring knowledge and the social construction of knowledge has been an important principle in socio-cultural theory. Learning should take place in authentic contexts - the 'communities of practice' described by Lave and Wenger (1991). The challenge is to translate constructivist concepts incorporated in curriculum theory into curriculum practice.

A Relevant Science Curriculum

Curriculum design is a complex process. The principles, which guided the design of the curriculum implemented in this study, centred on 'relevance' and provided a means for further exploring relevance. A number of aspects need to be considered when designing relevant curricula. Most indigenous people who form minority groups in western countries want their children to receive an education that will provide them with the skills to live as competent and engaged citizens (Linkson, 1999) This often implies a western education. At the same time, parents want their children to be familiar with their own culture and to maintain the beliefs and practices of that culture. In a country like South Africa, the curriculum is based on western culture (as is the case in most formal education systems). This is especially true of the science curriculum where the subject matter is based on a western worldview. It is recognised that a curriculum based on western culture may impact negatively on a student's indigenous cultural beliefs and consequently affect levels of achievement (Linkson, 1999). The question is whether a South African science curriculum should be based on a western worldview and include only western science? Should a culturally relevant science curriculum not include traditional knowledge as well? The collaborative efforts of indigenous and western teachers in writing curriculum support materials that are culturally appropriate, may be part of the solution to this problem (Linkson,1999).

Curriculum 2005 (DoE, 1995) suggests that cognisance should be taken of indigenous beliefs and incorporated in the curriculum. This should contribute to making the curriculum more relevant for indigenous people. Fleer (1997) pleads the case for a curriculum, which incorporates a multiple worldview. She sees this as the only alternative for an Australian society, which is becoming more and more multicultural. Curricula should be aligned with culture to enhance learning. This view of curricula cannot be mass marketed, as it is specific to a certain culture and therefore site-specific in nature. Such a curriculum should be built around the local interests and culture of the students, interfacing with every aspect of their lives (Davison and Miller, 1998). However, these authors are of the opinion that such an approach might preclude the development of a structured curriculum. If science is socially constructed, different ways of explaining nature have to be an integral part of the curriculum and not only mentioned as a form of so called 'respect' and tokenism. This would require a multicultural science curriculum (Zarry, 2002). In the South African context, previously disadvantaged schools are not usually described as multicultural as the majority of the learners are from the same culture. However, in the context of this study, a large number of learners come from rural areas and research suggests that rural learners are more inclined to hold on to various cultural explanations for phenomena than urbanised learners. Added to this is the fact that the curriculum is based on a western view of science. Inclusion of indigenous knowledge in the curriculum may well make it easier for learners to engage with 'western science' as inclusion of their own cultural knowledge serves to affirm learners.

Baine (2000) speaks of an ecological inventory approach to curriculum design, meaning the design of a curriculum that is relevant in a particular environment. Such a curriculum would benefit learners in their own environments, as well as future environments. According to Baine, most curricula favour learners in urban settings, leaving rural learners disadvantaged economically, socially and politically. In the South African context diverse curricula for different environments may be viewed with suspicion, as it may be reminiscent of the apartheid era where curricula were differentiated on racial grounds. Nevertheless, the intention in this study is to develop some understanding of what kind of curriculum would benefit the learners in this particular context by exploring what they perceive to be relevant to their lives.

Although culture-specific curricula is advocated, globalisation is often a barrier to such development as it encourages a global culture, rather than a cultural specific approach (Thomas, 1997).The culture-specific component should complement the basic learning requirements common to all schooling. Recent reforms in science curricula have moved towards more relevant science knowledge in that the science included in many curricula can be used as a tool for personal and societal improvement (Wallace and Louden, 1998). Such curricula are aimed at producing scientifically literate people and is described as science which draws upon the social and cultural interests of the community. It is relevant in that it is able to bridge the gap between learners' common-sense knowledge and the formal knowledge of science.

Science materials used in such curricula would therefore follow a constructivist approach to learning. This aspect of relevance was also addressed in this study.

The question arises whether learners, who were born or have spent most of their lives in cities, in townships or in informal settlements, still maintain traditional beliefs as strongly as rural people do? To what extent is their worldview shaped by the conditions that shape their personal lives? Could it be that learners from such communities are in need of curricula that relate as much to their personal lives as to their traditional cultures? If this is true, how do curriculum designers ensure that the curricula will relate to the personal lives of learners? Buckland (2002) views the curriculum as inseparable from the socio-political context of the learner. This is especially true in the South African context, where the social context is of crucial importance. The social context of the children involved in this study has enormous influence on the way learners engage with the curriculum and what they perceive to be relevant.

The work of Goodenough, (2001) on Multiple Intelligence theory (MI) suggests that teachers who have knowledge of this theory will be able to design science curricula that are more meaningful, relevant and personalised. This stresses the importance of involving teachers in curriculum design because only teachers will have that kind of knowledge about learners to design personalised curricula. As a personalised curriculum has to take various learning needs into consideration, it necessitates constructivist pedagogy. Geelan (1995) offers the matrix technique as a possible solution to the development of relevant curricula. This technique is based on a constructivist approach to curriculum development. Within a matrix approach, meaning is not imposed, defined and implemented by the teacher and absorbed by the learners, but emerges from the collaborative processes of directed enquiry - the 'story' of the classroom (Geelan, 1995).

The design of a relevant curriculum hinges on the participation of the teacher, as it is the teacher who is familiar with the local context and understands what might be relevant to learners in that context. The value of the teacher as co-participant in curriculum development is evident from the research conducted by Riquarts and Henning Hansen (1998) on the PING Project (Practising Integration in Science Education) where all stakeholders collaborated in the design of a relevant curriculum. Kirk and Macdonald (2001) suggest that the teacher's authority in curriculum change is located in the local context of implementation of any reform and is based on their knowledge of their learners, colleagues, available resources and school structures. They make a valuable contribution by adapting materials to fit their local contexts. Decentralisation may well offer the opportunity for teachers to be more involved with the design aspect of the curriculum, allowing them to build in various dimensions of relevance. Unless there is a deliberate effort to allow teachers to adapt the curriculum to suit particular learners at the local level, teachers will not have much influence on curriculum reform as they are rarely active at the interface between the context where knowledge is created (university) and the context where it is reproduced (school) (Bernstein, 1990). According to Klein (1992) teachers seldom have the opportunity to engage in the processes of curriculum development or to reflect on their own practice and are therefore more likely to accept the curriculum as a given. Leat and Higgins (2002) argue that curriculum development is impossible without teacher development and make a strong case for professional development. McCutcheon (2001) is of the view that teachers need to become involved in curriculum development by taking an active role as researchers, co-researchers and developers of theories from their perspective. This view was strongly supported and it was for this reason that the teachers of this study were involved in the design of the lessons used in this study.

Taylor (2002) uses Bernstein's curriculum models to classify Curriculum 2005 (DoE,1995). Where the performance model focuses on specific learning content and texts, with the teacher having a prominent role, the competence model is based on a learner-centred approach where learners take control of their own learning. There are different kinds of competence approaches i.e. the radical and progressive approaches. The performance model proposes that formal knowledge be taught through the different syllabi. There is no place for everyday knowledge in this model. The competence model recognises the value of everyday knowledge and views the two-way relationship between school knowledge and everyday knowledge as important pedagogical tools. Curriculum 2005(DoE,1995) represents the radical competence model, which demands that all knowledge be equal. The RNCS (2002) has taken a more progressive competence approach in that it does distinguish between everyday knowledge and school knowledge. The lesson series designed for this study took the position that everyday knowledge provided the foundation for structuring formal school knowledge.

In the preceding discussion, emphasis was placed on the role of the teacher in developing relevant curricula. It was pointed out that a number of factors inhibit teachers' participation in curriculum design, and therefore their influence in determining the nature of the content and the degree of participation of learners in the classroom. An important aspect of a relevant curriculum is participation by learners as well as teachers in the design of the curriculum, both in term of content and activities. This implies participation of learners in the decision-making process. A review of the literature revealed that most research reports such participation within a learner-centred framework. However, learner-centredness mostly focuses on learner-activities, rather than on decisions with regard to the content included in the curriculum. For example, the research of Wubbels and Brekelmans (1998) reported the participation of learners in determining the direction class discussions take rather than selection of content. The focus was on the importance of a teacher's attitude in eliciting participation by students in classroom discussions. Malcolm and Keane's (2001) research on learner-centred curriculum, revealed the distribution of power and authority in a context where participation is integral to the design of the curriculum. In this research learners developed ideas around suggested themes. One of the few studies conducted with elementary learners, show that young children value a degree of autonomy; many want to make their own choices about the activities they engage in and the work they do in the classroom, while others value autonomy with regard to personal matters, not school matters (Daniels and Perry,2003). Ninnes (1995) reported extensive participation of learners in his research with regard to choice of groups learners wished to belong to, as well as the fact that the curriculum design was based on the informal learning of learners in his study.

The lesson series that was used in this study was designed as an example of relevant science, as well as a tool to elicit deeper understandings of relevance and the value of relevance to the learners in this particular context. In the design, a number of dimensions of relevance were addressed.

- Cultural relevance, practical value in the daily lives of learners, interests of learners, helping to make sense of the world and relating to their personal and social aspects of their lives (helping with day to day living).
- Relevance with regard to further schooling and possible future careers (the content addressed outcomes from the Natural Science Learning Area).
- Relevance, with regard to immediate usefulness, as well as usefulness in the long term was addressed in this way.

The curriculum used in this study expresses social constructivism and in the design of the lesson series, draws on critical constructivist approaches. Learner-centred approaches, based on problem solving, also informs the design of this curriculum. Learners were given considerable freedom to ask questions about phenomena presented , talk about their experiences and write stores about them The design of the curriculum is based on conceptions of curriculum as story. The use of a story enabled me to address complex issues and fold in multiple themes. Through the use of plot the story provides coherence and development. The story used in the lesson series resonated with personal experiences , while at the same time highlighted common experiences. While the theme studied was presented as seven work sheets , with each work sheet focussing on a different aspect, the story prevented fragmentation of the lessons into separate units. Different teaching strategies were employed to allow for the development of a range of outcomes and to accommodate different learning styles.

ASSESSMENT

The RNCS (2002) defines assessment as "a process of gathering information about learners and is measured against assessment standards." Assessment standards describe the various levels at which the learning outcomes may be achieved. They describe what learners should know and be able to do. While the RNCS (2002) includes both science outcomes and critical and developmental outcomes, the assessment standards only describe how the science outcomes should be assessed. Although the assumption is that the critical outcomes be achieved through the science outcomes, there are no guidelines as to how these outcomes should be assessed. This represents a very narrow view of the complex interactions that occur in classrooms that produce a variety of outcomes that are not covered by assessment standards. Traditional assessment techniques are advantageous in measuring content related knowledge and are easy to administer and useful for policy decisions (Kelly, 2003). Pen and paper tests are an efficient way of assessing knowledge and understanding but can be misused. They are often described as objective and valid, but these claims are often false (Malcolm, 1999a). Many issues such as language, culture and the social environment complicate the process. In addition, they are often used to improve marks, especially in poor socio-economic environments. This leads to short-term improvement, at the cost of the long-term development of learners. New goals of assessment in science focus on the need to link science to the broader social context, but assessment practices have not caught up with this shift.

Social constructivism acknowledges that the learner brings a rich source of prior knowledge to the learning situation (Kasanda, Lubben, Campbell, Kapenda, Kandjeo-

Marenga and Gaoseb, 2003). This knowledge may find expression in a variety of activities and is often not measurable. Different approaches to assessment are required to accommodate the various ways in which learners construct knowledge in social settings. Learner diversity requires the implementation of various assessment strategies as different learners may demonstrate the achievement of different outcomes in a variety of ways. Pen-and-paper tests cannot adequately assess the complex competences that underpin Curriculum 2005 (DoE,1995). They can assess some (Malcolm, Kowlas, Stears and Gopal, 2004) for example, knowledge and application. The challenge is to find ways to assess a range of outcomes that cannot be tested by measuring performance, as pen-and-paper tests form one small measure of what learners actually experience in the classroom (Veronesi, 2000).

Alternative assessment strategies that allow for integrating assessment into instruction and assess outcomes such as the Critical Outcomes of Curriculum 2005 should be utilised. Such strategies will allow learners to demonstrate outcomes in different ways like drawing or writing, observing and communicating. Unfortunately these performance-based tasks do not reflect competence adequately if the learners are not proficient in the language of instruction. Performance based tasks assess a broader range of outcomes and they are often assessed as enabling behaviour – enabling science learning. Instead, these outcomes should be assessed as separate in their own right as developmental or critical outcomes and not linked to science learning as such. (McMillan, Myran and Workman, 2001). Science outcomes such as knowledge and skills may be measured by more conventional means, such as tests and tasks. Outcomes that are not science outcomes, but are achieved through science learning, are often complex and difficult to assess. Such outcomes are best assessed through a variety of strategies. There is evidence that teachers do assess performance that cannot be tested, such as participation and effort. This requires an interpretive approach to assessment. By closely observing learners or by eliciting response from them in a variety of situations, the teacher gets a sense of which outcomes are achieved.

Another approach that is appropriate for assessment of outcomes other than science outcomes, is described as interactive assessment (Cowie and Bell, 1999). Interactive assessment involves the teacher in noticing, recognising and responding. It may be implemented when no specific assessment activity is planned. This type of assessment hinges on student-teacher interactions and allows assessment of a wider range of learning outcomes than specific science outcomes. It allows the teacher to gain ephemeral information that is of a verbal nature (comments and questions) and non-verbal (body language) interactions with others. This is called noticing as part of assessment. The teacher will notice different information from different students at different times This information may be connected to science, but is also related to social and personal development. An interactive teaching approach provides the challenge of what and when to assess and keeps the process manageable (Zeegers, 1996). Unfortunately, the value education departments, learners and the general public attach to marks, does not bode well for an approach where learners are assessed by interpreting their actions, attitudes and emotions (Donald, Lazarus and Lolwana, 2000).

This study included lessons and a lesson series that had the purpose of relevance and were developed as relevant science lessons. This meant that by meeting different needs, outcomes other than knowledge outcomes were achieved. These outcomes are interlinked and difficult to assess. An interpretive approach where actions and interactions are closely observed as well as conversations with learners are conducted, provide a means of understanding which of these outcomes have been achieved. This study made use of the interpretive approach to find out what outcomes were achieved besides science learning outcomes, while analysis of tests and work sheets provided information on achievement of science learning outcomes. Critical constructivism is mindful of the fact that conventional assessment disadvantages marginalized groups. In the context of this study the most obvious aspect is language. From a critical constructivist perspective, power sharing in the classroom has to extend into assessment as well. This might mean that learners negotiate with teachers what is to be assessed or they are given the opportunity to demonstrate competence in a variety of ways.

In a learner-centred classroom, where social constructivism and critical constructivism is expressed, the achievement of many outcomes are anticipated and these outcomes require assessment in a variety of ways on a continuous basis.

CONCLUSION

In this chapter, constructivism and in particular social constructivism and critical constructivism as a basis for defining relevance and curriculum design, have been proposed. A number of issues that emerge when attempts are made to apply social constructivism in curriculum and teaching, have been discussed. These include issues of power sharing, learner centeredness, language, different worldviews, border crossing as well as the purpose of science education. An overview of a number of curriculum theories were presented. The curriculum used in this study is based on a critical constructivist, learner-centred approach. The views of a number of authors as to what should be included in a relevant curriculum were discussed, as well as the complexities of assessment in a learner-centred classroom where many outcomes may be achieved, were discussed.

CHAPTER 3

METHODOLOGY- PHASE 1

INTRODUCTION

The research was conducted in two phases, which employed different methodologies. In this chapter, the methodology for phase 1, which is essentially interpretive, is described. The purpose of phase 1 was to explore learners' perceptions of what they thought of as relevant science. The first step was to talk to teachers about their learners, and observe the learners in classroom situations. This knowledge guided talking to learners about what they might regard as relevant, in terms of their interests, purposes and topics. The next step was to see how learners respond to relevant science lessons that the teachers conducted. This allowed opportunities to observe how learners responded and provided a basis for talking to them about what they had learned. The purpose was to elicit information of what they thought was relevant in terms of their science learning, not only with regard to interesting topics, but in relation to their day-to-day lives and experiences, trying to find out what was of value to them in their science learning. The final step was to talk with parents and the children about life in the community and the parents' hopes for the children.

As these lessons were designed and taught by the teachers, the setting is described as conventional. Some input from the research team did occur as teachers discussed their lessons with the team. However, the lessons were similar enough to the science lessons usually taught to be regarded as conventional. The learners' responses to these lessons were used as a springboard for further exploration of relevance during interviews with learners. In this chapter, information on all the research instruments used to gain data in this phase of the study is provided, justifying the choice of instruments where necessary.

METHODOLOGICAL FRAMEWORK

The approach in phase 1 was essentially interpretive, in that descriptions of and insights into the children's lives and learning, from the perspectives of the children, their teachers and parents, were sought. I sought to maintain some distance from the various respondents as I gathered the data, whether through interviews or observations (Mason,2002). Social constructivism provided a framework for the design of instruments and methods and the lens through which the data were interpreted. This was chosen because of the concerns for learning, relevance and the individual and social factors that shape learning. The social constructions of these learners, the social world that the learners produce and the interaction of individual and group influences, needed to be understood. It required a 'thick' description of events and actions of the participants in the study.

To determine the impact of the learners' social environment on what they see as relevant in science, the everyday circumstances of the learners, as well their engagement with school science, was focused upon. To explore conceptions of relevance, two broad strategies were used. One was to gather information on the children's experiences and interests, from which judgements about what was 'relevant' were made. The second was to observe their responses to attempts at relevant lessons and to use their responses as a basis for further probing. In both strategies, information was sought from a variety of sources (Peshkin , 2001).

The three teachers who worked with these learners and had insights into their every day lives, were heavily relied upon. The teachers acted as collaborators as they administered questionnaires given them and provided useful information about learners that guided classroom observations and questions posed to learners. They also played an important part in the design of the lessons and presentation. The teachers provided information through interviews and assisted with interviews with parents of the children. The teachers had insight into the interpretation of the data and this ensured that a 'consensus construction' emerged from the data (Guba and Lincoln, 1994).

An inductive method was employed as the participants were observed in a particular setting and certain concepts emerged. This led to the generation of theory to explain the particular context in which I worked within a social constructivist framework. An inductive approach necessitated in depth observation and interpretation of events. Interviews contributed greatly to the data collected for this study. This necessitated a good relationship between the teachers, learners and the team which conducted the interviews as these relationships could shape the data which emerged from the interviews (Clandinin and Connelly ,1994). In this case the data was obtained from interviews conducted by different members of the team. Comparison of the data from interviews conducted by different interviewers, served as a form of triangulation.

THE SETTING

The three schools that participated in the study are situated in the townships of Khayelitsha and Guguletu on the Cape Flats. They were chosen because they represented a cross-section of the isiXhosa speaking communities of the Cape Flats. The school communities consisted of learners from established townships and informal settlements, urbanised children and children from rural parts of the former Transkei. A further criterion was that the teachers should be effective and committed and live in the community. This was important, because of the knowledge and skills the teachers had, their insights into curriculum and their preparedness to experiment. These particular schools were selected as part of the PSP evaluation because of their involvement with PSP. As the schools were already in the evaluation programme, consent to participate in this research was part of the consent to participate in the evaluation. This helped the research team with access to these schools. Because of the interpretive orientation of the research and the plan to work in depth with children and their teachers over time, the study was limited to one class from the three schools. This enabled deeper levels of trust and communication, even at the outset, because the children, their teachers and the researchers committed themselves from the beginning to working together over a two-year period. The classes were selected on the basis that their science teachers were part of the PSP and regarded as competent teachers, familiar with the principles of OBE.

Grade 5 classes were used in the study, as the evaluation focussed on learners in the intermediate phase, specifically grade 5 learners. In grade 5, science lessons become more formalised, focussing on science concepts. This usually means that science teaching becomes more structured in the science classroom and a specific time period is allocated to science on the timetable. Grade 5 learners are also able to communicate more easily during interviews. The use of English as the language of instruction, is official policy (although in practice this does not happen) and it was thought that this would also facilitate communication. As the evaluation of the PSP covered a three-year period a track of the learners and their teachers, could be kept. This made it easier to conduct the second phase of the study in the learners' grade 6 year. The unit of research of phase 1 was a class, rather than individual learners, as learners' responses to relevant science and other interpretations of relevance emerged in their interactions with each other. This choice was made partly from the framework of social constructivism and partly because, from the perspective of teachers and curriculum designers, the class is the natural unit of teaching and learning.

A TEAM APPROACH

The data were collected by a team of which I was a member. This meant that a great deal of interaction occurred between team members and teachers. This enabled a relationship of trust to develop between teachers and researchers. The members of the team worked at the three schools while the research was conducted and as the lessons often ran concurrently, data could be collected simultaneously from the three sites. At other times two members of the team were involved with observations of the same class. The advantage of this approach was that the team as a group provided input into the design of the lessons. Where more than one researcher was present in the class, while lessons were taught, discussion of observations were possible allowing for a degree of triangulation.

ANTICIPATING ANALYSIS

The design of instruments necessitated some consideration of how the data obtained from these instruments would be analysed. Wolcott's (1993) categories of description, analysis and interpretation to discuss the findings, are used. An interpretive approach enables descriptions to be developed, themes and categories to be analysed and the meaning of the data to be interpreted (Creswell, 2002). One important analytical tool was the narrative type of inquiry (Polkinghorne, 1995) as opposed to the paradigmatic type. I wished to produce storied accounts from the data collected from teachers, learners and parents , rather than collect storied accounts and analyse them. The latter approach is well suited to life history research, while my data were obtained by asking specific questions , rather than collect storied accounts. The data used to develop these narrative accounts were obtained mostly through interviews. I chose to present the data as narratives as the data from different sources overlapped and in this way I avoided repetition. Chapter four represents the descriptive stage, while chapter five represents the analysis stage. The interpretive stage for both phase 1 and 2 of the study is covered in chapter 9.

RESEARCH INSTRUMENTS

A classroom is a complex environment and to obtain insight into learning in classrooms required more than one method (Tobin and Fraser, 1998). Treagust, Jacobowitz, Gallagher and Parker (2000) similarly report on the importance of having various data sources when interpretive studies are done. A number of research instruments were used to generate data. I believe this multi-method approach adds rigour to the study (Denzin and Lincoln, 1998).

Interviews

Lincoln (1995) describes the interview as the preferred tool for qualitative research. The interview is more than excavating facts - it involves the construction and reconstruction of facts (Mason , 2002). Subjects seldom give full explanations of their actions or intentions, all they can do is offer accounts or stories about what they did and why (Denzin and Lincoln,1998). Even if the participant makes a false statement, this is data, because it is the participant's perspective (Neuman, 1997). Talking is the primary medium through which social interaction takes place (Silverman, 2000) and is therefore an extremely important tool for data collection within a social constructivist framework. Rather than taking a realist approach i.e. expecting an accurate account from an interview and trying to verify this account, the narrative approach is preferred where the participants response is an account of the way they see the world (Silverman, 2000).

In this study, construction and reconstruction were an important aspect of the interviews conducted, in view of the fact that participants were not always able to verbalise their feelings in a second language. Clues other than verbal ones enabled data to be constructed from interviews. Interviews resonate well with my ontological and epistemological positions in that the research questions are designed to explore people's knowledge, views, understanding, interpretations, experiences and interactions as meaningful properties of their social reality. My epistemological position refers to the relationship of 'knowing' between me and the participants. Understandings from an interview is not an extraction of facts, knowledge is constructed or reconstructed during the course of the interview. Lemke (1998) regards the analysis of verbal data as an extremely important method when examining particular communities in depth, as this allows the researcher to learn a great deal about a particular class.

A multi-method strategy with regard to interviews was employed.

- Focus group interviews with teachers.
- Focus group interviews with learners.
- Focus group interviews with parents.
- Structured interviews with learners.

(Table 1, p79)

Interviews conducted with the teachers were open-ended, a similar approach to what Silverman (2000) refers to as a narrative approach where the interview data accesses various stories or narratives through which people describe their worlds. The open-ended question approach facilitates an inductive method of generating data, because the data collected is less structured and allows for categories, trends and hypotheses to emerge (Ledbetter, 1993). Notes were taken during the interviews with parents and teachers.

Focus group interviews were chosen with the learners instead of individual interviews, because this type of interview allows for the exploration of issues of interest in a dynamic manner (Osborne and Collins, 2001). It uses group interaction to probe and to elicit responses and offers a degree of support and security as well as the option not to respond. There is no compulsion in the focus group interview to tell a 'story'. Interviews conducted with learners took different approaches. One interview with a group of learners was audio taped, while notes were taken during the rest of the interviews.

Observations

Interpretive research leans heavily on detailed observations. Observing or participating in or experiencing real-life settings can capture knowledge of the social world. From an ontological and epistemological point of view, observations were essential to this study. Denzin and Lincoln(1998) warn that there are no objective observations, only observations socially situated in the worlds of the observer and the observed. At times I acted as an observer (the outsider) and at other times I was a participant in the events that were observed. The following events were observed.

- One lesson on the same topic in two different classes.
- Three lessons on different topics in three classes.

(Table 1, p78)

Extensive notes were taken during the observations of the lessons. These observations not only served to demonstrate how learners interacted with each other, as well as with the content; it also made it possible to observe how the different teachers approached their lessons and interacted with their learners ,using their knowledge of their learners.

IMPLEMENTATION

The data were collected during the learners' grade 5 year. Members of the research team assisted in the collection of data. The data below are presented in chronological order

Teacher interviews

A focus-group interview was conducted with the three teachers of the grade 5 classes from the three schools. This interview was recorded as a narrative account. The purpose was to find out what knowledge these teachers, as science teachers, have of their learners to enable us to gain a sense of the teachers' knowledge of their learners, knowledge of the everyday lives of the learners as well as knowledge of the learners' conceptual development in science. This interview produced the first set of data. This information so collected would contribute to the design of relevant science lessons.

Classroom observations - stage 1

Learners were observed in their science classes during science lessons. Two classes were observed. Their respective class teachers taught the same lesson to each class. A second researcher, in collaboration with the teachers, developed this lesson. The topic was taken from the current science curriculum. Observations were sometimes made of the whole class - this happened most during the teacher-directed phase of the lessons, when most of the interaction was between learners and teacher. During activities we moved about amongst the learners, sometimes observing groups, sometimes individuals. Observations included watching and listening to learners as they interacted with each other and watching what they wrote or did when completing activities. The data were recorded as two narrative accounts.

The purpose of these observations was to elicit some information with regard to learners' knowledge of science concepts, their interactions with each other during group work, as well as to observe their responses to a topic that was relevant to their everyday lives. It was necessary to observe if they were able to use their everyday knowledge to solve problems in the science class. This information was also used to elicit information from the learners during interviews.

Learner interviews

Learners were interviewed in focus groups at the end of the observed lessons. These interviews served different purposes. Some were reflective, where learners were asked to reflect on their feelings about science in general, about the practical value of the science in their lives and how they used their everyday knowledge in the science class. In other interviews they were questioned about specific activities in lessons such as their experience of a practical activity or how they enjoyed working together or which activities they preferred. At other times they were asked to talk about their interests in general.

The purpose of the interviews was to hear from the learners how they took home what they learned at school and the knowledge, experiences and questions from home they brought to school. A sense of how the learners related to the content taught in the lessons, needed to be obtained. All this information served to provide a sense of the lives of these learners. Each focus group consisted of five learners.

Interviews of learners by teachers

Teachers were asked to add to the information given in the interviews by observing certain learners over a period of time and then interviewing them. Semi-structured interviews were used to obtain this information. Two teachers interviewed twelve learners individually over a period of time. Learners' responses were recorded on the schedules. Twenty-four interview schedules were completed. The purpose of the interview schedule, was to elicit information with regard to learners' home conditions, social life, interaction with family members and interests, adding to their knowledge of their learners.

Classroom observations – stage 2

A second stage of this phase of the research started with observations of three lessons, each lesson taught by a different teacher, covering a different topic. Each teacher selected a topic and designed a lesson. As the teachers taught the lessons two researchers observed each lesson. This was necessary because of the high levels of inference involved. The purpose of the observations was to observe how teachers use knowledge of their learners in the design of science lessons. It also served to enable an observation of how learners engaged with the content during the lesson. It enabled observation of the interaction between teacher and learners and how the teachers used learners' knowledge to build on and extend the lessons. These observations produced two written accounts for each lesson; a total of six.

Learner interviews

These interviews followed the stage 2 lessons. Focus group interviews were conducted with learners from the three classes. Two interviews with five learners each were conducted in each class. This produced a total of six written accounts. The purpose of these interviews was the same as for the interviews following the stage 1 lessons. It added to our understanding of what learners regarded as relevant, both in terms of science content and being able to use everyday knowledge in the classroom, or use what they had learnt in class in their everyday lives. It provided a sense of what learners regarded as important to learn.

Parent interviews

Parents of learners from two schools were invited to meet the teachers and members of the research team. The teachers took the lead in arranging the interviews and were present during the interviews, translating where necessary. As the parents knew the teachers, but not the research team, their presence was crucial as it helped to establish rapport between the two groups and served to build the teachers' as well as the schools' reputation in the community as it was obvious that parents welcomed this opportunity to air their views.

Parents were interviewed in two focus groups. As each question was put to them and they discussed it among themselves, the different responses were recorded. The questions focussed on their expectations for their children with regard to schooling, their perceptions of community life and the impact of community life on their children, as well as their aspirations for their children in the future. The purpose of the interview with parents was to gain some understanding of parents' views of their children's lives and their hopes for their children's future. This included their view of the role of schooling and particularly science education, as well as what they viewed as a relevant education for their children.

TABLE 1 CRITICAL QUESTIONS, RESEARCH INSTRUMENTS AND DATA –PHASE 1

Critical question	Instrument	Data
1 What do learners regard as relevant science curriculum?	1.Focus-group interview with three teachers.	1.One narrative account.
2.How do learners respond to relevant science curriculum in a conventional setting?	2.Observations of a lesson in two classes.	2.Two narrative accounts.
3.How do teachers use the knowledge they have, to teach relevant science?	3.Focus-group interviews with two groups of learners of five each.	3.1One audiotape of the interview. 3.2.One written account
	4.Interviews with learners by two teachers.	4. Twenty- four completed interview schedules.
	5.Observations of three different lessons in three classes.	5. Six written accounts.
	6.Focus group interviews with learners.	6.Six written accounts of each interview.
	7.Focus group interviews with two groups of parents.	7.Two written accounts.

ISSUES RELATED TO METHODOLOGY

Data Collection

This research was part of a larger study and I was part of the research team conducting the study. This meant that other members of the team also collected data for this particular study. Examples of collaborative data collection were,

- Interviews with teachers to obtain data about the learners in their classes.
- Observations of one of the classes during stage 1 of the study.
- Interviews with a group of learners from each of the classes from stage 2 of the study.

The fact that more than one person collected the data was an advantage in that it allowed for triangulation. It engendered trust in the teachers as they had the opportunity to interact with a number of researchers. Different researchers also interacted in different ways with the learners and elicited responses that one researcher may not have been able to do. Where alternative perceptions existed, this was discussed, but essentially the analysis reveals my interpretation of what emerged from the interviews or during the observations.

Ethical Considerations

Various ethical aspects need to be considered in this study. As social constructivism is the framework within which the study was conducted, the values of the participants emerged from the data, influencing their responses. Constructivism brings a strong ethical focus to cross-cultural interpretive research as it governs the knowledge-generating activities of the research (Cobern, 1996). This knowledge is placed in the hands of the researcher and places the responsibility on the researcher to use it in an ethical manner. From this point of view, ethics form an intrinsic part of the study. It is therefore necessary to ensure that every aspect of the research is ethical and protects the rights of every individual concerned (Sowell and Casey, 1982). Ethical considerations are also important with regard to my actions in this study. As part of a larger project, the evaluation of the PSP programme in the Western Cape, obtaining ethical clearance was not a problem as permission had been granted by the provincial authorities for the evaluation to be conducted. Nevertheless , although the teachers were quite aware of what was happening and where this study fitted in, the learners were quite unaware that they were to be part of this research project. In this sense there was an ethical responsibility to these learners, as they were included in the study because their teachers were selected to be part of the study.

