

Primary School Teachers' Understanding and Interpretation of Problem-Solving: How it is promoted in Science Lessons, Why and Why not?

By

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DECLARATION

I, 'M'aseapa Mookho Violet Makhele Moeletsi (registration No. 200102901), a candidate for the degree of Doctor in Education, hereby declare that except for the quotations indicated in this text, and such help as I have acknowledged, this is the result of my investigation and research and has not been submitted in part and full for any other degree to any other university. I further cede copyright of the thesis in favour of the University of Kwazulu-Natal, Westville campus, Durban.

Moeletsi

11th April 2005

Signature

Date

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DEDICATION

This thesis is dedicated to my lovely daughter Motena. It is also written in memory of my beloved late son, Seapa, who loved his mother, and always expressed his mother's uniqueness, but did not live to see her goal achieved. May his soul rest in peace.

ABSTRACT

This study explores how Lesotho primary school teachers understand and interpret problem-solving (PS) and how they teach and support it. Observation schedules and semi-structured interviews were used to collect data from classrooms, teachers and learners. The findings revealed that teachers have considerable understanding of (PS) and value it but are not teaching it. Teachers attribute this to their lack of knowledge, the difficult conditions in their schools, policy constraints (such as assessment) and their own habits and behaviours. However, the data also indicated that teachers, with support, can successfully design and teach appropriate lessons in their schools, raising issues about their knowledge, beliefs, identity and structures.

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ACRONYMS

DPS	Deputy Principal Secretary
DTEP	Distance teacher education programme
ECCD	Early Childhood Care Development
EFA	Education For All
FPE	Free Primary Education
HOTS	Higher Thinking Order Skills
LCE	Lesotho College of Education
MOE	Ministry Of Education
NCDC	National Curriculum Development Center
NTTC	National Teacher Training College
PS	Problem-Solving
TSD	Teaching Service Department

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CHAPTER 1

Background to the study

1.1 Introduction

Problems. Problems! Everybody's got Problems. Yet when faculty consider introducing Problem-based learning into their courses, one of the perceived "problems" is lack of suitable problems. White (1995: 1)

Teachers, as a result of curriculum policies in countries such as Lesotho, are faced not only with the expectation that they will teach problem-solving to their learners, but with a wide range of problems in their daily work. These include policy dictates, community expectations, working conditions, participation in school management, and the diversity, dynamics and complexities of their classrooms. Teachers are expected to be problem-solvers themselves and to pass these skills to their learners, all as means of improving the quality of education.

Many developing countries have suffered the after-effects of colonialism even long after their independence (Chivore, 1992). Problems were evident in political, social, and economic areas. In education, problems included high teacher-pupil ratios, inadequately qualified teachers, many unqualified teachers in schools, high drop-out rates, irrelevant educational provision and insufficient facilities. Educational systems responded by reconstructing their education systems and expanding primary education (Chivore, 1992; Ndawi, 1997).

To produce more qualified teachers, teacher education was expanded, including extensions of distance education. With the international call for Education for All (EFA) by the year 2000 (Ndawi, 1997), the demands for schooling and teacher education became even higher.

The situation in Lesotho was similar to other developing countries (Ministry of Education, 1982). During the colonial era, education was in the hands of the churches that controlled primary and secondary education as well as teacher education, and the government's role was the payment of teachers (Education Sector Survey, 1982). During the postcolonial period, through its Five Year Development Plans, the Ministry of Education exerted pressure and control over the policies and development of the education system (Ministry of Education, 1982). This led to the First Five Year Development Plan, which included the closure of the seven teacher training colleges which were run by the churches, and the establishment of the Lesotho National Teacher Training (N.T.T.C.), as well as the inception of in-service teacher training programmes.

In spite of the Lesotho government's work, the problem of low quality education is still recurring (Ministry of Education, 1999). The success of education lies largely in the success of primary school education as the foundation for further development. Many studies have focused on the inputs to education (resources, facilities, teachers, curricula), rather than the processes or outcomes of schooling (Fuller, 1987). This is applicable to the studies in Lesotho.

Quality education is a global concern and a challenge. This challenge is due to rapidly growing technology and hence changing job demands as well as changing culture-influences that impact on developing countries such as Lesotho. With such challenges at hand, it is of utmost importance that researchers, educators, teacher educators and teachers take a leading role in researching and attending to the improvement of quality of education.

Quality education has many dimensions such as learners' achievements and their assessment; their preparedness for the labour market; learners' academic progression, and their personal and social development. My particular interest in this study is the development of higher order thinking skills (HOTS).

1.2 Rationale

Concern for the quality of education in primary schools in Lesotho became an issue for me, as a teacher educator with direct knowledge of the literature and policies, and direct experience of the schools. I felt I was somehow part of the problem. I identified through literature a gap in research and the efforts intended to improve education: many of the local efforts were not directed at classroom practice. Hence to me, these were misdirected efforts and incomplete ventures.

Like many other countries worldwide (Dreyfus & Jungwirth, 1980), the Lesotho government wishes to provide quality education, and has developed policies to achieve it (Gill & Akindele, 2002). Amongst other things, its primary school education policy aims to encourage children “to think for themselves” and “to test their conclusions”, thus laying a solid foundation for critical and scientific thinking (Gill & Akindele, 2002). The Ministry of Education, Sports and Culture, through its national Curriculum Development Centre (NCDC), stipulated in the intended curriculum that science education was aimed, in part, at helping children with skills to solve problems. It expects learners to be exposed to situations that stimulate their curiosity, so that they identify problems and attempt to solve them (MOE, 1999). My interest in this study is to focus on the experienced curriculum in terms of problem-solving and problem-based teaching/learning as part of HOTS.

1.3 Definition of HOTS

The definition of HOTS itself is problematic (Hobden, 2002). However, McLoughlin and Luca (2002) point out that though theorists differ in their definitions, they agree that it means going beyond the given information, encouraging adoption of a critical stance, evaluating, and having meta-cognitive awareness strategies and problem-solving skills. The definition of problem-solving as one aspect of HOTS is similarly problematic (Hobden, 2002). Shibata (1998) makes reference to confusion between “issues and problems” and “causes and problems”. De Bono (1976) points to the many definitions

given by teachers that embrace an element of problem-solving. However, he indicates that problem-solving in teachers' definitions usually does not embrace understanding and clarifying the situation or context of the problem, although the context is critical to the definition of the problem. Garcia (1994) points to a view common among students and teachers that problems are tasks or exercises assigned to students by teachers from day to day which may be misleading. This narrow-minded view of what problems are, poses a challenge to the wider views held in the policy documents. It invites discussion of diverse types of problems in terms of their conceptual framework, social nature, mechanical/design aspect etc.

Problem-solving can be differentiated from problem-based learning. Problem-solving is the process of solving a problem, while problem-based learning uses a problem as the context for a range of learning outcomes (Waterdown, 1995). The question/problem may be loosely structured such that it allows varied interpretations, and hence creativity and critical discussion. In other words, problem-based learning sets up a context in which learning can take place, and problems are chosen with this end in mind. In problem-solving, on the other hand, the learners are engaged in real problems, in real-life situations, where the solution is of primary importance to them. The learning that is involved is learning that is relevant to the problem. During problem-solving, learners must make decisions. Decision-making involves judgments, rationality (Duch, 1996), cognition, emotions and compromises, indicative of the complexity of the issue and the strategies involved. Accordingly, it is difficult to refer to a specific strategy of problem-solving, because the appropriate strategy depends on the context (including the people involved). A strategy that could be used to solve a particular problem in a particular situation may not be appropriate for another problem in another situation since the situation may require a different rationalization, a more complex judgment, or different emotions. Problem-solving is more than cognition: it requires judgment of value, which may involve ethics, contradictory consequences, and different uses of resources.

A further issue is the problem of identifying a problem at all. A problem to one person or group may not be a problem to another. Shibata (1998) seeks to get around this by proposing a distinction between a problem and an issue.

Even when the nature of the problem is agreed upon, the extent to which it constitutes a problem depends on who is facing it. The capacity to solve the problem can mean it is hardly a problem at all: for a learner who has relevant experience, reasoning skills and the knowledge and knows how to access the necessary resources, the 'problem' is routine or automatic and hence unproblematic. Some problems involve recall more than problem-solving skills, if those problems are familiar to the solver.

This raises another distinction that is helpful: the distinction between a problem, and problematic (Ailwood et al, 2000). While a problem might appear to be solvable (at least in principle), that which is problematic involves complexities and conundrums that to some extent have to be lived with. 'Problem-solving' in the case of a problematic seeks resolutions more than solutions, and offers them more tentatively. Some problems are more problematic than others. Further, knowledge itself is problematic, arising from its epistemological assumptions, explanatory limitations, and because the knowledge (or depth of knowledge) required for a specific problem is lacking. For primary school learners, whose conceptual understanding is incomplete, and for whom classroom knowledge may not fit easily with everyday experience and cultural knowledge, further dimensions of the problematic nature of knowledge are added. The idea that all knowledge can and should be 'problematised' is important in constructivist learning theories, and central to critical pedagogy (e.g., Habermas, 1992, Giroux, 1992).

In view of the conceptions of 'problem' and 'problematic' outlined above, Vygotsky's social constructivism, Lave and Wenger's (1991) situated cognition and Habermas (1992) critical theory have been chosen to provide the central framework for the research. Constructivism is viewed as learning based on the belief that knowledge is not transferred from the teacher to the learner (Gray, 1997). The learner, individually and as part of social groups, constructs meaning and knowledge herself (Gray, 1997; O'Loughlin, 1992;

Windschitl, 2002). Hence, meaning and knowledge are socially constructed. Teachers who engage in constructivist methods take a different instructional role from that of the traditional teacher, seeking to elicit, challenge and build on learners' existing knowledge, rather than 'delivering' knowledge. Windschitl (2002) points to the difficulties of this method in that it requires reorienting traditional classroom cultures and beliefs of both pupils and teachers. O'Loughlin (1992) observes that construction of knowledge by learners requires teachers to release power to the learners, and teachers seem to be resistant to this.

Similar to constructivism is situated cognition in which learning is context-bound and makes sense especially within particular situations. Learning as active participation is seen in terms of belonging and participating in communities of practice (Wilson & Myers, 1999). It is seen as a dialectical process of interaction with other people, tools, and the physical world (Wilson & Myers, 1999). Cognition is tied to action, either direct physical action or deliberate reflection and internal action. Action involves values and judgments. To understand what is learned is to see how it is learned within the activity context. Knowledge located in the actions of persons and groups in these ways is typical of African philosophy and evident in traditional African education, for example in 'mantloaneng' (Wendy houses), 'thakaneng' (where girls sleep together regardless of whether they belong to the same family), and 'lebollong' (an initiation school preparing boys/girls for adulthood). These are social groups in the developmental stages of a *mosotho* child where it is believed that education and knowledge are passed or gained by joining groups and experiencing situations. Knowledge is not just an individual experience but is contextual and belongs to the group. It evolves as learners participate in and negotiate their way through new situations. The development of knowledge and competence involves continued knowledge-using in authentic situations, so that knowledge is depicted as a discourse. Acquisition of knowledge takes cognizance of pre-knowledge and makes sense of the present situation in relation to those involved and associated groups. Social activities and social interactions that could be interpreted as enculturation or socialization are not just a means by which people learn to think, but also how they engage in thinking (Wilson & Myers, 1999).

In line with social constructivism and situated cognition is critical theory (e.g. Habermas 1992). Habermas's emancipatory knowledge stresses human social interaction, consensual norms, and reciprocal expectations about behaviours between individuals. Freirian theory similarly reflects knowledge as socially constructed through the dialectal tension of praxis. According to Freire (1973) learners have to move from seeing themselves as objects to seeing themselves as subjects; they need to be involved in dialogical action with the teacher. For Freire, dialogic action has two dimensions – reflection and action. When action *and* reflection work together, one gets praxis, which enables transformation (socially, individually, politically) to take place. He insists, "Dialogue cannot exist unless the dialoguers engage in critical thinking", "Without dialogue there is no communication, and without communication, there can be no true education" (Freire, 1973:73)

Constructivism, situated cognition and critical theory, separately and together, define a kind of learning that is akin to problem-solving, through the stress they place on construction of ideas and actions in context, for individuals and social interactions. One place where problem-solving and learning clearly merge with each other is in metacognition.