The ethics of doing research in this community go beyond obtaining permission from authorities or parents/guardians. The nature of the research required learners and teachers to reveal very personal aspects of children's lives. This was revealed through interviews, stories told and written, as well as through teachers' previous experiences with their learners. These intimate details were disclosed to the class teachers, researchers or peers by children who are generally very trusting. The ethical question arises in respect of whether the information is simply used as data, maintaining confidentiality or does a researcher act upon information revealed in this way? Some of the information was sensitive and one might argue, should be acted upon. We took the decision not to act upon this information, but this has consequences insofar as the learners might have expected a response. On the other hand, had we decided to act upon the information, whom would we report it to? Do we have a responsibility to the education authorities? Do they have the authority to act? There are no simple answers to these issues. My actions have been guided by the principle that whatever decisions were taken, it was imperative to ensure that the learners are not affected in any negative way. Working with these children over a long period of time meant that a closer relationship developed between the research team and the school community than would have if the research was a one-off data collection event. This may have raised expectations that we may be able to make a difference. I believe that working with the team may have positive consequences in that the teachers may have taken something from the experience that may benefit the learners. The learners may also benefit from the fact that it will allow their voices to be heard and in so doing may bring about a difference in approach to curriculum design.

Validity

What criteria should be used to judge the quality of this study? As an interpretive study the criteria of objectivity and generalisability do not apply. The criteria suggested by Guba and Lincoln (1998) of trustworthiness and authenticity are more applicable to this study than the term validity. As a study embedded in social constructivism with an interpretive methodology, I believe it would be inappropriate to evaluate the study according to traditional principles of validity. Gitlin and Russel (1994) regard a text as being trustworthy if the relationship between what is said and the person doing the talking is made apparent. This principle was apparent in this study. Another criterion of trustworthiness is the degree to which the research process enables disadvantaged groups to fully participate in the decision making process. Both teachers and learners were involved in this way, teachers decided on content and strategy in one phase and learners decided on these issues in phase 2. Another aspect that should be considered is the degree to which I, as the researcher influenced the process. My questions determined the focus of the study as they were guided by the purpose of the study and the research questions. My style and form of communication also influenced the data produced. The fact that a team was involved at certain times brought different perspectives and produced different outcomes. All of these point to the fact that using the criterion of validity will have little value in this study. Trustworthiness and authenticity are more appropriate criteria by which to judge. As this study is cross-cultural, the argument that knowledge claims can only be credible and fair if local people are involved in a sense of ownership and empowerment may apply (Waldrip and Taylor, 1999). In fact, there was a degree of empowerment for both teachers and learners, as well as parents. The results of this study are not transferable. The quality by which it is therefore judged is internal validity or rather, credibility and internal consistency (Neuman, 1997). The teachers in the study made decisions as to which learners were to be interviewed and this lent more credibility to the study.

Although it was stated that validity was inappropriate in the sense of determining whether the data are 'true', the data generated from three different sources in phase 1 of the study, namely responses from learners, teacher interviews and parent interviews complemented each other to such an extent that it could be regarded as a form of triangulation. This is in accordance with what McFee (1992) refers to as triangulation within a method as it brings to bear more than one viewpoint on a single aspect. However, I am in agreement with McFee that one should not overestimate the value of triangulation. Triangulation is an alternative to validation (Denzin and Lincoln,1998).

Reliability/Dependability

Reliability cannot be based on duplicating procedures as this study is specific to this particular context at this particular time. Reliability should rather centre on attempts to satisfy the underlying principle of voice and should lead to understanding and reconstruction. Viewed from this perspective, Lincoln's (1995) use of dependability rather than reliability is a more appropriate definition for the data generated here. Dependability requires the findings to be plausible, forming a coherent picture of the participants and their everyday experiences (Neuman, 1997). This picture relied heavily on the responses of the learners in this study; their credibility was crucial to the dependability of the study.

Generalisability

Taber (2000) refers to analytical generalisation, which involves a reasoned judgement about the extent to which findings from a study can be used as a guide to what might occur in another situation - the reader should judge if a generalisation claim is sound. Generalisability is not an issue in this study as the research is about learners in a particular environment at a particular time. Similar results in another context should not be expected, as the study is about the uniqueness of this particular context. If the study is generalisable, it is not because the assertions apply to other settings, rather that other evidence within the setting supports the patterns found in the setting. This is evidence of internal generalisation (Erickson, 1998).

CONCLUSION

In this chapter, the methodological position has been clarified and attempts made to show how the theoretical framework of social constructivism, as well as the research questions, guided the methodology during this phase of the study. An overview of the different types of research instruments employed to obtain relevant data for phase 1 of the study, has been given. An explanation of how the instruments were used and in which contexts they were used and a discussion on various issues related to the methodology during this phase of data collection in an effort to clarify the position, has been given. The data obtained in this phase of the study will enable answers to the first three research questions.

In the next chapter the findings that emerge from the data recorded in this phase will be recorded as narrative accounts of a teacher and learners. The teacher's narrative is a composite of the data that emerged from the three teachers who were participants in the study. This narrative shows what the nature of the knowledge is that these teachers have of their learners and how they use this knowledge in the design and delivery of their lessons. The learners' narratives are composites of all the data obtained of learners through observations and interviews. These narratives give an account of two learners who experience the science lessons in different ways.

CHAPTER 4

DESCRIPTIVE ANALYSIS – PHASE 1

INTRODUCTION

The approach used in the first part of this chapter is the creation of a fictitious teacher, Zanele. Her narrative is a 'factitious' account that demonstrates her knowledge of her learners, as well as how that knowledge is used in her lessons. Her narrative also includes an understanding of her learners' responses to relevant science. Zanele's narrative is a composite of the analysis that emerged from the data obtained from the three teachers and parents, as well as from the observations made by myself and two other members of the research team. This is made possible by the fact that common threads were identified across the data obtained from the participants (Clandinin and Connelly, 1994). Zanele's account of her experiences emerged from a content analysis (Patton, 1987) of the data recorded from the sources discussed in chapter 3. A deeper level of analysis will be discussed in subsequent chapters.

Polkinghorne (1995) refers to this approach as narrative analysis where synthesised information obtained from the data is compiled into a story. This type of analysis moves from elements to stories, as opposed to analysis of narratives, which move from stories to common elements. Data are presented by tracking the experiences of this fictitious teacher over a period of time. She relates her experiences as a collaborator in the research process. The purpose of the research is to understand what the teacher knows and understands about her learners, their communities, their everyday lives and their school experiences. Interactions with learners unfold during the process.

In the second part of the chapter, learners' responses to relevant science are described. These responses will be related as a 'factitious' account of two learners, Bongi and Thembi, as they describe their experiences in their science classes. Each learner's account is a composite of two groups of learners who respond in different ways to science lessons. The data for this analysis was obtained from classroom observations, semi-structured interviews and focus-group interviews with learners.

The findings are reported as a narrative of the teacher on the one hand and the narratives of the learners on the other hand, combining a succession of events into a unified episode. In this way 'stories' are produced of the teachers' and learners' experiences over a period of time. In the stories, events and actions are drawn together into an organised whole by means of a plot (Polkinghorne, 1995). The plot is the conceptual scheme by means of which individual events are displayed. The different elements of the data have been organised into the stories in such a way that the stories give meaning to the data.

ZANELE'S STORY

What do I know about my learners and how do I use this knowledge? I was the class teacher for this class in their grade 5 year. In their grade 6 year I took them for science only. The school I teach at is in Guguletu. I grew up in Guguletu and although I do not live in Guguletu anymore, I live in a neighbouring township and still have strong ties with Guguletu. The learners, who attend the school where I teach, come mainly from Guguletu and the neighbouring Oliver Tambo informal settlement. Some of the learners even come from as far as Khayelitsha. My learners come from both township communities and informal settlement communities. The fact that some learners were born in Cape Town, while others are recent immigrants from the former Transkei or other rural areas, add to the complexities of my classroom. I am inclined to think of my learners from the established township as urbanised and the children from the informal settlements as rural, although the distinction is not that clear-cut. There are people who move from other urbanised areas to Guguletu to be closer to the city centre and are forced to live in informal settlements.

The school at which I teach is a brick structure. Classrooms have tables and chairs, but are poorly resourced in terms of learning materials. I rely heavily on materials from PSP workshops, adapting the materials for my science lessons. I have a long relationship with most of the learners in my science class and feel that I have a deep understanding of them – both inside and outside the classroom. I am interested in their home environments and I am familiar with the conditions they live under at home. As a result, I believe that learners trust me and readily confide in me when they have problems. I think my classroom is a happy place, where learners socialise with ease. I have come to realise that the everyday lives of children who live in the established section of Guguletu is often different to the lives of those learners who live in Oliver Tambo Village (the informal settlement). Township children understand English better, but their isiXhosa is often a mixture of dialects. They and their families have some money and children get stimulation in richer ways. They have friends from multicultural schools in the suburbs and often visit shopping centres in the suburbs.

Most families have TV and radios. Those children who come from more well-off families, often have TV games. TV is seldom used as an educational tool, mostly for entertainment. Popular programmes are Dragon boyz, Crazee movies, Generations, Bombay, School TV, Jam Alley, Take 5, Backstage, Soul buddies, Phat Joe, Nikita Shiena, Telebuddies, wrestling and Popeye. They have access to libraries. These children often go to the cinema and they are strongly influenced by United States culture.

As the children become more urbanised, they develop more informal relationships with their parents, teachers and elders, moving away from the more formal relationship between children and adults that exist in traditional African culture. They are able to express ideas and feelings more easily. They don't want to identify with rural people. Township children are aware of the fact that they live in 'proper' houses, compared to children from informal settlements. Most houses have electricity and water. Although these houses are brick structures, they are often quite small, giving rise to cramped and overcrowded conditions. There are often between six and twelve people in one house, from different segments of the extended family; single parent families often live together. Children have to share bedrooms with various members of the extended household. Parents in these households are often at work for long hours or socialising somewhere else, so that children look after each other. There is much activity in the streets in the evenings. Hunger is an issue. Some learners come to school hungry. The 'school-feeding scheme' is important: Learners are provided with two slices of bread, with jam or peanut butter. Although they are often hungry, when I ask my learners what they would do if they had more money, the answer invariably is: buy clothes and toys.

Although I work with learners in grades 5 and 6, many of them are twelve or thirteen, the age at which the transition from childhood to becoming a teenager begins. I am concerned about them, as I am aware of the problems that lie ahead. As they socialise more with adults, violence, physical abuse and sex become more widespread, affecting most learners, not only those who are abused by family members. I know that by the time my learners reach the age of fourteen or fifteen many of them would have joined gangs, bending to peer pressure to dabble in alcohol and other drugs. A colleague expressed our frustration.

> It is difficult for kids to buy cigarettes, but not to buy drugs and alcohol!

The children from rural areas have a richer vocabulary and speak a 'purer' form of isiXhosa than urbanised children. I think that children from the rural areas have a more difficult time, in many ways, than urbanised children. The households are very poor. Stimulation is limited, either through conversation or through experience. They have little access to libraries because they are not members. Librarians are often employed because they are local rather than because they have skills, and so are not very helpful.

Rural children are more withdrawn and interaction with adults is more formal. They are rural people and ambivalent about it, recognising their identity, but feeling also that being rural is a social handicap in this area. They live in makeshift houses, often in crowded and cramped conditions, physically difficult, with rain, wind and cold. Most children have the dream of buying their parents 'proper' homes one day. Adults struggle to find work and poverty is a serious issue. Children often look after each other when adults are out working or socialising.

> Give a child some clothes - say a tracksuit top because the child is cold - and the family might sell it or distribute it to another child. In this context, illness is a real problem.

After school they help their parents who work, with home chores. They take care of themselves. They wash their school clothes and do their homework on their own, without supervision. Much of the social life is 'in the street' – especially with the increase in lighting.

Connection to water and electricity is increasing. There is much abuse of the electricity supply, by wiring into the municipal system or into other house supplies. There are enough electricians in the community to effect these connections, but the wiring is often dangerous.

For many children in my class, hunger is a big issue. Sometimes there is only enough for two meals a day, breakfast and supper. Lunch is skipped to save for supper. Often children go to bed without food.

> You take care not to eat in front of the children, because it is likely that some of them have not eaten much for days. Children sometimes fight over bread at school, snatching from each other.

Yet they are often reluctant to admit that they have not eaten, saying that they get enough food at home.

By age fourteen to fifteen, the children spread into the townships, wanting to copy the township children and be accepted by them. Children from the informal settlements face the same problems as the township children and more. They are in bigger confusion about role models and identity, because of their rural base, the rural base of their parents/adults and their lack of money. Although the two groups of learners in my class face different challenges, they do share some common interests. Learners are mostly engaged in similar activities after school. These are household chores, watching TV (often at friends' homes), doing homework and playing with friends. Most learners engage in formal sports. Most boys play soccer, although there are learners who are interested in less popular sports such as gymnastics and swimming. Girls enjoy netball. One of my learners takes ballet lessons and this has become the main focus of her life. (Many of the sports and other activities offered in the township are part of development programmes.)

I try to encourage my learners to read and when I question them they say they do read, but reading materials vary. Children often have to depend on their parents or other family members to bring reading materials from work. Most learners read magazines and comic books. Story books, science books and books on health and cooking are obtained from the library when possible. There are many problems facing my learners. The children bring interests that are foreign to their parents into the home, as well as a change in behaviour that parents construe as disrespectful. This leads to increased friction, disintegration and abuse. These social conditions spread into the schools. As early as grade 4, some children come to school recovering from drink or drugs or physical abuse - feeling ill, sleeping at their desks and being hungry. Frequent drunkenness is more common with young girls than young boys. Social workers in the schools try to help. What their work reveals is the extent of young children's experience with alcohol, drugs and sexual abuse.

For boys, the peer group and street culture are critical. For girls it is different. Coming to the city, changes girls' lives. Thirty year old men team up with fourteen to fifteen year old girls, buy them clothes, give them money, take them to the city and have sex with them. For the girls, a thirty-year old boyfriend and early pregnancy are fashionable. The men often want babies, so do the girls. The girls see their future not in work or education, but in being 'looked after' by a husband/lover. AIDS, STDs, pregnancies and exploitation are all issues.

The girls opt for males, not jobs.

The boys don't have this option. I know that many of my learners will not stay at school beyond grade 7 or 8. In general, neither boys nor girls see education as meant for them once they reach fourteen or fifteen. For me, this is a challenge and I often worry about what I could do in my lessons to make learners want to continue with school. Knowing what the background knowledge and interests of my learners are might help me to design lessons geared towards their interests.

Township girls and boys are interested in machinery. They want to know how things work, they want to use and fix machines. They find appliances such as microwave ovens, vacuum cleaners and lawnmowers interesting. They enjoy using electrical appliances and battery gadgets. They are also interested in living things like fish, cats and dogs. They enjoy factual knowledge, especially 'exotic' knowledge from cities and distant places - certainly not rural knowledge. They like fire - as a phenomenon, as a tool and as a risk. These children are more orientated to learning for 'fun' than children from the informal settlements are. Rural children have less knowledge of appliances and machines. For example, boys would be more inclined to cut grass with pangas than a lawn mower. Boys know about plants and animals. Many grew up as shepherds and were taught by their fathers about nature, sheep, cows, animal and plant behaviour. They have become keen observers of nature. If they haven't actually worked as shepherds they know about these things, through observation and oral teaching. Even in Cape Town, boys and their fathers go hunting with dogs, looking especially for rabbits for food. They also trap birds and search for birds' eggs. Girls from rural areas have their own chores and knowledge - fetching water, washing clothes, crushing mealies, cooking... They bring this knowledge with them.

Children in the informal settlements are more oriented to 'learning for survival', rather than fun. They enjoy applying their rural knowledge with regard to living things such as birds, snakes, vegetable gardens, animal behaviour, soils, trees and their uses (especially for medicinal purposes). They enjoy factual knowledge, related to life in rural areas. They are generally not interested in exotic things. Even something like the ocean, which is very close to where they live now, does not interest them. Some of these learners though, want to know more about distant places and lives. Like the urban children in my class, rural children are also interested in fire - for the same reasons.

Children, in general, like technology. They want to know how things work and like to design things, for example scooters, box carts and toys, useful as well as pretty things. They enjoy practical activities and skills they can take home and into their lives.

Cultural beliefs and traditional sayings are an important part of children's lives and belief systems – especially, but not only, in the informal settlements. Traditional medicines, the cultural dimensions of language and sayings are all part of their lives. Children at this age enjoy accruing sayings and teachings and much of their informal learning centres on these sayings. The families of both groups of learners practise various rituals. These rituals are performed in different ways, according to their clan names. Examples are mbeleko (initiation), ukwenda (traditional weddings), utsiki (sheep slaughtering), traditional healing, making umqombothi (xhosa beer), umthandazeli (faith healing), amasiko (rituals), ukusila (making customs for luck in order for their ancestors to be with them), ukubhaca (cuts on the back and front of the neck) and inggitho (finger cutting). These rituals are of great significance to my learners.

Although my learners are relaxed and happy in my class, I am aware that there are many things that most learners, to a lesser or greater degree, are not interested in. For instance, they are reluctant to do experiments, especially with unfamiliar equipment (even with simple things such as beakers), they prefer demonstrations. They need change of activity/focus often and multiple stimulations. The formality of the classroom and school routine switches them off. They don't respond to questions such as 'What does this mean?' 'What is happening here?' 'What did you learn from this?' They say English is easier 'when you are relaxing', such as watching TV. They can retell a story/demonstration from TV, but not something that happened in school. They want frequent change at school, but will watch TV by the hour and are happy to watch repeats of TV shows. They have trouble following instructions and reporting 'in steps' (either orally or in writing), a process, demonstration or argument. They enjoy learning from watching – watching without 'listening' or 'reading'. For example, they can appear to be reading books but in fact are simply talking about the pictures. They like to watch other children, watch the teacher, etc.

I believe there are problems with curriculum structures, especially since OBE. In the Foundation Phase, the 'integration' of science in to Life Skills often means a focus on health and personal development. Science gets little time and even then is not developed in any structured way. Children do a lot of 'draw the picture' or 'fill in the blanks' worksheets in the Foundation Phase. The science that is presented is not very rigorous. For example, children will learn about 'the seasons' by naming them and talk about temperatures and rain, but not about the causes of the seasons. Foundation Phase teachers often don't know much science and do little research – they assume their own knowledge is sufficient at this level. Also classes work mostly in isiXhosa in the Foundation Phase. The net effect is that children come into the Intermediate Phase with poor backgrounds in reading, writing and science and this slows progress in the Intermediate Phase.

I have a long association with the PSP. I attend their workshops regularly and I use their material and adapt it to suit my learners. When the PSP approached me to participate in a project as part of an evaluation of the PSP programme, I readily agreed. One aspect of the project was to design and teach science lessons to my grade

5 learners to try to establish what they experience as relevant in their lives. In the first stage of the project a lesson was designed in collaboration with two researchers. We all agreed on a topic. We selected the topic that we believed learners would find relevant because it related to their everyday lives and we thought they would be able to use knowledge acquired in the science class in their everyday lives. I designed the next three lessons, selecting topics from the themes suggested by the National Department of Education in their documents on the Natural Science curriculum. I used ideas from the PSP material to guide me in the design of the lessons as these materials are designed along the lines of the above themes. Although I know my learners well, I was interested to see how they responded to lessons that were designed especially for them. Up till then I had taught science lessons that were either taken from the PSP materials or from other textbooks. And this was a new experience for me.

Stage 1: Lesson 1

The topic selected for this lesson was 'Purification of water', because obtaining clean water was a problem for many learners. Most homes do not have running water and I am aware of the fact that water is often collected from streams or from tanks collecting rainwater. The lesson was developed to incorporate interaction between learners, as well as interactions between learners and myself. The greater part of each lesson was devoted to activities where learners interacted with each other and equipment, resources and worksheets, as well as with me. The group activities allowed learners to work in different ways to some extent. The research team and I felt that it might be easier to find out what the interests of learners are if the lesson was set in a particular context. I described a scenario of a pipe that had burst in the township, leaving residents without water. (In this way all learners, including those from the townships with piped water, were included.) Learners were asked to use the available equipment in any way to clean the dirty water they were given. We wished to observe,

- How the learners engaged in practical activities?
- How they liked to learn? (Did they enjoy discovering things or did they want to be given information?)
- Did learners prefer to get information from their teachers?
- How did learners use their everyday knowledge?
- Did the knowledge help them to expand their conceptual framework?
- Are the learners able to develop science concepts as they engage in activities and use their everyday knowledge?

Observation of the class revealed that learners were eager to explore possibilities. They immediately took pieces of equipment and started to experiment. Although the class was a bit disorganised, a lot of positive interaction occurred. It was very difficult to determine which learners in each group understood the purpose of the group's chosen activity. Most learners were observing what one or two members of the group were doing. Learners were familiar with the concept of filtering – they used sieves, wire gauze, tea strainers, cloths and cotton wool to strain the water. The way in which they used their fingers to stir the water as it was filtering, suggested that this might be a familiar activity. All groups ignored the filter paper as they were unfamiliar with its use. The use of chemicals, like Jik, or boiling to purify water, was unfamiliar to them. Learners took some time to realise that cleaning water required more than filtration. One group eventually realised that by boiling water it is cleaned. They had difficulty in understanding that a chemical could purify water as they associate chemicals with pollution. The concept of germs was unknown. Learners could easily explain concrete concepts, but the more abstract concepts took much longer to develop. At this level learners are unable to conceptualise microscopic life, such as bacteria, etc.

When the learners had completed the activity, I attempted to link the concept of impure water to substances that are soluble. Learners copied a table with soluble and insoluble substances from the chalkboard. This discussion helped learners to form some understanding of the concepts they had previously struggled with. There was little evidence of deep thinking. Learners were provided with a work sheet to complete as they engaged in the activities, but most of them did not write much. I was not surprised, because I know that many of them find it too difficult. When I do want them to write something, I usually appoint a scribe for each group. The scribe fills in a response on behalf of the group. This usually works well if the scribe is a competent writer, but learners became frustrated when the scribe is less competent. A test was written at the conclusion of the lesson. This test consisted mainly of input from members of the research team. Learners did not do well in this test as I believe that they did not understand most of the questions. The questions were also formulated in a way that learners do not respond to. They do not like questions that require them to explain their answers.

Stage 2

During this cycle I taught three different lessons, covering three different topics. All three topics were taken from the PSP materials and adapted to suit this particular class. As the topics were taken from the PSP materials, which are based on the national science curriculum, the relevance of these lessons lay in the fact that the materials are regarded as important for the development of science concepts that would be useful for learners in the long term. I also tried to adapt the content in such a way that learners would find it relevant to their everyday lives. This was easier with some topics than others.

I tried to implement a learner - centred approach in these lessons as well and I believe this contributed to relevance. We were interested to see to what extent the learners participated in the activities. This proved very difficult for the researchers as most learners have difficulty in expressing themselves in English and therefore interact with each other in isiXhosa. I translated for the researchers or if I gave instructions in English, I translated for learners who did not understand.

The same aspects were focussed on as for lesson 1:

- Engagement in practical activities.
- Collaborative learning.
- Use of everyday knowledge.
- Development of concepts.

Lesson 1 - animal life-cycles. The class was divided into groups of six. The lesson was linked to the last lesson on vertebrates. I asked learners to give me examples of vertebrates. Answers offered were reptiles, mammals, birds, amphibians and fish. I spent some time explaining the concept of life cycles. As learners responded, I wrote their answers on the chalkboard. In this part of the lesson learners did not interact with each other. In the second phase of the lesson, learners were asked how animals reproduce. At this stage of the lesson I often switched to isiXhosa as the learners were unfamiliar with the English terms. Learners are used to me switching easily from one language to the other. I also wrote new words on the chalkboard.

Groups were given work sheets with pictures showing different stages of particular life cycles. Groups were asked to place the stages of the life cycle in the correct sequence. Three life cycles were included - frogs, humans and whale life cycles. Learners cut out pictures and sequenced them. The girls enjoyed doing this more than the boys. When required to read sentences from the work sheet, many learners struggled. The choice of examples was important. Learners found the human life cycle interesting – they all had knowledge of this process and some learners expressed amazement at the fact that humans have similar life cycles to animals. Unfortunately, the only pictures I could get hold of, were those of white westerners.

The class related well to the topic. When bird reproduction was discussed, the levels of participation rose dramatically. Some learners, who seldom participated, contributed energetically to the discussion. Many learners, especially boys, knew a lot about birds and their life cycles. I knew I had to make use of this opportunity and encouraged the learners to share their experiences with the class. Looking back, I would say the learners spent too much time on the activities, but at least learners have a good understanding of life cycles now. The fact that five or six learners in a group had to share a worksheet meant that many learners never had an opportunity to read from the worksheet. Usually only one member did the cutting as well, while the others watched.

Lesson 2 - sorting and classifying. In this lesson no prior discussion of classification occurred. Learners were grouped and each group was supplied with pictures of different plants and animals. Learners were instructed to look for similarities and differences among the given examples. I did not want to introduce the topic of classification as I wanted the learners to come up with their own ideas of classification. Unfortunately, this did not work very well as I realised that learners needed to understand that they were required to look for common characteristics and to focus on observable characteristics. In spite of these problems, learners worked quietly in their groups. The task was different for different groups as the sets of pictures were different. Two strategies were prevalent. Some groups started with grouping, while others started by selecting all pictures that were different. I realised too late that some of the pictures were problematic, they were not to scale and sometimes a picture depicted a whole plant; sometimes just part of a plant. I also realised that it might have been more useful if all groups had the same pictures. Most groups only sorted the pictures into plants and animals, there was no attempt to form smaller groupings.

Once this had been done, a class discussion ensued about their findings. I then proceeded to explain the basic principles of classification. There was little evidence in this lesson that learners used everyday knowledge to do the activity. Many of the plants and animals were unknown to the learners. The problem was compounded because learners concentrated on functional similarities and differences, rather than structural ones. (For example, they all fly, rather than they all have wings). This made grouping of unknown animals very difficult. In spite of this the learners seemed to enjoy the task of grouping and sorting and interacting in groups. Unfortunately the task was very drawn out and many learners sat around waiting for others to finish the task. The activities were simple and did not appear to be of major interest to the learners. In spite of this, there was evidence of good engagement during the whole class discussion. It appeared that the collaborative aspect of the lesson was of interest to learners, rather than the content. The follow-up activity required learners to sort animals into predetermined sets. This activity was taken from the PSP material. Although this was a closed task, it did provide opportunity for good problem solving. Learners were required to read and write during the activity. Many learners have trouble with words such as frog, crocodile, eagle, etc. Learners have a number of misunderstandings, for example that not all flying animals are birds, not all scaly animals are fish, not all birds fly and not all swimming animals are fish.

Lesson 3 - energy changes. During this lesson there was very little prior discussion as learners started the activity immediately. In groups, they built fires outside and observed 'everything that happened'. Learners were very excited by the activity, fire was something they are all deeply interested in. Given that many of them live in houses constructed from highly flammable materials, it is not surprising. All the learners participated with confidence, familiar with the procedure of starting a fire. The boys particularly took great pride in striking matches in ways that demonstrated practice. At the conclusion of the activity learners moved back into the classroom where they were asked to prepare a poster of the changes they observed and to relate these changes to energy ideas from earlier lessons. Much time was spent on arguing what to write on the poster. All learners communicated with each other in isiXhosa. They were required however, to write up the poster in English. This proved very difficult for most learners.

The posters were presented to the class, with each group explaining their understanding of energy transformation. Most reported changes were not energy changes, only observations of other changes that occurred. Most learners associated fire with 'power' and energy - they understood the use of this energy in their homes for cooking, heating and lighting. When I asked the question, 'What is energy?' one group had good answers. Most answers were off the mark. One group realised that heat is a form of energy. Most learners did not see light as a form of energy. There generally seems to be confusion with regard to concepts. Learners had very little opportunity to write, as the scribe was the only one who wrote on the poster. I found this experience very valuable as it helped me to think about alternative teaching strategies, as well as drawing ideas for lesson topics from the learners' everyday experiences.

Parents as sources of information

I was asked to arrange a meeting between parents of my learners and members of the research team. I was able to do this in my capacity as a collaborator in the project, as well as my position as teacher in the community. Two groups of parents participated in the process. They were interviewed at different times by one of the researchers. I did not contribute to the formulation of the questions that were asked during the interviews, but played an important role in making the parents feel comfortable and translated where necessary. For me this was a valuable experience as it enabled me to hear the views of the parents of my learners and this gave me more insight into the lives of my learners. Focus group interviews were conducted with two groups of parents. These interviews were unstructured open-ended interviews. Parents were asked to discuss questions and one member of the group reported back when parents spoke isiXhosa.

Parents were asked to respond to the following and to reflect on certain aspects.

- A day in the life of your child.
- How do your children like to learn? (Learning by doing, learning how to or learning about)
- What was this community like seven years ago?
- What will this community be like in seven years time?
- What would you like your child to be able to do?
- Where would you want them to be? (By the time their children leave school.)
- What would you like them to learn about at school in science?
- How do we ensure that children stay at school?

Group 1 consisted of parents from the townships as well as Informal settlements.

Group 2 were all from informal settlements. Some are urbanised, while some have recently immigrated from rural areas.

Township parents describe their township as having clinics, youth centres, community halls, parks and churches. Although the infrastructure provided by the government has improved, the social fabric of the community is disintegrating. This is exacerbated by unemployment and the high crime rate. As one parent put it,

> People want to dress smartly, where does the money come from?

People from the informal settlements have different views on the quality of life in their community. Although everyone complains about poverty and crime, some parents appreciate the limited facilities that are provided such as running water, electricity and a transport system, while others complain about the lack of libraries, parks, clinics and sport fields. They want tarred roads and an isiXhosa school. The high rate of unemployment is of great concern to all parents as is the fact that the community has more illiterate people than literate people. Township parents are of the opinion that their children are 'brighter' than children from rural areas. They also thought that children learn more valuable things in urban areas. Township parents are concerned that their children watch too much TV. They realise that part of the problem is that children are unsupervised while parents are at work. Parents expect their children to do their homework in the afternoons. While parents are at work, children do not do chores. Many children spend their afternoons at recreation centres.

Children from informal settlements spend their time in much the same way as township children. Some do chores, others play sport. When they need the library to do projects they have to travel some distance. Those who have TVs spend some time watching TV. Some parents are concerned that children spend too much time away from home in the afternoons, come home tired and do not do homework. These children spend some of their time engaging in conventional children's activities such as playing games and making wire cars. Some parents feel that their children learn fast, while others believe that their children do not learn easily. Hunger is mentioned as a possible cause for a lack of concentration. They mention the example of cooking to demonstrate how fast children learn. Parents agree that most learning occurs by copying and by explanation. Visual learning is important. An example is learning about cultural practices by observing others. Initial learning interests them, but if a task becomes too complex they lose interest. Some learners question why they have to do things.

Parents feel that although the quality of their lives has improved in terms of facilities provided by the community, community life has deteriorated. All parents were of the opinion that there was less crime and disease seven years ago, more jobs and cheaper food. Some parents are not hopeful for a better life. They see a community of older people, as the younger people will have died of AIDS. They are aware of the fact that there are fewer and fewer jobs available. They fear that this will lead to more crime. One concern is that children appear to be less interested in cultural beliefs and their language. Other parents are hopeful of a prosperous life for their children, as they believe that their children are getting a good education. Their dream for their children is a good education and a solid spiritual life. Parents would like their children to learn about a range of things at school. These range from practical things such as the environment, food gardens, building houses, fire, how to fix things, agriculture, electricity, to subjects such as microbiology and economics that may help their children to obtain jobs. Although two subjects are mentioned in terms of possible careers, those parents who suggested them see microbiology as a good subject to help someone understand diseases and economics to help someone to start a business. Some uncertainty as to what children might need in the future surfaced in the discussion. The importance of science as a tool for survival was also raised. Parents feel that children can be encouraged to stay at school by giving them financial and emotional support and stressing the importance of school. They believe that it should be instilled in children that teachers are also parents and not policemen. I was pleased to hear that parent's valued schooling. I realised that what the parents had shared during the interviews, corresponded with the knowledge I have of my learners. I was encouraged by the fact that I have such insight in the lives of my learners.