Metacognition is a strategic form of learning (Hollingworth & McLoughlin, 2001; whereby learners plan and monitor their cognitive processes to improve their learning effectiveness. There is a relationship between metacognition and problem-solving in that to think metacognitively one needs to think strategically, logically, intentionally, effectively and efficiently. This is problem solving, where the problem is how to learn.

1.4 Teaching problem solving in Lesotho Schools

Given the scope of the notion of 'problem-solving' and consequent difficulties of definition, it is not clear whether problem-solving as a generic skill can be taught, or more precisely, whether skills developed in one knowledge domain and context can be

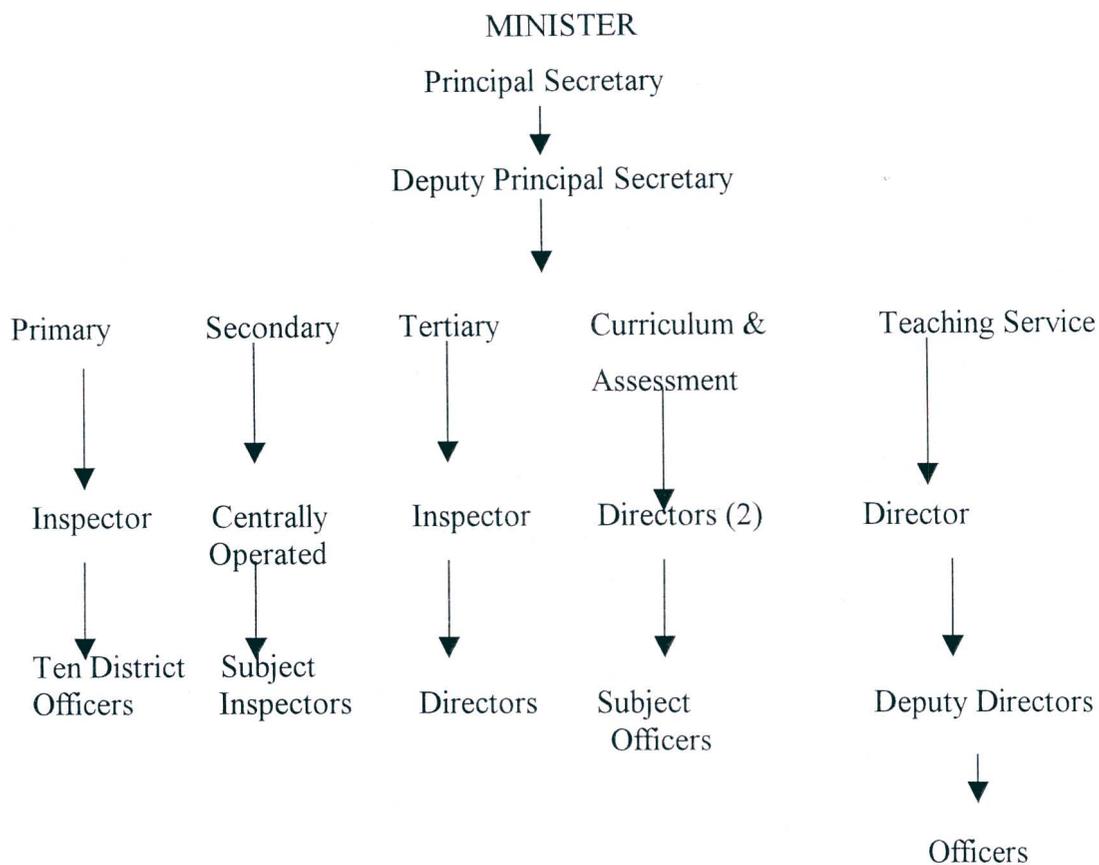
transferred to another. As much as there is assurance that problem-solving can be taught (Nisbet, 1990). There is controversy about the transferability of skills to different contexts (Bereiter, 1997). The policy solution to this, in Lesotho as in other places, is to require problem-solving to be taught in all of the domains defined by learning areas, and in a range of contexts to which those learning areas relate (Gill & Akindele, 2002). While this policy is readily defensible, it is in many ways at odds with the structures, traditions and capacities of schooling.

The Lesotho education system consists of two main sub-systems, the schooling and the administration. The administration sub-system is under the leadership of the Minister of education and below him the Principal Secretary then the Deputy Principal Secretary. The Deputy Principal Secretary is in charge of five departments: primary education, secondary education, tertiary education, curriculum and assessment and the teaching service commission.

The department of primary education is headed by an inspector who is in charge of ten (10) districts, administered by senior education officers who work with Education officers. The Early Childhood Care Development falls under primary education. The department of secondary education in contrast is centrally operated from the Ministry of Education and training (MOET) headquarters and inspectors are allocated per subject.

The Curriculum and Assessment Department is responsible for curriculum guidelines, syllabuses and timetables, and the approval and prescription of text-books and other resources. The teaching service and commission is responsible for employing and firing of teachers. The model of the Lesotho education system is represented in figure 1.1 below:

Fig. 1.1 Lesotho education system model



1.5 Schooling sub-system

The general model

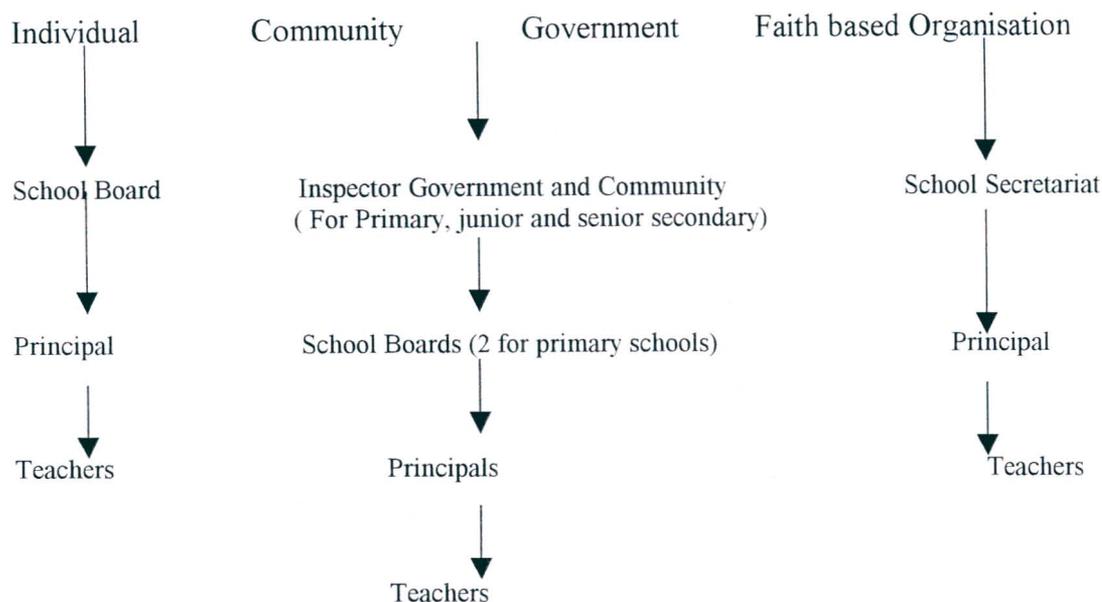
Schooling is based on an ideal model of schooling from three (3) to eighteen (18) years plus. Schooling at the age of three-and-half to five is at early childhood centres at six (6) to twelve (12) years in primary schools; between thirteen (13) and fifteen (15) in lower secondary schools, and lastly, between sixteen (16) and eighteen (18) in higher secondary schools.

Fig. 1.2 Ideal Model of schooling

Tertiary	18 Years +
Senior Secondary	16 - 17
Junior Secondary	13 - 15
Primary	6 - 12
Early Childhood Care Development	3 – 5

There are four types of schools according to proprietors: schools owned by individuals, the community, government and faith-based organizations. The administration of the individually owned schools is such that there is a school board under which is the principal then the teachers. With the community and government schools the inspector is in charge of both primary and secondary schools. There are school boards that are answerable to the inspector. For primary schools there are two school boards with the principal and the teachers. With regard to faith-based organizations there are school secretariats, the school boards, the principals and the teachers (see fig. 1.3 below). It should be noted that the school boards recommend the employment of teachers while the Teaching Service Department (TSD) makes the final decision on the employment and dismissal of teachers.

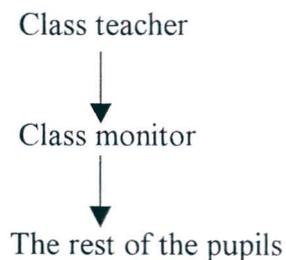
Fig. 1.3 Schooling sub-system (Administration)



Classroom setting for administrative purposes

For the purpose of administration and discipline, the teacher is responsible for a particular class, then there is a class monitor and then the rest of the pupils.

Fig. 1.4 Classroom setting for administrative purposes



Classroom setting for academic purposes

Primary school education starts from Class 1 to 7. One teacher is responsible for a class and teaches all the subjects to that particular class except for a few schools that have adopted subject teaching where specific teachers teach specific subjects in different classes/standards.

The structures described above portray the historical background of the ownership of the schools mentioned earlier in this chapter. The schools belonged to the missionaries whose purposes for schooling were for individual learners and future citizens to communicate with the colonial masters either in their homes as helpers or in offices as public servants. Hence, there was less or no stress in learner-centred and problem-solving education, as advocated in the new policies. Within the present structures there is a confusion or power struggle between the school proprietors (the churches and the community) and the government (policy-makers), hence the difficulty in drawing the line as to who owns what power up to what point.

To strike a balance among the new policy statements, the government states that education should be seen as 'a three legged pot', for which the churches, the parents and the government should be accountable. However, the metaphor is silent on the position of teachers (implementers). There is definitely confusion surrounding central control and devolution. Everyone is used to a highly bureaucratic system evident in the government, though the new policies require at least some devolution.

The ideal situation is that on day one (1) of the year during lesson period one (1) (of science) all the grade (six) 6 classes in all schools around the country should be doing a similar lesson according to a set time table. The prescribed syllabus details the activities, teaching/learning resources, learning outcomes and the methods to be used. There are thus state textbooks, syllabuses, and examinations, timetables but also an expectation that

education will be contextualised/ localized, and that teachers will do problem-solving and child-centred education in the existing structures. Considering these structures (that form the context in which teachers work) and the nature of problem solving and learner-centred education, my interest in the 'intended' and 'implemented' curriculum extends to what the teachers do in their classes in relation to problem-solving and why they do what they do.

1.6 Description of schools

In phase 1 of this study twenty-one (21) primary schools were visited. Among them four (4) were not very far from the main town centres so they could be classified as urban schools. Seventeen (17) could be classified as rural schools. Among those in the rural areas, there were three (3) in the foothills. To access them during working hours one has to spend a night in the area or else rent a car from the nearest town to get to the school the same day. For the two in the lowlands the teachers organized a 'bakkie' (vehicle), which picked them up at a central place, and took them to school and back everyday. Therefore for one to get to the school on time one has to be there at pickup time. The alternative is to walk to school from the main road for about 4 hours. Of the twenty-one (21) schools, three (3) were in the north foothills of the country, two (2) were on south foothills and sixteen (16) were in the lowlands. The 21 schools varied in size. Teacher and pupil population as well as infrastructure differed. Pupil population ranged from 500 to 1800. In some schools there were single streams from Class 1 to Class 7, while in others there were double or/and treble streams. Class sizes ranged from 30 to 70 pupils. Teacher population ranged from 4 to 21, with mostly women teachers.

In most schools each class had its own room (classroom) and an office for the principal, except for one school that did not have an office for the principal and had too few classrooms. The following classes shared classrooms and teachers (combined into one class): Classes 1 and 2, and Classes 3 and 4. This arrangement is referred to as a multi-standard approach to teaching. In all the schools visited there were about three classroom blocks erected by the government.

The official time to start the school day is 8.00 a.m. However, it was noted that there were variations. For some schools assembly began at 7.45 a.m. for others at 8.00 while for others at 8.15 a.m. All schools started with assembly, hymns, prayer and announcements either by the principal or vice-principal. Any visitor to the schools has to report to the principal. With some schools on departure a visitor has to sign a logbook showing the following details: visitor's name, purpose of visit, the date of visit and signature. Although the study began with these twenty-one (21) schools, a description of school A given below is intended to provide a composite picture of how a primary school in Lesotho looks like.

An example: School A

Masilabelong Primary School is about ten kilometres from the main town. Its proprietor is a faith-based organization.

The school population

In every class/standard there are two (2) streams. In each stream there are about sixty (60) pupils, except in the upper classes where the average number of pupils is forty-five (45). The roll of the school was nine hundred and forty-seven (947). There were twenty-one (21) teachers, of which nineteen (19) were female. The principal of the school is a lady teacher in her mid-fifties. She is rarely found in her office. Most of the time she is in the classrooms with teachers, team teaching, helping to mark pupils work or talking to the pupils.

The principal's office

The principal's office is full of posters bearing the following slogans: commitment to work, teachers' responsibility to children, and teachers as parents. Apart from these is the main timetable, and a teachers' roster for conducting assembly, supervising cleaning of

the surroundings and other extracurricular activities. There is a cabinet as well as a table and three chairs in the office.

The classrooms

The description of the classroom here refers only to the three classrooms whose teachers were participating in this study. Three (3) of them have a cabinet where the teacher keeps schoolbooks and other teaching-learning materials. There are desks for the pupils, a chair and a table for the teacher as well as a chalkboard. In each classroom there is a timetable, very few commercially purchased charts and many pupils' drawn charts on the walls.

Due to Lesotho's history of education, with churches running both the primary and the secondary schools, there are comparatively few community, government and individually owned schools. Therefore, the sample of schools in this study is typical of primary schools in Lesotho.

1.7 Purposes of the study

The central purpose of this research was to investigate what teachers and their classes understood by 'problem-solving' and what teachers did in their classrooms to support it. Expecting that some teachers would give more attention to this than others, I wanted to explore their reasons for what they do and do not do, anticipating possibilities and limitations such as personal knowledge and beliefs, time and resources. Thus the focus of the study was on teachers, not students, grounded in teachers' lives in their classrooms. At the schools I wished to look into what actually happens in the classroom in terms of quality teaching and quality learning, specifically focusing on HOTS. I wished to examine why teachers decide or do not decide to engage pupils in HOTS.

The following research questions were formulated:

- What do teachers (and their classes do) in their science classes, and to what extent do they promote problem-solving and higher-order thinking skills?
- What do teachers understand by ‘problem-solving’?
- Why do teachers make the choices they make, in relation to problem solving?
- Why do teachers change or do not change their practices?

1.8 Significance of the study

In a society that is changing politically, economically and technologically, the demand is higher than ever for members to be competent partakers in societal activities. Hence they need abilities in higher order thinking skills. Schools are intended to help prepare for this kind of society. The findings of this study will help teacher educators in Lesotho to look critically into the curricular offerings for student teachers, their orientation to higher thinking skills, and their effectiveness. The study will inform policy-makers on amendments and improvements on policy issues that impact on teachers’ decisions and actions. When referring to development of the ability to think, Marzano et al (1988) point to the roles of those who are responsible in management and policy formulation in education. This study will guide future researchers on classroom activities and other aspects that impact on quality education. These findings will also help me, as a teacher educator and researcher, to better understand teachers’ knowledge and beliefs. In understanding how teachers make their choices to do problem-solving, I expect to better understand blockages and hence be in a better position to help teachers change their teaching practices/behaviours.

1.9 Methodology

As outlined earlier, the framework for this research was informed by constructivist learning theory, situated cognition and critical theory, especially as they come together in problem-solving. This framework was applied to teachers’ learning, as they identified problems in their teaching and schools (related to the teaching of problem-solving), and analysed and responded to those problems. It also provided the framework against which

they could assess their own teaching and lesson designs. Accordingly, the research design began with a representative group of 21 teachers. I then worked closely over a long period of time with smaller groups, to tease out in some detail the problems the teachers identified, and to explore solutions.

While the methodology has some characteristics of action research, with cycles of action, reflection and experimentation, it was not action research insofar as its purpose was not teacher change: its purpose was to use action and reflection as means of better understanding teachers' knowledge and beliefs, the conditions in which they work, and the reasons for the decisions they make.

The methodology used is described in detail in Chapter 3. In summary, it proceeded through six phases, as follows:

In Phase 1, a representative sample of Lesotho primary school (Class 6) teachers and their classes was observed, and teachers and some of their pupils were interviewed. Twenty-one (21) primary schools were chosen, in the lowlands and foothills of seven out of ten districts in Lesotho. In Phase 2 teachers were given lesson scenarios as instances of problem-solving and problem-based learning. Individually and in groups they discussed with me whether the scenarios constituted problem-solving or not. They analysed the kinds of problem represented, and why or why not those scenarios might work well in the classroom. The purpose of this phase was to work more closely with the teachers and probe more deeply their understanding of problem-solving and the conditions in their schools. This phase involved twenty-five (25) teachers. In Phase 3, in a smaller group of teachers (Fifteen (15) in all, but led by three (3)) we chose one of the scenarios and developed it into a full lesson. In Phase 4, some teachers taught that lesson, while others observed and critiqued the lesson. In Phase 5 these (and other) teachers attended a workshop, where they reflected on ideas of learner-centred education, problem solving, and the conditions in which they worked. Finally, in Phase 6, I observed three of the teachers teaching their classes and had interviews with them and others, much in the style of Phase 1.

Six methods of data collection were used: classroom observations; teachers' responses to lessons and scenarios; teacher interviews at school level; student interviews at school level; specially designed tasks for pupils; and workshop activities for teachers.

1.10 Outline of Chapters

This report is divided into chapters as follows: Chapter 1 describes the background of the study, the research problem, and the rationale and significance of the study. In doing so, it briefly reviews the literature related to Higher Order Thinking Skills (HOTS) and outlined the relevant educational structures and policies in Lesotho. The rationale and purposes were followed by a summary description of the methodology and methods.

Chapter 2 reviews in some detail the literature of educational quality and HOTS, especially problem-solving, and problem-based teaching and learning. It develops the theoretical framework of the study, incorporating constructivism, situated cognition and critical theory. Because teachers are the focus of the study, this chapter also reviews literature on teacher beliefs, identity and teacher change in relation to their classroom practices.

Chapter 3 describes the methodology and methods used in the study, including the research design, the methods for gathering data and how data were analysed. It justifies these choices.

Chapter 4 summarises the data from the six phases, indicating how each phase led to the other. It draws together the major findings and interpretations.

In Chapter 5, the findings of this study are elaborated and discussed in relation to the literature, leading to theoretical conclusions and interpretations.

CHAPTER 2

Literature Review

2.1 Introduction

This chapter reviews literature on the quality of education focussing on problem-solving, problem-based learning and the theoretical frameworks on which they are based. Because the focus of the research is teachers, the chapter also reviews literature on teachers' beliefs and identities, development and change, especially in relation to learner-centred approaches, problem-solving and problem-based learning.

Teaching and learning are viewed through lenses of constructivism and problem-solving. In this, teaching and learning are similar: when teaching, the teacher is also learning, making sense and meaning out of experiences and solving problems. The quality of teachers' instructional practices depends on the solutions they come up with.

Teachers' classroom instructional practices are influenced by their beliefs and perceptions of themselves as teachers and as well as their perceived roles as teachers. These beliefs in turn impact on the quality of teaching they offer. They include ontological and epistemological perspectives of their subject (in this study science) and beliefs about learning and learners. These perspectives determine the way teachers teach and their reactions to their efforts to change their classroom instructional practices.

2.2 Educational Quality and Higher Order Thinking Skills

The term 'quality', in educational terms, is complex and problematic. One approach is to define quality operationally, according to pre-set standards and pre-specified services and products (Wild, 1985). Browning-Carr and West-Burnham (1994) state in an international review that standards differ across countries and may be expressed differently. They cite specific expectations of students (Ontario); interaction between curricula and criteria for marking (Sweden); pupil's achievements in specific subjects

with specified evidence of difficulty (England); and achievement of aims and contents of each subject in every school level (Japan). Quality may also be defined in terms of changes or increments in students' knowledge, attitudes, values and behaviours. Alternatively, quality may incorporate performances beyond school, such as the ability to fit into the workplace or to use learning in an everyday lives. In this study, quality has been viewed especially from the perspective of higher order thinking skills, skills that include critical, creative thinking and problem-solving. The focus is on problem-solving.

We cannot talk about quality without referring to quality inputs and processes, as well as outputs. Most education systems, especially in developing countries, inclusive of the Ministry of the Education (MOE) in Lesotho, invest heavily in educational inputs, such as school expenditures, resource materials, teacher education and school management. They expect to get quality products in the form of student achievements in test scores, progression up the educational ladder as well as good performance in subsequent employment and citizenship as a result of quality inputs. However, this assumption is not always borne out in practice, and many countries around the world (in UK, Australia, Canada and South Africa) have increased their emphasis on outcome measures.

Educational policies, ranging across assessment and examinations, teacher/pupil ratios, structures of schools and community, funding, norms and expectations, are aimed at improving the quality of education and at the same time facilitating effective management of the education system. By 'structures' in this case I mean social and management structures that exist within the school setting and impact on the functioning of schools and teachers. If quality outputs in the form of effective teaching are expected, all policies and structures can be considered as inputs, in that they impact on the possibilities and judgments that teachers make in their instructional practices.

Educational quality defined in terms of student outcomes or educational inputs requires processes, at the system, school and classroom levels. Therefore attention needs to be paid to the part of the processes in an input-process-output model is also required (Needles, 1988). Effective teaching is a key process. Critical thinking and problem-

solving as the outputs depend on inputs and processes: if the purpose is to improve problem-solving, this purpose must be clear, and inputs and processes have to be organised. However, care should be taken not to regard the input-process-outcome model as linear, causal, or even manageable. What goes on in the classroom does not entirely depend on what the teacher does but on other things such as structures and conditions that exist in the school community and broader society, expectations, norms and working conditions.

Many studies that have dealt with process have given information on the quantity of instruction (Needles, 1988): the length of instructional programmes, time in school, homework frequency and time spent on class preparation (Fuller, 1987). While there is clearly little opportunity for students to learn if they spend little time in class, or their teachers are poorly prepared, quality as well as quantity is involved.

A common definition of quality education is in terms of student achievement in test scores. Hannaway (1992) argues that attention to HOTS raises educational standards. However, tests are limited in what they can measure, and their capacity to measure problem-solving is questionable. Even when tests purport to measure critical thinking and problem-solving, it is not clear that they do: performance on the test questions depends also on familiarity with the question and context, language and knowledge. Tests commonly address levels of knowing and pieces of knowledge that are not necessarily indicators of critical thinking (Hummel & Huitt, 1994; Nowark & Plucker, 1999). Critical thinking and problem-solving assessment procedures are often haphazard or non-existent. Hambleton and Sireci (1997) argue that teachers are focusing their instruction on achievement tests and consequently neglecting higher order thinking skills in classroom activities.

While written tests often fare badly in their attention to and measurement of higher order thinking skills, some researchers have suggested that students' underachieve in examinations due to lack of or non-engagement in higher order thinking skills (e.g.

Marzano et al, 1988). Except in the most routine of examination questions, higher order thinking skills are an advantage.