WHAT DO LEARNERS REGARD AS RELEVANT SCIENCE CURRICULUM AND HOW DO THEY RESPOND TO SUCH A CURRICULUM IN A CONVENTIONAL SETTING?

This phase is referred to as a conventional setting because the class teacher taught the lessons and the content used during this phase of the study, was taken from existing syllabi or from PSP material. Although the lesson on water purification was based on learners' everyday experiences, as was the introductory activity to the energy lesson, the topics came from the PSP material and these topics are found universally in science textbooks. The notion of relevance in this context refers to the fact that the materials were adapted to include some of the learners' everyday experiences and a learner-centred pedagogy was implemented.

Bongi and Thembi are both learners in Zanele's class. She has taught them science for two years. Their narratives will be written as two parallel stories. In each narrative the learners give a short account of the backgrounds, their home lives and their experiences in the science class. Their experiences of the lessons described in Zanele's story are related in greater detail. The class teacher, a second member of the research team and I designed the first lesson on water purification. This lesson was repeated in three classes. The second set of lessons was taught in three different classes. The data obtained from all three classes were used to construct the two narratives.

BONGI AND THEMBI'S STORIES	
Bongi's story	Thembi's story
I was born in Cape Town and I live in Khayelitsha with my parents and four brothers and sisters. We only speak isiXhosa at home. My father was retrenched from his job last year and was without a job for nine months. He recently started a new job. My mother is a domestic worker and works two days a week. Our family is poor and went through difficult times when my father was out of work. At times there was very little food in	I was born in Cape Town, but was sent to live with my grandmother in the Transkei when I was a year old. My mother is a single parent and could not look after me and my five brothers and sisters. When my grandmother died, I had to return to Khayelitsha. We only speak isiXhosa at home. My mother is a cleaner who has worked for a number of cleaning companies. My mother does not keep a job for long

the house. In spite of the fact that my father was without a job, my parents did everything in their power to keep all of us at school, as they always say that a good education is the best thing they can give us. My parents encourage me to work hard at school. They don't like it when I spend time on the streets in the afternoons. I don't understand why because I like to be with my friends after school. There are not many books at our home-only a few magazines that my mother brings home from her work. When I have to do projects at home, I go to the library in Guguletu. My parents are not able to help me with my homework as they both had very little schooling. I enjoy science lessons, because we often work in groups and do practical activities	because she drinks too much. When my mother has had too much to drink, she often forgets to cook. My mother gets very angry when she gets home and we have not done the housework. When she is angry, she often beats us. I often go to play with friends, as I do not enjoy being at home much. My mother thinks reading is a waste of time. I have to do my homework by myself. I am unable to visit the library, as I do not have bus fare. My mother is usually not at home when I get home from school. My older brother and sister should be at school but often stay at home. My mother wants them to look for work to earn money for us to live on. I love my science teacher. I enjoy being in her class although I do not always enjoy science. I enjoy sitting with my friends in a group in the science class, talking about

in science. I don't mind copying information from the chalkboard, but I don't enjoy writing down my own thoughts.	things that interest us. When I am with my friends at school, I do not have to think about what is happening at home.
The lesson on water purification was fun because each group was free to decide what method of purification to use and our teacher did not mind if we made a noise as she expected us to share our views.	I enjoyed the lesson on water purification because I have some knowledge about this and I could make suggestions to our group. I like working in a group because I often learn from my friends and if I don't understand something, nobody notices.
I enjoy doing experiments and I want to learn about new things, especially things I did not believe before.	I think learning science might help me to get a job one day. I enjoy learning about nature and other familiar things. I don't enjoy doing experiments.
I think it is important to learn about pollution because all the streams in our township are polluted. I never knew that invisible things could be so dangerous, but I know now. We learnt that a substance like Jik could be used to clean water by killing germs. Although Jik is a dangerous substance, we learnt that it is useful if you only use a little bit at a time.	I think it is important to know how to clean water, because sometimes we have to use water from the dirty river. We learnt not to put plastic and other wastes in the rivers. We also learnt how to clean water by straining it and by boiling it. I think that by boiling the water, you remove dangerous chemicals.

Our teacher encouraged us to use methods we used at home, but I don't recall using filtering and straining processes at home.	I found it strange that a substance like Jik could clean water. I always thought chemicals cause pollution.
We tried to figure out how tap water was cleaned and came to the conclusion that it most probably is done by adding chemicals.	It was easy to understand how straining works because I often help to strain the mixture when we make traditional beer.
Although I usually enjoy group work, some of our group members were lazy during this lesson and did not contribute to our activities at all.	I have heard that we should boil water when we take it from the river, but I do not understand why. Has all the water that comes out of the tap, also been boiled?
I don't usually use the science I learn at school at home, but I think I will be able to use my knowledge about Jik that cleans water, as well as my knowledge of what germs do. The lesson on animal life cycles was very interesting, because I love learning about mammals and birds. When we talked about bird life cycles, I had a lot to say as I often	What I liked about this lesson was that our teacher wrote notes on the board that we could copy. Although our teacher had written the answers of other learners, she did not mind if we copied it. This was easy and we did not have to think about our own answers. I liked the fact that I could use my knowledge about beer making in this lesson.

go hunting with my father on the Cape Flats where we often see birds' nests. Although I like to learn about things that I can contribute to, I also enjoy learning about new things like the solar system. I found the lesson on classification less interesting, although it was easy to group the pictures into animals and plants. When our teacher asked us to make smaller groups, I was stuck. Eventually my group managed to group animals into those that fly, swim, have scales and so on. Most of the animals in the pictures are familiar to me as I have seen pictures of them in books. The plants were a problem, as I had not seen such plants before. When we learnt about energy and change, we went outside to make a fire. This was great fun. We had to watch the fire burn and observe the changes that occurred. Back in the classroom we had to write all our observations on a poster. I did the	I liked learning about the human life – cycle. At first it was difficult to follow what our teacher was saying because she spoke English, but when she translated into isiXhosa, it was easier to understand her explanation. All we had to do was to cut out the pictures and place them in the correct order. I just sat watching as someone else in the group cut out the pictures. When I had a problem putting the pictures in the correct order, my friend helped me. I did not enjoy the lesson on classification much as I did not understand the pictures. Most of the plants and animals were unknown to me. When our teacher told us to look for similarities and differences I did not understand what she meant. Fortunately some of the other members in my group were able to group some of the animals. We all enjoyed going outside to make fires during the lesson on energy, but I was not

poster in our group. I knew that our teacher wanted us to observe different forms of energy, but the only one I was sure about, was heat. I was not sure if light was a form of energy.	sure what I was supposed to observe. I saw a lot of smoke, but I did not know if this was energy. Perhaps any visible change is an energy change. I did not participate when my group made their poster, because I felt I did not know enough. For me, the most important observation was the smoke from the fire – perhaps the energy from the fire is in the smoke.

CONCLUSION

The results that emerged from the various data sources were reported as three narratives - one narrative of a teacher and two narratives of learners. These narratives represent a descriptive analysis of the data obtained from the first phase of the study.

The narrative of Zanele, the teacher, gives an account of what teachers know about their learners in this particular context and describes how a teacher may use the knowledge she has of her learners in her teaching. This knowledge may enable a teacher to incorporate aspects of relevance into the lessons. The data described here contributes to the answering of the first three critical questions. The narratives of the two learners allow some insight into the background of these learners; their everyday lives and their experience of science. These accounts give some indication of learners' responses to lessons that are taken from traditional syllabi and adapted, to a greater or lesser degree, to these learners particular contexts. This data also contributes to answering the first and second critical questions. The insights that emerge from a deeper analysis of the findings reported as three narratives will allow an interpretation of how teachers contribute to relevant science lessons and how learners respond to these lessons.

CHAPTER 5

DISCUSSION – PHASE 1

INTRODUCTION

A number of themes emerged from the narrative accounts of chapter 4. These themes represent categories of knowledge that teachers have of their learners, where each category speaks to a different dimension of relevance. The data revealed issues that teachers need to engage with if they wish to understand their learners sufficiently to teach relevant science. Data from the children, from their responses to the lessons and from the interviews, were also categorised. As for the teachers, the categories from the children refer to dimensions of relevance.

TEACHERS' KNOWLEDGE AND HOW THIS KNOWLEDGE IS USED

An analysis of teachers' knowledge of their learners indicated that teachers do not only have knowledge of their learners in relation to the learning of science and their interactions in the science class, but that they have a deep understanding of the lives of their learners. This includes an understanding of their backgrounds, their social lives and their socio-economic circumstances. This knowledge enables the teachers to understand how learners' perceptions of relevance are influenced by what happens in their lives.

Learners' backgrounds and interests

Zanele describes two groups of learners, those who were born on the Cape Flats and are fully urbanised and those who have strong rural roots, having immigrated fairly recently mostly from the Transkei. The groups differ with regard to their interests, their worldviews, their attitudes to authority and their interests in their culture. They also have different views of the purposes and meaning of learning.

> Township children see learning as learning for 'fun'; rural children see learning as learning for 'survival'.

Although Zanele finds the classification of children according to their rural and township backgrounds helpful and interesting, there are differences within these groups and there are other dimensions of difference, such as abilities, personalities, learning styles and gender. This research did not seek patterns of relationship between groups of learners and their responses to relevant science. Zanele's focus on the rural/urban classification is because it characterises the community and hence adds an important dimension to diversity, over and above differences in personality, for example.

The fact that learners differ with regard to their interests makes it difficult for her to select topics that all learners find relevant.

> Township boys and girls are interested in machinery.
>
> Rural children have little knowledge of appliances or machines.

Her pedagogical approach may also be influenced by her knowledge of the different attitudes to authority.

> ...they develop more informal relationships with their parents, teachers and elders, moving away from the more formal relationship between children and adults that exists in traditional African culture.

Teachers need to recognise and respond to learner diversity and encourage participation by all learners (Freed, 2000). This brings to mind Dultz's (1999) suggestion of the use of learning profiles in which learners' learning needs, interests and inclinations are recorded by various stakeholders (learners, teachers, parents, curriculum designers etc). Zanele does not use specific techniques to keep track of the diversity of learners in her class, but she is nevertheless well informed about many aspects of her learners' lives. Zanele uses her knowledge of her learners in different ways. Her knowledge of the Transkei was helpful when learners from the rural Transkei used examples from rural areas in class discussions. Her lessons included aspects that she knew they would find interesting, such as reproduction. Her use of pictures in this lesson was based on her knowledge of the ways her learners enjoy learning. As she understood their backgrounds she could select a topic, like water purification, as she knew that many learners do not have access to clean water. The lesson on energy transformation was introduced with an activity that was familiar to all learners – that of building a fire. As learners enjoy presenting their work, she often required them to do presentations or to write on the chalkboard.

Learners' everyday knowledge

Zanele has a deep understanding of her learners and believes that it helps them if they can connect the science of the classroom to the science of the home. She is aware of the fact that her learners' social environment requires them to have practical knowledge to survive in their hostile environments. This knowledge is acquired in the home, where young children often have to fend for themselves and struggle to survive. It is also acquired on the streets where they spend much of their time.

> Boys know about plants and animals.
>
> Girls know about fetching water.
>
> They trap birds and search for birds' eggs.

When the connection between everyday knowledge and formal school knowledge is established, learners are able to take their science knowledge from school into their everyday lives. Their scientific knowledge is then transposed into the world of everyday materiality (Désautels and LaRochelle, 1998). The importance of linking their learning to everyday knowledge is that it provides learners with the science they can use in their everyday lives and enable them to build on their experiences, interests and prior knowledge (Stears, Malcolm and Kowlas 2003). Vygotsky's view that mental functioning (science learning) can only be understood by examining the social and cultural processes from which it is derived is emphasised in the work of Duschl and Hamilton (1998). It is important to understand learners' backgrounds and teachers who believe they should have in-depth knowledge of their learners make this possible. The teacher needs to find ways to introduce and explain useful and relevant ideas at appropriate times and in ways that make sense to children. Teaching and learning is closely linked to events, phenomena and language from the everyday world and teachers have to continually move between the physical phenomena and two different sets of ideas associated with them - those that children bring and the ideas of science. (Asoko, 2002).

Zanele knows that her learners have practical knowledge that she can use to extend formal science knowledge. She knows she cannot always select topics that every learner has practical knowledge of. At best she would try to select topics that most learners have knowledge of, most of the time. Three of the four lessons drew on learners' everyday knowledge. The lesson on life cycles used learners' knowledge of bird life cycles to extend their knowledge of other types of life cycles, while the lesson on water purification used learners' knowledge of straining and filtering to move into more abstract forms of purifying water, while the lesson on energy changes used knowledge of fires.

Although 'survival' learning (like the lesson on water purification, where they learnt about things that have practical value in their everyday lives) is important, she includes 'fun' learning in her lessons as well. This was evident when learners made fires to observe changes that occurred. The importance of linking the formal knowledge to the learners' everyday knowledge became apparent when Zanele taught the lesson on classification. The way in which she presented the lesson did not connect well to learners' everyday knowledge. They were not able to link most of the examples to animals and plants they were familiar with and therefore did not see the relevance of this lesson. Learners indicated in the interviews that they did not use this knowledge in their everyday lives. Zanele, however thought it was important for them to learn to classify living organisms.

Formal science knowledge

In terms of formal science knowledge, Zanele is aware of the fact that a significant number of her learners have difficulty in understanding abstract science concepts. This was evident from they way most learners clung to the idea that water can be cleaned by filtering alone. The lesson on classification also proved difficult for them as the method used to sort and group the plants and animals were based on a scientific approach rather than a practical approach. When learners were asked to observe changes that occur when a fire burns, they were more interested in changes such as smoke forming, rather than the energy changes that occur.

Zanele is aware of the fact that learners are much more interested in practical knowledge than theoretical knowledge. This was evident from their enthusiasm and levels of participation when they engaged in tasks where they could apply their practical knowledge, such as straining water and making fires. When she used learners' everyday knowledge and introduced practical activities in which all participated, she expected her learners to develop some theoretical knowledge of water purification, forms of energy, ways to sort and group and an understanding of different stages of development in different life cycles. While some learners were able to develop theoretical knowledge, others were content with their practical knowledge. This is illustrated during the practical activity on water purification where everyone used familiar equipment and used practical, familiar methods to clean water, but no one showed any desire to know what filter paper was. They were clearly more interested in the practical knowledge they could use in their everyday lives, rather than the theory behind polluted water. The test that learners wrote on the water purification, confirmed this. While some learners demonstrated theoretical knowledge, a significant number did not. Zanele was of the view that part of the learners' poor performance was due to the nature of the questions in the test.

The parents from this community value schooling and see science as having economic value in terms of job opportunities. The parents' concept of relevance relates more to the long-term value of science knowledge in terms of job opportunities and further science learning although they also value useful knowledge for everyday living. It would seem that both teachers and parents favour a science curriculum that would help learners to move from their present context to a more favourable environment, while learners find relevance in using their everyday knowledge in the classroom and using school knowledge in their home environments.

Ways of learning

The data from teachers and parents suggest that most learners prefer to learn through observation rather than by being actively involved. According to Zanele, learners do not like doing experiments and prefer the teacher to demonstrate things. The interviews with parents confirmed that learning at home occurs by observing or copying and explaining if the first two strategies don't work. This approach to learning has implications for a learner-centred approach as espoused by Curriculum 2005. Research has shown that, besides science learning outcomes, a variety of other outcomes may be achieved if a learner-centred approach is applied in the classroom. These include social and emotional outcomes as well (Daniels and Perry, 2003). Power–sharing is an important example of a strategy that may affirm learners and develop self-confidence and a sense of belonging. If however, some learners in a class are unfamiliar with a power-sharing approach and view the teacher as the ultimate source of authority, the teacher has to be aware of this and gradually ease the learner into accepting an approach where learners and teachers share power. Although Zanele uses strategies that allow power sharing she is, in this context, still the authority figure in the classroom.

By diversifying curriculum design, opportunities may be created to implement a variety of pedagogical strategies that may address different domains of relevance. By presenting the science curriculum as a series of different modules with different approaches, teachers may be able to reach out to different learners by allowing them to see relevance in a number of domains. These domains might include processes, contexts and purposes. This raises the question of the purpose of a curriculum. Which aspects of relevance should a curriculum address? Dultz (1999) is of the view that children should learn things that they desire to learn, things that are necessary to learn to survive in this world as an autonomous and fully functioning human being and those things that inspire us to be good and kind members of the human race.

Such a curriculum would include a number of domains of relevance that might help learners acquire the necessary knowledge, skills, attitudes and values that would allow them to become the type of citizens espoused in the critical outcomes of Curriculum 2005. However, when Malcolm, Kowlas and Stears (2003) ask the question, "Is the purpose of the curriculum to help children with their immediate needs in their communities or help them 'get out'?" A relevant science curriculum should not lose sight of the importance of the immediate needs of the learners, especially in the context in which this research was conducted. In spite of Zanele and the parents' observation that learners prefer to watch and learn, she included different strategies in her lessons that allowed for different ways of learning. She has an understanding of the importance of facilitating the achievement of a broader range of outcomes than science outcomes and used various strategies to meet these outcomes.

Opportunities were created for individual and group activities. Learners were expected to complete the table on soluble and insoluble substances individually, while fire building and poster drawing. Filtering and classification activities were all group activities. In the water purification lesson, learners were presented with a problem which they had to solve. They were engaged in practical activities, with a number of pieces of equipment, allowing learners to experiment freely. The active participation in this activity contradicted the opinion of Zanele and the parents that they did not enjoy this type of activity. Making the poster drew on learners' writing and drawing skills, as well as their communication skills. All members of each group participated by giving advice as to what should be written on the poster, while learners who enjoyed writing and drawing made the poster. Other group members gave advice or observed quietly. The lesson on life cycles provided opportunities for different ways of learning as well. Learners had to reach consensus when sequencing the different stages of the different life cycles. Most learners were able to arrange the different pictures in the correct sequence, preferring this practical activity to writing. All the lessons provided the opportunity for interaction between Zanele and the learners.

Some learners enjoy contributing to the discussion while others are content to sit quietly, listening to the discussions. It is difficult for Zanele to know what the individual learning style of each of the learners in her large class (50 learners) is and for that reason she tries to introduce a range of strategies that accommodate as many learning styles as possible.

Social and personal aspects of learners' lives

With regard to the social and personal aspects of learners' lives, the community in which the learners live is a fast changing community in some ways, but in other ways very little has changed. This was evident from the responses given by the parents of the learners. There is frustration that the social fabric of their community seems to be disintegrating although community services have improved. Learners do not experience this change as their parents do, but are affected by the frustration experienced by their parents and other adults. Zanele is aware that these tensions extend into the classroom and contribute to instability in the home lives of her learners.

> The children bring interests that are foreign to their parents into the home, as well as a change in behaviour that parents construe as disrespectful. This leads to increased friction, disintegration and abuse.

Knowledge of the learners' home lives and social circumstances is essential in understanding their learning. Social constructivism views the social environment of the learner as crucial for making meaning in the school context. Learners bring their experiences from their informal environment to the formal school environment. When their home life is disrupted, children look to their teachers for the care they do not receive at home. Brown (2003) in his research quoted a teacher as saying,

> I do lots of hugs - I use body language. I rarely raise my voice. I treat them with respect. I'm friendly, but not their friend.

A grandmother, an aunt or even an older sibling care for many of the learners in this context. They often lack attention, supervision, understanding and caring at home. Zanele is aware of the importance of demonstrating a caring attitude. A teacher like Zanele might be aware of the fact that she is unable to help learners who have problems at home, but allowing learners to approach her and listening to these problems, affirms learners and creates a more conducive atmosphere for learning. Knowledge of this aspect of learners' lives enables her to build it into the curriculum, making the curriculum more relevant, where relevant in this case does not refer to science content, but to relevance in terms of learners' everyday lives. Learners may experience science lessons as relevant if the personal aspects of their lives are brought into the science classroom where the teacher shows some understanding of the problems learners experience in their personal lives.

Culture

An important aspect that emerged from the study was the fact that learners regard their traditional culture as important. Although rural children might be slightly more knowledgeable about traditional cultural practices, all children are exposed to these practices and practise them to a greater or lesser degree. In this community it is therefore likely that these learners hold beliefs that conflict with science concepts taught at school. The subculture of poverty appears to have a bigger influence on learners' worldview than other forms of culture. The data presented in Zanele's account describes the levels of poverty experienced by the communities to which these learners belong. This applies to both groups of learners.

Although poor people around the world generally do not see much value in schooling as they find it irrelevant and believe that it does not guarantee a job (World Bank: voices of the poor, 2000), the parents of these children still view education as the solution to poverty. Although they see education as having practical value in the everyday lives of their learners, its most important function is to secure jobs for their children. Many of the learners however, have different views from their parents and see very little value in education, feeling alienated from school. As soon as other options materialise it becomes very difficult to keep them at school. Acknowledgement of the cultural beliefs of learners is important within a framework of social constructivism. Learning will only occur if the connection between the spontaneous conceptual domain of the home environment and the formal domain of the school is secured. This may be difficult if the learners' cultural milieu is ignored. Acknowledging learners' interests and values may also contribute to the achievement of a broader range of outcomes, including essential critical outcomes as espoused by Curriculum 2005.

The school system in general seems to pay very little attention to the traditional culture of learners in a broader context. The children in this study experience schooling through a western culture and in a sense are 'enculturised' into a western culture. More attention ought to be paid to learners' cultural heritage in general, both in the science class and in the broader school environment. If poverty is viewed as a subculture with a particular worldview, the issue of border crossing arises. Reay (2001) working with poor, working-class children in England, has strong views on the value of schooling for these children. In her view schooling does not help children to develop and 'find' themselves. Instead it requires them to 'lose' themselves as it expects them to change and embrace values that are foreign to them in order to succeed. This raises the issue of a relevant curriculum for learners. If the curriculum is designed to meet the needs of the learners, this problem might not arise. Barton (1998), working in high poverty schools, is critical of the "Science for all" reform movement. She regards it as meaningless to learners if it simply implies access to resources. The science that is taught has to be relevant to these learners in poverty environments for it to have any chance of success. Again relevance may lie in what learners' value and deem worth learning, such as day-to-day survival, engaging in activities that affirms and builds confidence rather than scientific knowledge required for further schooling.

Research on the views of African American children in high-poverty urban schools as to what they regard as the most important aspect of schooling, revealed that they placed a high premium on the teacher-student bond. Affective, nurturing teachers are regarded as important to the early learning and development of African American children. (Slaughter-Defoe and Carlson, 1996) The reason given for this in Slaughter-Defoe and Carlson's study, is the nurturing African American mother as role models for the teacher. Zanele is aware that learners may experience conflict between western culture and traditional African culture. Although she acknowledges this possible conflict she tries to manage it by identifying with the learners. She did not attempt to present science in relation to learners' cultural beliefs, nor did she discuss cultural beliefs in the science class, in any of the lessons observed. Learners need time to reconcile traditional 'beliefs' and scientific 'beliefs'. This may mean that cultural beliefs have to be discussed in the science class.

> Mich le: Do you talk about culture in the science class?
>
> Zinzi: No
>
> Mich le: Do people in your community do science?
>
> Noma: No

There appears to be some reluctance on behalf of teachers to do this, as it is often not regarded as 'science'. Those teachers who do attempt to adapt their curriculum to make it more relevant complain that they do not get sufficient support.

> What they tell us to do, we don't have the resources. And we don't have the texts that are relevant to Africa (Malcolm et al, 2003).

While Zanele may not build traditional cultural aspects into her lessons, she pays attention to the influence of poverty on the lives of her learners. She supports the parents by encouraging her learners to stay in school for as long as possible. She does this by making sure that learners experience the practical value of what they learn in science, in their everyday lives. This was evident in her lessons on water purification and life cycles. Only if this happens there might be a chance of them seeing the long-term value of schooling in terms of future job opportunities. For Zanele it is important that learners who are deprived of food, clothing, attention and caring parents, turn to her. She cherishes her nurturing role and although she is not in a position to remove them from their environment, her support helps them to view the school in a more positive light.

LINKING TEACHERS' KNOWLEDGE OF LEARNERS TO RELEVANT SCIENCE

The above categories emerged as important considerations for teachers when designing relevant science lessons. They may be viewed as various dimensions of relevance that may be incorporated into science lessons. The use of everyday knowledge in the classroom emerged as an important dimension of relevance as more learners are able to make sense of formal science concepts if they are linked to informal knowledge. The diversity of the classroom places great demands on teachers when selecting content. Incorporating everyday knowledge means she has to select content that all learners are able to respond to. However, the teacher's pedagogical approach will determine to what extent these categories are incorporated into science lessons.

A learner-centred approach would allow a teacher to incorporate various other dimensions into her lessons. This approach would address the notion of relevance in that learners are actively involved in various activities, which may accommodate various learning styles and multiple intelligences. When learners are involved in activities that require them to find answers, solve problems and work collaboratively, different dimensions of relevance are addressed. A learner-centred approach allows the teacher to include aspects such as the social and personal lives of the learners, as well as their culture. It means that teachers have to take the subculture of poverty and the worldview associated with it into consideration when planning teaching experiences as this would influence what learners regarded as relevant. By including these dimensions of relevance, learners' immediate needs may be met, as well as long-term science outcomes.

LEARNERS' RESPONSES TO VARIOUS DIMENSIONS OF RELEVANT SCIENCE

The data obtained from the learners complemented the data obtained from the teachers in that they experienced various dimensions of relevance in these lessons. Interviews revealed that certain dimensions of relevance identified by the teachers were however, not addressed in the lessons.

Everyday knowledge as a dimension of relevance

The first lesson was closely linked to learners' everyday experiences and their responses indicated that they experienced this lesson as relevant. They could use their everyday knowledge in the science classroom and acknowledged the fact that they had learnt new knowledge that was useful in their everyday lives. I wanted to see if learners were able to use their everyday knowledge in the classroom and whether they would be able to use some of their prior knowledge in their science lesson. It is, of course, much easier to observe whether they are using their everyday knowledge in the classroom than to determine whether they are able to use their newly acquired knowledge in science in their everyday lives.

There was evidence that they were using their everyday knowledge in various ways:

> Mich le: How did you decide to clean the water?
>
> Sibongile: We used the 'lap' (cloth)
>
> Mich le: Why did you use the cloth?
>
> Sibongile: We do that when we make African beer.

and

> Mich le: Some of you stirred the water with your finger while you were straining the water. Why did you do that?
>
> Thula: To make it go faster
>
> Mich le: Where did you learn to do that?
>
> Thula: When we strain (sift) flour

Two of the stage two lessons, life cycles and forms of energy, included aspects of learners' everyday lives and experiences and learners saw relevance here. The choice of examples in the life cycle lesson, provided the opportunity for learners to contribute knowledge from their everyday experiences and also included topics that learners found interesting. For instance, boys displayed remarkable knowledge of bird life cycles as they observe this in nature every day. Making a fire was relevant as learners were able to bring their own knowledge to the activity:

> The fire does work for us because it has power
>
> It cooks our food
>
> It gives heat and boils water

Conceptual understanding as a dimension of relevance

The interviews confirmed that a number of learners demonstrated some understanding of the concepts covered in the lessons:

> Mich le: What did you learn today?
>
> Thembe: We learnt that a river can be dirty
>
> Mich le: What did you learn about cleaning water?
>
> Noma: We learnt how to strain water
>
> Mich le: What did you learn about Jik today?
>
> Sitho: It cleans
>
> Mich le: What does it clean? What part of the water does it clean?
>
> Bongi: It takes away the germs

The interviews also revealed that a number of learners did not extend their understanding and still held misconceptions.

> Mich le: What did your group use to clean the water?
>
> Mondli: We boiled the water
>
> Mich le: Why did you boil the water?
>
> Zodwa: To take out the chemicals

Learners also had a problem with the concept of forms of energy and energy transfer. They seem to cling to the concepts that they do understand, such as heat energy, that they do not easily make new connections i.e. the concept that light is a form of energy.

The second set of lessons was more traditional in the sense that the topics were drawn from the PSP material, which uses conventional science topics. These lessons were relevant from a curricular point of view as the content was taken from the curriculum and was regarded as important as it provided a foundation for building science concepts and the development of skills such as sorting and grouping, as well as an understanding of biodiversity as an environmental concern. The interviews with learners revealed that a significant number found little relevance in science content outside the classroom. Their conception of science is that of a school based activity that is engaged in at certain times. All learners interviewed did not believe that science is practised in their communities. The idea that many members of the community, such as Sangomas, work in scientific ways was foreign to them. This is, most probably, the dominant view of the community. As the RNCS (2002) emphasises the fact that indigenous knowledge should be included in the curriculum, teachers may have to consider including this aspect in their teaching. This may well strengthen the link between spontaneous, unstructured knowledge and formal, structured knowledge. This would also enable learners to see the value of their classroom knowledge in their everyday lives. In the interviews with learners, many of them felt that they seldom use knowledge acquired in the science class at home, but did acknowledge that some of the lessons that preceded the interviews, did allow for this to happen.

Participation as a dimension of relevance

An important aspect of a learner-centred approach is co-operative learning and many learners see relevance in participation in classroom activities. Some learners however, are ambiguous about co-operative learning (group work). At one level they enjoy working together as this gives them the opportunity to socialise. On the other hand, some learners feel that they are disadvantaged because they end up doing all the work. There does not seem to be a strategy to ensure that all learners contribute. The implementation of established group work strategies might encourage learners to be more accountable when working together. Observations showed that the learners enjoyed engaging in practical tasks, in contrast to the teachers' statements that they did not enjoy experiments. This was also confirmed in the interviews.

> Mich le: Do you like doing practical work?
>
> Sibongile: Yes.
>
> Mich le: Why?
>
> Sitho: It is fun.

The reason may be that the practical activities observed were open-ended and there was no formal step-by step instruction. Also, the equipment used during the lessons observed, were familiar household items. They certainly enjoyed the practical activities more than writing activities. In the interviews all learners said one of the reasons they enjoy science is because of the practical activities involved.

The relevance of participation lies in the fact that when learners work together, they socialise, strengthen social groupings, support each other and in so doing, build confidence. Group work also allows for achievement of certain critical outcomes.

Culture as a dimension of relevance

Although learners were initially reluctant to talk about their culture, most probably because they had never done so before in the science class and did not think of their culture as relevant with regard to science , what emerged from the interviews was that they would like to learn more about some aspects of their culture, for example initiation. There appears to be little discussion on the meaning of various cultural practices.

'Exotic' knowledge as a dimension of relevance

Interviews with learners also revealed that a number of learners would like to learn about less common topics and therefore saw relevance in curious and exotic processes and phenomena.

> Mich le: What did you like about to-day's lesson?
>
> Lungi: To learn about germs – that it could kill us

and

> Mich le: What else would you like to learn about?
>
> Sandile :Volcanoes, the Solar System
>
> Thuli: We learn things that we did not know
>
> Noma: We learn things that we did not believe – Jik can clean water.

CONCLUSION

In this chapter the categories that emerged from the data in Zanele's story, were discussed. These categories represent the knowledge she has of her learners and how she uses that knowledge to design lessons that her learners experience as relevant. The data from the learners' stories reveal that they respond to similar dimensions of relevance as identified in Zanele's lessons. Learners respond in different degrees to different dimensions of relevance and the lessons provide the opportunity for these learners to respond to these dimensions.

Science lessons that use content from children's backgrounds and interests and builds on their knowledge and experience rather than teaching traditional science content, is dependent on sources that would provide input with regard to learners' background and interests. These sources are teachers. It is the teacher that is close enough to her learners to discover the interests of her learners as well as factors that shape the lives of the learners in her care. She is the person able to 'make a difference' in their lives with a caring and nurturing attitude (Knobloch, 2003). This fact made it possible to design lessons that were relevant to these learners. To meet the various needs of learners, requires an interpretation of relevance in a variety of ways. Learners responses provided some insight as to how different learners experience relevance. By planning and presenting the lessons in this way, the lessons were relevant to the learners, although not all dimensions of relevance were included. The lessons also included dimensions that may be more relevant to teachers and designers of Natural Science Curriculum than the learners in this particular context.