Hannaway (1992) and Hambleton and Sireci (1997) point to the imbalance of the curriculum taught in schools in their emphasis on basic skills rather than higher order skills. They point to the likelihood of teachers concentrating on basic skills given the ease with which they are taught and assessed as compared to higher order thinking skills, and the ways in which achievement tests encourage low level skills. Hannaway (1992) also points to diversities from class to class because of differing interpretations of the (intended) curricula by different teachers. Curricula interpretations and classroom practices also have implications for teacher training.

Assessing higher order thinking skills is a challenge because learners' thinking must be 'observed', not just their results or products (Thomas, 1992). Existing right and wrong answer approaches to testing are clearly inadequate (SCANS, 1991; Thomas, 1992). New forms of evaluation are required, such as complex performances, observations during project work, tailored-response tests, stimulated recall, scenario analysis, and concept mapping. Existing methods (such as true/false, multiple choice, open questions and essays) can be adapted by having students indicate their thinking, or requiring evaluation and critique (Chalupa, 1992).

2.3 Definition of Higher Order Thinking Skills (HOTS)

The definition of HOTS itself is problematic (Nisbet, 2000; Hobden, 2002). However, McLoughlin and Luca (2002) point out that though theorists differ in their definitions of HOTS they agree that it means going beyond the given information; encouraging the adoption of a critical stance; evaluating; and having metacognitive awareness strategies and problem-solving skills, being autonomous thinkers (McLoughlin & Luca, 2002), having reasoned judgements, and being critical (McLoughlin & Luca, 2002; Pellegrini, 2002). However, This is still a broad definition. Cotton (undated) warns that care must be taken in using the terms 'thinking skills', 'critical thinking', 'creative thinking' and

‘higher order thinking’. She points to the lack of consensus on meanings of these terms, and demonstrates her point by comparing four definitions of critical thinking.

Difficulties in defining higher order thinking skills (HOTS) can be linked back to difficulties in defining ‘thinking’ in the first instance. Cotton (undated) refers to thinking skills as basic and advanced skills that govern a person's mental processes, but this too is a broad definition. Different ways of thinking can be classified according to purposes and, implicitly, processes of thinking.

In this regard, Cotton (undated) refers to classification of critical thinking, creative thinking and metacognition. Critical thinking concerns abilities to base evidence on reasoning, considering alternatives and perceptions of the whole situation. In this sense it is systematic, analytic and convergent. Creative thinking, in contrast, is characterised by fluency, flexibility, originality and elaboration. It is imaginative, subjective, divergent. Lastly, metacognition refers to awareness of one’s thinking, expressed in planning, assessing and monitoring. In practice, critical thinking, creative thinking and metacognition work together, regardless of the central purpose of the thinking: an analytical task requires creativity and metacognition; a creative task requires analytical thinking, and so on. Somewhat similarly, Bloom’s taxonomy of educational objectives distinguishes knowledge, comprehension, application, analysis, synthesis and evaluation, arranged in a hierarchy. Synthesis and evaluation clearly involve knowledge and comprehension, but knowledge and comprehension also involve some synthesis and evaluation.

Generally HOTS refer to critical thinking, creative thinking, metacognition and problem-solving, or, in terms of Bloom’s taxonomy, application, analysis, synthesis and evaluation. I will use this common sense, broad definition as a starting point for discussions with teachers.

2.4 Thinking as an objective of education

A central objective of education is to teach thinking, whether 'what to think' or 'how to think' (Marzano et al, 1988; Schafersman, 1991; Gill & Akindele, 2002). The goal of teaching thinking is seen by Nisbet (1990) and Cotton (undated) as at least as old as Ancient Greece. Cotton (undated) states that capability of thinking has been regarded as characteristic of an educated person in the twentieth century. It is valued as part of a 'liberal education'. It is also increasingly recognized as an immediate goal of education for participation in a technologically growing society and an ever-changing world (Cotton, undated). De Bono (1976) has been outspoken about the bias of traditional subjects against thinking, a bias he sees expressed in methods of teaching, learning materials, examinations, timetables and management structures that lock up the education system. For example, regardless of curriculum policies, if assessment is centred on high-stakes such as, written tests that can be passed without attention to higher order thinking skills, the system works against 'thinking'. When learners do engage in thinking for themselves, reasoning on the basis of experience and probing discussions, this is often construed (by students as well as teachers) as a waste of time, delaying completion of the syllabus and, perhaps, marks in an examination. Further, the idea of children thinking for themselves can be problematic in some cultures, communities and classrooms, due to the norms and expectations that prevail. Children the thinking for themselves may question authority, power and hence stability. This is often a concern in African cultures, as in many others. The lack of yardsticks to measure how imaginative, critical and expressive children should be creates confusion, in policy development and perhaps more even in policy interpretation and implementation.

2.5 Thinking can be taught and improved

People can be taught to be better critical and creative thinkers and problem solvers. To engage in thinking one needs to use different patterns of thinking as ways of contextualizing thinking and using it strategically. De Bono (1976) equates thinking with perception and refers to improving education as a deliberate effort in encouraging

thinking. The importance of teaching children to be more effective thinkers is increasingly recognized, for example, in curriculum policies in countries around the world. It is therefore justifiable to expect teaching of thinking in schools. One way is to achieve this provide classroom environments that support thinking. Such classrooms are characterized by dialogic conversations where learners reflect and become critical and creative.

According to McGuiness (2001), the appropriate stimuli for developing thinking include words and phrases such as: 'suppose'; 'imagine'; 'try to predict'; 'my question is'; 'I can't decide because one criticism is'; 'think of another solution'; 'What is your conclusion?'; 'Why?'; 'What do you mean by that?'; 'Can you put it in another way?'; 'Can you give another example?'; 'How can we find out?'; 'What would happen if?'; 'What are your reasons?'

To attempt any problem with the intention of solving it, one has to think and reason out one's actions or verbal statements. Paul (1993) states that a common defect of students' reasoning is traceable to defects of purpose. He postulates that if the purpose is unrealistic, contradictory, confused or muddled, the reasoning to achieve it is problematic. Secondly, for any reasoning there should be a point of view, a conceptual frame or frame of reference. Thirdly, Paul points to the importance of clear and accurate evidence for non-defective reasoning. His recommendations resonate strongly with standard requirements in the design of research: there should be clear research questions, an articulated conceptual framework, and the gathering and use of evidence as part of argument.

2.6 Levels of thinking called for by different kinds of questions, purpose and context

In the learning-teaching process, the presentation of tasks and questions denotes and reflects the levels of thinking demanded from learners, whether low level (recall of information and routines) or high level (requiring critical and creative thinking). As noted earlier, high level thinking, including problem-solving, cannot proceed effectively

without knowledge. This requirement is expressed in the hierarchy of Bloom's taxonomy, and in the emphasis in traditional testing knowledge. While test questions can seek to focus on thinking skills and purposes at different levels, the extent to which a higher order question truly represents 'analysis' or 'synthesis' depends on the individual student, and the kinds of experience and practice she had in relation to the question.

Although it is assumed that HOTS can be assessed more accurately through the use of open-ended questions, portfolios, investigations (Carmen, 1990) and the use of appropriate vocabulary (Carns, 1996; McGuinness, 2001), tools used to measure HOTS often lack validity and reliability. They tend to measure knowledge or language skills more than HOTS. Another difficulty facing the assessment of HOTS is the assumption that too often the tools assume logic and rationality. In problem-solving, and critical and creative thinking, one uses not only logic or rationality. The situation invariably calls for imagination, value judgments and decision-making. For example, many assessment tools (especially in testing) require one right answer, while in HOTS there may be many 'right' answers (Duch, 1996).

Advocates of teaching HOTS call for group work, collaborative projects and other strategies to promote sharing and evaluating ideas, imagining scenarios, assuming responsibilities and so on, but this challenges traditional conceptions of individual assessment and independent work, raising issues not only definitions of validity but ethics. For example, does one allocate grades to individuals or groups, and how does one respond to groups that were unable to operate effectively, or individuals who did or did not contribute, or groups and individuals who made extensive use of people and resources beyond the school, to which others had no similar access? How fair can one be to individual learners? What does 'fair' mean?

2.7 Higher Order Thinking Skills can be taught and supported

There are two competing approaches to teaching higher order thinking skills: infusing HOTS into curricular subjects (Nisbet, 1990; Wilson 2000; Cotton, undated), or direct

teaching of HOTS as generic skills. Those in favour of infusion argue that when higher order thinking skills are taught separately from subject areas, they are taught as fragments and their transfer or application to new situations may not occur. They (infusion supporters) maintain that thinking is about ‘something’, and should be taught in the context of the relevant learning area(s). If HOTS are taught in the different knowledge domains, transfer and generalisation of the thinking skills are intertwined with teaching and learning in the subject area (Nisbet, 1990; Cotton, undated). Supporters of infusion maintain that this approach enables students to learn thinking skills rather than learn about them (Cotton, undated). In contrast, those who favour direct or separate instruction of higher order thinking skills argue that student who are not exposed to initiating and applying these skills in situations beyond subject areas and schools, are not likely to develop them. They argue that the skills can and must be taught separately and directly.

There are also intermediates who feel that, as with any other teaching, there is no best or singular effective way of teaching problem-solving. They propose that both approaches (infusion and direct instruction) are appropriate (Cotton, undated). Cotton also points to other considerations, such as the time requirement for individual students in learning HOTS, differences in learners, importance of good classroom climate, conditions, attitudes, knowledge, beliefs and perceptions, and culture.

Manzo and Manzo (1995) list the following instructional elements for fostering HOTS in the classroom:

- Asking for discovery, invention, and artistic/literary creation.
- Creating curiosity and new ideas with enthusiasm.
- Exposing learners to new twists on old patterns and inviting them to look at old patterns from new angles.
- Creating opportunities for learners to constructively critique new ideas (which almost always require some fine-tuning).
- Resetting expectations to the fact that there will be many more “misses” than “hits” when reaching for workable new ideas.

- Learning to invite contrary, or opposing positions (for new possibilities are often discovered in this way and existing thoughts, patterns, and beliefs can be tested and strengthened).

Manzo and Manzo, (1995) list the following as possible questions that could invite HOTS:

- How is this study like another you/we have read? This question encourages students to make connections and see analogies.
- Does this story/information make you aware of any problems that need attention? This amounts to asking students to see themselves as active participants in problem identification as well as problem-solving.
- What does this mean to you and how might it affect others? This pair of questions gives students a chance to express their own interests but also to empathetically consider and understand the views of, and possible consequences for, others.
- Is there anything wrong with this solution, and how else might this problem be solved? These questions are at the heart of successful critical analysis.
- What more needs to be known or done to understand or do this better? This is a pointed request for creative problem-solving that invites thinking “beyond the lines.”
- What is a contrary way of seeing this? Being able to examine issues from multiple points of view helps students clarify their thoughts.

2.8 Problem-solving, as HOTS, can be taught

Give a man fish and he eats for a day; teach a man to fish and he eats for life-time (Norman, 1988).

Like HOTS, definitions of problem-solving are problematic (Hobden, 2002). Shibata (1998) makes reference to confusion between ‘issues’ and ‘problems’ and ‘causes’ and ‘problems’. De Bono (1976) points to the many definitions of problem-solving given by teachers, all of which involve an element of problem-solving. However, he indicates that

problem-solving in teachers' definitions usually does not embrace understanding and clarifying the situation or context of the problem, yet the context is critical to the definition of 'the problem'.

The many definitions that teachers attach to problem-solving may be indicative of the different types of problems that individual teachers see and different conceptions of the 'problem'. It could also be argued that teachers have many and valued definitions of problem-solving given the different contexts/situations in which they work. They view problem-solving differently in the different contexts. Teachers themselves have to identify what the problems are in the contexts in which they work. To achieve this they have work in interactive ways with groups. By so doing they are better able to see the problem as a whole, not as parts of a whole.

Garcia (1994) points to the view common among students and teachers that 'problems' are tasks or exercises assigned to students by teachers from day to day. For example the kinds of problems presented at the end of chapters in science textbooks. This focus often leads to neglect of other kinds of problems such as conceptual, social and environmental problems, riddles and puzzles, experimental or design problems.

Shibata (1998) makes reference to confusion in problem-solving terminology. He provides an example of the confusion between 'issues' and 'problems', 'causes' and 'problems'. He identifies seven terms associated with problem-solving; purpose, situation, problem, cause, soluble cause, issue and solution. Shibata defines purpose as what people want to do or to be. He maintains that this is the first step in problem-solving. According to Shibata, circumstance is characteristic of a situation. Situations are not usually problematic, hence they should be looked at objectively to avoid narrow sightedness and prejudice in defining and solving problems. 'Problem', however, is regarded as a portion of a situation that defines or intervenes in its purpose. What brings about the problem is, by definition, cause. Shibata says problems can be specific while causes can be more general hence the importance of finding specific causes of problems as part of problem-solving. He points out that when solving a problem, the focus should

be on soluble aspects, and once a specified action is taken to solve the problem, it might realize an issue. According to Shibata (1998), issues are contrary proposals to solve problems, for which the outcome is resolution more than solution. Problems are negative expressions while issues are positive expressions. Shibata points out also that ‘problem’ is a subjective concept: a problem to one person may not be a problem to another.

Preliminary investigations suggest that Lesotho primary school teachers they regard teaching problem-solving as itself problematic. Awareness of possible strategies may not be enough, because contexts and hence problems and priorities differ. Teachers themselves have to be problem-solvers. Encouraging teachers to form collaborative learning groups in order to reflect on their practice suggests how best they can improve their practice. This is one way forward. In this way, if teachers are to be able to solve their problems, they may be better able to pass the skills on to their pupils.

2.9 Skills and strategies attached to Problem-solving

Garcia (1994) points out that problem-solving involves abilities to think critically. It requires one to identify, group and classify information into categories of ‘relevant’ and ‘irrelevant’, ‘useful’ and ‘useless’, ‘necessary’ and ‘unnecessary’ and to apply pertinent information to the problem at hand. Hollingworth and McLoughlin (2001) identify problem-definition, planning and monitoring of learners’ thinking, as important steps in teaching problem-solving.

Strategies suggested for problem-solving expand on those presented earlier for HOTS. For example, Ommundsen (2001) says students have to define the problem carefully, explore the solutions, narrow their choices then test their solutions. He recommends that students work in small groups. He suggests presenting the problem and activating the groups by asking the groups to analyse the problem and brainstorm possible solutions, providing feedback through small group discussions. Ommundsen (2001) stresses the importance of the teacher circulating among the group, giving assistance but not providing solutions nor controlling the agenda of the groups.

As mentioned earlier, there are different types of problems, and the nature of a problem depends on the situation, the people involved and their purpose. Strategies for solving a social problem need not be similar to those of solving a technical problem or a design problem. For example, problems of an alcoholic besieged with financial, marital and personal difficulties (social problems) are quite different from those facing an engineer when seeking ways to dispose of chemical waste safely (design problem). Problems that face a chess master, a psychological counselor, or a policeman/woman tend to be quite different and need different strategies.

2.10 From problem-solving to problem-based teaching and learning

Problem-based learning can be differentiated from problem-solving. The former uses a problem as the context for a range of learning outcomes while the latter is the process of solving a problem. In the former, the problem is a means to learning; in the latter, the learning is a means to solving the problem. In practice, of course, this distinction is blurred. Learning occurs and the problem is solved – but the emphasis is different, and problems are different. Problem-based learning motivates learners in that they know why they are learning what they are learning, the problem provides a structure for the learning, and the desire to solve the problem encourages thinking and acting. Torp and Sage (1998) point to the fact that well chosen problems present holistic learning experiences, offering exposure to rich content and essential skills such as critical and creative thinking, and demanding decisions which take into account conflicting interests and incomplete information.

Problem-based learning has considerable support in fields such as medicine (Waterdown, 1995; Wang et al, 1998), where it can be used to encourage interdisciplinary thinking (concern for the ‘whole patient’). It has natural resonance with the ways in which doctors and paramedics work in practice. Waterton (1995) and Burch (1995) draw attention to the fact that problem-based learning calls for new ways of thinking about the structure of knowledge, and new forms of action and interaction in classrooms. Thus the learning

purposes, classroom activities, social and intellectual climate, roles and assessment are all changed in comparison with traditional learning strategies.

Problem-based Learning can be based on content from the current curriculum (Wang et al, 1998), presented within the context of the problem and the learners' experiences and interests (Christensen, 1995; Littlejohn & Awalt, undated; White, 1995; Greenwald, 2001). The choice of problems is important. They need to be interesting and worth solving (from the students' perspective); they have to be rich in learning opportunities, and they have to be manageable and do-able. The problem presented to learners should challenge their understanding of concepts, require them to make logical and rational judgements, and justify their decisions (Duch, 1996). Duch further suggests that good problems are open-ended; not limited to one correct answer; connected to learners' prior knowledge; require different opinions and should encourage higher level critical thinking. They can usefully be framed in a scenario or case study format, or in an actual situation. The problems will often be loosely structured, imitating the complexity of real life. Learners must feel they are engaged in learning and at the same time solving an interesting problem (Littlejohn & Awalt, undated).

2.11 Interesting problems, socially supportive environments and adventurous situations

Problem-based learning constitutes a major shift in the learning environment of the classroom, compared to traditional teaching.

Hollingsworth and McLaughlin (2002) maintain that in order to provide students with the skills required for problem solving, the environment needs to offer an orientation to problem-solving, support for planning of the task, selecting, and reflection. Practitioners of Problem-based learning advocate classroom environments where learners feel safe and accepted, where they are given opportunities to search for new information and experiences in order to make meaning of what they are learning. In order to achieve these interactions between learners, involvement and cooperation are required from the

learners. In such learning environments, it is important that each member sees herself as an active member of the learning community and knows her role and the expectations of the task and other members. The environment can also allow for personal learning preferences and talents. Such an environment involves new roles and power relations in comparison with traditional classrooms.

2.12 Teachers' and pupils' roles

In traditional classrooms, most learners (and their teachers) associate learning with getting high marks/grade and moving to the next level/class/grade not necessarily with understanding.

To this end, many teachers see their primary role as providing information and explaining ideas and routines. Hence they are central authorities in knowledge and management. In contrast, teachers' leadership in problem-based learning tends towards questioning, sharing power (in management as well as knowledge), facilitating, guiding and coaching. Archibald and Barrows, 1982; Wang et al, 1998; Burch, 1995; Christensen, 1995; and Littlejohn and Await (undated) argue that facilitation should be aimed at cultivating learners skills, focusing their efforts, fostering their resourcefulness and maintaining an interactive climate of learning. Archibald and Barrows (1982) see facilitation as helping learners to locate relevant information, sort through potential interpretations and coach learners on data handling skills. They refer to this as 'met cognitive coaching'.

A key issue in the change of classroom environment is the shift in power-relationships in the classroom. In traditional education, learners are at the lowest level where power is concerned: educational systems, administrators, teachers, parents and the community determine the 'what' and 'how' of learning without asking the learners themselves. Even researchers who do research on learning and learners themselves seek permission from others: from education departments, school principals, teachers and parents. Problem-

based learning shifts from 'power on' to 'power to' the learners. Many teachers' fear that control and authority will seemingly be taken out of their hands and given to the learners

This rethinking of roles from the traditional to the new suggests change in teachers' classroom lives and practices that may not be easy (Waterdown, 1995). Also it demands that teachers reconstruct identities, especially as they shift from power owners to power sharers. Some educators are scared of loose structure and change ([//mcli.dist.Maricopa.edu.labyform/fall/forum7.html](http://mcli.dist.Maricopa.edu.labyform/fall/forum7.html)). Their fears are rooted not only in their capacities, but concern that change may tamper with standards or cut across school norms of classroom management, noise levels and so on. Other people resist change because of their personal beliefs.

In developing countries such as Lesotho, which depend heavily on donor agencies, which determine and dictate change in part, the concerns of this writer/teacher can be understood.

Much has been written about helping teachers to change, especially in the change towards constructivist learning, cognitive development and cooperative learning. Simon and Schifter (1991), Schifter and Simon (1992); Wood et al (1992) and Schifter and Fosnot (1993) provide examples of projects and studies. Borko and Putnam (1996) focused on helping teachers to construct epistemological perspectives informed by constructivist views, while Smith and Neale (1991) examined teachers' orientations towards science teaching and learning, and their conceptions of science teaching. Their goal was to help teachers move towards conceptual change orientation. Carpenter et al (1988,1989) focused on pedagogical content knowledge, arguing that teaching is essentially a problem-solving endeavour, where problem-solving strategies are informed by in-depth knowledge of students and the subject. The extent to which these researchers changed teachers' beliefs and behaviours is not clear from the reports, especially when it comes to long-term change. Rogan (2004) reports on a well-funded programme in South Africa, linked to curriculum policies introduced in 1997 and associated programmes of teacher development, in which some of the trappings of the new policies were in place (for example, children sat in groups and discussed ideas). However, the changes fell well short of the ideals envisaged in the policies and discussed and used in the workshops.

2.13 Teacher knowledge, beliefs, values and identity

Teachers' beliefs and theories represent a rich store of knowledge of objects, people, events, experiences, thoughts and decisions, as well as classroom practices. It is this knowledge that guides teachers' perceptions, processing and actions in the classroom (Pajares, 1992).

There are three epistemological conceptions to which teachers' knowledge can be related: the positivist, interpretivist and critical theory views (Calderhead, 1996). Calderhead argues that within the positivist view professional knowledge is seen as a set of law-like generalizations that can be applied. The interpretive position regards meaning as context-based and attached to interpersonal and social lives, while critical theory depicts power relations with a view to human rights and democracy. Critical theory aims at conscientising teachers to the uses of knowledge and its value (Calderhead, 1996).

Within this framework, a well-rounded teacher uses different types of knowledge, including subject, craft, personal, practical, case and theoretical knowledge. Subject knowledge incorporates content, pedagogical and curricular knowledge (Calderhead, 1996). Also important to the teacher is knowledge of the learners – individually and as groups or subcultures (Shulman, 1987; Strassenburg, 1987; Schempp, 1995; Borko & Putnam, 1996; Anderson, 1987). Likewise, context is another significant factor (Anderson, 1987; Strassenburg, undated).

These different kinds of knowledge come together in a teacher's conception of good teaching and good classrooms. Calderhead and Robson (1991) report that pre-service teachers held vivid images of teaching based on their experiences as students. These images influenced interpretations of particular courses and classroom practices and played a powerful role in determining how they translated and utilized the knowledge they possessed and how they determined the practices they would later undertake as teachers (Pajares, 1992). Nespor (1987) points out that knowledge alone is not adequate

for decision-making and prioritisation in the classroom situation: values and beliefs, structures and relationships play their part in the interpretation and simplification of a situation.

In the case of problem-solving and open approaches to the design of teaching, studies have generally indicated that teachers who possess greater subject knowledge tend to emphasize the conceptual, problem-solving and inquiry aspects of the subject matter. Those who possess insufficient subject matter knowledge emphasize facts, rules and procedures, becoming prisoners of their lesson plans and texts (Borko and Putnam, 1996; Baxter et al, 1985). Borko and Putnam (1996) point out that research into teachers' subject knowledge is limited, perhaps due to researchers' beliefs and assumptions that teachers do understand the content they are teaching.

Baxter et al (1985), Carlsen (1987), Krajcik et al (1991), Smith and Neale (1991) and Smith and Schifter (1989; 1991) are among researchers that report that even experienced teachers lack subject matter knowledge and have limited conceptual understandings. Krajcik et al (1991) and Smith and Neale (1991) have engaged in intensive projects aimed at changing teachers' subject matter and pedagogical content knowledge. They report progress, but note that it is slow and needs on-going interaction.

Knowing what learners bring to the classroom, their prior knowledge, their conceptions and misconceptions, abilities and thinking, are also important to the teachers' knowledge. Borko and Putnam (1996) indicated that prospective teachers' knowledge and beliefs about learners are limited and resistant to change, even change through instruction and experiences in teacher education programmes.