Teaching strategies allowed for processes and created contexts that allowed learners to see relevance in what they were doing. It also allowed for learners' purposes to be fulfilled. For instance, learners wanted to extend their practical knowledge. It is clear from the findings in this phase of the study that learners do respond to relevant science. However the findings show that they respond to different dimensions of relevance. Most learners respond positively to the fact that they are able to bring their everyday knowledge into the classroom. If the science class is not perceived to be a place where they are constantly confronted with unfamiliar experiences but are allowed to contribute, this may add to their perception of the class as a haven from which to escape from the hazards of their everyday lives.

Although phase 1 of the study covers learners' responses to science lessons, the content of these lessons could still be regarded as conventional as it covers topics that are taught universally in primary science classes. It also brings into question the aspect of relevance as the topics were selected either by teachers or in collaboration with teachers, myself and another researcher. It was thought to include more dimensions of relevance if learners determined what the content of the curriculum would be. This meant that learners had to be consulted as to what they would like to learn about. In consultation with the three teachers, a strategy was devised to obtain information from learners with regard to their interests. This led to phase 2 of the study where a series of lessons would be designed based on the input from learners. These lessons would create the opportunity to probe more deeply what learners experience as relevant.

Chapters 6, 7 and 8 will cover the methodology, findings and analysis of phase two of the study.

CHAPTER 6

METHODOLOGY – PHASE 2

INTRODUCTION

This chapter reports on the methods used to obtain data, as well as the methodology applied to analyse this data that enabled understanding of how learners responded to science lessons in an arranged setting. It is described as an arranged setting because data were collected during a period when I taught a series of lessons while the class teacher was present in the class. The purpose was to explore more deeply learners' interpretations of what they perceive to be relevant science by collecting data on how learners responded to the lesson series that was regarded as relevant science, as well as probe further dimensions of relevance as experienced by the learners. Phase 1 was an exploratory and interpretive phase, using knowledge from teachers to present lessons that included a number of dimensions of relevance and were taught by the teachers. Phase 2 attempts to bring various dimensions of relevance together in a lesson series. By making use of information from learners in the selection of topics, it allows the inclusion of further dimensions of relevance, the central criterion being the use of learners' everyday knowledge. Everyday knowledge provides a foundation for the construction of formal science knowledge and, in conjunction with appropriate teaching strategies, provides further dimensions of relevance - such as personal and social dimensions that learners respond to. This is made possible by the fact that learners' lives, as well as interests, are brought into the science classroom. This lesson series represents a curriculum more attuned to the needs and interests of the children and their communities, not only because they influenced the choice of topic, but also because they were allowed to influence what happened in the classroom during lessons.

This arranged setting has implications for my methodological framework as it places greater emphasis on the participation of learners. It is also in this phase where aspects of critical constructivism are brought to the fore. The arranged setting raises certain methodological issues that will be discussed. Information shall be provided on all the instruments used to obtain data during this phase of the study, justifying the choice of instruments where necessary. The approach described by Wolcott (1993) and used in phase 1, namely that of description, analysis and interpretation of data, will be applied in this phase as well.

METHODOLOGICAL FRAMEWORK

The methodological focus of this phase is participative as various levels of participation were integral to the study. Learners participated in the initial stages with regard to content. With regard to pedagogy, learner-centred strategies were implemented requiring active participation from learners. Teachers acted in an advisory position, with regard to the teaching strategies implemented and the teaching segments of the lesson series. As critical constructivism provides the framework for this phase of my research, a participatory methodology is appropriate as participation was geared to transformation as it sought to give teachers and learners a voice with regard to what was included in the curriculum. It also placed an obligation on me to take cognisance of the political and social issues in the practice of education in this particular community. By employing participatory strategies, it becomes easier to challenge deep-rooted power inequities (Gaventa and Cornwall, 2001). Problems raised by Robinson (2002) with regard to participatory research, did not have an impact on my study, as it was not a long-term participation by learners and teachers. The problem of participants withdrawing from the study did therefore not arise.

The most important shift with regard to participation occurred with my moving from a position of observing researcher, to researcher-participant. From an 'outsider' to an 'insider' position, so to speak. As the teacher in the classroom, I became part of the process, working closely with the learners. My position in the classroom as teacher and researcher raised a number of issues. It raised the need to consider my position and actions in the classroom, as well as the need to interpret what happens in the class in a broader personal, social and political context. I had to be mindful of the fact that my imposition, as well as my teaching strategies shaped the way the learners responded and learnt. This necessitated the shift from social constructivism to critical constructivism, as the focus shifted from building knowledge to critical inquiry. I had to pay careful attention to the learners' purposes, as well as issues such as freedom, authority and social responsibility (Jofili, Geraldo and Watts, 1999).

Where social constructivism is concerned with the way learners make meaning in social contexts, critical constructivism has two assumptions about learning – one is a critical assumption that the fundamental goal of learning is to continuously transform existing knowledge and practice to emancipatory ends. The second is a constructivist assumption that knowledge is actively built by the learner (Wang and Odell, 2002). The emancipatory aspect of phase 2 lay in the fact that learners determined which type of knowledge they engaged with and the fact that this knowledge had immediate value in their day-to-day lives. Kincheloe's (1991) view of critical constructivism is that it is concerned with what learning experiences mean to learners. Learners should build their own knowledge from the interaction between their everyday experiences and the science knowledge of the school. This aspect was very strong in this lesson series, with the result that learners' self-esteem increased as they took ownership of knowledge. This knowledge was not restricted to science concepts, but included practical knowledge for daily living and knowledge of the community. In this setting learners were challenged to participate in a different mode, as my pedagogy was different to the teachers'. An element of social transformation was present in the lessons as learners engaged with content that was socially relevant. The issue of power was raised, as the learners were able to choose the topics that were to be taught. In this way I believe learners felt that their voices were valued. Learners were in a position to decide, to a certain degree, which knowledge was useful to them, strengthening the participative aspect of the study. The informal knowledge may help learners to make meaning of more structured formal knowledge described in the curriculum. On the other hand, the informal everyday knowledge of these learners may be more important to them and more helpful in their everyday lives.

By balancing these power relations I could determine what 'voice' was mirrored in my research. As a participant-researcher, I was under an obligation to ensure that the other participants' 'voices' emerged strongly, rather than only my voice as a researcher (Gitlin and Russel, 1994). The narratives produced of a teacher and two learners strengthens the 'voice' of the participants. A strong emergence of participant voices, adds to the authenticity of the study. The voices of the teachers and learners that have been silent in the past were heard in their experiences as well as their input into the science curriculum.

SETTING

The three teachers and their classes, who participated in the first phase of the study, also participated in this phase. This data were collected a year later when the learners were in grade 6. As the evaluation of the PSP was still in progress, access to these schools and the classes could still be gained through the PSP. All three classes participated in the initial stages of data collection, but the complete lesson series was only taught in one class. The exact participation of each class shall be reported at each stage of data collection.

RESEARCH DESIGN

As in phase 1, the data were collected primarily in classrooms and a variety of research instruments were used. In phase 2 data collection was centred on the lesson series, using input from the learners who had provided information. As an instrument the lesson series had to provide opportunities to probe relevance. While learners provided input with regard to the content, the teacher and I brought opportunities for different ways of learning to the design of the lessons. Although the lessons were presented as work sheets, coherence was maintained by using curriculum as story in the design. The lessons were designed to be relevant and were conceptualised as relevant science curriculum, but the series was also an instrument as it enabled me to probe relevance more deeply than I had done in phase 1. The lesson series was piloted to determine whether the activities were suitable for learners at this level and to see how long it took to teach. Some revisions were made before it was implemented. The lesson series formed the central focus of data collection. As the lessons were taught, data were collected in various ways. All the steps involving the collection of data in phase 2 were participative. Most of the data were collected by me, although other members of the research team were also involved. I shall declare this at each appropriate stage.

RESEARCH INSTRUMENTS

The following instruments were used.

- Classroom discussion in all three classes.
- Activity by learners in all classes.
- Design of the lesson series.
- Pilot study.

Observation of the lessons in one of the classes and part of the series in the other two classes.

- Focus-group interviews with learners.
- Assessment tasks and tests in one class.
- Interview with the teacher who was present while the complete series was taught.

(TABLE 2; p159)

Classroom Discussion

- The three classes were visited with an isiXhosa-speaking researcher. The learners were asked to discuss any topic they would like to know more about. Learners were encouraged to speak in isiXhosa if they wished. The topics were translated and recorded in writing. The purpose of this activity was to identify topics that could be used in the design of the lessons, the assumption being that learners would identify topics they were either interested in, what they regarded as 'useful' or what was essentially part of their personal lives. This would enable them to bring their interests and lives into the classroom. As a participative inquiry it was necessary to elicit this information from the learners. As the learners' meaning of relevance needed to be probed more deeply than in phase 1, this approach was essential. Within a critical constructivist framework, there was an obligation to give the learners a voice and to allow them to take more control of their learning.

A number of topics were suggested. Learners' responses were discussed with the teachers. The following topics are examples of what the children mentioned.

- Volcanoes.
- Solar system.
- African culture (for example, initiation practices).
- The importance of plants.
- Plant names.
- How to make safe medicines using plants.
- Animal reproduction.

- How to make cars.
- How to fix and repair damaged goods.
- Cooking.
- Fire.

A specific topic was chosen based on discussions with teachers.

Learner Activity

On a subsequent visit to the three schools, learners were asked to tell stories about their experiences related to the chosen topic. They could speak in isiXhosa or English, whichever they preferred. No restriction was placed on the learners with regard to what they wished to talk about. If they wished to talk about things unrelated to science, they were allowed to do so. The stories were audio taped.

The list of topics included topics that did not appear to be deeply personal, but the interesting thing was that every learner's list included fire. Various aspects of fire were mentioned, examples of which are listed below. Most of the questions about fire related to the social and cultural aspects of their lives, rather than fire as a natural or scientific phenomenon. For instance, the effect of fire on their lives as a result of social conditions emerged from most accounts. They were concerned about the fact that the effect of fire on their lives was due to human behaviour and not a natural event. Nevertheless, although humans were mostly responsible for the effects of fire on their lives, they had very little control over fire in their lives (for example, of homes burning down, whether their own or those belonging to friends and family). They have practical knowledge of how most fires start and most know how to put out fires. The range of topics showed us that learners had practical interests, as well as interests in more exotic topics. As fire was such a strong influence in their lives, I decided to select fire as the theme for the lesson series.

Children were asking questions such as,

- What causes people to die without burning?
- How do fires burn people?
- How does uvutha cause fires?
- Is the sun a fire?
- How does a bomb produce fire?
- What makes a volcano?
- Why does an electric fault cause a fire?
- How do we make a fire by rubbing stones or sticks together?
- Why do people allow children to play with fire (matches)?
- Why do people watch when there is a fire and not help?
- What can you do to stop a shack from burning?
- How does a fire extinguisher stop a fire?
- Why does a fire change colour?
- What is the purpose of fire?
- Is fire important?
- Where does fire come from?

The teachers were asked to allow the learners to write about fire. They could either write stories about fire or write about experiences with fire. When the classes were visited to collect the written stories, learners were asked to talk about fire. These accounts were audio taped. Most learners' spoke about what they had written, but some learners had different stories to tell. Most of the accounts were written and spoken in isiXhosa and were translated by an isiXhosa-speaking researcher. This activity produced one hundred and thirty stories about fire. These stories provided the basis for the content included in the lessons. In this way I ensured that the learners found the topic interesting and had practical, everyday knowledge of the topic. As the purpose was to design a relevant science module, this strategy enabled it. From a critical constructivist view this strategy is justified as it allowed learners to take ownership of their learning as they could make choices regarding the curriculum. This approach also provided the opportunity to address political and social issues in this particular context as the learners chose a topic that was socially relevant.

Lesson Series

The science lesson series was an instrument for data collection as it produced a large amount of data and allowed learners to explore different dimensions of relevance. The following data were produced while the lessons were taught.

- A video taped account of the lessons.
- Three questionnaires completed by the learners and their families.
- Work sheets produced by the learners.

Design of the lesson series

The lesson series was designed within the framework of social constructivism. Many of the activities started with the everyday knowledge of the learners and attempted to extend their knowledge from there into the more formal conceptual domain. This is important from a social constructivist perspective as learners constructed knowledge and made meaning from the social world in which they operated. The knowledge they brought from that world provided a foundation to build a framework for more formal knowledge constructs. Interaction between learners in many activities allowed for the possibility of learning from more capable peers. The information collected from the learners' stories and written work was used as a basis to design a series of science lessons. The theme for the series was 'Fire'. The intention was that the lessons would include various dimensions that learners might experience as relevant. All learners had identified fire as a topic that interested them. Although they all had experience of fire there were many aspects they did not understand and wished to know more about. A lesson series on fire could also be designed in such a way that it covered concepts included in the theme 'Energy and Change'. Energy and Change is included in the RNCS (2002) as one of the themes of the Natural Science Learning Area. It was therefore relevant in terms of the possible outcomes that could be achieved in terms of concepts, as well as the development of process skills. As the topic related to the community to which the learners belonged, the aspect of science and society could also be addressed.

The theme of the lessons allowed for the personal circumstances of learners (abuse, alcoholism, disease and death) to be incorporated into this lesson series as well. Learners were able to use their everyday knowledge and bring their personal lives into the classroom. From a critical constructivist view, this was important as it allowed for learners' voices to be heard and addressed social issues as well.

The lessons were learner-centred, not only because they focussed on learning styles, but also on the interests and needs of learners. By allowing the learners to select a theme, personal and social issues of these learners could be included in the curriculum to a much greater extent than in phase 1 of the study. Different teaching strategies allowed for the development of a range of outcomes and accommodation to different learning styles. Learners could express understanding in various ways. As a learner-centred module learners made meaning in different ways. The different strategies included investigations, experiments, drawing pictures and bar graphs, writing, oral accounts and completing diagrams. The range of activities involved thinking, doing, feeling and creating. Aspects of 'divergence' were present where individual thinking and doing occurred, as well as 'convergence' where groups collectively produced ideas (Malcolm, Kowlas, Stears and Gopal, 2004). The design of the lessons were based on conceptions of curriculum as story. The use of plot in the story provides for coherence and development. The story provided the underlying structure for the lessons and centred on a story of three children from the Cape Flats and their experiences with fire. The story's context is a social setting, linked to learners' personal experiences. As the children's experiences with fire were followed through the story, learners were able to identify with them.

The lessons were divided into three sections. These were,

- Veldt fires.
- Fire in our townships.
- Fire and people.

Work sheets were designed around activities. Seven work sheets were included in the series. At the end of the first day, learners were given a questionnaire to take home. Three groups of learners from each class were given three different questionnaires.

They were asked to complete these questionnaires with their families or anyone who shared their home with them. Questionnaire 1 contained questions with regard to the type of material their homes were made of, as well as the safety aspects of their homes. Questionnaire 2 contained questions relating to people's knowledge of what to do when people are hurt in a fire. Questionnaire 3 contained questions relating to people's knowledge of how to extinguish fires, as well as their understanding of how these methods work.

The purpose of the questionnaires was to probe learners' and their families' understanding of fire in their everyday lives. This information could be used to build on my knowledge of learners' everyday knowledge as I engaged with them during teaching.

Work sheet 1 - Veldt fires. This work sheet dealt with the causes of fire. Activities in this work sheet were telling a story about the different causes of fire and drawing pictures of what they remember best from the story. These activities gave insight into the aspects of fire that were most important to different learners and what was most relevant to them with regard to fire.

Work sheet 2 - Fire in our township. This work sheet covered the concept of flammability. Activities in this work sheet was the predict-explore-confirm activity. Learners were given six different materials and asked to predict which ones would not burn easily and use them for the design of their house. They then designed a house, using materials that would not burn easily. They tested their hypotheses by burning the materials. This activity probed responses to relevance with regard to everyday knowledge. It also allowed for divergence as learners voiced their own ideas, but in the design of the house a convergence of ideas was required.

Work sheet 3- This work sheet covered the concept of energy transformation. Learners engaged in activities such as finding out if fire has energy, which forms of energy are observed when a fire burns, how we use fire in our homes and what are sources of energy. Learners were required to answer questions in pairs. This activity tried to probe how learners related to formal science concepts and how they were able to link these constructs to their everyday understanding of fire.

Work sheet 4- In this work sheet the causes of fires in homes were discussed, as well as the ways of putting out fires. This was linked to the scientific concepts with regard to fire, for instance what is required to make a fire burn. Activities were listing causes of fires from experience, writing stories about fires in homes, identifying methods of putting out fires and identifying air as an essential element in the burning process. Various activities such as individual writing, group discussion, a practical investigation and consensus activities, were engaged in.

The purpose of this activity was to determine if these learners had any scientific explanation for the phenomena they experience all the time and if they were interested in the scientific explanations for these phenomena.

Work sheet 5 - Fire and people. In this work sheet learners engaged in discussions about what people use to put out fires. The idea that all these methods have the same function was stressed. The purpose was similar to that of the activity described in work sheet four. Learners produced a bar graph to present information. The purpose was to determine whether learners could present information in different ways.

Work sheet 6- This work sheet dealt with the effects of fire on people. The strategies employed involved the jigsaw activity, as well as a drawing activity to illustrate the pathway air takes into the body. This activity was linked to the role of smoke. As this activity depended on learners working together, the notion of learning from each other was the main purpose of the activity, as well as introducing learners to new concepts.

Work sheet 7- In this work sheet learners engaged in two activities. In one activity they were required to write about the positive, negative and interesting things about fire. In the second activity the beginning of a story was read to them and they were required to write what they thought the outcome of the story would be by finishing the story. The purpose here was to determine what knowledge learners' value and therefore what they see as relevant knowledge.

Pilot study

The pilot study was limited in that it only concerned the lesson series. It was not designed to test any of the other instruments that were used during phase 2. The pilot study was conducted in a Grade 6 class at a primary school in a township outside Durban. The learners in this school are all isiZulu speaking, although the medium of instruction is English. As these learners belong to a different culture and live in a different community, the purpose of the pilot was not to find out how learners respond to the science lessons as these lessons were designed for learners in a different context who may have different purposes as well. The purpose of the pilot was to find out how much time was required to teach the module as well as to determine how appropriate the learner activities were. It was also necessary to find out how learners would respond to a teacher who did not speak their language and how the class teacher could assist with translation during lessons. The lessons were designed to be taught over a period of 12 hours. The pilot study showed that this was possible. It also showed that it worked best if taught over four three-hour periods. After conducting the pilot study, minor revisions of the lessons were made.

Teaching the lessons

In the approach taken when teaching the lessons, it was necessary to be mindful of critical constructivism as the framework within which this research was conducted. The importance of basing the content on practical, everyday knowledge that all learners had, as well as implementing learner-centred strategies, meant that learners could and did take ownership of knowledge. In this respect the knowledge had an emancipatory purpose as it increased learners' self esteem and respected their dignity. This approach gave the science lessons social relevance.

One class was selected in which to teach the complete series of lessons. I taught the complete series to this class, strengthening the participative aspect of the research, as I became the teacher in the classroom. Learners from the other two classes participated by contributing stories, but were taught the introductory lesson by their respective class teachers. As I was conducting this research in Cape Town, it was not possible for me to teach the lessons series to all three classes. I believe that this was also unnecessary, as I concentrated on building a relationship with one class and I believe this more important than trying to establish relationships with three classes that may be less close than the one class.

The class to which the complete series was taught, was videotaped. Learners were videotaped interacting with each other, listening to the teacher (researcher), following instructions and responding to questions. The lessons were taught over four days. The long sessions provided valuable flexibility in managing the activities and developing knowledge and skills. At times the whole class was videotaped, but most of the time the focus was on small groups of learners. The videotape was an essential instrument in this context (while teaching the learners). This involvement enabled me to experience the process from the 'inside', while observations from the 'outside' were also important. The videotape enabled a less-pressured observation of the process. Researchers observed each of the other classes. They were given guidelines as to what they should focus on in their observations. They recorded their observations in detail. In this way, data of classroom interaction and learners' views were supplemented.

Assessment

As it was necessary to find out if and how learners responded to relevant science, it was necessary to assess learners. As outcomes were used as indicators of relevance it was important to assess whether a range of outcomes were achieved. These included science outcomes, such as science knowledge and process skills, critical outcomes, as described in the RNCS (2002), as well as personal outcomes. It also included individual as well as group outcomes. Assessing learners' responses to relevant science meant that an important focus of assessment was how learners' linked the science of the classroom to their everyday lives and whether they engaged science deeply.

Assessment strategies were mindful of the frameworks used in this study. This meant taking into account how knowledge is constructed from a social constructivist perspective. This was possible because the activities included in the lessons, were based on a learner-centred approach, an approach that fits the theory of social constructivism. The participative framework required the inclusion of participative tasks in the assessment, as well as the teacher's view of which assessment methods should be used. It also attempted to allow learners to shape how and what should be assessed.

Various approaches were used to assess learners. As the context was important, it was important to assess classroom activities to assess a broader range of outcomes. Classroom observations allowed assessment of how learners engaged with the topic, how they engaged each other and how they used everyday knowledge. The work sheets were designed in such a way that learners could draw and write on them, sometimes writing creatively, at other times answering questions. Learners could present information in different ways. The work sheets were analysed to determine the degree of practical knowledge and theoretical knowledge demonstrated by learners, while drawings and stories were analysed to see what knowledge learners valued. Videos enabled assessment of the degree to which learners engaged each other during class activities.

The decision was taken to include written tests as a form of assessment as well. Written tests are accepted as important tools for assessing science knowledge. The tests provided the opportunity to assess learners' understanding of science concepts, as well as a number of process skills. These skills included the ability to apply the science learnt in the classroom to their everyday lives, interpreting information and analysing given situations. The tests complemented the assessment tasks and observations, but they were limited in that they could only assess certain aspects.

Although the intention was to use one test to assess the knowledge and skills mentioned above, in the end three tests were used. The first test included a number of questions, including multiple-choice questions and questions based on drawings. In one question, learners had the option to either write or draw a response. There were indications that language was a problem in the first test. Learners were given a second test in which an attempt was made to eliminate, as far as possible, incorrect responses due to an inability to understand the questions. This test consisted of three questions. They were similar to the questions in test 1, but this time care was taken to phrase questions in such a way that learners did not misinterpret them. Two of the three questions were multiple-choice questions and one was based on a given drawing.

A decision was taken to administer a third test. Although the questions still required learners to apply knowledge, the questions were phrased in such a way that learners' thinking was guided by a number of steps. This assessment included a range of questions, with most questions accompanied by a diagram for clarification. This test was administered six weeks after the second test, as I only decided to set a third test after the second test had been analysed.

TABLE 2 CRITICAL QUESTIONS, RESEARCH INSTRUMENTS AND DATA –PHASE 2

Critical question	Instrument	Data
How do learners respond to relevant science in an arranged setting?	1.Class discussion	1.1.List of interesting topics 1.2.Written and Audio-taped stories
	2.Lesson series	2. Work sheets
	3.Classroom observation	3.Video-tapes of classroom events
	4.Focus-group interviews with learners	4. Written accounts and four audio taped accounts
	5. Interview with class teacher	5.Written account

Interviews

Learners

At the end of each day a group of five learners were interviewed. On day one and two the same group of learners were interviewed, while on day three and four a second group of learners were interviewed. These were focus-group interviews as learners discussed the questions amongst themselves. The questions were open-ended to allow learners to respond in different ways. One group of learners from each of the other classes were also interviewed in the same way by each researcher who observed the learners while the teacher taught the introductory lessons of the series.

Learner interviews are a very important aspect of this study. As a research instrument its purpose was to provide data, but as some of the data provide evidence about outcomes achieved, it was also a way of assessing learners. The interviews therefore complemented the classroom observations, work sheets and pen and paper tests to assess outcomes. Careful questioning brought information to the fore that allowed an interpretation of responses. The purpose was to find out what learning had occurred by questioning learners about what they had learnt from the experience. At the same time, what they regarded as relevant in the lessons and how it helped them to learn science, was inferred. In this way the interview produced data about learners' science learning as well as learners' conceptions of relevance.

Teachers

After the lesson series was taught the class teacher, who was involved in the process, was interviewed. The purpose of this interview was to gain some understanding of the teacher's view of the way in which the learners responded to the module. The focus here was specifically learners' responses with regard to science knowledge and skills and their engagement in science activities. As the teacher has a good understanding of these learners, it was felt that she was best able to determine the level of involvement by the learners, as well as their science knowledge. She was also able to determine to what extent learners could make connections between their everyday experiences and the theoretical knowledge of the classroom. This interview contributed to the assessment of learners as well.

METHODOLOGICAL ISSUES

Data collection

As with phase 1, the research team assisted with the data collection and provided input with regard to the design of the lessons. The data collected were,

- Observation of the introductory lessons of the series in two classes.
- Two focus-group interviews of learners by fieldworkers.
- Interview with the class teacher.

As with phase 1, collecting data with a team brought different perspectives to the study.

Language

The fact that the class teacher spoke the same language as the learners was very important as it allowed for a more intimate relationship between learners and teacher. Although the policy at the moment is that English should be the medium of instruction from Grade 4, code switching is allowed. The teacher should be careful not to alienate learners by insisting that they only use the language of instruction. The class teachers in this context allow their learners to speak freely in their mother tongue as the use of their mother tongue was less inhibiting than when they are forced to use a second language. When learners are allowed to speak and write in their mother tongue, they reveal much more of their interest in and understanding of science.

The fact that I did not speak the same language as the learners and teachers was an issue. It limited interaction with parents of the learners and the learners themselves. Because of this I often relied on the teachers to translate learners' responses from isiXhosa to English or my responses from English to isiXhosa to enable the learners to understand me. Language issues also emerged from the interviews conducted with learners as some learners did not understand English very well or if they understood they had difficulty in responding in English. Learners who were more competent in English acted as translators for other learners. One aspect of the study required learners to talk and write about certain topics. Many learners spoke and wrote in isiXhosa and to enable access to be gained to this information, an isiXhosa-speaking translator was employed to translate the texts.

When it was obvious that learners did not understand the questions or statements on the work sheets and tests, the class teacher translated for them. Nevertheless, when the test was marked, it became obvious that there was a problem with regard to language. Learners misunderstood the use of certain phrases. This was the reason three tests were eventually administered, as it was necessary to ensure that misinterpretation of the questions was not due to a misinterpretation of the language. This however remained a problem, as the influence of language in the results obtained cannot be totally eliminated. It is also difficult to determine how my lack of knowledge of the learners' mother tongue may have influenced the learners' reaction to me in the classroom as their teacher.

Power and Participation

The participatory element of my methodology brings the issue of power relations to the fore. One aspect that was relevant to the study was the issue of 'researching down' (Lather, 2001). The participants of the study may be regarded as 'marginalised' because of their socio-economic position. Was I the 'outsider', intruding into their lives; gaining information that would ultimately benefit me, or did they see me as someone who could make the broader education community aware of the issues facing members of this community? Did my position as outsider benefit me in that it was easier for learners to share certain ideas with me, rather than their teacher? (Foster, 1994). The fact that I became a participant in the process, blurred the boundary between researcher and researched to an extent, bringing me closer to an 'insider' position.

The participatory nature of the research was a means of closing the gap between myself, the teacher and learners. Participation occurred in varying degrees and at various levels. The class teacher was a participant in that she gave advice and was present during the teaching of the module, providing input where necessary. However, the class teacher was often reluctant to voice her reservations about planned activities and would only comment after the fact. Nevertheless, I believe that I managed to reduce the perception that I was in a position of power by building a relationship with the teacher over a period of time and by socialising with her. I also made it clear to what extent I relied on her support in the classroom, especially when issues of language came up. The class teacher was in a position to advise on how much time per day could be allocated to teaching the lessons, as well as when the best time would be to teach the lessons. When learners were engaged in group work, the decision was left to the group as to who would be responsible for certain tasks; they determined pace as they were given the time required to complete tasks. Learners and the class teacher determined how and when switching to isiXhosa would occur and learners made the decision which language they would speak. However, as I tried to link these lessons to the outcomes of the Natural Science Learning Area, certain decisions were made about what would be studied within the context of the chosen topic.

Learners participated by contributing knowledge of their environment that enabled design of the range of science lessons. While all learners participated with regard to content for the lessons, the degree of participation during the lessons varied, with learners contributing in varying degrees. I became the participant when I became the teacher in the classroom, influencing the agenda in greater detail. With regard to knowledge, it clarified the fact that knowledge was distributed. I had knowledge of science, learners had knowledge of their community and themselves. I had the power to help learners, while they had the power to withhold information if they were so inclined. The type of knowledge produced, such as issues that affect the participants' lives, raised consciousness and had a liberating effect.

My relationship with the learners also underwent changes over time. The fact that they used my first name, removed me from the category of 'teacher' to a certain extent. The informal way in which the interviews were conducted also helped them to see me more as an interested adult, rather than a teacher. Trust was engendered in the learners by allowing them to question me about my personal life and about certain things they wanted to know the answers to. The teachers were aware of my link with the PSP. This created the possibility that they could perceive me as an agent of the PSP, evaluating their teaching every time I entered their classrooms. The learners, similarly, saw me as a 'teacher' and initially behaved towards me as if I were a new teacher.

Tension in purpose of the lesson series

It is necessary to explain for what purpose the lessons series was used in this research. Firstly, the lessons were designed to include various dimensions of relevance identified in phase 1. There were many different dimensions of relevance present in the lessons and different learners responded differently to different dimensions. This created a range of variables within the lessons that cannot and should not be separated. The dimensions that the module clearly emphasised are content, processes and purpose. It aimed to connect the formal theoretical knowledge of the school to the everyday, practical knowledge of the learners. It allowed learners to indicate what was worth learning. All these dimensions are woven into the fabric of the lesson structures.

The intention was that the lesson series would combine a number of dimensions of relevance, more than the lessons in phase 1. Although the lessons are defined as relevant science lessons, it is not the intention to evaluate the lesson series in its effectiveness as relevant science lessons, simply to provide learners with opportunities to experience science in different ways and to allow them to respond to these dimensions of relevance. From this perspective, the lessons series is an instrument as it allows me to obtain data. The data revealed what learners regarded as important in these lessons. A decision about what was relevant was not imposed, but learners were allowed to tell what they enjoyed most from the lesson enabling identification of those aspects, which they responded well to. The module does not allow a definition of relevant science. Instead, it provides a basis from which to explore further dimensions of relevance.

CONCLUSION

In this chapter, the critical elements of this phase of the study were fore grounded and reasons given why a critical constructivist perspective was necessary to frame this phase. The reason why the participatory approach was essential, was also explained. A detailed account of the research instruments used to obtain the data required for this phase of the study, explaining how and where each instrument was used, was given. The purpose of the lesson series as the main focus of this phase was discussed. The various issues related to the methodology during this phase of data collection, was discussed in an effort to clarify my position with regard to each of the issues. The data obtained in this phase should enable the answering my third research question.

In chapter 7 the findings that emerged from the data recorded in this phase will be recorded as narrative accounts of a teacher and learners. The teacher's narrative is a composite of the data that emerged from an interview with the class teacher. This narrative will describe the teacher's views of how learners responded to the lesson series. The learners' narratives are composites of all the data obtained of learners through observations, class work and interviews. These narratives give an account of two learners who respond to different dimensions of relevance in the lessons.

CHAPTER 7

DESCRIPTIVE ANALYSIS – PHASE 2

INTRODUCTION

The approach followed in this chapter is similar to that followed in chapter 4, namely the application of Polkinghorne's (1995) narrative analysis. The teacher, Zanele, narrative is the account of one teacher, while the learners' accounts are composites of a number of learners. This chapter gives an account of Zanele's interpretation of her learners' responses to the science lessons taught in the arranged setting. It also gives an account of the two 'factitious' learners, Bongi and Thembi, who respond to the lessons in this arranged setting in different ways. The setting was different to the setting described in phase 1 of the study, as I became the teacher in this setting, bringing with me a possible range of different teaching strategies. My role as teacher, the teacher's role as support in the class, the different strategies implemented contributed to the context, being different enough to define it as an arranged setting.

The narratives describe the way in which the learners responded to various dimensions of relevance. Learners responded well if the content covered was related to their everyday experiences. Their knowledge was extended when learners used their experiences to construct formal science knowledge. However, learners responded to more than relevant content, they responded positively to a wide range of learning activities and to the fact that they had more power to influence the agenda than in conventional lessons. Added dimensions of relevance are the context in which the content is used, as well as the purposes of learners – what they regard as worth learning about and the reasons they have for engaging in the lessons they way they do.

I have chosen to report part of the findings of phase 2 as the teacher, Zanele's narrative for various reasons. Although the teacher's narrative of phase 1 is a composite of three teachers, this narrative represents the responses of one teacher. The narrative was constructed on the basis of experience of the teacher's actions, both in and outside the classroom. Data obtained from the video, as well as the interview and conversations with the teacher were used to construct the narrative. I chose to report it as a narrative as I believed this would provide consistency in the format of the methodology. A similar format to phase 1 would provide a link between the two phases. As the learners responses were recorded as a narrative this provided coherence within the chapter as well. Presenting the data as a narrative, also made it possible to present the teacher's own feelings, as well as her observation of her learners as a coherent unit. Data obtained from assessment of learners, are presented as narratives of Zanele, the teacher and Bongi and Thembi, the learners. The data were obtained from work sheets, videotape, learner interviews and pen and paper tests.

ZANELE'S ACCOUNT

When my learners moved up to grade 6, I continued as their science teacher. During the course of the year the researchers, with whom I worked the previous year, approached me. They wanted to know what I thought of an approach to science teaching where learners and teachers contributed to the design of the curriculum. Instead of using the traditional science topics found in most school textbooks and trying to give it some local relevance, the approach would be to use content determined mainly by the learners to design science lessons. This would create the opportunity for learners to bring their practical knowledge into the science classroom. I was excited by the idea and agreed to participate in the project. Although I knew my learners very well and knew what they were interested in I believed that, if they had the opportunity to choose a topic, the level of interest would increase. It was therefore important to obtain information from learners about topics they wanted to discuss in the science class.

When Michèle and another member of the research team arrived to find out what they were interested in and what more they wished to know, I facilitated the process. In this way fire was identified as the most suitable topic as it appeared on every learner's list. I was not surprised at the choice. Although some learners have an interest in learning about strange and exotic things, most learners have an interest in those things that connect to their everyday lives and experiences. Learners have knowledge of fire as they experience it on a regular basis. Everyone has had direct experience of homes burning down in their community and some of my learners have lost family members this way.

Once the topic was identified, I was asked to allow my learners to write about fire. I told them to write about anything they wished, as long as it was related to the topic. When the researchers came to collect the stories the children were asked to talk about fire. Some learners spoke of what they had written, while others told new stories. Although many stories contained similar content, I could see there was much information around which to build science lessons. Although science lessons are usually about an hour long, I was asked whether I could arrange to have the class for longer periods over a number of days. The longer sessions would provide the opportunity to complete activities in one session and to observe learners as they worked together, communicated with each other and completed tasks. The longer sessions also allowed for individual activities to be drawn together into group responses. I understood the reasoning and agreed to make the arrangement. In working together over a longer period of time we also felt that this would allow for bonding in groups, strengthening ties and providing opportunities for affirmation. We believed that longer periods would allow us to build the above dimensions of relevance more effectively into the lessons.

Michèle taught the lessons, while I was present in the class. I wanted to observe how my learners engaged with the material covered in the lessons, as well as how they reacted to the various teaching strategies they were exposed to. I was also able to translate from English to isiXhosa when learners did not understand. I was surprised to see how reserved my learners were initially, as they knew Michèle and had worked with her before. I thought the reason might be that they were intimidated by the fact that the lessons were video taped.

On the first day, the concept of flammability was covered. Most learners made the connection that veldt fires are more likely to occur in summer than winter. On what causes fires, some interesting answers emerged. One aspect was the fact that most learners believe that people cause fires and that this is mostly due to negligent adults who are either drunk or not teaching or supervising young children properly. When a story was read about 'uvutha' (magic/ witchcraft) as a cause of fire, all listened intently, although only a few learners indicated that they have knowledge of this phenomenon. These learners say that they believe that 'uvutha' starts fires. By this they mean that fires that appear to start spontaneously are caused by magic. I thought that children from rural areas were particularly interested as they claim to have observed this phenomenon. I understand what they are talking about as I have seen it myself. I have seen chairs and computers catch fire spontaneously, but cannot explain it. I believe though that there must be some 'scientific' explanation for it. I was pleased that this discussion was included in the lessons, although I do not usually discuss this kind of thing in class. I know this is part of the learners' lives and culture, but when you use materials from textbooks or other sources, these topics are not covered. I agreed that inclusion of the idea of 'uvutha' in the module would help learners to understand that different ways of understanding phenomena are accepted in the science class and that they should feel free to talk about their different understandings in class. The fear of fire seems to run so deep that fires started through 'uvutha' does not appear to be more frightening than any other fire. When learners were asked to draw a picture of any scene from the stories they had heard just before, many of them drew a scene from the stories about 'uvutha'. Most of the drawings were of people sleeping in a room where a fire started. The fear of a fire breaking out in a house while the occupants are asleep seems to be deeply entrenched.

Learners started by writing enthusiastically on the work sheets, but many did not keep this up. I was not surprised, as I know that they do not often write in English, unless they copy it from the chalkboard. Instead, most devoted their time to drawing scenes from the story in the work sheet. The above activities attempted to explain the fact that certain conditions are conducive to starting fires, as well as the fact that we require something to ignite the fire. Learners discussed in their groups what would burn easily. The skill of prediction was developed here and learners showed competence in this skill. They have knowledge of different materials and which ones burn easily. This made it possible to make correct predictions. Their everyday knowledge was used to advantage here. The activity, in which they were required to design a house of materials that would burn easily, was attempted with great enthusiasm. The results of the predicting activity were discussed on day two. At this point learners interacted freely with Michèle. On day two, more learners also participated more freely in groups. They seem to understand the idea of prediction. Most were confident that their predictions were correct (they were!). When learners were required to rank houses from photographs on the grounds of their flammability, they were able to do so as they could apply knowledge gained in the previous activity. I was proud to see how well the learners participated. Even some learners, who seldom participate in class, were participating. One of the learners, who usually participates well in class, had recently experienced severe trauma at home and had been withdrawn lately. I was pleased to see that even she participated more than she had before.

At this point the work sheets started to focus on the scientific concepts related to fire. Learners were becoming much more confidant to answer and interact. The question: 'Does a fire have energy?' evoked different responses. Some said yes, some said no. One learner who said yes, because it has heat. This shows some understanding of heat as a form of energy. I was confident that learners would be able to do the activities in this work sheet as they had been introduced to the concept of energy in grade 5.

I was disappointed, however, to hear that some learners still lacked understanding of the concepts. I thought all learners would know that heat and light are forms of energy, but some learners still did not understand that light was a form of energy. Many learners responded to questions related to these forms of energy. Movement energy in this context and chemical energy were foreign to them. It took some time for learners to connect what were discussed with regard to different types of energy and to the energy they use in their homes. Most learners were attentive when a concept was explained. There seemed to be a high level of interest in this discussion. This was most probably due to the fact that they were able to draw heavily on their everyday experiences. The fact that learners were able to distinguish between different types of energy, indicates knowledge gained through everyday experience – they use energy for heating and lighting, but when it came to explaining energy transformation, interest waned as this concept has little value in everyday life.

The next work sheet was introduced by reading stories. We started with one story of a resident's house that burned down and a collection of other peoples' experiences with fire. The focus of the stories was how fires are put out. This did not involve the learning of new concepts, but attempted to find out how learners understood what happened when fires were put out. The learners loved listening to these stories as they recognised them as the stories they had written or told previously. Once learners had identified how fires were put out, the next question arose as to what happened when sand or water was poured onto a fire. Most learners understood the visible, concrete example of fuel, but not the less visible ones such as air. They know that we fan a fire that will not burn, but do not connect this to a lack of air. After some time, however, the action of fanning the fire made sense to a number of learners.

Learners were familiar with the candle and jar activity and were quick to respond that the candle went out because the air in the jar was used up. Most learners knew the idea that a candle needs oxygen to burn, the difficult part was linking this concept to a fire and its requirements when burning. The fact that the fire also produces carbon dioxide while burning, took some time to understand. This is an important concept as it explains the danger of suffocation as too much carbon dioxide removes oxygen. I was pleased that the activities were geared towards content that I felt learners at this level should understand, such as the fact that air contains different gases. I thought that learners could connect their everyday knowledge of putting out fires to the science concepts such as oxygen required by the fire. As soon as the discussion moved away from the everyday knowledge of the learners, where everyone contributed confidently because they had practical knowledge, the difference in levels of understanding became more obvious.

Learners are familiar with the different methods of putting out fires - they do it all the time. One boy mentioned branches - this was not a method mentioned previously. They do not think about the reasons. The activities on the next work sheet confirmed my belief that learners do not enjoy writing. Questions that required them to explain something are a big problem to some learners. The last activity required them to draw a bar graph in which they presented given data. Everyone seemed to enjoy this activity, even those learners who were not too sure what was expected of them. This was more evidence of language being a barrier. In spite of the fact that everyone was confident that they could draw a bar graph, not everyone was able to reflect the data accurately on the graph. Many learners constantly referred to adults who are drunk or absent when fires break out, as well as children who are not supervised and then cause fires. I know that their social environment influences everything they experience. The threat of fire is a permanent feature of most families' lives and the fact that adults are often drunk and not capable of making rational decisions makes life difficult for these learners. I cannot simply ignore this plea for help. I know and the learners know that I cannot solve their problems, but it does seem to help if their problems are acknowledged and they have the opportunity to talk about them.

The first part of the next work sheet was an activity where learners were required to teach each other about the different ways in which people die in fires. The intention was that learners should realise that you need not be burned by fire to die. Learners were interested in the phenomenon, but the activity was not successful. They did not seem to be able to see the purpose of the activity and did not take to the idea that they would be taught by their peers. I was not surprised, as I knew they were not familiar with this strategy. Normally I would explain something like this and learners would listen to my explanation. I was not familiar with this activity and could not explain the procedure to the learners in isiXhosa. I knew that the learners would find it difficult to read the English text.

Learners know that people require oxygen to breathe. By tracing the path that air follows when it flows to the lungs, they were able to make the connection between their knowledge of oxygen and the consequences when people breathe in smoke and are deprived of air. Unfortunately some learners had a problem expressing this. In the last work sheet learners were expected to write again. I was surprised to see that they enjoyed this writing activity. I concluded that the reason was that they were only required to write a few words in the first activity and were free to write whatever they liked to finish the story. I was confident that most learners had developed some understanding of science concepts and linked the knowledge acquired in the classroom to their everyday lives but I was also aware that the learners' inability to communicate very well did not necessarily convey that impression. When I spoke to them in isiXhosa, they indicated that they had questions to ask about their experiences with fire in their homes. While many of these questions were answered during the course of the lessons, there were still unanswered questions. Most of these questions related more to the social and cultural aspects of their lives than the science aspects.

I was pleased that I was able to observe different strategies of teaching and decided that I would integrate some aspects with the PSP materials for future use.

LEARNERS' RESPONSES TO RELEVANT SCIENCE IN AN ARRANGED SETTING

Bongi and Thembi's responses to the science lesson series based on topics identified by the learners themselves, will be described as two narratives. As learners do not normally have a choice with regard to what they learn about in science it was important to know if their responses would be different to that of the conventional setting. I was particularly interested to see if they responded more deeply to various dimensions of relevance included in the lesson series.

Bongi and Thembi's Stories

When our teacher and Michèle asked us to tell them what we were interested in and would like to know more about, we wondered why they wanted to know. When

Michèle returned some time later and told us that most of us wanted to know more about fire and that she was going to be our teacher for a couple of days, we were surprised. She said she wanted us to write about fire or to tell the class anything we wanted to about fire, because she knew we knew a lot about fire. She said she would use the information she obtained from us when she taught us. We enjoyed writing and talking about fire because we have experience of fires. Most of the children in our class enjoyed doing this because they could write or talk in isiXhosa. Some time later Michèle visited our class again. She was going to teach us for four days and we were going to learn more about fire. We were worried that she could not speak isiXhosa, but our teacher assured us that she would be present all the time to translate if we did not understand something. We were looking forward to science lessons about fire and we wanted to hear the story of the three children who live in a community like ours and their experiences with fire.

Everyone in the class was a bit nervous at first because we did not think of Michèle as a teacher. We were used to her observing us during science lessons and talking to us afterwards, but not teaching us. We quickly got used to her and it was like having any other teacher. When we came to school on the day our lessons on fire were to start, our teacher told us that we were going to have science from eight till eleven o'clock for four days. We were worried that we would be bored doing so much science, but it turned out okay because we were doing so many different things. Most of the time we worked in groups and we enjoyed talking about what we know about fire. We also wanted to know what was going to happen in the story of the three children.

On the first day we were given questionnaires to complete at home. Michèle asked us to complete the questionnaires with our families. Some children did not return the questionnaires because they did not get help at home to complete the questionnaires.

Bongi's story	**Thembi's story**
My parents helped me to complete the questionnaires. The first questionnaire asked questions about the houses in the townships and how fireproof they are. Our house is built of bricks with an iron roof. We have electricity. Some of the houses in the neighbourhood get electricity illegally. Homes have very few plug points and people plug in too many appliances at the same time. Our family and other families use paraffin, gas and methylated spirits besides electricity to cook and heat our homes. My parents are sure that our house will not catch fire easily as there are no materials that burn easily in our home.	I completed the questionnaire on our home. Our house is made of bricks with an iron roof and the inside walls are made of 'ceiling board'. We have electricity, but, like many of our neighbours, we use paraffin stoves or primus stoves, because the electricity is often cut off. My mother believes that our house is safe because we do not have many things in our house that can burn.

Nobody in my family has been in a fire, but we know people who have been caught in fires and whose homes have burnt down. My parents have told me to avoid being close to a fire as I could choke to death. My father knows how to revive someone who has inhaled smoke from a fire. My mother knows that one should allow burns to dry, but she does not know why.	My family also completed the second questionnaire, which was about what to do if people are hurt in fires. Some of my relatives experienced fire in their home before and my uncle burnt to death in a fire. Our neighbour escaped from her burning home, but was very ill from inhaling smoke from the fire.
The third questionnaire was about putting out fires. My family knows that the easiest way to put out a fire is to use water. You can also use sand and blankets.	My family knows that fires are often caused by electrical faults. We know we should not use water to put out fires caused by faulty electrical wires.

Veldt fires: In this worksheet the children in the story come across a veldt fire	
Work sheet 1	
Bongi The first part of the work sheet was about veldt fires. We often see fires burning in the distance, on the mountains. I know that such fires occur mostly in summer	Thembi I thought that fires occur when it is hot. That is why we have more fires in summer. I did not think about the fact that the grass on the mountain may be dry at

where we live, where the grass is dry because it does not rain. I know that wet conditions cool things down and reduce the chances of fire. When we were discussing how fires started, the idea of uvutha came up. I have heard of uvutha from other family members and neighbours before, but was surprised that this had come up in class. I enjoyed listening to a story about uvutha but I will not admit in class that I believe that a fire could be started by magic. I would like to talk to a Sangoma about uvutha. I enjoyed the drawing activity. I drew a picture of a cupboard that was on fire. The clothes in the cupboard had started burning by themselves	this time of the year. My friend said that the sun started fires on Table Mountain as the sun moved behind the mountain at night. I am not very interested in veldt fires. I am more concerned about fires in our township. When we were asked how fires start, I immediately thought of how people start fires. I know about uvutha as my grandmother often referred to it. I think it is likely that fires could start in this way, but I don't think that this kind of fire is more dangerous than fires caused by irresponsible people. I drew a picture of a person asleep in a room that was on fire. I did not think about how the room caught fire; what was important was the person in the room who might burn to death

Fire in our township: In this section the children in the story experience fire in their township and ask questions why fires occur so easily.	
Work sheet 2	
We all enjoyed going outside to burn the different materials. Everyone in my group knew a lot about the different materials homes are made of and could easily say which materials would burn more easily. Designing a house using materials that do not burn easily was fun. I drew the house while the other members of my group told me what to do. Testing our prediction by burning materials outside was great fun. When we were shown photographs of three houses made of different materials, it was easy to see which house had the most materials that burn easily.	Everyone in my group could guess which materials would burn easily. We have experience of this as many of the houses in our neighbourhood are made of the same materials. I enjoyed counting how long it took for each piece of material to burn. It was easy to see which house in the photograph would burn more easily than the others. Only one group in the class thought that a house made of hardboard was the safest house. We thought this was strange, but when they were questioned they said they thought the iron frame of the house would not burn. Then we understood what they meant.

In this work sheet we started talking about energy	
Worksheet 3	
I believe a fire has energy because a fire	At first I did not think that a fire has

has heat. When we did the activity, I understood that energy changes from one form to another and that there are different forms of energy. I thought that anything that burns is fuel, but I understand now that some things burn easily but do not have much energy.	energy but after the activity I understood that light and heat are forms of energy. I still do not understand what movement and chemical energy is. I also do not understand what the teacher means when she speaks of how one form of energy changes to another. I know that fuels have energy and fuels burn well. Plastic must be a good fuel because it burns easily.
Fire and people: The next worksheet focussed on people and their experiences with fire. The three friends spoke about a house that had burnt down and they wondered how it happened.	
Work sheet 4	
We listened to stories about fires in homes and how these fires are put out. I can understand how water puts out a fire because it takes away the heat from the fire, but I do not know why sand puts out a fire. I know that you need fuel to make a fire, but I never realised that something else is	I loved listening to the stories about how people put out fires. There are many different ways of doing this and we have to know all about them. I know that you have to use sand or water to put out a fire. I don't know why it works, but I have seen that it does. I saw the candle go out when the jar was

needed to make a fire burn. It was only after we did the candle and jar experiment that I remembered that we often fan a fire with a newspaper when we cannot get it to burn properly. Then I understood that air was necessary as well. I understand now why some people die when they are near a fire, without being in the fire. It is because a fire produces carbon dioxide when it burns and then there is too much carbon dioxide in the air and these people suffocate. Everyone in our group agreed that the next time we helped people in a fire, we would know what to do to save them.	placed over it, but I do not understand what this has to do with the fire. I know that the candle needs air, but a fire needs wood or paper or paraffin. I found it difficult to read about what air consists of. The words were difficult and I did not understand what this had to do with fire. When we were told that the fire formed carbon dioxide, I could not believe this because I have never seen it. I thought it was important to talk about saving people from fires.

Fire and people: The children wonder what was used to put out the fire in the house. They try to explain how sand, water, blankets, etc put out fires.	
Work sheet 5	
I know that water will take away the heat from a fire and this will put out the fire, because a fire cannot burn without heat. I also know there are other things that	I know what to use to put out a fire, but I do not understand why things like sand, water and blankets put out fires.

people use to put out fires. I thought that blankets and sand could also remove the heat but now that I know that a fire needs oxygen to burn, I understand that these things also take oxygen away from the fire. Now I also understand why beating a fire with branches will put it out. We talked about fire extinguishers because we have all seen them. I am glad I understand now how a fire extinguisher works. We always see the fire brigade use fire extinguishers, but I never knew what was in the extinguisher and only understand now that the chemical keeps oxygen away from the fire. Drawing the bar graph was easy – we have often drawn bar graphs. Some members in my group do not measure properly, they are happy if their graph is more or less correct.	When we discussed this in class, I remembered that a gas is also important for a fire to burn, but I could not remember whether the gas was oxygen or carbon dioxide. I am not too interested in what makes a fire go out. To me it is more important to know how to put it out. The things that really bother me about fires, is how they start in the first place. It just seems that people cause most fires. Most of the time adults are drunk or absent when fires start and this really scares me. I wish I could find a solution to this problem. I don't understand how a fire extinguisher works, but I don't really mind – as long as I know how to use it. Drawing a bar graph was fun – it was like drawing a picture. I could use any colour

	I wanted for the bars. I enjoyed comparing my graph with my friends' graphs.
Fire and people: In this work sheet the children in the story spoke about the effects of fire on people.	
Worksheet 6	
We learnt about how people die in fires. We learnt about this in a way we had never done before. We were expected to teach each other. Most of us did not like the idea of learning from each other and did not enjoy reading in English. It was only after it was explained to us that we understood why people die in fires without actually burning. The next activity on the work sheet where we had to show the way air flows to your lungs was very easy. I understand now how hot air can damage your lungs. I know that suffocation means that you do not have enough oxygen to breathe	I did not like this activity at all because I did not understand why we had to teach each other and there was too much reading in English. Most of us did not understand what was written in the paragraph we were supposed to read. A few members in my group said they enjoyed working in 'home' and 'specialist' groups, but did not enjoy all the reading. I understand now that people can burn to death and suffocate in fires. I could easily show the path air takes to my lungs and I understood that you suffocate when you do not have air to breathe

Fire and people: How do we feel about fire?	
Work sheet 7	
I really enjoyed this lesson because I was able to write about anything I wanted to. I wrote about the good and bad things about fire.	I enjoyed this section although I do not enjoy writing. I could write about anything to do with fire. I wrote mostly about the bad things that fires do.
What I found most interesting was the fact that you could die if the burns caused by a fire became infected.	I finished the story about Spud, but I did not write much, although we were allowed to write in isiXhosa.
I really enjoyed finishing the story because I could make up my own story. My friends and I had a happy ending to the story where Spud was saved from the fire, but I was surprised to hear that so many of my classmates had sad stories. I suppose it is because so many of us have had such bad experiences of fire.	Everybody I spoke to wrote a story in which Spud died and David was burned in the fire. They all had sad endings to their stories. Some children even wrote about David killing himself when he found out that his dog had died. We all think about fire as something bad and forget that it can be very useful too.

Groups of learners were interviewed at the end of each day. Bongi and Thembi represent two groups of learners.

Bongi	Thembi
We were asked to talk about the lesson taught that day. I thought the lesson was fun because I like to draw. I enjoyed learning where fire came from and also that sun or lightning can make a fire if the grass is dry. I know that glass can cause a fire in grass, but I do not know why.	When we spoke about what we had learnt, one of my friends said that science helped one to find out things. Some members in my group had much to say about 'uvutha' - they believe that a Sangoma sends a fire to you.
We all mentioned 'uvutha'. I believe that uvutha is a magic fire caused by the Sangoma. One member of my group said she believed fire was a gift from God. It was important for me to talk about this with my friends and teachers.	Some did not know about uvutha before, but have heard people talk about it, but did not know what it was. I enjoyed the story about uvutha because it taught me more about my community.
We all agreed that we had learnt useful things that day, especially the information about materials that do or do not burn easily. Although we learnt a lot about fire, we would like to learn more. We could use this information at home to help us if there is a fire.	Most of the learners in my group felt that they never before used knowledge from home in the science class. They feel that they just use knowledge that they learn at school in the science class, although one boy in my group said he used knowledge from home. I agreed with my friends that we enjoyed the science lessons, except that we had to write too much. We are not

Although I knew a lot about fire, I learnt so much when we discussed things in class and it helped me to understand the science we learnt more easily. Although learning about fire in our township is useful, I would like to know more about things such as volcanoes, tornadoes and the planets. I would like to know more about my body.	used to this. We know that most fires start because parents are drunk or go away and leave small children at home. I would like to learn what to do about this problem. My friend wants to know whether uvutha and volcanoes is the same thing. If a volcano is not magic, how can the fire from a volcano flow like a river?

ASSESSMENT

By observing learners as they engaged in activities and by analysing the interviews conducted with them, as well as their work sheets and tests, it was possible to determine what they had learned and how this learning reflects their responses to different dimensions of relevance. As the learners' responses to various dimensions of relevance are interconnected in various ways and not always distinguishable as separate entities, assessment is a complex process. It was not possible to quantify how each learner responded to each dimension of relevance. Instead, the narratives of Zanele, Bongi and Thembi are used to illustrate the variety of responses expressed in various degrees by individuals and groups of learners.

Zanele's Narrative

The good thing about the variety of learning activities was that there were so many ways of assessing learners. These assessment strategies allowed us to assess a variety of outcomes. Examples of activities that were assessed were teamwork, drawing activities, factual answers, the ability to manage themselves and the ability to make predictions. Learners' responses confirmed earlier comments that learners like to learn by listening, but it was also clear that learners greatly enjoyed the practical activities. Although learners were assessed in different ways, it was ensured that they wrote tests as well. Tests are easier to assess than other activities and as they assess individual learners it is regarded as an important form of assessment by the school. I believe that the learners also take written tests more seriously, as this is seen as a form of judgement of their abilities. They don't see drawings and stories as requiring 'right' answers. I shared my opinions of written tests with the researchers, making it clear that learners respond well to questions that require simple responses. I was disappointed in my learners' responses to the test. I do believe that part of the reason learners performed poorly was that they were not used to the way in which the questions were structured. Judging from the responses to the questions in the first test, learners' interests ranged from learning new facts that contributed to their scientific knowledge to participation in activities, to talking about things they were familiar with.

Language proved to be an issue in the administration of the test. I warned the researcher that learners do not respond well to statements such as 'Why do you say so?' or 'Explain your answer'. This was probably due to the fact that learners interpret 'why' differently to the way it was intended in the test. While the test question expected learners to explain their answers, learners' interpretation of 'why' was procedural and therefore did not require reasons or explanations. This was also an issue in the work sheets where learners' scientific understanding was assessed. We decided to use a second test, using only multiple-choice questions. We hoped that this would eliminate the language problem to a certain extent. Learners performed slightly better on multiple-choice questions, but this did not solve the problem of understanding the questions.

I could see that a number of learners had difficulty applying knowledge in the classroom to everyday situations. It is possible that they may require an intermediate step to help them to establish a link between classroom science and real life situations. It is with this in mind that a third test was designed. In spite of this adjustment, the results were not significantly better than in the other two tests. In spite of the value that is often placed on pen and paper tests, I do not believe that the results are significant in pointing to the various outcomes achieved and the different dimensions of relevance the learners responded to.

Bongi and Thembi's Narratives

Bongi's story	**Thembi's story**
I enjoyed working as a team with my friends. Designing a house using materials that do not burn easily was fun.	I really love working with my friends in a group. It is easier for me to work if my friends support me.

I drew the house while the other members of my group told me what to do. Testing our prediction by burning materials outside was great fun. I like it when the teacher asks questions when we discuss science in class because I enjoy knowing that I understand the science. The discussion on fuels and energy was interesting for me because we use fuels all the time. I enjoyed listening to the experiences of my friends as they related their stories on fire. Some of them have really had bad experiences. I am glad that I have not lost a family member or friend in a fire. Although I like learning about new things in science, I enjoyed talking about fire, because there was so much we knew and could use in class. The new things we learnt about fire, was also very useful to us.	I prefer to talk about science in our groups, rather than answering questions that the teacher asks me. It was easier for me when we discussed possible answers in small groups and then when two groups got together to decide whose answer was best. When we talk about possible answers, it is easier to make decisions. When we had to predict which materials would burn easily, everyone in my group could guess which materials would burn easily. We have experience of this as many of the houses in our neighbourhood are made of the same materials. I loved listening to the fire stories, because so many of them described things that I have also experienced. I enjoyed the lessons on fire because it was useful. A lot of the things we learnt

I prefer drawing to writing. Drawing is fun and our teacher often complements me on my drawings. When we were asked to show the pathway through which air moved to our lungs, I understood why we suffocate from smoke and how hot air can damage your lungs. I know that suffocation means that you do not have enough oxygen to breathe. I enjoyed the lessons because I can use the knowledge about fire at home. Although I do not enjoy writing tests, I know that they are important. We wrote three tests. I could answer most of the questions, except those questions where I was not sure what the question meant. The multiple-choice questions were easy. Sometimes I find it difficult when the questions seem to expect answers we did not discuss in class. When the questions	could be used to protect us against fires. I also felt confident when we spoke about fire because I knew some things about fire. I loved drawing instead of writing. It was easier for me to show what I felt in the drawing, than to describe my feelings. I did not enjoy writing on the work sheets. Using a drawing to show how air moved to our lungs, was much easier than explaining how this happens. I could easily show the path air takes to my lungs and I understood that you suffocate when you do not have air to breathe. The thing I enjoyed most about these lessons was that there were things I knew and could talk about. I hate writing tests. The most important reason is because I have to think by myself and cannot talk to my friends

in the last test consisted of a number of steps, I realised that we had discussed this in class. We had just used different examples.	about the questions. When we wrote the class tests, there were many questions I did not understand. To me some of the questions were about things we had never discussed, although my friend explained to me later that we had actually talked about similar things in class.

CONCLUSION

The narrative approach was used again to record the data obtained in phase 2 of the study. All three narratives, as in phase 1, represent a descriptive analysis of the data. Zanele's narrative describes her experience as an observer, but focuses mainly on how her learners respond to a different teacher (myself) and a lesson series based on content determined by the learners themselves. This input is valuable as she knows her learners well and is able to compare the way they respond to these lessons, compared to previous lessons taught. Her narrative included a description of how learners like to learn, as well as what they had learnt from the lessons. The narratives of Bongi and Thembi give an account of how learners experience the lessons in different ways. As in phase 1, two groups of learners emerged, represented by Bongi and Thembi respectively. Their narrative also includes a discussion on what they had learned. Although both groups of learners responded positively to the connection between everyday knowledge and science knowledge, they responded differently. The differences, as well as the reasons for the differences, will be discussed in following chapters. The narratives from chapter 7 will be analysed in chapter 8 by developing categories from the holistic account presented in this chapter. These categories will be presented as propositions about relevant science. I will then be in a position to answer the critical questions which relate to relevant science in an arranged setting.

CHAPTER 8

DISCUSSION – PHASE 2

INTRODUCTION

The narratives of Zanele, Bongi and Thembi, compiled from the video tape of the lessons, interviews with learners and class teacher and the work sheets containing a variety of activities, provided insight into the way learners responded to a lesson series that was deemed relevant. While the narratives of chapter 7 presented a holistic account of the ideas and experiences of the teacher and learners, this account was constructed from a number of categories identified in the data. In this chapter these categories will be drawn from the three narratives. This process was essentially reiterative as the categories were used to construct narratives in chapter 7, while the narratives are used to identify dimensions of relevance in chapter 8. These two strategies complement each other, allowing identification of the dimensions of relevance from one set of data and organising it into categories in a second set that is reported in this chapter. Open coding was used to analyse the data and create categories. These categories which describe the dimensions of relevance that learners respond to, are presented as propositions about relevance science. Six propositions are described in this chapter.

PROPOSITIONS

Everyday knowledge

Children's everyday knowledge and concerns provide a springboard for learning science. As the lesson series was about fire, a topic selected by learners, the content was based on the everyday knowledge of learners. This knowledge was used in the work sheets that were used to structure the activities into coherent sections of the story of the three children and their experiences with fire. Although different learners have different knowledge of fires, their collective knowledge contributed to a wealth of information that provided a springboard for further learning. Learners knew exactly how to put out fires, but did not understand why these methods worked. Petrol, as fuel, interested them because they had seen the damage caused by petrol when people use petrol to burn down other peoples' homes. They demonstrated some knowledge of flammable materials and were familiar with a number of fuels. They knew that most people die in fires because they suffocate. Learners are concerned about their inability to control fire and the social conditions that are often the cause of fires, which lead to the death of many people in the community.

The activities accommodated a range of learning styles, allowing learners to demonstrate a variety of science outcomes. These outcomes included science knowledge, as well as a number of science process skills. The issue of science and society was addressed throughout a number of activities with learners, developing an understanding that scientific knowledge may contribute to the development of society. Using learners' knowledge of natural fires and fuels used at home, developed the concept of flammability. The concept of fuels providing energy was developed from their knowledge of different fuels and what these fuels do. Learners understood this concept very well. A number of activities required learners to write individual responses. These were either prior knowledge or responses to explanations or class discussions. Examples are, explaining how fires start and listing examples of fuels used in their homes and the forms of energy observed as a fire burns. The concept of energy transformation followed on from here. The work sheets and tests showed that the majority of learners were able to link a burning house to chemical changes occurring because of the application of heat, but had difficulty conceptualising it as an energy change. A large number of learners were still not thinking of heat as a form of energy.