The issue, however, goes beyond one's knowledge of students, to ways of using that knowledge, especially students' ideas, experiences and talents. Smith and Neale (1991), for example, report that even in lessons designed to be learner-centered and constructivist in approach, teachers did not know how to make effective use of learners' ideas and predictions to move forward with their lessons.

2.14 I teach who I am and who I am is shaped by my beliefs

Teachers not only teach subject content but also display who they are. Who they are is shaped by their beliefs and their beliefs are determined by who they are. Who they are is guided by their personal and social histories, their experiential knowledge, perceptions, values and norms, as well expectations of them from the larger community, the school community and their professional community.

However, while the importance of teachers' beliefs in their classroom practices is clear, (e.g. Nisbett & Ross, 1980; Boiko & Putnam, 1996; Fang, 1996; Johnson, 1994; Pajares, 1992; Prawat, 1992; and Powell & Anderson, 2002), the nature of the relationship is not clear. Readence, Konopak and Wilson (1991), and Duffy and Anderson (1984), for example, found inconsistencies in teachers' beliefs and their classroom practices. Fang (1996) points out that teachers can hold a range of beliefs, some more general than others, and some more fixed than others, from which they select according to context, given the complexities of school and classroom life. Teachers can also hold beliefs about what they 'should do' (in an ideal sense), but for a range of reasons, choose to do something else. Decision-making, in practice, is more complex than proceeding from knowledge and beliefs to decisions and actions.

Teachers, from day to day, operate within a web of strings and relationships that pull from all sides. The decisions they make and their behaviours/actions are influenced by policies, personal values, beliefs and purposes, working conditions, likely consequences, experiential and theoretical knowledge, identities, expectations from the community, norms, and interest groups, and the politics and dynamics of schools and classrooms. Given this complexity, simple causal relationships between teachers' knowledge, beliefs and actions are inadequate. As noted earlier, the definition of 'belief' firstly is ambiguous (for example in its mix of values, principles and knowledge). Second, an individual's

beliefs range in scope and rigidity: a belief that it is wrong to kill is of magnitude different from a belief that a child should not question the authority of her teacher. Beliefs may contradict one another, and need not be consistent with actions taken. Third, while beliefs may be shared, they are presumed to be personal and individual. Hence, as explanations of action, they do not easily accommodate social and environmental factors, or means-ends considerations.

Identity offers an alternative construct. A teacher's identity or rather identities, are more fluid and able to change from one context to another, depending on who or what the teacher wants to identify with and why (Desrochers et al, 2002; Peeler & Jane; 2003; Macdonald, undated). Identity implies relationships with other people, with physical settings, interests and ideas, so that the teacher can have and work towards a number of identities at once. At the same time, identities are produced as lived experience and participation in specific communities (Avery & Carlsen, 2001). Identities have political, strategic and purposive dimensions.

The idea that identity hinges on how an individual likes to see himself (in a particular context), how he wishes others to see him, and some sense of 'belonging'; gives it explanatory power when thinking about teachers and teacher change. A teacher likes to see herself as a particular kind of teacher, a leader or a follower, respected for particular ways of working and particular talents. However these choices are made in the context of the school, the classroom, the profession, and the community, at a point in time. Given the structures of schools, careers and communities, the influences of senior staff, colleagues and administrative structures in the school are likely to be critical. When learning is considered as socialization or enculturation into the norms and values of a community, a teacher is under pressure to adopt those norms and values. This suggests that on the one hand, if the community says teaching is about the delivery of knowledge by the teacher, or finishing the syllabus early, the teacher who identifies with the community will feel pressure to do that. On the other hand, if the teacher chooses to identify with innovation and change, she might move towards becoming a leader in the community, seeking to change the community itself.

Giroux (1992) points out that teachers have to analyze their relationship with the community (and various sub-communities) to define themselves as social agents. They may choose to perpetuate the rules, beliefs and expectations of the community, or to wait for a while, or to break from those norms. A break may mean breaking the bond with the community.

This struggle with change is complex. A relevant theory to illustrate this point is social judgment theory (Sherif et al, 1965; Brown et al, 1989). When people receive new information they classify it almost at the moment of perception into one of three zones: a latitude of acceptance, a latitude of suspended judgment/non-commitment, and a latitude of rejection. Acceptance is influenced by personality and authority of the source, what others are doing with the information, the extent to which the information calls for change, and the consequences of using the information, especially for the individual receiving it. Ego-involvement (the likely effects of the information or change for the individual) is important, anchored in favoured positions (beliefs, ambitions, identities) that the individual accepts *a priori*. The greater the individual's ego-involvement, the narrower the latitude of acceptance, so, for example, a science teacher might be non-committal about a change being made in language teaching, but reject immediately a similar change in science.

2.15 Research Frameworks

As indicated in Chapter 1, the theoretical framework chosen for this study draws on constructivist and social critical learning theories, situated cognition and concepts of identity. In the following sections, I review literature in these domains, and bring together notions of problem-solving and teacher change, to provide the theoretical framework for the research.

In learning theory, objectivists argue that learning is indicated by behaviour, and is achieved through transmission and training (Jonassen et al, 2000). Quality of learning

involves reproduction of the required behaviours, usually as set by instructors/teachers. Constructivists argue instead that the knowledge is constructed in the learner's mind and those constructions define personal realities. The mind interprets events, objects, and perspectives rather than simply receiving and remembering knowledge. Jonassen et al (2000) point to epistemological assumptions of constructivist theorists that 'truths' are constructed, and knowledge is a function whereby an individual creates meaning from her experiences. Constructivist educators strive to create learning environments where learners engage in critical and participative roles (Jonassen et al, 2000).

Constructivism has been developed in a number of forms, some essentially individualistic and psychological (personal constructivism), some emphasizing the importance of social interaction and social history (social constructivism), and some proceeding more deeply into the factors that determine the acceptability and legitimation of knowledge (radical constructivism). Social constructivism concerns the construction of knowledge as part of the social environment (Gergen & Gergen, 1986; Vygotsky, 1978) and as part of cognitive engagement in activities. Schwartz et al (2001) indicates that knowledge is one of the many human activities that characterizes interactions such as communication, negotiation and conflict, which all involve language and representation.

Accordingly, McLoughlin and Luca (2000) point out that learning is best achieved when cognitive approaches are integrated with social approaches. McLoughlin and Luca (2000) maintain that during learner interactions in creating collective solutions to a problem, learning is enhanced. They point to the roles of statements, counter statements, defense, and challenges to students' assumptions and explanations that are all part of social interactions, and promote knowledge construction, reconstruction and learning.

Social and radical constructivism merge with critical theory, whereby different constructions are evaluated against value positions, such as an emancipatory ethic (Giroux, 1992) and/or an ethic of care (Collins, 1990). These values positions are also outcomes in their own right. Higher order thinking, problem-solving, 'deep understanding, and metacognition are clearly part of critical approaches.

Critical theory, like social constructivism, is based on social construction of knowledge. Habermas's (1992) practical knowledge and emancipatory knowledge both point to the importance of human social interactions bound with norms and expectations for groups and individuals. Like Habermas, Freire (1973) speaks of the importance of self-reflection and dialogue in emancipatory knowledge. Through dialogue and the give and take of ideas, knowledge of the self, the group and the environment grows. Dialogue also involves sharing power, as advocated by constructivists. Freire (1973) further proposes that dialogue go beyond talk and interaction to action or praxis, where dialogue and action work together. Critical theory, social constructivism and problem-solving thus come together.

In situated cognition too, knowing, learning and cognition are social, drawing on the situations in which they are placed, expressed in the actions of individuals within communities of practice. Active participation in the community involves relationships with the community, which has rules, norms and beliefs that both support and constrain the individual. Constructions of individuals are interactive with constructions of the community and ways of belonging. Communities and sub-communities operate at different levels, interacting (or not) in different ways. Thus an individual belongs to a number of communities, and has multiple identities that serve as tools for thinking and acting.

In theories of situated cognition, the situation or context in which thinking and learning occurs is emphasized: the construction of meaning is tied to a specific context and purpose (Wilson & Myers, 1999; Bereiter, 1997). This raises issues of the transferability of what has been learned. What is learned in one situation may be difficult to transfer or apply to another situation. To this dilemma, Bereiter (1997) offered an explanation. Bereiter attributes ease of transferability to the similarity of constraints and affordances across situations. Constraints and affordances are not characteristics of the environment or the person (considered separately), but of the relationship between the person and the environment. Hence the transfer depends on the same kind of relationship coming into

play in different situations. Greeno et al, further point out that transfer depends on goals and what the situation calls for; cognition is situated, but when working towards a particular goal in a particular situation, people call on experiences in similar situations and/or with similar tasks.

2.1.6 Teacher Beliefs, knowledge, identity and change

Teacher change is often considered a key element in any successful educational reform because of the assumption that better teaching will lead to better education for learners affected by the change (Powell & Anderson, 2002). Teachers are viewed as important agents of change in any educational reform and the expectation is that they implement and effect change at school and at classroom level. As much as they can effect change they are also capable of being obstacles to change due to classroom practices that emphasize factual and procedural knowledge at the expense of deeper levels of understanding (Prawat, 1992). This is attributed to strongly held beliefs (group or/and individual beliefs), knowledge (existing knowledge etc.), identity, norms and structures that exist within schools and larger communities. In moving towards a constructivist, critical theory and situated cognitive approaches to teaching, teachers need to change.

Learning new knowledge (regardless of the type of knowledge) involves confronting existing perceptions and beliefs with existing knowledge. These may be common group and/or individual beliefs. Individuals or groups have certain beliefs because of the situations/contexts within which they live or operate, and the structures within which they exist. Within these structures are a range of norms and expectations.

Efforts to enhance teacher development and change that focus on different teachers' anchor positions, but aim at changing teachers' behaviour in terms of classroom instructional practices, have been carried out in the past (Dwyer, Ringstaff & Sandholtz, 1991; Swafford et al, 1991; Luft, 2001; Murphy & Sato, 2002; Daniels, 2002; Hall et al, 2002; Powell & Anderson, 2002). Some of these have been successful while others have not.

Dwyer, Ringstaff and Sandholtz (1991) report on one project intended to change classroom practices by introducing technology in the form of computers. They point out that while the classrooms changed due to the presence of technology, teacher's beliefs about teaching and learning did not change. Hence classroom practices remained the same. In relation to this project, Dwyer et al (1991) say that everyone focused on innovation, computers and software and paid less attention to the elements that would most likely remain the same, that is the instruction, students' tasks and assessment.

Luft (2001) reports on a project that was intended to change teacher's beliefs about inquiry-based instruction and points out that interview results revealed that participant teachers held didactic, transitional, conceptual and constructivist views about teaching (that is, views that indicate learner-centred practices). However Luft (2001) showed that, as a group, participating teachers showed a significant change and yet changes in their beliefs as individuals were not significant. Luft therefore attributed behaviours to teachers' learner-centered beliefs. He attested that their beliefs may have directed their practices and that lack of change in beliefs may have been due to the stability of their beliefs.

Powell and Anderson (2002) refer to research by Krajcik et al (1994) on project-based instruction a professional development programme that was designed to help teachers solve scientific problems and develop new practices and visions of classroom practices. Ladewski et al (1994) reports on the case of a teacher who was involved in this project and held beliefs that were in conflict with the project. Among them was a belief that the teacher is a central figure in the classroom and that it was important to cover the fixed body of content set by the district curriculum framework.

Another professional development project (Swafford et al, 1999) was intended to change teachers' classroom practices. It focused on enhancing teacher knowledge, knowledge of teaching and learning and providing teachers with opportunities for collaboration and reflection. A shift in focus of classrooms from teacher to learner, a broader and more

balanced approach to curriculum and assessment, and a more pervasive and powerful role for problem-solving were revealed as the end products of the project. Teachers became more autonomous and flexible, more confident and willing to take risks. However, Swafford et al (1999) believed that the increase in content knowledge in teachers who were part of the project did not fully effect the classroom practice changes observed. Instead they attached the changes to research seminars and the opportunities for collaboration and reflection provided to the teachers.