While some learners were quite capable of writing correct responses based on prior learning and class discussions, some of the learners did not complete the worksheets and if they did, seemed to rely on their group members for support. When they were not able to get this support, they produced incorrect responses. Figure 1 shows and example of a correct response from a work sheet.

2. Write down the names of three materials that you think would not burn easily
a) Card bord
b) Silling Bord
c) tin foil

FIGURE 1. Learner's response on a work sheet

The concept that material that burned easily and fast and was not suitable for building, was well developed as learners engaged in a practical activity, burning different materials. Although the jigsaw activity itself was less successful, learners wanted to know how people were harmed by fire. We discussed suffocation, burns and infection as causes of death due to fire. As learners were interested in learning about these facts, they were content to listen to explanations. The relationship between air and combustion was less clear to a number of learners. A large number of learners do understand though, how a fire extinguisher works. The class teacher was also confident that they had an understanding of the concept.

Reseacher: Which things do you think they really made a connection to?

Teacher: Like the carbon dioxide and the oxygen. They learnt something new.

The class teacher was confident that learners responded positively.

Researcher: So how did the learners respond do you think?

Teacher: They responded very well.

Researcher: In what way?

Teacher: They answered all the questions, they participated in various groups, they wrote and made drawings in groups.

During interviews conducted subsequent to the teaching of the lessons, a number of learners showed evidence that their thinking had moved beyond what they initially brought to the classroom. While the stories showed that the human factor was dominant, a question about how fires start produced the following response.

When grass is dry and the sun is hot...

Lightning

When the sun is hot and there is glass lying on the grass.

A number of process skills were developed as learners engaged in the activities. They were required to observe the burning of different materials and as they had to time how long it took for each material to burn, correct observations were important. Observation was also important when they did the candle and jar experiment. A number of learners were able to apply their knowledge from one context to another after a few activities, while certain learners had difficulty doing this. While many learners made the connection to air as a requirement for combustion, a number of learners could not apply this to activities related to fires in their communities. The ability to apply practical knowledge in everyday situations was evident from the responses in the tests though. However, as soon as a question dealt with a more abstract concept and was asked in a particular context that required learners to apply what they had learnt in a new context, some performed poorly. This appears to be a case of learners who have practical knowledge and are not interested in giving scientific explanations.

In the activity where they were required to present information in a bar graph, learners also participated with enthusiasm. This activity required the skill of presenting information in different ways. Most learners are capable of presenting information in this way, although some learners appeared to view this activity as something similar to a drawing, carefully selecting different colours for the different bars, rather than ensuring that information is correctly represented. Figure 2 shows an example of a learner's bar graph.

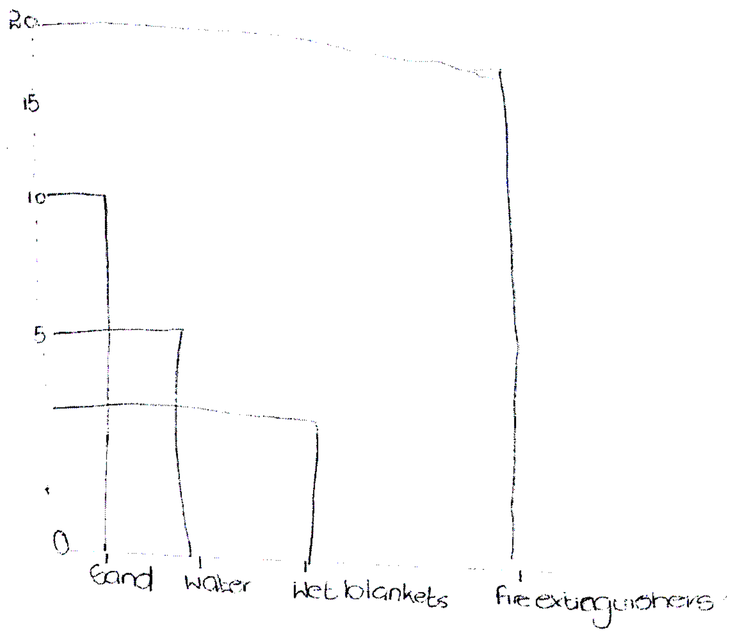

FIGURE 2. A learner's bar graph

The skill of prediction was developed with the activity of predicting which materials would burn more easily. The majority understood the principle of prediction, as well as the importance of measuring by counting. Learners were quite capable of solving the problem of where air goes when it is inhaled. This knowledge helped them to understand how smoke and heat caused suffocation. They understand what damage could be caused by hot air or smoke entering the lungs. Learners had a good idea that fire damages lungs and that a fire deprives people of oxygen, although some learners had a problem expressing this.

While learners were extending their science knowledge through activities, they were developing other skills that may be expressed as critical outcomes. These outcomes provided a means for learners to achieve the science outcomes. Learners were assessed to determine if the science and critical outcomes were met. These included responses on work sheets, observation of groups when engaged in tasks, as well as tests. Work sheets allowed an assessment of the learners' ability to communicate, as well as their conceptual understanding and problem solving skills. Observations allowed for assessment of communication, self and group management and problem solving, while tests gave an indication of conceptual understanding and the ability to apply knowledge. The implementation of a variety of assessments was necessary to determine whether the outcomes were met. It was especially difficult to assess conceptual development (due to language constraints), hence three tests in which questions were formulated differently.

The evidence suggests that science learning was enhanced in many learners when everyday knowledge was used as a springboard. Using everyday knowledge makes it possible to include various dimensions of relevance in the science lessons. The content was relevant as it was determined by the learners and was strongly connected to their everyday lives, bringing the dimension of relevant context in as well. The lessons were also relevant with regard to teaching strategies, as the strategies selected were learner-centred. Learner-centred lessons had implications for classroom management and power relationships bringing in further dimensions of relevance such as purpose and structures. The intention was that their engagement in these relevant activities would encourage the further learning of science.

Many learners, as represented by Bongi in the narratives, achieved a range of outcomes including science outcomes. A number of learners, as represented by Thembi in the narratives, often had problems making connections. They seemed to have difficulty understanding abstract concepts like energy and invisible substances like oxygen and carbon dioxide. Some learners required more time for understanding to develop and benefited from a step-by-step approach. Responses to questions in the work sheets, class discussions and tests showed that a number of learners found it difficult to change their previously held ideas easily, in spite of using their everyday experiences to explore these concepts.

Social and Personal Aspects

The social and personal aspects of learners' lives, especially the practical aspects of survival, impact on their interests and the way they experience science and thus provide a framework for deciding what is worth learning. The stories, interviews and other responses represented here provide insight into the influence fire has on the lives of these children. It reveals the extent to which the social and personal dimensions of their lives shape their view of science and the school. For these learners a strong aspect of relevance lies in learning about people in their community, their traditional culture and the practical skills that allow them to survive in their environment. These aspects of relevance impact strongly on the way they perceive the science as it is presented to them, as it influences purposes, processes and structures and the context in which it is used. Interviews and learners' stories revealed how aware they are of the role people play in starting fires in their community.

Fires start when children play with matches, gas, and paraffin –because small children don't know.

The following stories represent direct translations from isiXhosa to English.

Lungi

One afternoon my mother, my sister and brothers were just relaxing and chatting to each other. My mother had a pot of samp on the stove, she left it there because it takes time for samp to cook. Then all of a sudden my father who is an alcoholic came and he was very drunk that day and demanded my mother give him food, my mother told him that the food was not ready and he got very angry and kicked the stove .The stove fell and caused a huge fire.

Sandile

In 1999 Mr Shezi was sitting in his house drinking beer when he suddenly fell asleep. He was suffering from a headache and forgot that he was cooking. While he was asleep his pot fell and the whole house burnt down. He got burnt too and died on the scene. One of the neighbours phoned the fire brigade. We waited and waited but they did not come...

Traditional culture is very much part of social and personal experiences. The stories below were written by learners and give some indication of how learners experienced this phenomenon.

Thembi

My mother told me a story about 'uvutha'. She said that if you want 'uvutha' you must go to 'ugqigha' (herbalist) and tell him that you want 'uvutha' to be sent to someone. You will have to pay the herbalist some money to cast 'uvutha' onto another person. What happens is that the person or his clothes ignite spontaneously.

Langa

My story is about 'uvutha'. My mother was sleeping when she suddenly saw her clothes getting burnt, but she did not get burnt. Then she went to 'ugqigha (a herbalist) and he told her that someone wanted her to die.

Nkosi

Sbusiso went to the kitchen to drink some water only to find that there was a fire. The cause was unknown. His parents suspected that someone has just sent 'uvutha' to the family.

Thula

One day we visited one of my neighbour's houses. We were sitting in the kitchen and my mother and my neighbour were busy talking when all of a sudden a fire broke out. At that time my neighbour was showing my mother the clothes she had bought for her kids for Christmas and they were beautiful clothes. The fire burnt everything, furniture as well as the clothes she had bought for her kids for Christmas and her whole house was burnt as well. Then she went to see the herbalist and the herbalist told her that it was one of the neighbours who were jealous of the clothes that she just bought for her kids for Christmas. The herbalist also told her that the same person also killed her dog that has just died.

The interview with the teacher revealed how learners are expected to learn science while they often struggle with personal problems. She felt that such learners could cope if they thought what they were learning about was useful and worthwhile.

> Researcher: Were there some learners that don't usually participate, but who participated more, or some who participated less?
>
> Teacher: Yes, there were some kids like Nkosinsthi, who participated more also, Zanele is a child who usually participates, but not much .She is not stable, but despite the fact that she is a child who has experienced a tragedy. She came to school only that week but she could not help... I think the subject was so interesting, she showed more participation than when she usually is in class.

These aspects of learners' lives provide a framework against which they judge the worth of everything they do or learn about in class.

Observation throughout the lessons showed that learners' interest levels rose when the human factor was introduced. Learners relate everything about fires back to people. They are interested in the role people play in fires. When they were asked when most veldt fires occur in the Cape, some learners said in winter. They made the connection between people making fires because of the cold and then the fires get out of hand, rather than thinking about other causes of veldt fires. Learners were more concerned with the human aspects related to fire than the scientific underlying phenomena. They responded positively if they viewed the knowledge as something that related to their lives. It was evident that learners valued learning how to survive in their communities, as well as learning more about their traditional culture. Fire is a dominant factor in their lives and they need to know more about it. Understanding how to deal with fire helps them to survive in a community plagued by fire.

Another example of how the social and personal aspects of their lives influence their interests came from the fact that oxygen supports combustion. Learners were given an example of a burning house and had to decide what would slow down the fire, open or closed windows. It was clearly stated that there were no people in the house. Less than half gave the correct response. It appears that when confronted with a real-life situation of a house on fire, the first response was to think of the possibility of people in the house. It would then make sense to open windows and doors. It would seem that while I attempted to contextualise a question, learners had a different interpretations. Had I asked, does a fire require oxygen, all of them would most probably have given a correct answer. Their interest in people came strongly to the fore again when they were given three photographs of shacks and asked to select the house that would not burn as easily as the others. They were interested in this knowledge, but there was more to this activity than I intended. The people living in these shacks interested them as much as the materials the houses were made of.

One aspect learners referred to in all interviews was that their culture was addressed in the stories. They appreciated the fact that it enabled them to learn more about their community. Each group wanted to know more about the phenomena discussed in class. The class teacher agreed that learners appreciated the fact that this aspect was introduced.

Researcher: They enjoyed the traditional stories

Teacher: The children who told the stories come from the Eastern Cape. I know about the stories. Those children cannot explain how it happened, I cannot either. Water cannot put it out, only milk can. I saw computers burn, plastic chairs - out of the blue.

Researcher: Was it worth having that part in the module?

Teacher: Yes it was worth it, especially for the children from Khayelitsha. They are interested because this is what happens in their community, so maybe they are also wondering how and why. It is part of their culture and part of their lives.

When learners were asked to draw any scene from all the stories that were told in class, most learners drew a scene depicting 'uvutha' (Figure 3.). This is an indication of where their interests lie.

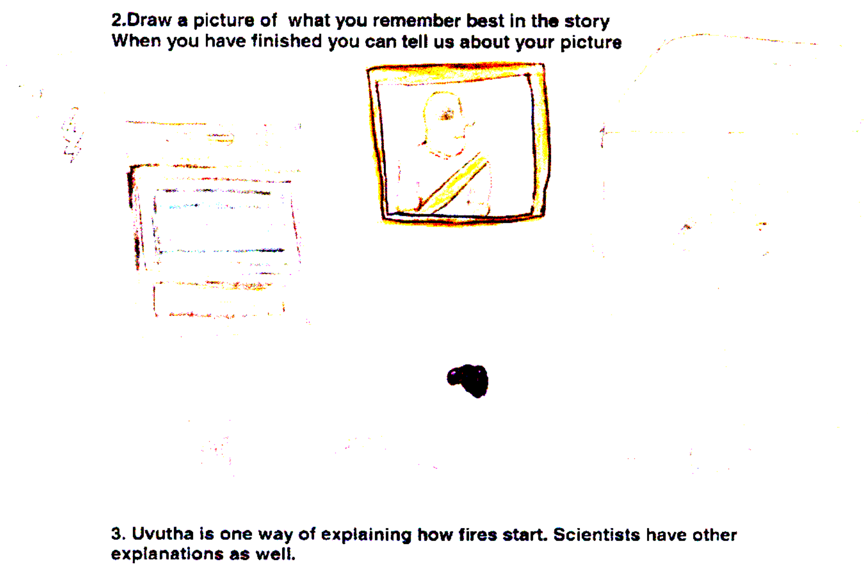

FIGURE 3. A learner's representation of a story

Although not all learners indicated in class that they were interested in this phenomenon, it was brought up in every focus group interview, with learners wanting to know who has observed it and who could explain it. To them this important knowledge and they appreciate the fact that they were allowed to discuss it.

> Uvutha can come to people.
>
> Uvutha is a magic fire – Sangoma makes fire.
>
> Sangoma will cause fire if she hates you.

When learners were asked to list positive and negative aspects of fire, most learners responded by giving examples of negative aspects of fire but had a more difficult time expressing positive and interesting features of fire although they use fire in their homes all the time. This showed that they mainly perceived fire as a negative force in their lives. A few learners seemed to have difficulty in extending their knowledge. They repeatedly gave responses that showed evidence of practical knowledge, but no further development of scientific concepts. These learners were content to know how to deal with problems related to fire that impacted on their lives, without the desire to understand the underlying science concepts. These examples show that learners see relevance in science that is practical and useful to their survival in the community. It also demonstrates that learners experience their learning as worthwhile when they are able to participate with confidence, building their self-esteem.

Life on the Cape Flats

The problems of life on the Cape Flats is far removed from the standard science curriculum but need not be. Although the learners' stories were written before the lessons were taught and provided the information on which the lesson series was constructed, some of them are presented here to provide insight into life on the Cape Flats and these learners' experiences of it. Two themes emerged from the stories. Irresponsible adults mostly cause fires and learners are powerless to influence adult behaviour. Fire is also used as a tool for revenge. The problem of irresponsible adults is closely linked to socio-economic factors in the community. Lack of supervision of young children, violence and alcoholism are all issues that learners have to contend with in their everyday lives. The issue of fire as a tool for revenge is of great interest to them, but does not appear to be more threatening than other causes of fire in their lives. Their stories confirm the social problems these children have to contend with.

Noma

> I went to visit my cousin who lives in New Race in the shacks and I was going to sleep over, my cousin lived with two other guys and one of them was drunk and he warmed food on the stove then he slept and forgot about the food... the fire broke out, and one of the guys was sleeping on the other side of the room that was burning. .... they broke the door to try and help him but it was too late... We saw burnt hands, bones of the person who was inside the house.

Sitho

> It was a late Saturday night, my sister's boyfriend and her ex-boyfriend were fighting over her. Then her ex-boyfriend threatens to burn our house if my sister does not get back together with him.....when she came back her ex-

boyfriend had already burnt down the house, I cried and cried seeing that our house was being destroyed by fire.

Bona

My father was drunk. He went out to buy the insides of a cow and came back and put them on the stove and fell asleep. When he was asleep the fire broke out, when one of my younger sisters saw the fire she quickly went to tell my other big sister, Nikiwe. Nikiwe phoned the fire brigades immediately.

Siyanda

I live with my uncle in Khayelitsha. One evening he came home from work drunk. It was dark inside the house and he lit the candle and fell asleep. When I entered the room I saw smoke coming out of his room and went to check the room was on fire. I tried to wake him but he could not wake up then the fire got him on his head. ...and my uncle died on the scene.

The interview with the class teacher supported the view that often the problems of the children that she has to deal with are far removed from the curriculum.

Researcher: One of the things children talked about was managing adults when a fire broke out. How do you tell an adult that it is dangerous to put a candle there and what do they do when a firebreaks out and the adults in the house are drunk?

Teacher: Yes, it is because it is something that is in their community; it is something that is in their minds that if the fire breaks out there is somebody in the shack who cannot save themselves.

Researcher : Are kids frustrated by the fact that we cannot help them?

Teacher: I don't think this frustrated the kids – that question is the question they usually ask –they tell the story of the uncle that was drunk. There is nothing they can do.

These examples highlight the problems learners contend with. These problems are part of their lives, shaping their lives and interests.

Generally, textbooks and learning programmes that are developed as resources for science learning, do not include social and personal issues that children struggle with in their day-to-lives. Topics that are universal, rather than contextualised for particular environments, are usually included in such textbooks. This fits with the conception of the universal nature of science. Examples from a number of textbooks confirm this. Topics such as Heat, Electricity, Water Cycle, Fossils and Structure of the earth are covered in the textbook Stepping into Natural Science and Technology Grade 6 (Wagner et al, 2002). Topics in Science and Technology (Smith et al, 1998) cover Human digestive systems, Global cycles, Food preparation and preservation, Clothing, Energy, Motion, The atmosphere and Global pollution. The Science Education Project's textbook, Natural Science (2001) has similar topics. These include Using Electricity, Reproducing Life, and Looking into space, Getting materials. Although the PSP developed their learning programmes in collaboration with local teachers, most of their topics are of a universal nature as well, rather than geared towards learners' specific needs. Energy and Change for Grade 5 (2000) covers Making electrical circuits and Conductivity. Life and Living for Grade 5 (no date) include Life cycles and Classification (the examples used by the teachers in lessons described in phase 1). Matter and Materials Grade 5 (2000) includes topics such as Mixtures, Measurement, Liquids, Solids and Gases, while Earth and Beyond Grade 5 (2002) includes The solar system, Seasons, Day and Night and Weather.

Although these topics are presented as universal topics, some effort is made to contextualise certain topics. What they do not do is to address the issues learners face in particular communities. A number of these topics do provide scope for personalising the curriculum, making it more relevant to the lives of these learners, by including aspects that they deem worth learning.

Links to the science curriculum

Possibilities exist for linking the experiences of children from the Cape Flats to the science curriculum, especially if they are able to take their science knowledge back to the community. Although the lives of these learners are immersed in the day-to-day struggle for survival and there appears to be little connection to the current science curriculum, there are possibilities to link the curriculum to their experiences. To make this possible the curriculum has to be localised to allow learners to bring their everyday experiences into the classroom and establish links with the curriculum. The lesson series was able to do that. The knowledge and skills that learners acquired were useful in their everyday lives and grounded in the curriculum.

The predict-observe, explain activity was an example of this. It used learners' experiences to teach the concept of flammability. The activity had other purposes in that it provided the opportunity for the development of other outcomes, but the knowledge was valuable to the learners as well. The majority of learners enjoyed this activity and they believed it taught them something they could use at home, for instance, materials that burn easily and those, which don't.

Mich le: Can you tell me what you learnt about fire?

Bona: We learn what is flammable.

Siyanda: We learn about chemical energy… that a fire has energy.

Lungi: We learn what is easy to burn.

Mich le: Why is it important to know which things burn easily?

Langa: We built a house. We know what materials to use now.

The more conventional candle and jar experiment demonstrated the importance of air for combustion and learners understood that to extinguish a fire you need to remove air (oxygen) from the fire and this had practical value in their lives. Although most learners did not seem to think the science behind the explanation very important, what was important was to be able to put out the fire. Some learners were very interested in the fact that it was oxygen. Knowledge of how people are injured in fires and how to treat them was useful knowledge and linked to the curriculum. The interviews with learners showed evidence that they thought they had learnt new knowledge and could apply this in their everyday lives. It was evident that they valued the knowledge they could use to help people, when a fire broke out.

Mich le: Can you tell me what you learnt about fire?

Zandile: We learnt how to help people that are in fires.

The fact that they could contribute knowledge to the learning environment appeared to be an affirming experience for them. All learners were sure they did not learn science at home, but that they did learn things in the lessons that they could use at home.

> Themba: If one is making a fire outside on a windy day the wind might blow some of the burning wood and if the grass is dry, it will catch fire.
>
> Mich le: When you learn new things in class, do you talk about it at home?
>
> Bona: Yes.
>
> Mich le: Are people at home interested in these things?
>
> Bona: Yes.
>
> Siyanda: No, not really. They would rather hear about things around them.

The class teacher's view was,

> Researcher: Did you feel they were making connections between their home and the school?
>
> Teacher: They were making connections.

These examples show how many opportunities there were to cover universal topics in a localised curriculum. Learners were able to take this knowledge home and use it in their everyday lives. This lesson series only covered a limited amount of science and this particular group of learners influenced what was covered. In another context, a similar topic may allow for learners to engage in other aspects of science learning. The possibility of localising the curriculum is made possible by the RNCS (2002), which stipulates that 30% of the curriculum should be localised.

Shared Experiences

While children bring different experiences to the science class, they do share common experiences and are interested in sharing these experiences and ideas. Learners' stories, as well as the activity that required them to finish a story, revealed intimate details of their personal lives and feelings. Learners were prepared to share their experiences with others in the class. The stories showed each child's personal experience and revealed to what extent they have common experiences. Where learners were required to complete the story, different endings emerged, although there appears to be a common thread in that most of the stories had a sad ending. Again learners voiced their negative feelings about fire.

> David ran away, Spud burned in the fire and the whole family cried...David ran home. He found Spud on the way and tried to save Spud, but Spud burned to death. David was so sad he killed himself by jumping into the fire

> ...When David turned around, he saw Spud burning in the fire, was sad and wanted to die with his dog.

> Saw his dog in the fire, the dog was burned. Was so sad, threw himself into the fire because he loved his dog and wanted his dog so badly. David ran home, told his parents that Spud was lost. Did not know if Spud burned in the fire. Called the fire brigade, Spud was saved by them.

The following stories also show that although the experiences are different, there is a common thread running through all these stories. Sharing these experiences with each other may help learners to cope with these difficulties, both emotionally and at a practical level.

Nathi

> My next-door neighbour has six small children. One hot summer day she was busy cooking with a gas stove, she left the house for a few minutes to go fetch some water in the river nearby because there wasn't enough water in the house. The children then noticed that there was a bottle of water, which was on the table they then took the bottle of water and pour the water into the stove and the stove blew up. The children quickly ran off the house, but there was a small baby who was lying on the floor…

Similarities and differences between learners emerged in the class activities. They were interested in each others responses for example, when one group of learners gave an answer to the question about which house would burn more easily, that was different to the other groups, they were interested in the reason for their answers. They participated enthusiastically in activity where they had to decide whose answer was most appropriate, as this provided the opportunity to discuss each other's answers.

Learning About Less Connected Things

Learners are thoughtful about issues that are less connected to their immediate surroundings. Although the link between everyday knowledge and formal science knowledge is the central criterion for relevance in this study, it is important to acknowledge that many learners of this age group are interested in exotic phenomena. The interviews showed that a number of learners who are more articulate and demonstrated an understanding of the science, were particularly interested in exotic phenomena that did not relate to their everyday lives. Interviews raised the following questions,

- What are tornadoes?
- We want to learn about planets
- Is uvutha and volcanoes the same thing?
- How can fire from a volcano flow like a river?
- How do floods happen?
- How do you get snow at Christmas?

Most of the topics mentioned by learners have a scientific basis and could serve as foundations for modules in science. This would allow for a curriculum that includes modules in science that are diverse and have different orientations. Not all modules have to consist of local content. In fact, many learners may find such modules relevant as they satisfy their interest in exotic phenomena.

CONCLUSION

Analysis of the teacher and learner narratives produced a number of categories that were presented as propositions about relevance. These propositions describe the dimensions of relevance that learners responded to during the teaching of the lesson series. Evidence was presented to support the propositions made regarding relevance to these learners as they engaged with the lessons on fire. The everyday knowledge of learners is an important criterion of relevance with regard to what is worth learning and extending in science knowledge. The other propositions are linked to this central proposition. The problems learners face in their everyday lives influence their everyday knowledge and the way they experience science. By bringing everyday knowledge into the classroom, it is made easier to bring aspects of their social and personal lives in as well. Everyday knowledge also allows learners to bring common experiences to the classroom.

The evidence for the way learners respond to science lessons that are described as relevant, was presented in this chapter. In the next chapter this evidence, along with the evidence reported in phase 1, will be discussed. This will allow an explanation of why learners respond the way they do.

CHAPTER 9

INTERPRETATION AND CONCLUSION

INTRODUCTION

In the preceding chapters the responses of learners in a particular context were described and analysed, in both conventional and arranged settings. The findings showed that different learners responded in different ways to different dimensions of relevance. In this chapter, the findings of phase 1, which explored different dimensions of relevance in a conventional setting, and phase 2 which explored dimensions of relevance in an arranged setting, shall be interpreted. Before discussing the different ways in which learners respond to relevant science, the meaning of relevance, as it is applied in this context, needs to be defined. Relevance is a complex concept and may be interpreted in different ways. Lessons from phase 1 were relevant in the sense that the content was closely related to learners' everyday experiences. The lessons were relevant from the teachers' point of view, as they believed that the topics covered were important for science learning. In phase 2 the curriculum content was relevant in the sense that learners selected a topic they were interested in. Fire was something that they wished to know more about. The content in this phase was therefore based on learners' everyday knowledge. Secondly, it was relevant because it was an extension of their everyday experiences and brought their everyday lives and interests into the classroom, including cultural aspects. The pedagogical approach introduced various dimensions of relevance as this approach allowed not only for learners to achieve a range of broader outcomes, but also allowed for learners' social and emotional needs to be met.

The structure of the lesson series also added another dimension of relevance. The approach was taken of presenting the lessons as a story of three children added to the relevance of the curriculum as the learners identified with the characters. The structure of the lessons added a further dimension of relevance as learners influenced the agenda and determined to a certain extent what would be discussed and the direction the discussion would take. Relevance also needs to be qualified in terms of who it is relevant to and to what purpose it is relevant. In phase 1 the teachers chose content that they believed was linked to the everyday experiences of learners but the content in the curriculum was also determined by the DoE. In the second phase learners chose content that interested them and was closely linked to their everyday lives and was not taken from the DoE curriculum. Nevertheless, some of the content covered was based on the National Curriculum. The DoE therefore regarded these concepts as relevant.

Although certain aspects of the lessons focussed on aspects of science that are relevant for future science learning, the relevance focussed on in this study was relevance with regard to learners interests, relevance with regard to immediate usefulness and therefore relevant in the short term. It also focussed on the relevance of the school and the purpose of the school to these learners. The different ways in which learners responded to the science lessons in both phases of the study, as well as my interpretation of why they responded in these ways, will be discussed as a number of outcomes.

- Participation as an outcome of a relevant science curriculum.
- Self-affirmation as an outcome of a relevant science curriculum
- Critical outcomes as outcomes of a relevant science curriculum.
- Science outcomes as outcomes of a relevant science curriculum.
- Science concept development as an outcome of a relevant science curriculum.

PARTICIPATION AS AN OUTCOME

Analysis of the findings in both settings show strong evidence that levels of participation were very high during lessons where everyday knowledge was the main criterion of relevance as this allowed for a range of other dimensions of relevance to be built into these lessons. Everyday knowledge included various aspects of relevance such as practical knowledge that helps learners in day-to-day survival, knowledge of cultural practices that learner's value and the fact that shared knowledge in a community of learners brings personal aspects such as relationships to the fore. Social and critical constructivism place value on the everyday knowledge of learners as this knowledge provides a basis from which learners construct further meaning and allows the value of knowledge in a particular context to be questioned.

Learners were able to link their everyday experiences to the content covered in the lessons. The ability to make this link was made possible exactly because the content introduced into the science lessons is from the learners' everyday lives. Although the lessons from both phases covered relevant content, the lessons taught in phase 2 were based on content selected by the learners themselves. The content was particularly relevant as it did not use conventional content and attempted to contextualise it but took everyday experiences and knowledge from learners and developed a theme around it.

These findings refute the suggestion made by Moll (2001) that this link does not occur easily as everyday knowledge is contextualised and school knowledge is decontextualised and when formal learning occurs, day-to-day experiences are transcended. In fact, day-to-day experiences serve as a foundation on which to build school knowledge. It brings 'invisible knowledge' to the fore, allowing for it to be discussed and reflected upon. All of this makes participation possible. Data from both phases produced evidence that learners were enthusiastic and participated fully with the level of participation higher during phase 2. This is based on the enthusiasm demonstrated by learners in producing material for the lessons, as well as their willingness to share their experiences with the rest of the class. This enabled learners to bring their everyday knowledge into the classroom. In the case of phase 2 lessons, it was often the actual experiences of learners that formed the basis of discussions. Sharing experiences, including social problems and interests, leads to a higher degree of participation.

Learners share cultural beliefs and want to talk about them and learn more about them. The inclusion of cultural aspects led to increased participation. Relevance was enhanced by the culture appropriateness of the content, as well as the inclusion of experiences that showed evidence of multiple worldviews. A number of the activities in the lessons encouraged participation. For some learners this was passive participation in that they observed, while for others it was productive in that they were more involved. Many learners participated in more in-group activities than in individual activities, while others tended to participate less in a group situation. The degree of participation was different for different learners at different times – sometimes learners would demonstrate a high degree of participation, at other times less. Relevance for the learners lay in the fact that they were able to participate. Participation in itself was therefore an outcome of a relevant science curriculum, as learners felt more comfortable in the science class because they had a stronger sense of belonging. The development of a stronger identity was expressed in participation. High levels of participation were also an expression of democracy as learners choose to become involved at different levels. This created the possibility for all kinds of learning in the science classroom.

SELF-AFFIRMATION AS AN OUTCOME

As with participation, the evidence suggests that learners are affirmed when everyday knowledge is used in the science class as it allows for other dimensions of relevance to be included. The lessons used the everyday knowledge and experiences of learners, acknowledging the similarities and differences between individuals and groups of learners. The activities brought these similarities and differences to the fore. Different activities allowed for different purposes to be addressed and in so doing, served to affirm learners. While some learners' interests lay in learning science for future schooling, others were interested in learning for survival. Learners had other purposes as well, such as philosophical and critical purposes. They wanted to know what to do to make their community safer from fire and tried to make sense of what was happening in their communities.

Lessons also took the different learning styles of learners into account and drew on their knowledge. While some learners enjoyed writing, others enjoyed talking. Certain learners were more responsive to strategies that encouraged social interaction where security within the group was important as well as those strategies that required creativity, such as drawing, or creative writing. The fact that a number of learners were also interested in learning more about natural phenomena that were unfamiliar to them, is evidence of the learners' need for individual growth and satisfaction (Fensham, 1988) when learning science. During activities where learners produced creative work they were deeply engaged, respecting differences that emerged.

Learners also found self-affirmation in the fact that there were not only differences among them, but also many similarities. They all took pleasure in expressing themselves through drawing and they wanted to discuss their culture. All learners participated in practical activities with great enthusiasm. Group activities that required discussion were also popular. They wanted their needs expressed in the classroom and wanted to engage in activities that addressed their survival in their communities. While the individual lessons, as well as the lesson series, were designed to develop a scientific view of the everyday phenomena that influence the lives of learners, the lessons aimed to do more than this. The intention was not only for learners to develop and formalise their everyday knowledge to a scientific view of that knowledge, but to take the knowledge they had developed in the classroom into their daily lives. In this way the curriculum addressed the needs of learners more comprehensively. These needs included day-to-day survival in a community plagued by fire.

The stories learners completed, their written stories as well as their drawings show a high level of participation, as well as preoccupation with the social implications of fire in their lives, rather than a deeper understanding of the underlying scientific concepts. From a social constructivist perspective these learners may be deeply involved in constructing social and emotional interactions, rather than science knowledge (Donald et al, 2002; Malcolm, 1999).

Where the curriculum includes content relevant to learners' everyday lives, confidence is built as learners engage with content that they relate to and are able to contribute to in the classroom. Learners build confidence in an atmosphere where their everyday knowledge is appreciated and their interests are addressed in the classroom. This affirmation and nurturing, shapes the climate of the classroom, providing new learning possibilities. It would seem that a relevant curriculum addresses the development of personal, emotional and social dimensions of learners' lives. This serves to affirm learners. The learning experiences of these learners may not have the purpose of developing a scientific view, but towards some other purpose. The purpose might be emotional security in an atmosphere where confidence is built and caring teachers nurture learners. If social and personal outcomes are the primary goals, these learners would not be concerned with processing new knowledge that is not immediately useful.

The role of the teacher is crucial for these learners as a sympathetic approach creates a nurturing atmosphere for these learners who view the school as a safe place and concentrate on personal and social aspects of school, rather than knowledge outcomes. Many of these learners are not given the care and attention they need at home and look to the school to provide these. This has implications for the way the class is managed, as well as the view of what constitutes knowledge. The relevance of this curriculum lay in satisfying the social and personal needs of learners. Those learners who view school as a safe haven, a nurturing environment where confidence is built and important aspects of day-to-day survival are taught, need a curriculum that is localised. It is only through a localised curriculum that these social and emotional needs of learners will be addressed. Especially in the context where the experiences of the learners form the basis for the lessons taught. These learners benefit by being affirmed in an atmosphere where their knowledge is appreciated. This allows them to participate in an educational context where they are able to contribute to the general pool of knowledge. The outcomes achieved appear to be more of a social and personal nature - participation, equity, self-confidence and enjoyment (Fraser, 1998). By localising the curriculum, the opportunities for learners to be affirmed increase. Relevance, for these learners, lay in the fact that they were affirmed. Self-affirmation is therefore an outcome of a relevant science curriculum.

CRITICAL OUTCOMES

The structure of the individual lessons, as well as the lesson series, was based on a learner-centred approach. This approach created the opportunity for the development of broad competences. These competences are described as seven critical outcomes in Curriculum 2005 (DoE,2005).

- Identify and solve problems and make decisions, using critical and creative thinking.

- Work effectively with others as members of a team, group, organisation, and community.
- Organise and manage themselves and their activities responsibly and effectively.
- Collect, analyse, organise and critically evaluate information.
- Communicate effectively using visual, symbolic and/or language skills in various modes.
- Use science and technology effectively and critically showing responsibility towards the environment and the health of others.
- Demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

As learners engaged with the various activities, a number of critical outcomes were achieved. Many activities required teamwork, where learners were required to work together to produce a common product. For example, the decision of which materials should be used to design a house required teamwork, as did the building of a fire and measuring time. The activity where learners had to decide how to clean water required a team decision. Learners not only enjoyed these group activities but indicated that they could work effectively in most instances as teams, producing a common product where required. Teamwork and individual work required self-management. As learners were allowed to pace their work, individually or as groups, this was important as learners had to manage their time and activities effectively. Most learners developed a degree of competency in this regard, completing activities and contributing to a group effort where required.

All activities required some form of communication. Learners communicated with each other and with me. Communication was often verbal when discussions occurred. Examples were discussions on fuels and energy. They communicated effectively when telling their fire stories. Learners were not as competent in communicating in writing, because of the reasons discussed in earlier chapters, although their written stories were good. Generally they were more competent in creative writing than factual reporting. Communication through drawing was very well developed with most learners preferring to communicate in this way. Opportunities for critical thinking and problem solving were present in activities such as water purification, the house design and finding the route that air would take to the lungs. Two of these problems were presented to the group, while individual learners were required to solve the third problem. The groups showed evidence of having developed these skills effectively, while the individual activity showed that a few learners had not fully mastered the skill.

Learners were aware of their responsibility towards the environment as was evident in the lesson on water purification, where pollution was discussed. They know that people are often responsible for dumping wastes in rivers. Cultural aspects of learners lives were discussed in the activity that looked at the different ways fires start. Learners were initially sensitive to the fact that aspects of their traditional culture were discussed in class, but became very interested and contributed to the discussion when fire stories were discussed. Learners were required to discuss the methods people used to put out the fires and to decide what it was that put out the fire. In this way learners learned to analyse particular situations and to think critically. The fact that the stories themselves caught learners' interest helped to ease them into the next step of analysis and critical thinking.

As learners engaged in activities that were aimed to enhance science learning, they were aware that the knowledge engaged with was part of their everyday experiences. This provided the opportunity to become aware of the interconnectedness of things. The problems they discussed in class had relevance in their communities. Another important outcome was the ability to make sense of the world. There was also evidence that learners achieved this outcome in their understanding of phenomena that were covered. This extended into the desire of a number of learners who wished to understand phenomena that they were not familiar with and could be described as 'exotic' phenomena. They wished to know more about other parts of the world and how things that they had never seen, work. The critical outcomes are cross-disciplinary and are viewed as essential outcomes for citizenship. In this sense they are important in the long term and provide learners with the skills to function effectively in society. They are also important in that they provide a framework within which specific science outcomes may be achieved. This curriculum created the opportunity for the development of critical outcomes. As the critical outcomes stand above the science outcomes, the critical outcomes in themselves are outcomes of a relevant science curriculum.

SCIENCE OUTCOMES

Scott and Driver (1998, p70) define a curriculum as

> "a set of learning experiences which enables learners to develop understanding towards a scientific view."

The everyday knowledge used in the lessons of phases 1 and 2 provided the basis for the relevance of the curriculum. This relevant curriculum made the achievement of the important outcomes discussed in the preceding sections, possible. While these outcomes are important, they are not specific to a science curriculum. A science curriculum has to ensure that science knowledge and skills are developed, distinguishing it from any other curriculum.

Science knowledge, skills and values are discussed in the RNCS (2002) as the Natural Science Learning Outcomes. They are,

- Learning Outcome 1: Scientific Investigations

  The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.
- Learning Outcome 2: Constructing Science Knowledge

  The learner will know and be able to interpret and apply scientific, technological and environmental knowledge.
- Learning Outcome 3: Science Society and Environment

  The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment.

The RNCS (2002) stresses the importance of learners being able to use science, not just acquire it. These outcomes are designed to enable this as learners engage with the content described under core knowledge and concepts. In the descriptions of the outcomes, it is clear that they provide some latitude in how they may be interpreted. For instance, at the intermediate phase level the knowledge outcome includes aspects that require learners to simply name things, while at other times they require some understanding of theoretical concepts. The core knowledge is structured as four content areas - Life and Living, Matter and Materials, Energy and Change and Earth and Beyond. The intention is that teachers draw from this content in the design of learning programmes. Added to this is the rule that 30% of the time allocated for Natural Science should be used to develop the curriculum around local contexts. This aspect provides an important dimension of relevance.

The content selected for the lessons in both phases, was from the everyday lives of the learners and the pedagogical strategies applied were aimed at providing opportunities for achieving knowledge, skills and values by using learners' existing knowledge, exploring learners' way of thinking about science and using activities to extend knowledge from the present way they thought of science to a way of thinking that was more representative of a scientific way of knowing. Building on learners' knowledge by using their everyday knowledge as a springboard for the development of science knowledge, can be accomplished. Science learning is facilitated if the learner is able to connect the formal, structured science knowledge of the classroom to the informal, unstructured science knowledge in the home. While different activities focussed on the achievement of different science outcomes, these outcomes are intertwined making it impossible to separate them in each activity. This is especially true of outcome 2.

The predict-observe-explain activity was an example of an investigation. It contained all the steps necessary to achieve learning outcome 1 as learners had to formulate a hypothesis, carry out a plan, make observations, collect data and report on their findings. As reported earlier, learners participated enthusiastically, achieving the different aspects of the outcome as teams. The candle and jar experiment was also an investigation that was more open than the previous one with fewer steps. While learners all made correct observations, a small number of learners were not able to explain their observations. Although the investigations made the achievement of process skills possible, they also had knowledge outcomes. It allowed for the development of knowledge of gases and their functions, as well as knowledge of materials and an understanding of the concept of flammability. This points to the difficulty of trying to separate the outcomes, as knowledge outcomes are inevitably part of the other outcomes.

As learners participated in the activities many opportunities arose for them to engage with science knowledge. Using their informal, unstructured everyday knowledge to develop formal, structured science knowledge did this. This focus on learners' everyday knowledge implies a particular view of the classroom, referred to as a socio-cultural view by Scott and Driver (1998). Bernstein's reference to invisible pedagogy (1977) is similar in a sense that it makes the inclusion of the culture of the family and community possible. Both classroom observations and learner interviews support the view that not only were learners more deeply engaged, but more learners were participating and developing knowledge when they built on their existing knowledge. The interviews, class work and tests produced evidence of knowledge construction in a substantial number of learners. They extended their knowledge of fuels from their existing knowledge. Learners were aware of heat and light as experienced in their everyday lives. The lessons enabled them to formalise this knowledge as forms of energy and some learners were able to extend it to other forms of energy. The concept of flammability was well developed as learners demonstrated in the burning activity. Knowledge of the importance of air, specifically oxygen, was developed in a number of learners. Learners had good understanding of concepts related to life cycles as was observed during classroom discussion. While most learners had an understanding of the observable causes of water pollution, many learners struggled with the less visible causes.

The conclusion is that in the majority of learners, when engaged in science content that is relevant to their everyday experiences and interests, knowledge construction is enhanced as they are able to build on their existing knowledge. However, learners did not only bring their everyday knowledge into the classroom, but were able to use their new knowledge in their everyday lives as was evident from the interviews. While the findings show that many learners were able to process concepts in such a way that it enabled them to build new conceptual knowledge on existing knowledge, a number of learners were not able to process new knowledge in a way that allowed them to build on existing knowledge. It is not a question of knowing in different ways and gaining knowledge in different ways – learners are focussing on different aspects of the world (different knowledges have different values).

The lesson on water purification stressed the importance of the relationship between science, society and the environment as espoused by learning outcome 3. Learners understood that science knowledge may be used to improve the environment but were very aware of the role people played in polluting water. The learners' stories and class discussions revealed that they were aware that part of the problem of fires in their community was due to the fact that their community did not have access to technology i.e. electricity. In fact, the science-society aspect of the lessons in phase 2 was integrated into outcomes 1 and 2 throughout all the activities, confirming earlier comment that it is often difficult to separate the outcomes in teaching situations. The use of community life to develop science knowledge made it possible for learners to see the connection between science and society. This was evident from the interviews where learners mentioned that their science knowledge would help them in their communities.

SCIENCE CONCEPT DEVELOPMENT AS AN OUTCOME

The preceding section discussed the achievement of the three science learning outcomes in a relevant science curriculum. The construction of science knowledge is one of these outcomes. The RNCS (2002) describes this outcome as including the ability to collect and extract information, analyse and interpret this information and use concepts. However, a number of learners had trouble formalising science concepts within the context of a relevant science curriculum. The use of everyday knowledge was useful for developing science outcomes at simpler levels such as naming and describing, as well as developing process skills. It was also helpful in creating problem-solving situations and helped to develop an understanding of the relationship between science, society and the environment. While a significant number of learners demonstrated advances in conceptual development while interacting with various aspects of relevant science, a number of learners did not seem to benefit from this approach with regard to the development of science concepts. This was evident from their responses in the work sheets and tests, as well as the interviews. Most responses to questions were responses based on everyday experiences. These learners were apparently having difficulty moving from everyday practical knowledge to theoretical knowledge.

Developing science concepts depends on the learners being able to develop an internal structure that will allow for new concept development. This will allow learners to link the realities of the physical world and the symbolic scientific knowledge used to describe that world. This process should allow for a knowledge change to occur. Chin and Brewer (1998) describe certain factors which influence this change. These are prior knowledge, characteristics of input information and processing strategies. The lessons relied heavily on the prior knowledge of learners, pedagogical strategies were learner-centred, which meant that input information occurred in such a way that conceptual development could be enhanced and created in an environment for processing of knowledge. In spite of this, a number of learners could not move to theoretical knowledge. As learners engaged in different activities it was clear that some learners had difficulty in processing the information they engaged with by developing formal concepts. They continued to use their informal everyday knowledge, as is evident from the quote below.

The fire will go out if I cover it with sand (prior knowledge, practical and useful).

When the reasons why the fire would go out were explored through a number of activities to develop the concept of air (oxygen), certain learners could not build this concept into their existing knowledge structure. Information from interviews, as well as analyses of responses in work sheets and tests, showed that these learners kept on repeating the everyday knowledge they already had. They showed no inclination to expand their knowledge. While conceptual development does not proceed at the same pace in all learners there was sufficient time, as well as sufficient variation in the given tasks to enable conceptual development if this was an outcome of relevance for these learners. If learners do not make sense of new concepts, these concepts have very little value for them. They come to value other aspects of schooling, rather than the acquisition of new knowledge. To these learners other outcomes of a relevant science curriculum apply.

One reason for this inability to process new concepts might be cultural. Border crossing, referred to previously, may be difficult for certain learners but as all learners are from the same, non-western, culture this seems unlikely. There is no evidence to suggest that those learners, who do have difficulty in conceptual development, have stronger cultural bonds than others. In fact, one of the learners who was quick to grasp new concepts and contributed a great deal in the classroom, lived for extended periods with her grandmother in the former rural Transkei. Gamble (2002) uses Bernstein's horizontal and vertical discourses in her work where horizontal discourse refers to the everyday, common sense knowledge and vertical discourse to structured, abstract knowledge. This may be regarded as another form of border crossing, as learners are required to move from the horizontal discourse to the vertical discourse. Pedagogical strategies in the classroom may enable the learner to use horizontal discourses to structure vertical discourses. Instead of viewing the two in opposition to each other, it may be more useful to acknowledge the difficulty in drawing a clear distinction between the two.

As the use of everyday knowledge is the central criterion of relevance, context is an important aspect of this research. As the RNCS (2002) sees the purpose of the science curriculum as linking science learning to society, context is important. Using the everyday knowledge of learners made it possible for the achievement of outcomes such as participation and affirmation. The use of everyday knowledge also made a learner-centred approach easier, facilitating the achievement of critical outcomes. These outcomes may be a means of helping learners to move from practical to theoretical knowledge. Although context may be secondary for developing science concepts, it is primary for developing participation, affirmation and critical outcomes. This raises the question of what should be fore grounded in a science curriculum? Should science outcomes be fore grounded or should other outcomes be fore grounded?

IMPLICATIONS AND RECOMMENDATIONS FOR CURRICULUM DEVELOPMENT

The findings from phase 2 produced a number of propositions about relevance. Together with the findings of phase 1, these propositions were brought together in a number of outcomes of a relevant science curriculum. My thesis is constructed from these propositions and outcomes and is presented as implications for curriculum development. Relevant literature has been referred to throughout the report and I will draw from this to support my thesis.

For these learners, learning science in a context that makes use of their everyday experiences is important. They value the fact that their everyday experiences are used as a springboard for learning. Crossing between school learning and out of school learning is one of the more difficult borders to cross for most of these learners but if they see the use of their everyday experiences as more than just a device for learning science, they are more inclined to bring their home experiences to school. Although they might not see that they learn science at home and bring scientific theories to school, learning school science is made more accessible if it happens through everyday experiences. In allowing learners to determine the content in phase 2, they were able to select the kind of knowledge and experiences they wished to bring to the science classroom. The importance of the use of everyday knowledge in science learning is supported extensively by various authors(Gaskell,1992; Baine,2000; Campbell et al ,2000). However, the evidence suggests that when the everyday knowledge used, was decided on by learners themselves, the notion of contextualised science is extended, facilitating the move from informal, unstructured learning to formal, structured science learning,

Curriculum design and teaching may help to break down the border between in-school and out-of-school contexts. The difficulty in crossing the border between the in-school and out-of school context is partly because of the difference in structure between the two contexts. The school environment is structured with specific time frames, rules, norms and values, formal tests and so forth. The lessons in phase 1 were conventional lessons in every way, while the lessons series of phase 2 only differed in structure from conventional lessons in the long periods that were used for the lessons. The evidence of learners being able to cross the border between the two contexts was due to the particular design of the curriculum with its particular teaching strategies and contextualised content. While changing the school structure is difficult, teachers may be in a better position to facilitate change in content and teaching strategies in their classrooms. While a number of authors alluded to the difficulty of engaging teachers in curriculum reform (Bernstein,1990; Klein,1992;) this study showed that such curriculum change is impossible without teacher input. A much deeper level of teacher collaboration than that which is currently the norm is required to facilitate curriculum change.

For these learners science education is much more than only science. They value the use of their everyday knowledge in the science class because they want to link their school learning to their lives and their purposes. All learners place a high premium on participation and affirmation. The importance of participation has been reported on extensively. However, added dimensions of participation and affirmation are made possible by the fact that the personal and social lives of learners are brought into the science classroom. They want to learn about survival and they want to understand their lives and how their culture forms part of their lives. They experience science as part of the social and cultural aspects of their lives, rather than a neutral discipline. While science knowledge and critical outcomes may be valued, some learners place less value on science learning and the achievement of critical outcomes. For them it is important for their needs to be met in the science class. While the findings supported the evidence that addressing learners'social and personal needs, enhanced science learning (Osborn and Freyberg,1985; Posner,1992; Wallace and Louden,1998), it showed that for a number of learners, science learning remained secondary to other purposes such as affirmation and participation .

The outcomes of a relevant science curriculum as they are described here, highlights the problem of distinguishing between means and ends. Are science knowledge and skills the purpose of science learning or does the science content provide a context for learning more than science? The same question applies to affirmation and participation. Are these outcomes of science education ends in themselves or are they a means for science learning? The question applies to the critical outcomes too. The RNCS (2002) see them as standing above science outcomes and as an end in themselves, although they may be a means of learning science and other things as well. Science education should attempt to strike a balance between 'learning science' and 'learning through science'. The outcomes of relevant science discussed in this study are both a means to science learning and ends in themselves. This view is differs from much of the research in science education reported on in this study (Brown,2003; Daniels and Perry,2003) where other outcomes may be encouraged, but are seen as a means to achieving an end which is the enhancement of science learning.

This has implications for curriculum development as it raises the question of the purpose of a science curriculum. The science curriculum has the responsibility to develop conceptual knowledge and to educate towards a scientific way of thinking. While other outcomes are more generic and may be addressed in other classes, the science class is the only place where science learning will happen. While a science curriculum may place science learning in the fore ground, it may also provide for other types of learning and therefore other outcomes as well. While the RNCS (2002) supports this view in its preamble, the assessment standards of the Natural Science Learning Outcomes show no evidence of attention gives to such outcomes, as assessment focuses only on science outcomes.

The essence of a relevant science curriculum lies in a design that accommodates many dimensions. Such a curriculum uses the everyday knowledge of learners to influence the content used in the curriculum, the purposes of the curriculum and the processes whereby learning occurs. It takes the intentions of learners into account and allows them to influence the contexts in which learning occurs and as a result, the outcomes that emerge as a result of such learning. These learning outcomes are not in conflict with each other; they work together to support each other. The findings of my study point to the complexities involved in designing science curricula. The issues identified are those of a community of learners in a particular context. The dimensions of relevance identified apply to these learners. The content was relevant to this group, the social and personal aspects of relevance applied in this context. This is a unique situation and the interpretive nature of the study served to interpret what this particular group of learners experienced as a relevant science curriculum.

This brings to the fore the tension between a universal curriculum and a curriculum that addresses local interests, including indigenous knowledge. A universal curriculum has to allow for the development of universal outcomes of science education, while the localised curriculum strives to accommodate a broader range of outcomes, including those of participation and affirmation. Similar approaches to curriculum development are found in other countries where the national curriculum is adapted to suit the local context and teachers adapt their pedagogy to suit the curriculum and changes in resources - a relevant science curriculum bounded by a national curriculum framework (Cowley and Wiliamson, 1998). The way in which learners responded indicates that if science education does not pay attention to these issues, there is little chance of any other outcomes being achieved. It would seem that before these particular learners are able to benefit from schooling by building conceptual frameworks that would lead to achievement of outcomes for democratic participation and citizenship that will enable them to function in a broader society, their social and personal needs need to be met (Sjøberg, Schreiner and Stefánsson, 2004).

CONCLUSION

The thesis put forward - implications for curriculum development - may be interpreted through the critical questions that have guided this research.

- What do learners regard as a relevant science curriculum?
- How do learners respond to a relevant science curriculum in a conventional setting?
- How do teachers use the knowledge they have to teach relevant science?
- How do learners respond to a relevant science curriculum in an arranged setting?

Learners find relevance in a science curriculum that includes their everyday knowledge and experiences. They see relevance in a curriculum that responds to their purposes and uses contexts that brings local culture into the science classroom and provides opportunities to learn about survival in their everyday lives. They view science education as something much more than science, with learning outcomes that include more than science learning. Designing science curricula that have more purposes than only science learning, but at the same time foregrounds science learning, requires the input of science teachers. Only teachers are able to design science curricula that are localised, as they know the context and the learners they teach. This knowledge allows them to teach and design the curriculum in such as way that many dimensions of border crossing are facilitated, not least the difficult border separating in school from out-of-school.

The conventional setting provides less opportunity for learners to achieve outcomes of affirmation and participation, as the use of their everyday knowledge is limited. Nevertheless, there were instances where their out-of-school experiences were used in the science class. While learners responded positively during these instances, they were less responsive at other times. They were also less inclined to take their science learning home. The arranged setting allowed learners to influence the content used in the lesson series. This fact, along with the design of the lessons and the teaching, made it easier to break down the border between in-school and out-of-school contexts. Learners were more inclined to use their experiences in the science class and take these experiences home. The fact that learners influenced the content and context meant that more learning outcomes were possible. These outcomes were not all science outcomes, but complemented these outcomes where all the outcomes achieved were both a means to science learning or other learning and ends in themselves.

In conclusion, I wish to give a brief review of my research. Although my research focussed on a particular context of two urban townships in Cape Town, I believe it is important in the context of global science education reform. The theoretical framework that provided a lens for the study was constructivism. Social constructivism provided the framework for the research as a whole, while critical constructivism framed phase 2. While the literature on both forms of constructivism was reviewed, the literature on socio-cultural factors and classroom practice within a social constructivist frame was covered extensively. Literature on various curriculum theories were also reviewed.

The research was conceived in two phases. An interpretive methodology was used in phase 1, while phase 2 had a strong participatory focus, a methodology that was essential within a critical constructivist framework. Phase 1 is presented in chapter 3 to 5, while phase 2 is presented in chapters 6 to 8. Phase 1 covers research conducted in a conventional setting while phase 2 covers research conducted in an arranged setting. Teachers taught the lessons in phase 1, while I became the teacher in phase 2. In both phases, the descriptive analyses are presented as narratives. These are narratives of a teacher and two learners. In phase 1, the second level of analysis is presented as the teacher' knowledge of her learners, as well as the learners' responses to relevant science. The teacher's knowledge is reported as a number of dimensions of relevance while the report on learners' responses show that they respond to similar dimensions of relevance. In phase 2 the second level of analysis is reported as 6 propositions about relevance.

Chapter 9 brings together the findings of phases 1 and 2 as outcomes of relevant science. Together with the propositions discussed in chapter 8, they form the findings on which this thesis is based. The thesis puts forward a number of issues, which characterises relevance for the learners in this context and discusses the implications for curriculum design.

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APPENDIX A

PHASE 1; STAGE 1
Work sheet: Water Purification

Cleaning Water

A water pipe in the street that you live in has burst because a big truck has run into it. There is no water at home because of this. There would be no water for three days. The only place to get the water is from the river nearby.

You have the following things that you can see in the front of the classroom. Some of these things can be used to clean the water enough so that you can drink it.

Talk about what you could do to clean the water in your groups.

Try and clean the water using whatever you need from the table. Try as many ways to make it as clean as possible.

Write each step that you did and say why you did that.

1. 1st Thing that we did was:

we take dirty water and strain the wa ~~ter~~ ter and the will be clean.

Why did you do that? because we want wa ter to be clean.

2. The second thing that we did was:

we was boil ~~and~~ it the water and take strain it

Why did you do that?

because we want to clean the water and drink the water.

3. The third thing that we did was:

Why did you do that?

we boil the water and the will be clean

APPENDIX B

PHASE 1
Learner interview schedules

3. LEARNER INTERVIEW SCHEDULE

The main purpose of these interviews is to gain insight into the lives of the learners and to use this information when designing the curriculum module. The teachers may want to interview these learners in groups of 4-6 or individually.

As the teachers see the learners every day, they may want to interview over a period of time.

This interview schedule is semi-structured , although not all questions are included. The reason for this is that specific questions that teachers ask will be determined by the topic taught or by incidents that occurred in the classroom on a particular day.

DRAFT INTERVIEW SCHEDULE

Date and place of interview:____________________

Name/s of learner/s:____________________

____

____

____

School:____________________

Questions:

CULTURAL ASPECTS (INCLUDING LANGUAGE):

Possible questions may be:

1.Which aspects of your culture do you practise at home? Name a few.

____

____

____

2. Do all members of your family participate?____________________

3. Do you think these practices are important?____________________

4. What language do you speak at home?____________________

5. Which languages do people speak in your community?____________________

____

SOCIO-ECONOMIC CIRCUMSTANCES:

1. Home many people share your home with you?____________________

2. How many people share a room with you?____________________

3. How many meals do you eat per day?____________________

4. Do you have a radio or TV in your home?____________________

5. Do your parents have money for school books?____________________

6. Do your parents have money for new clothes for you?____________________

7. What would you like to buy if you had the money?____________________

____

____

____

____

RELEVANCE IN THE LEARNER'S LIFE:

1. What do you do after school?____________________

____

2.Which sports do you like? ________________________________

____

3.Do you read books? Which books do you read?

____

____

4. Which TV programmes do you watch?____________________

____

____

APPENDIX C

PHASE 2
Questionnaires

Slindile Khoza
grade 6B

QUESTIONNAIRE 1
HOW SAFE IS OUR HOME?

The purpose of this questionnaire is to find out how well your home is protected against fire.
Ask members of your family to help you to answer the questions.
The information you get may help you to plan to improve the safety conditions in your home or to give other people advice who may have homes that are unsafe.

1. What kind of material was used to build the outside walls of your house?
It was made by blocks and the mixture of cement.

2. What kind of material was used to build the inside walls of your house?
It was also made by the mixture of cement and sandy soil.

3. Do you have outbuildings close to your house? Yes I have.

4. What is this building made of?
It is made by the mud.

5. Do you have electricity in your home? If you have, how many electrical cords are connected to 1 plug?
yes I have electricity in my home. There are three cords connected in 1 plug.

6. Are any of the wires in the cords exposed. No

7. What other fuels do you use in your home?
We only use paraffin

8. Is your stove near a window? No, is near the door.

9. Are there curtains in front of the window? yes there is curtains in front of the window.

10. What are the curtains made of? Is made of poly and cotton

11. Are there any other materials in your home that burn easily?
yes there is only methylated spirits

Thank you for your co-operation

Wandile + Cele

QUESTIONNAIRE 2
WHAT DO WE DO WHEN SOMEONE IS BURNT IN A FIRE?

The purpose of this questionnaire is to find out if people in the community know what to do when people are burnt in fires.
Ask members of your family to help you to answer the questions.
The information you get may help you to learn more about how to treat people who are burnt or to give other people advice who may not have the knowledge your family has.

1. Has any member of the family ever been in a house that was on fire?
yes

2. If you have, how was your breathing affected?
She was chocking on [illegible]

3. Have you ever seen people who have been rescued from a fire?
yes

4. What was wrong with them?
the were burnt

5. What should you do if somebody has bad burns from a fire?
keep the wounds cool eg with ice or water

6. Should you cover the burns? Why /why not?
no the person should be taken to clinic

7. What should you do if someone has trouble breathing?
remove him from the smoke, [illegible] his noese and blow in his mouth to help him breath

8. What does it mean if someone has trouble breathing?
there have breathed in too much smoke

9. What must you do if someone has mild burns from a hot stove or any other hot object?
Place the burn in under cold water

Thank you for your co-operation

Dawn MDLALOSE

Grade 6 "B"

QUESTIONNAIRE 3
WHAT DO WE DO WHEN A FIRE BREAKS OUT?

The purpose of this questionnaire is to find out if people in the community know what to do when a fire breaks out?
Ask members of your family to help you to answer the questions.
The information you get may help you to learn more about how to put out fires or to give other people advice on how to put out fires.

1. Have you ever put out a fire in your neighbourhood?
yes

2. How did you put the fire out?
We used a fire-esctinguisher a[illegible]d a fire house.

3. How would you put out a fire started by an electrical fault?
put off the main switch then d[illegible] the flames with a house or an esctinguis[illegible]er.

4. Can you explain why you would put out an electrical fire in this way?
by putting off the main you cut o[illegible] the power so it won't do more damage.

5. When a fire breaks out in a house, would you open or close the windows and doors?
you open the doors and windo[illegible]

6. Why would you do this?
If you do not open the doors a[illegible]d windows the smoke and fire engulfs the [illegible]ouse.

7. What would you do when oil on the stove catches fire?
douse it with sand or put a [illegible] rug on it.

8. Why would you do this?
the flame surrenders faster th[illegible]s way.

9. What would you do when curtains in the house catch fire?
quickly get water to douse it [illegible] it doesn't spread to other arears.

Thank you for your co-operation

APPENDIX D

PHASE 2
Work Sheets

Fava Xolelwa Grade 4

FIRE IN OUR LIVES: VELD FIRES

WORKSHEET 1:

A.

Thandi, Bongi and Thabo were walking along a foot path on Table Mountain. Suddenly Thabo shouted: "Look- a fire!"
The friends start to talk about fires and when fires usually occur. They wonder if veld fires are more common in winter or summer.
Thabo asks: why dowe have so many fires this time of the year?

1. Can you answer Thabo's question?

It is because that in summer it is hot, dry and warm and planet it is can be burn.

B.

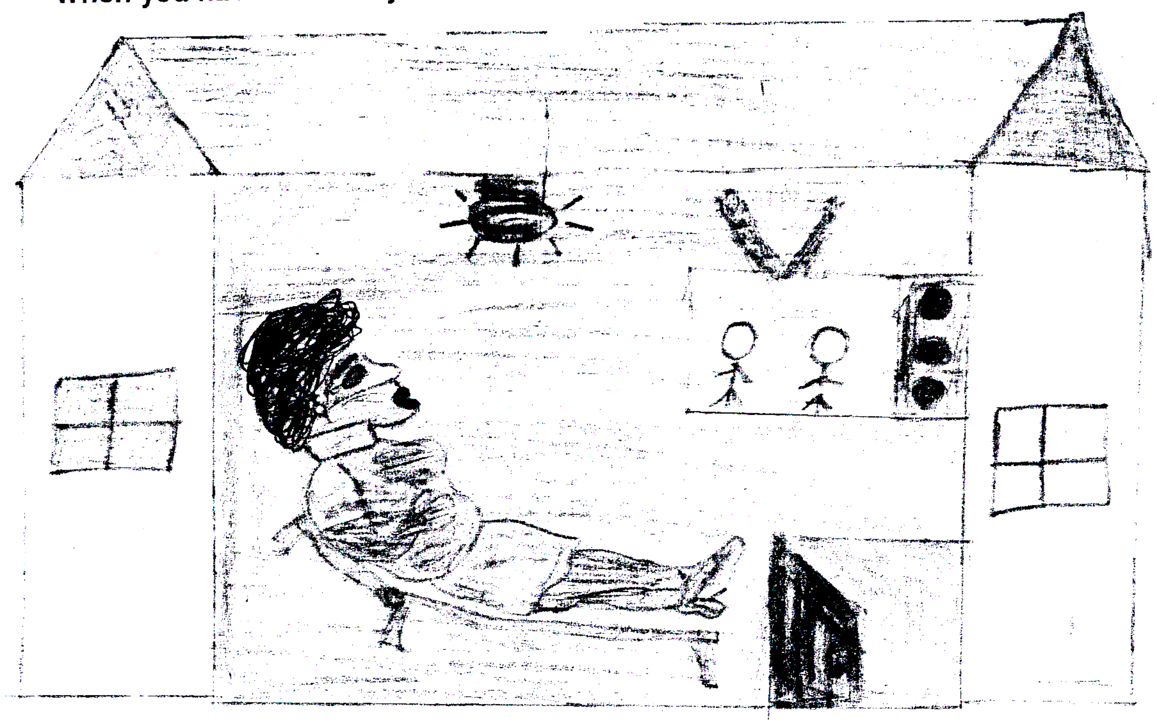
Bongi wonders: ' How do fires start?'
Thabo says: ' It starts by itself.'
Thandi says: ' No ,it is Uvutha (witchcraft)'
Bongi says: 'I think people start fires.'