Being provided with new frameworks such as learner-centeredness, power sharing, or problem-based learning could be empowering for the teacher, but could complicate her life by requiring her to change. This, Prawat (1992) attests, is true for the constructivist theory of teaching and learning. He indicates that it demands dramatic change in teachers' instruction, as well as the roles they and the pupils assume. Prawat (1992) further maintains that getting people to change their beliefs is difficult. He suggests that for change in peoples' beliefs to be effected, there should be dissatisfaction in the existing beliefs, available alternatives in extending understanding, new situations and connections between old and new beliefs.

Referring to constructivism as a new approach to teaching and learning Prawat (1992) points out that problems associated with constructivism could be overcome if teachers were willing to rethink both what subject matter knowledge means and how to foster this understanding in learners. What Prawat suggests is that teachers have to learn new knowledge; that is, teachers' public knowledge has to change. He points firstly to teachers' beliefs that content and learners are static and non-interactive hence their instructional mode is content delivery. Secondly, Prawat (1992) refers to what he calls 'naïve constructivism' teachers believe that classroom activity denotes learning. Another interesting belief among teachers mentioned by Prawat, (1992) and Powell and Anderson, (2002) is that of viewing curriculum as a fixed agenda with predetermined ends rather than interactive and dynamic. These beliefs, as Prawat attests, result in traditional, knowledge-transmission approaches to teaching and learning that are evident in many classrooms. Powell and Anderson (2002) confirm this by referring to teachers who were

participating in a Project-Based Instruction study, whose purpose was to get the participating teachers to understand a constructivist approach to teaching. It thus focused on problem-based instruction that was organized around a problem. They indicate that teachers who perceived curriculum as a fixed set were less likely to let the learners pursue their own enquiries.

In support of the above, Fang (1996) points out that many people view instruction as simply the delivery of information. The decoding of that information is the responsibility of students. Thus the teachers' responsibility ends when they have told students what they must remember to know and do. Teachers are viewed as experts in subject matter and content knowledge. The issue of how to translate this knowledge for students seems to rest outside the scope of the teacher's responsibility. It is suggested that many teachers proceed on impulse and intuition in teaching, relying on personal experience rather than on reflective thought and professional education (Lortie, 1975; Fang, 1996).

In view of the demands of this approach of teaching and learning (constructivism) and the traditional instructional practices evident in literature and classrooms, it is evident that there is a need for drastic change in teaching and learning and specifically in teachers' beliefs, knowledge, self-perceptions and practices.

As mentioned earlier, teachers' views of teaching and learning influence their classroom practice. Currently these beliefs support the traditional practice of instruction characterized by the teachers' transmission of knowledge and learners absorption, which emphasize teachers' role as that of a teller of truth injecting knowledge to the passive learner (Prawat, 1992; Pajares, 1992). It is assumed that if teachers are to adopt a constructivist approach to curriculum, they have to shift their thinking towards viewing it as a network of ideas to be explored rather than a course to be run. It is also assumed that teachers who have a conceptual view of disciplinary knowledge are more inclined to think of the learner in constructivist or interactive terms. However, it is shown that although the process of change is social, resulting in a new set of ontological

commitments on the part of the members of the disciplinary community, it is not necessarily gradual, especially in science (Prawat, 1992).

For change to take place, it is assumed that there should be professional development programmes geared towards effecting change. Both political and epistemological agendas should seek to create new opportunities for teacher growth and change. However, it should be noted that the role of professional development should not be considered in isolation with the individual teachers practice. Changes in practice do not necessarily result simply from providing new knowledge in a professional development context. There is rather a complex relationship between knowledge, beliefs, teacher identities and practice, which is unique for each teacher (Powell & Anderson, 2002). Powell and Anderson (2002) point out that change at the level of the individual teacher is only one aspect of educational change. Other aspects are school and organizational change. The latter is linked with political, structural and cultural aspects of educational reform, which in turn impact on changes occurring in the individual. This will determine the support the individual teacher gets to effect educational reform (Powell & Anderson 2002:111-112). Hence they argue:

Considering the context for change from the perspective of science education reform requires that we identify: curriculum materials that are available for the teachers to use in their classrooms; the factors necessary to support reform-based innovations; and the individual teacher's response to innovation. This means that the context for reform-based change linked to curriculum has three primary aspects: materials as a vehicle for change, the support factors for change inside and outside the school, and knowledge and beliefs of the individual teacher.

Political and institutional structures and policies determine what teachers can and cannot do and in turn affect their classroom instructional practices. The contexts in which teachers work or learn (especially with new instructional methods such as learner-centered strategies, problem-solving etc.), are introduced most often as policies or teacher development programmes initiated from outside (not within teacher groups or individuals). They often do not effect change in teachers. This may be due to the different

purposes of the initiators and the teachers as well as the power issues that are embedded within structures and policies. Powell and Anderson (2002) point to the importance of involvement of teachers in decision-making (as a means of power equity and sharing), in curriculum issues intended to change classroom practice.

Pointing to the limitations of the professional development programmes conducted in the past Murphy and Sato (2000) refer to the summary provided by Lieberman (1995): lack of knowledge of how teachers learn; ignoring teachers' definitions of problems in their practice; reform agendas which involve teachers in practices contradictory to accepted views of their professional learning; teaching described as technical skill, leaving little room for invention; building of craft knowledge; professional development opportunities which often ignore the critical importance of the context within which teachers work; strategies for change which often do not consider the importance of support mechanisms and the necessity of learning over time; The absence in schools of time and necessary mechanisms for inventing as well as consuming new knowledge, and advocating by those at the forefront of educational change for a constructivist approach in which teachers are seen as constructing their knowledge of teaching through their own apprenticeship of observation, which often consists of their experiences as students observing their teachers and their own experiences of teaching. Hence teachers construct their own understanding and meaning from their experiences.

For teachers to change their beliefs they must be dissatisfied by their beliefs and need to have an alternative that they understand and find useful. They should be able to connect existing and new beliefs (Prawat, 1992). For Prawat argues that the ideas that are put forward by reformers, especially those related to constructivist approaches to teaching and learning usually contradict teachers' beliefs (Powell & Anderson, 2002).

It is indicated in the literature (Cronin-Jones, 1991) that in the context of the implementation of an innovative science curriculum, five ideas dominate teachers' reactions to and accommodation of innovation in the curriculum. These are: students' need for direction in order to complete (and the direction should come from the teacher);

the teacher's control of the discipline, discussion and the content; the students' lack of capacity for independent work or thought; the nature of science as a static body of facts that need to be learned; and lastly, the reluctance of teachers to spend time on innovation if it is not viewed as leading to the learners' next learning experience (Powell & Anderson, 2002).

Gusky (1986 cited in Powell & Anderson, 2000) found that professional development activities were most effective at changing teacher beliefs when teachers could be helped to adopt a new practice, and could see that it was successful. Changes in belief follow changes in practice.

Realisation of the importance of the knowledge and beliefs of teachers about teaching and learning in particular subject matter domains led a number of researchers (Schifter & Simon, 1992; Smith & Neale, 1991; Carpenter et al, 1998 and Krajcik & Layman, 1989), focusing directly on projects which aim at changing teachers' pedagogical content knowledge and beliefs, as well as the impact of these professional programmes (Borko & Putnam, 1996).

All five projects aimed at helping teachers to change their instructional practices by supporting them in learning new pedagogical content knowledge and beliefs as well as subject matter knowledge. Although these different projects emphasized different aspects of teachers' knowledge, beliefs and practices, each of them assumed that meaningful changes in teacher practices required changes in teachers' pedagogical content knowledge and beliefs (Borko & Putnam, 1996).

Wood, Cobb and Yackel (1991), and Cobb et al (1990) focused on changes in the teachers' knowledge and beliefs about learning and teaching mathematics. The researchers found that the classroom environment was a significant source for teacher learning. Other findings of Wood et al (1991) were that creating a classroom environment that was based on constructivist views of learning played an important part, for these environments required changes in beliefs about mathematics teaching and learning and

knowing how to interact with the learners (Borko & Putnam, 1996). Teachers involved in these projects shifted roles from presenting information to the learners to encouraging learners to think. Teachers became aware of *not* imposing their methods of thinking. Instead they created opportunities for negotiating meanings and resolving conflicts (Borko & Putnam, 1996). Borko and Putnam (1996) point out that changes occurred only when teachers saw the problems with what and how students were learning and then worked to make changes.

2.17 Teachers Struggles with change

As they enter the teaching profession, teachers already possess beliefs about their roles as teachers, shaped by public and personal knowledge, through their experiences as students and expectations of them from the community.

If teaching is learning and learning involves socialization or enculturation into the norms and values of a community, when teachers join the teaching profession, they learn from a community of practice in the school that has its own beliefs, norms and expectations. To be accepted into such a community a teacher may choose to adopt the community's norms. If the community of practice says teaching is about the delivery of knowledge by the teacher and receiving by the learner, or teaching to finish the syllabus is a good thing the teacher who identifies herself with that community will do that. This indicates that the community and the situation in which that teacher works become important. If teachers have to change their roles as knowledge masters this will involve changing their practices, learning new beliefs and values, considering the expectations of the community and replacing old beliefs with the new ones. Giroux (1992) points out that teachers must be able to analyze their relationship with the larger community to apprehend themselves as social agents. In the final analysis one may see no need to perpetuate the rules, beliefs and expectations of the larger society. This may lead to breaking away from those norms, beliefs and expectations, hence breaking the bond with the community. This will call for judgment and decision-making by the teachers. It will also depend on the latitude of

acceptance of the persuasion for the desired change. For this persuasion to be accepted the following situations must pertain to social judgment theory (Brown et al, 1989):

- The new information must fall in the latitude of acceptance.
- The new information must be different from the anchor position
- The new information, while discrepant from the anchor, cannot be assimilated or contrasted.

Teachers' struggles with change could also be explained in terms of their already-constructed identity as a result of beliefs held and experiential knowledge. If teachers have entered the teaching profession as content deliverers, power owners and masters of all, it may be difficult for them to change. Change may take place only in extreme and extenuating circumstances/situations.

2.18 Teachers have to learn/change

To understand why teachers do what they do, one needs to understand the teacher himself, the complexity of his work and the context in which he works, leading to the complexity of his thinking and decision-making hence his behaviour/practice. The teacher from day to day operates like a spider in a web entangled within all the strings and pulled from all the sides. Decisions that teachers make and the behaviours/actions that they follow are dictated by policy, working conditions, their experiential and public knowledge, identities, expectations from the community, norms, values and beliefs. At these of the above fit into each other and interact, therefore influencing teachers' decision-making and actions. In order to understand why teachers do what they do or why they do not change, I use identity as a construct because of its fluidity; it changes from context to context (Desrochers et al, 2002; Macdonald, undated; Peeler & Jane, 2003). Identity is defined in social contexts and is produced as lived experience and participation in specific communities (Avery & Carlsen, 2001). I reject beliefs as a construct because of their diversity in meaning, ambiguity, their consisting of many concepts (Calderhead, 1996), although Nespor (1987) suggests that beliefs have stronger affective and evaluative components and that teachers often teach the content of a course

according to the values held of the content itself. This combination of affect and evaluation determines the energy that teachers exert on the activity and how they will exert it (Pajares, 1992). I reject these constructs due to their cognitive construction; they are deeply personal and unaffected by persuasion, hence they may be resistant to change (Pajares, 1992.)

With regard to knowledge while it is true that for teachers to teach they need content, pedagogical, curricular, learner, experiential as well as public knowledge (Shulman, 1987; Schempp, 1995; Jegede & Toplin, 2000), it does not necessarily mean that teachers' possession of knowledge will lead to action/practice or change of practices (Reddy, 2003). Therefore, teachers' knowledge may not necessarily be an appropriate construct in this study.

Policy on the other hand, is also rejected because as implementers of the policy through curriculum, teachers are expected to do much. However they are capable of being obstacles to the implementation of policy (Prawat, 1992). If what is to be implemented is not valued by the teachers it is unlikely to be implemented. Conditions/ situations under which teachers work are also determinants of what teachers do and how they do it.