1.What do you think? Explain how you think fires start.

can be caused when someone is Jelous of you and he goes to a wich doctor

Let's listen to a story.
Do you know any stories like this one?

2.Draw a picture of what you remember best in the story
When you have finished you can tell us about your picture



3. Uvutha is one way of explaining how fires start. Scientists have other explanations as well.

Dzina [illegible] Grade [illegible]

FIRE IN OUR LIVES: FIRE IN OUR TOWNSHIP
WORKSHEET 2

Why do we have so many fires in our townships?
Thandi, Bongi and Thabo met some their friends as they were walking down the road. "Did you hear what happened to Mrs Sisulu's house?" asked one of their friends. " It burned down last night. "
The friends then started talking about the possible causes of the fire. They agree that it most probably has to do with the materials the house are made of.
Let's see what these materials are like:

1. Write down the names of each of the materials you were given:

a) plastic
b) siling boart
c) card boart
d) ~~[illegible]~~ face of clothers
e) foil
f) silky
g) laice Piece
h)

2. Write down the names of three materials that you think would not burn easily

a) ~~plastic~~ Cyling ~~board~~
b) ~~card board~~ Card board
c) ~~laice piece~~ ~~Clothes~~ tin foil

3. Use the poster paper to design a house from the material you have in your group. Use the material you think will not burn easily.

4. Take the materials outside and burn them.

4.1.Write down which ones burn the fastest.

a) plastic

b) silky

c) laice piece

4.2.How can we measure which material burns the fastest?

4.3.Count how long it takes for the material to burn.

plastic take to 2 countings
silky take 7 countings
clothers take 4 countings
lace take 3 countings

4.4.Was you prediction right?

yes

5.Look at the houses in the pictures or photographs :
Which house is the safest house to live in?
Give reasons for your answer

We choose the house who has a blue paint it is safe for us it made up a zinc because a zinc is not burn easy like a house of card board, or a cyling board

6. Each of you will be given some questions to take home.
Ask your parents , brothers or sisters or anyone else who lives in your house to help you to answer the questions.
Remember to bring your answers to school tomorrow

Khokso Hlahatsi 4 June 2003

FIRE IN OUR LIVES: FIRE IN OUR TOWNSHIP

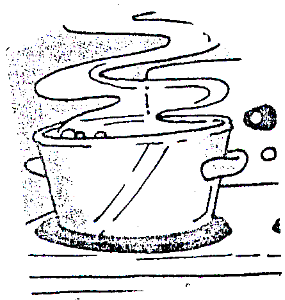
WORKSHEET 3

1. Does a fire have energy? Why do you say that?

Yes It has energy
It chang thing

2. Scientists say that Energy is needed to change things. What are some of the things you see and feel as a fire burns?

The smoke go up



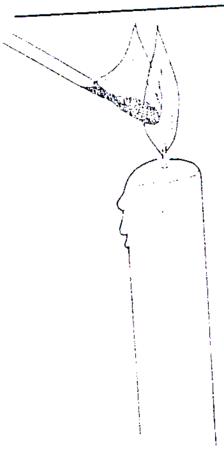
3. How do we know that there is energy in fire?

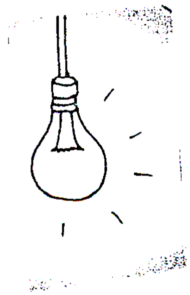
There is heat light and movement energy

4. Scientists say energy has different 'forms.'
A change in material is called chemical energy.
A change in temperature is called heat energy.
A change in movement s called movement energy
Light is called light energy

What forms of energy can we see and feel when a fire burns? Give your reasons.

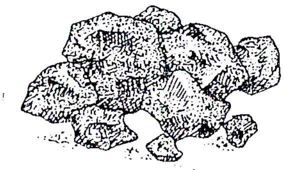
heat energy light energy and movement energy





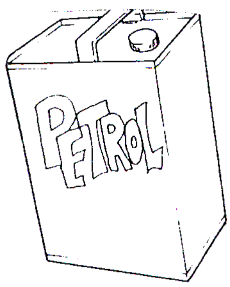
Khotso Hlahatsi 4 June 2003

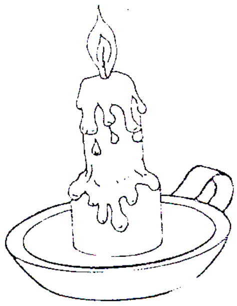
5. What do you use fire for in your home? What changes do you want to cause? Parafine heat energy and light energy



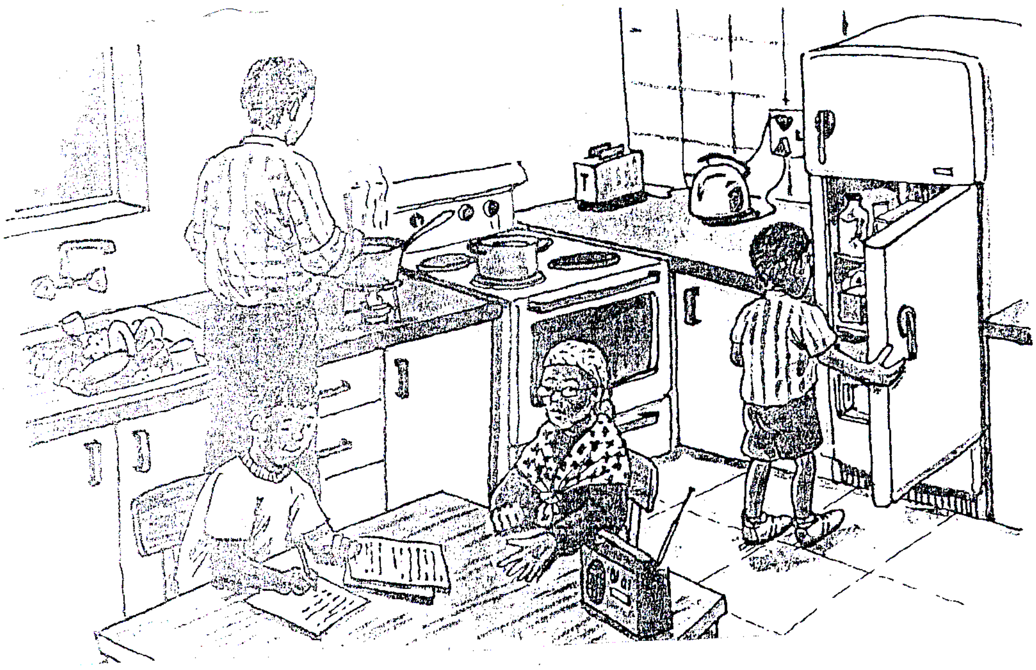
6.Fuels are materials we use to make fires. Write down all the fuels you know of that people use in their homes

Parafine
PeTrol
SPirit
PlaStic





FIRE IN OUR LIVES: FIRE AND PEOPLE Zimasa Sityata
WORKSHEET 4



A.
Thabo and his friends started talking about mrs Sisulu's house again and wondered why it had burned down.
1. Can you give Thabo and his friends some idea of what could cause a fire inside a house?

Foutos , carGarD , clouth , pram astom table

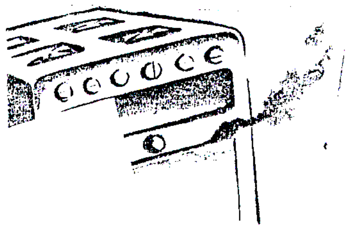
Let's listen to few stories about children your age who have seen houses burn down.

2. How did the children in the stories help to put out the fires?

yes Becous the water did that

3. Why do you think these methods work?

it work Bay water, Sand, and blenkens



B.

We have learnt that a fire needs fuel to burn and we have thought about ways to stop a fire

1. Does a fire need anything else to burn?

NO I do not think the fire need some thing else Because the fire has heat if you bour water the heat will not be able to burn again.

2.Form groups of three and compare your answers.

2.1.Are all your answers the same?

NO

2.2. If not, discuss the answers and write down those that you all agree on.

Jes the fire need air to Burn and a energy

3.Each group will report back to the class.

3.1.Do the different groups have different answers?

Yes is the same

3.2.Which answers are correct?

C.

We have learnt that air is also important. Let's find out more about air.

Read the passage on air. Each group will tell us something interesting about air.

1.What does air consist of?

Oxygen , Carbon dioxide, Nitrogen, and water vapor

2.Which gas do you think is necessary for a fire to burn?

It is Oxygen

D.

What happens when a fire has no oxygen?

Place the candle on the desk.

Light the candle.

Place the tin over the burning candle

Leave the tin over the candle for a minute

Lift the tin

1.What happened?

it came awite smowk

2.Why do you think this happened?

Becouse it was the oxegen

3.What gas was used by the candle?

It was the air gas

4. What gas took the place of the gas used by the candle?

it was the oxygen gas

FIRE IN OUR LIVES: FIRE AND PEOPLE
WORKSHEET 5

A.

What do you think they used to put out the fire in Mrs Sisulu's house?

1.Write down all the things you have seen people use to put out fires.

water, sand, blanket

Foam, Hose,

Fire extinguisher

2.How does water put out a fire?

3.How do sand or blankets put out fires?

4.Can you explain how a fire extinguisher works now ?

B.

During 2002 a number of fires occurred in Guguletu. The following were used to put out fires:

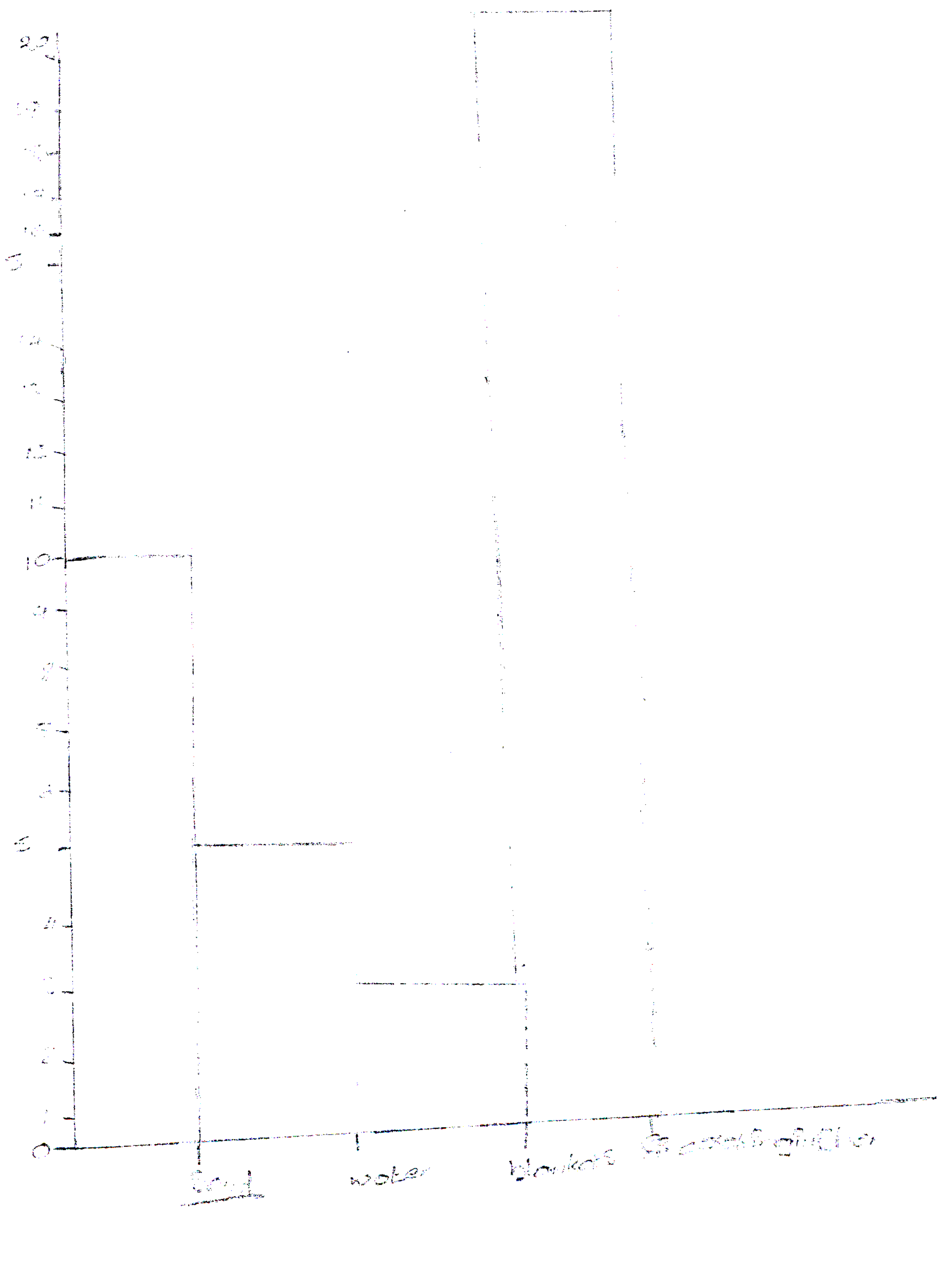
20 fires were put out by fire extinguishers that have carbon dioxide in them

10 were put out by sand

5 were put out by water

3 were put out by wet blankets

How can we represent this information in a picture?



22
15
10
5
0
water
blankets

FIRE IN OUR LIVES: FIRE AND PEOPLE
WORKSHEET 6

A.

Last year a house burned down close to where Bongi lives. He says that 5 of the 8 people who lived in the house died in the fire. The other three were taken to hospital.

He watched as they carried people out. Two of the people were badly burned. He cannot understand how the other people died because it did not look as if they had burned at all.

He also cannot understand why the people who were alive when they were carried out of the house, died later in hospital.

Have you ever seen people who were burnt in a fire?

Form groups of three. Each member of the group has a number 1 to 3. This is your home group

All the number 1's form a group; all the number 2's form a group and all the number 3's form a group. These are the specialist groups.

Each specialist group will be different information.

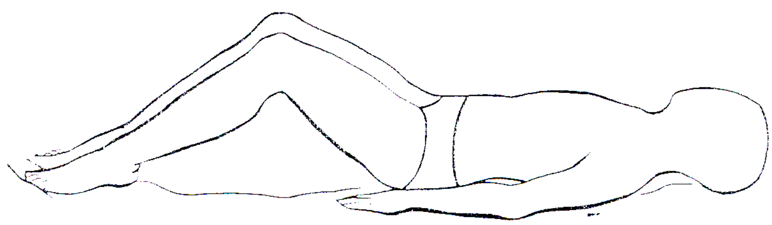
Group 1 : You have a topic on why people die from bad burns.

Group 2: You have a topic on people who survive a fire but die days or weeks later.

Group 3: you have a topic on people who die of suffocation.

Read through the information, talk about in your group and decide what you would like to 'teach' your home group about this topic. Once everyone has an understanding of the topic, you will return to your home groups .

You are a specialist on your topic. Tell your home group what you know about the topic. Try to answer their questions. If you cannot, ask your teacher for help.

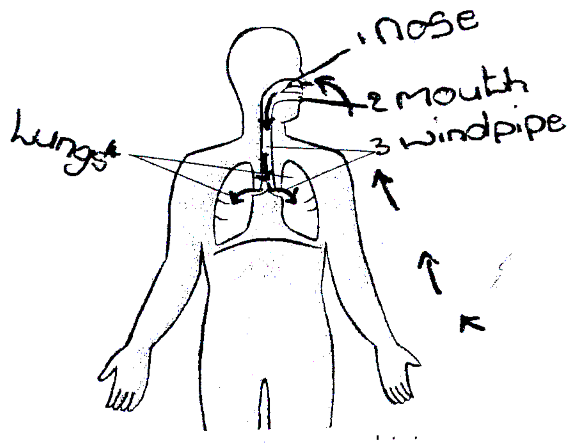


B.

You learnt that people who die in fires, but have no visible burns, die because they suffocate.

Gandhi Bobotyana

Your body needs oxygen; that is why you have to breathe. The oxygen is taken out of the air in your lungs.
Look at the drawing. It shows your lungs and the tubes that lead from your nose to your lungs.



1. Name the parts that form part of your breathing system

____

____

____

2.Draw arrows to show how the air flows from your nose to your lungs.

3.What will happen to your lungs if you are caught in a fire and you breathe in hot air?

I think If I breathe in hot air Your lungs will burn

4.Does the fire use the oxygen in the air?

Yes it use the oxygen

5. Will there be enough oxygen for people in the air while the fire is burning?

no

Gandhi Bobotyana

FIRE IN OUR LIVES: FIRE AND PEOPLE
WORKSHEET 7
A.
Could we live without fire?
1.Write down what you think is good (positive) about fire.

I think fire is good for Cooking
Fire is good for heat
fire is good it give us light.
fire is good by ernegy

2.Write down what you think is bad (negative) about fire.

fire is bad because it can burn your self
fire is Bad because it can kill you.
fire is bad because it can burned your house

3.Write down what you find interesting about fires.

We learn about uvutha
We learn about How Can you Stop fire
We learn about If you see aperson is burning
inside the House what can you do

B.
I am going to tell you a story. I will only start the story. You have to finish it.
How do you think this story will end?

① David ~~ran~~ Run and go home and he tell her farther there is fire up there and David's farther Run to see the fire David Came with the bucket of water and throw the water to the fire and the did not Stop and Phone the ~~F~~ fire fighter and fire fighter Stop the fire and David did not see SPud was not here When David and his ~~Fa~~ father go home and he Saw Spud Came with a Small boy Spud was dad. and David Cry loudly for his dog.

APPENDIX E

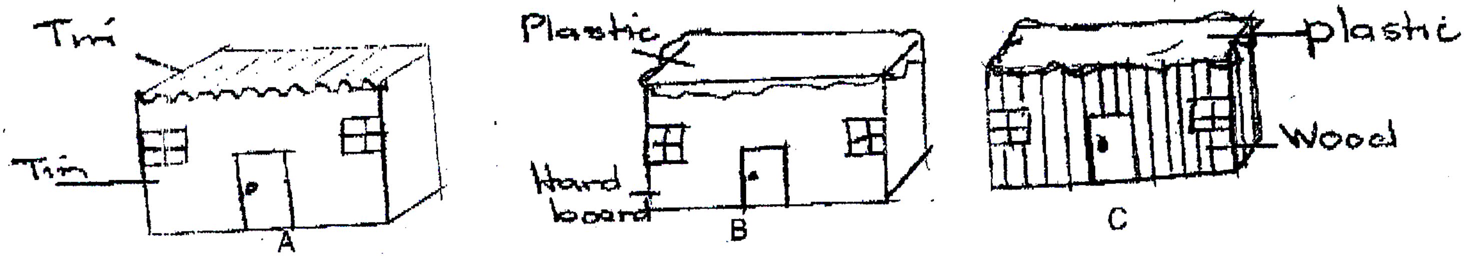
PHASE 2
Tests

TEST 1

FIRE IN OUR LIVES

Name: Nonelo Nutswa

Question 1.
Below are three pictures of houses – each made of different materials



1.1. Which house do you think is the safest to live in, in an area where there are many fires?
house a

1.2. Why do you say that?
because the tin house doesint bearn easily.

Question 2
We make a fire to use the energy from the fire. Energy has different forms.
A change in temperature is called **heat energy**
A change in material is called **chemical energy**

2.1. When a house is on fire, how do you know there is a chemical energy?
because if your house is made of a material that bearns easily the material will change.

2.2. How do you know there is heat energy?
because if your house is bearning you will feel that the house is hot.

Question 3.
Here is a picture of a house on fire

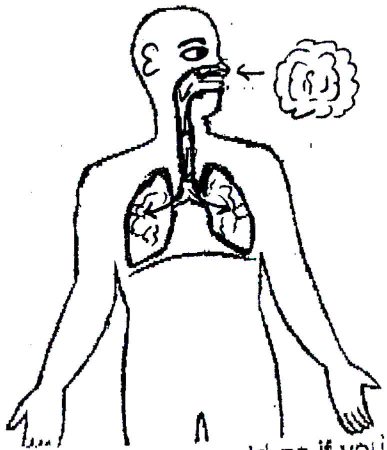
3.1.1. If a house caught fire when nobody was there, would it burn faster if the windows were open or closed? the house that will bearn fast is the house that has the window opend.

3.1.2. Why? because the house had the window open'd will be saported by the oxygen.

3.2. The owner of the house runs to it and her dress catches fire. The neighbours throw a blanket over her, and make her roll on the ground. How does this help?
because they wanndt the heat to be damage.

Question 4

The drawing below shows your breathing system.



4.1 Draw arrows to show where smoke would go if you breathed in smoke

4.2. Why do firemen wear masks or cover their nose and mouth with a cloth when they go into a smoking building?

because they dont want the carbon dioxied to get on their mouth and nose.

Question 5

Bongi burned her hand by touching the stove. Thabo told her to put her hand in cold water. How does this help?

because they want the water to stop the heat and skin to not be bearn.

Question 6

Bongi and Thandi were talking about fire extinguishers. They agreed that a fire extinguisher contained chemicals like carbon dioxide. They did not agree on how a fire extinguisher works.

Bongi says the carbon dioxide keeps the oxygen away from the fire and this makes the fire go out.

Thandi says the carbon dioxide cools the fire and this makes the fire go out.

Who do think is right? Bongi or Thandi?

Bongi.

Question 7

What was the most interesting thing we talked about when we studied fire. Explain it in any way you like. You could draw pictures, or write (in English or isiXhosa) or both.

Why did you find this interesting?

i liked that day when we were burning material i thou tha the plastic dosent burn easily.

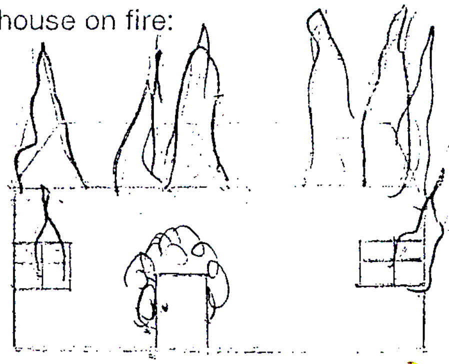
TEST 2

FIRE IN OUR LIVES

NAME: mu...zi zenzile

QUESTION 1.

Here is a picture of a house on fire:



There are no people in the house.

1.1. What is the best thing to do to slow down the fire? Underline the answer you choose:

a) Open the doors and windows

b) Close the doors and windows

1.2. Explain your choice (answer)

is becouse that fire 6 blow and other house

QUESTION 2.

A fire started in a house. The woman who lives in the house, ran to the house and her dress caught fire. The neighbours threw a blanket over her and made her roll on the ground. **How did this help to stop her dress from burning ?**

Choose the correct answer from the possible answers given below. Underline the answer you choose.

The blanket:

a) gives the fire heat

b) keeps the oxygen away from the fire

c) takes the heat from the fire

QUESTION 3.

3.1. Bongi burned his hand by touching the hot stove. Thabo told him to put his hand in cold water.

How does this help? Underline the answer you choose.

a) water keeps the germs out

b) water cools the burn

3.2. Thandi told him to put sunlight soap on the burn.

How does this help? Underline the answer you choose.

a) sunlight soap keeps the germs out

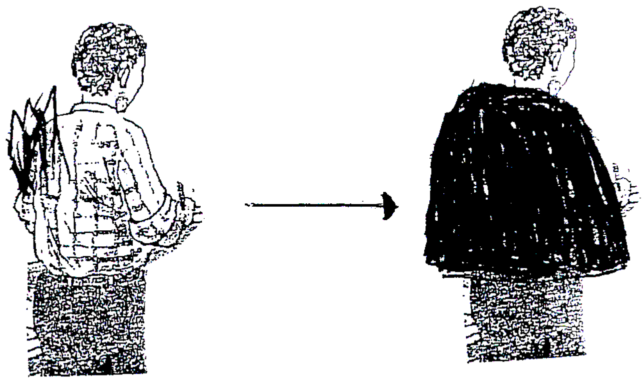
c) sunlight soap cools the burn

TEST 3

Zimasa Sibyata **FIRE IN OUR LIVES**

A.

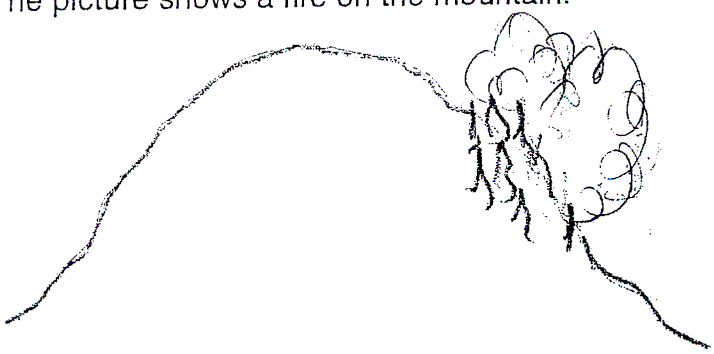
1. Do you remember what happened when we placed the jar over the burning candle?
2. Why did the candle go out? Because the is know air for the Fire
3. I am going to cover the candle with this cloth
Why did the candle go out? Becuse the cloth stop the Fire sow the was no air
4. The man in the picture escaped from a fire , but his jacket is on fire. People have wrapped a blanket around him



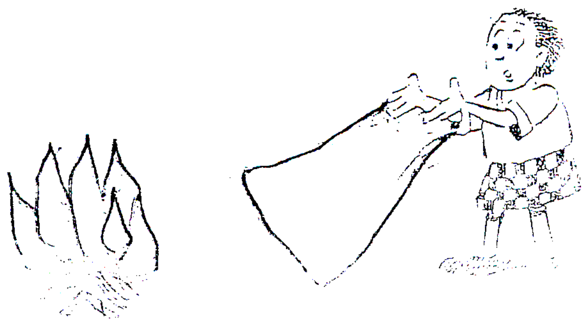
Why are they doing this?
Becuse there was no air for there Fire to Burn sow the fire stop and then he was sayf

B.

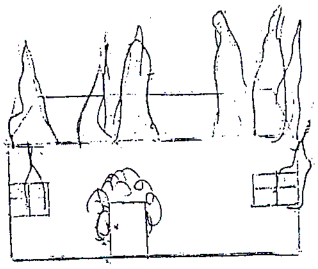
1.The picture shows a fire on the mountain:



1.1. Will wind make the fire burn better or not?
Yes ✓ or No
1.2. Why do you say so? The wind make the Fire to burn sow the Fire burn more and more
2. In the picture the woman is fanning the fire. Why does this make the fire burn better? For the fire to burn Becuse the woman give the fire air



3.Lets look at the candle in the jar again. The jar is like a house; the candle is like a fire burning in the house.
3.1Is the jar open at the top? yes
3.2.Is the candle burning well? yes
3.3 What must I do to put out the candle? to put some thing at the top
3.4.Here is a picture of a house on fire



What must we do with the windows and doors to put out the fire in the house?
to aupen the windows and doors for the fire to stop

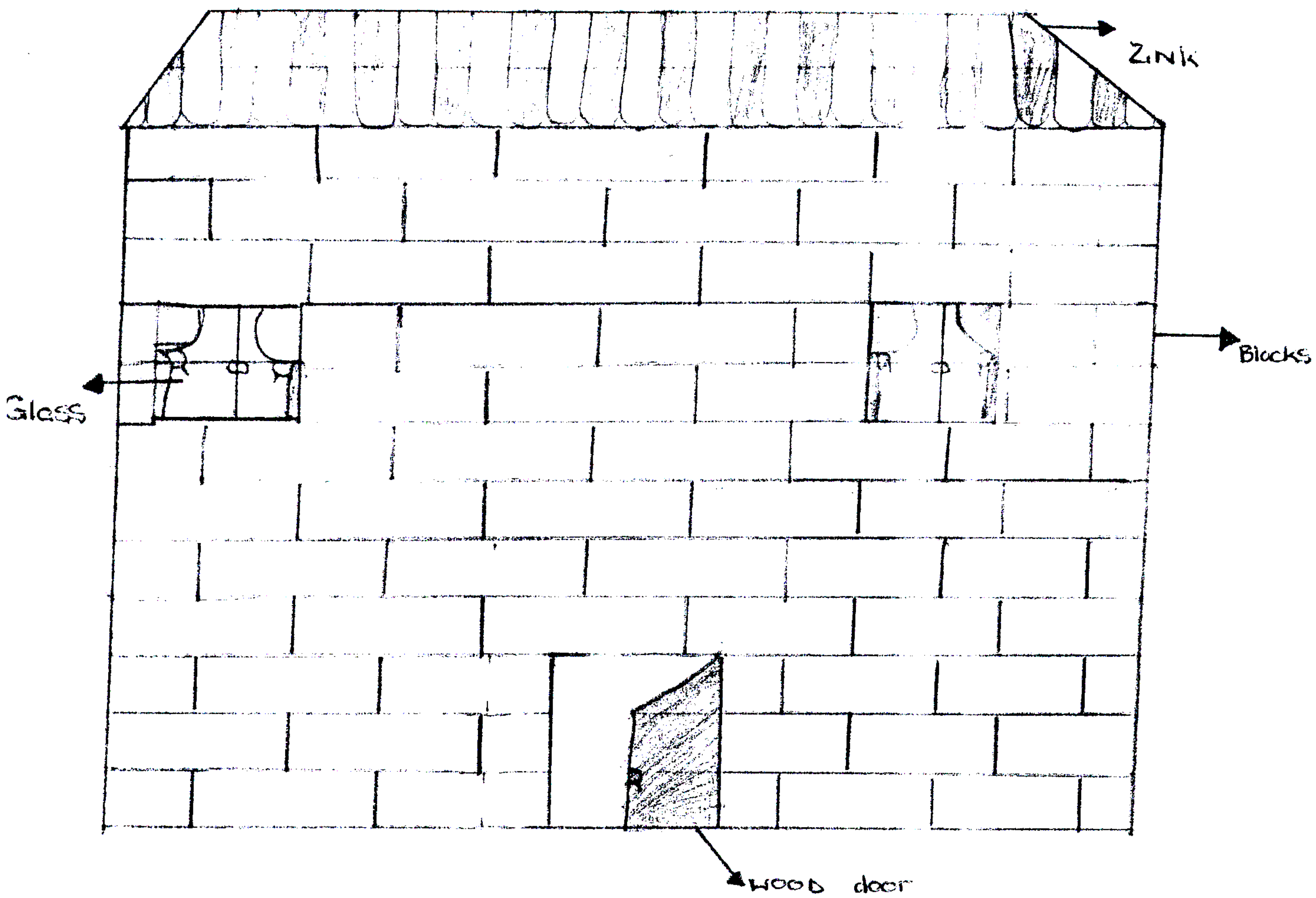
C.
Parrafin is used as a fuel in many homes. What do you use paraffin for in your home?
Underline the ways in which you use paraffin
To cook
To give light
To heat water for washing
To warm our home

You will remember that last time we spoke about the different forms of energy
Examples were:
Chemical energy
Heat energy
Movement energy
Light energy

What forms of energy is present when we burn paraffin to:
cook our food (in the food) Heat , Movement
Heat water (in the water) ~~Ligh~~ Heat , Movement
light a lamp Ligh energy
turn on a heater Heat energy

D. Use the blank sheet of paper to draw a house.
1. Write down the names of the materials you would use if you had to build this house? Zink , Glass , Blocks, wood door .
2.Why would you use these materials? They do not burN Isly

My House Zimasa Sityata



Becuse they do not burn Isly