2.19 Why not action research

As mentioned earlier my intention in this study was not so much to change teachers or their curricula or even to improve the situations in schools. While I was comfortable with the idea that teachers and schools might change as a result of involvement in my research, such change was neither their objective nor mine. The focus, from beginning to end, was on teachers' behaviours and actions; why they do what they do; why they do/do not change to suit the policies of problem-solving and HOTS. Put another way, my objective was not to 'solve' the problem, but rather to understand it. My concern was that a focus on 'solution' or changed practice might hurry the teachers and me too much through the analysis and understanding, with too much concern for results and change. Thus, while

the research framework called for actions and reflections, the purpose was to understand more deeply teachers' actions, than to chart their change and development.

2.20 Conclusions

It is evident from the literature that teachers enter teacher education and teaching with strong beliefs and public and experiential knowledge that influence their learning and classroom practices. These beliefs can work against promotion of higher order thinking skills, problem-solving and power-sharing. It is also evident that, whether experienced or not, teachers are likely to lack the knowledge that is necessary to enable them to work with open-ended situations and problems. In this, teachers as individuals are part of the 'organisation' defined by the education system and the school, and members of communities of practice (in the school and more widely) which have their own expectations, rules and structures. These structures and communities bear on decisions and actions that teachers can make as a result of power relations, rewards and constraints. Learning and problem-solving, for teachers as well as for students, are situated in social, physical and political contexts, and contextual factors influence what teachers do and do not do.

While identification with and belonging to the community of practice defined by teaching (generally) and school (in particular) is proposed as an important influence on teachers' actions, it should not be assumed that this identification is the only one operating. Within the communities of teachers and the school are subgroups with particular interests, perhaps connected through a variety of networks to similar subgroups. Also, an individual may wish to be identified as an innovator, a leader, or a particular kind of teacher, or might be identified in such ways by others. Identity is not only about conforming and conserving.

The possibilities for innovation and leadership depend in part on the structures and norms of the school. In this regard, Argyris's (1967) conceptions of single-loop and double-loop learning are relevant. Single-loop learning is essentially conservative, seeking to do better

work as defined by existing rules and norms. Double-loop learning is not conservative in these ways. On the contrary, it questions existing approaches, innovates and experiments. Argyris saw these kinds of learning as characteristics of organizations more than individuals: double-loop learning is encouraged and promoted by appropriate management climates, structures and leadership. This claim parallels claims made for classrooms: if problem-solving and higher order thinking are to be promoted in classrooms, double-loop learning is required, and appropriate beliefs, classroom environments and power relationships have to be in place.

It is evident from the literature reviewed in this study that much of the work done on teacher change has focused on teacher' beliefs and knowledge, from a constructivist perspective. In general, teachers' beliefs have been found to be contradictory to constructivist approaches to teaching and learning, the promotion of critique (or double loop learning) and the advancement of higher order thinking skills and problem-solving. Workshops and projects intended to change teacher beliefs and practices report some success, but not in ways that lead to self-sustaining changes in classroom practice. While this failure is often attributed, from a constructivist viewpoint, to the deep-seated nature of teachers' beliefs (their anchor positions), it may be that the studies have taken too little account of the 'situatedness' of cognition, learning and action. This idea directs the research to go beyond teachers' knowledge and beliefs, to explore the influences of identity and context on what teachers do, and to look to changes that need to be made in schools and education systems that can support and promote teacher change.

While a number of the projects and studies reviewed in this chapter focused on the need to change teachers, in this study the purpose was not so much to change teachers but to probe deeply the interactions of teachers' beliefs, knowledge, situations and identities in shaping what they do and why.

2.21 Projection for next chapter

The next chapter outlines the research method used in this study. It begins by mapping the six phases of the study, showing its purposes, activities and time frames. It discusses in detail the methods, procedures, approaches and instruments used. In all phases, the methods are related to the research framework and research questions. Also, the ethical issues considered during the study are presented.

CHAPTER 3

Research Methodology

3.1 Introduction

This chapter describes the methods used to collect and analyse data. The methods derive from the purposes and research questions outlined in Chapter 1, and the theoretical framework developed in Chapter 2.

The purpose of the study was to investigate what teachers and their classes understand by ‘problem-solving’ and what teachers do in their classrooms to support it. I wished to look into what actually happens in classrooms in terms of quality teaching and quality learning, focusing specifically on problem-solving. I wished to examine why teachers decide to engage or not to engage pupils in problem-solving. Thus, the research questions were as follows:

- What do teachers understand by ‘problem-solving’?
- How do teachers promote problem-solving in science lessons?
- Why do teachers make the choices they make, in relation to problem-solving?
- Why do teachers change their practices or not?

The theoretical framework was drawn from constructivism, critical theory and situated cognition, including the roles of knowledge, beliefs, contexts and identities in the pedagogical choices teachers make.

3.2 The selection of teachers and classes

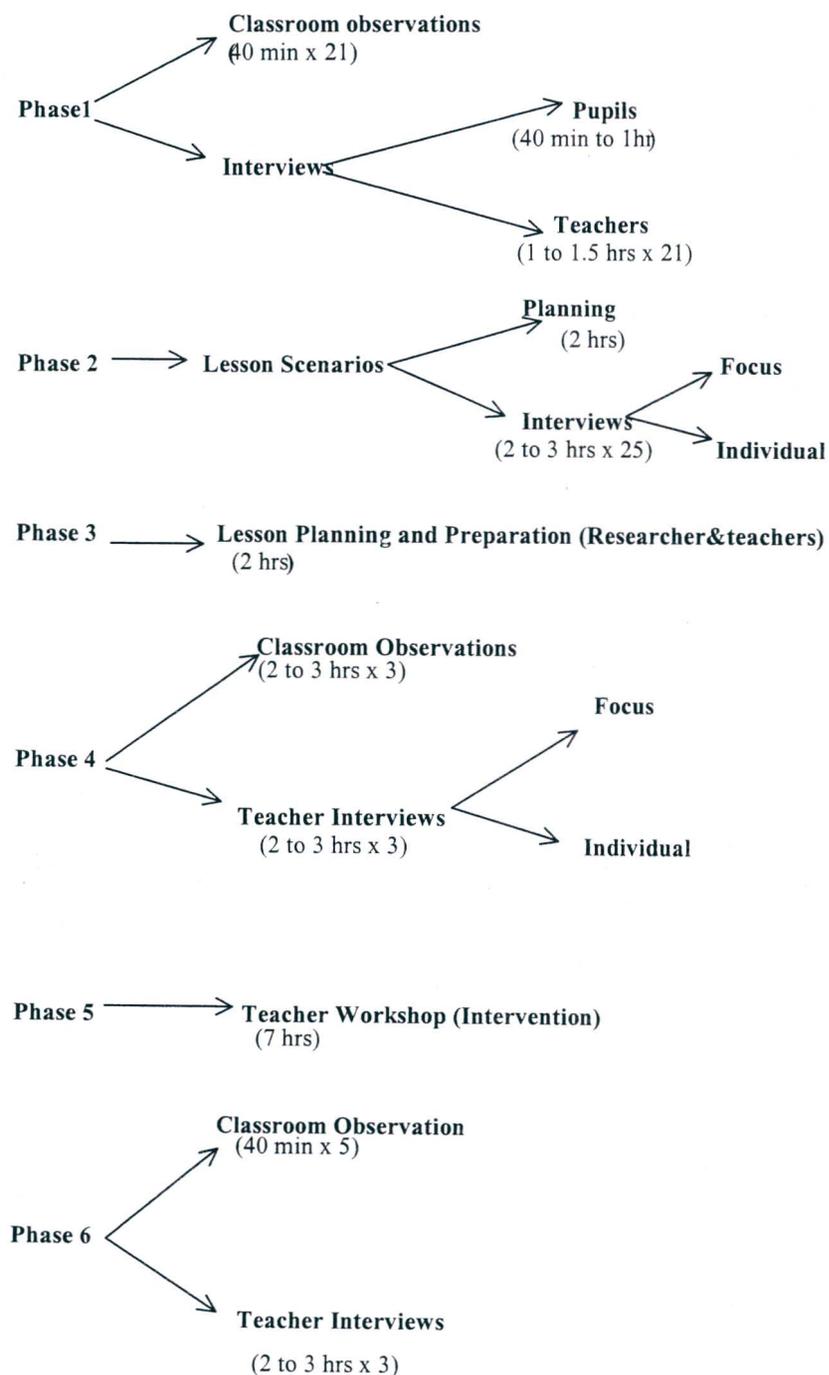
A formal letter seeking permission to carry out the research was written to the Principal Secretary, Ministry of Education, Lesotho. Since primary schooling is the basis of general education in Lesotho, teachers and classes in Class 6 and Class 7 (the last two years of primary school) were chosen for the study. Lesotho College of Education is the major provider of teacher education for primary schools, and its courses since the MOE

Plan of 1999, have given considerable emphasis to policies of learner-centred education, higher order thinking skills, and problem-solving. For this reason, graduates from in-service education programmes in 2000 were chosen as the appropriate population. In 2001, I issued 500 follow-up forms to graduates, seeking information that included the locations of their schools, directions to their schools and the classes they teach. Of these five hundred forms, 300 were returned. From this 300, I selected 50 teachers distributed across the lowlands and foot-hills, and wrote to say I would like to work with them in this project. Forty-five responded. I then wrote to the principals, to seek permission to work with their teachers. From the 45 teachers, I selected 21 who were teaching Classes six (6 or 7), distributed across the lowlands and highlands. This group provided the sample for Phase 1 of the study. The teachers were chosen because of their locations, with a view to statistically representing teacher population per district. In setting up the visits, the aims of the research were made clear, and teachers were encouraged to present a lesson in which they addressed HOTS. Although the teachers knew that I would be coming to their schools and the purpose of the visit, they did not know the time I would be coming given to my job demands and the limitations of public transport and accommodation. This was explained to the teachers before the visits. To allow some flexibility for the teachers and schools, a 'science' class could be natural science, agricultural science, health, or home economics, but with an orientation to higher order thinking skills and problem-solving.

3.3 Phases in the data collection

The research was designed in six Phases, as represented in Fig 3.1. Data collection began in May 2002 and ended in October 2003. The purposes, methods and sampling are described for each Phase separately.

Fig. 3.1. The six Phases of data collection Methodology



Phase 1: Classroom observations and interviews

In order to understand the experiences as lived (Sherman & Web, 1988) by the teachers and the learners regarding teaching/learning problem-solving, I chose qualitative research methods for this study. To understand these experiences I had to physically observe classroom activities in their natural setting (Vulliamy, Lewin & Stephens, 1990; Burgess, 1985). Classrooms are often 'black boxes' where no one knows what is happening inside except those who are in. Participant observations enabled me to share the experiences (Sherman & Web, 1988; Bell, 1999). Because teachers' and learners' underlying motivations and thoughts may not be revealed through observations, I supplemented the observations with interviews. Interviews served as a follow-up (Cohen & Manion, 1980; Borg, 1981) and validation of data (Burgess, 1985; Cohen & Manion, 1980). I also used interviews for the purpose of building rapport.

The purposes of Phase 1 were to see how and whether a sample of teachers in schools across Lesotho addressed problem-solving and higher order thinking skills in their science classes. I wanted to explore their understandings of problem-solving, and to find out from their learners, firstly, if the lesson observed was typical and secondly, their ideas and preferences about problem-solving and how they liked to learn. The sample consisted of 21 primary school teachers randomly selected from seven districts in the lowlands and foothills. The teachers were randomly selected from each district. Initially selection was made from teachers who had recently (in about 2 years) completed an in-service programme as part of upgrading qualifications, and who were teaching Classes 6 and 7. Their teaching subjects included Science, Home Economics, Health education, and Agriculture.

Classes were observed, and teachers and groups of children were interviewed. In this Phase, more than in later Phases, I chose to place myself as a non-participant observer, consistent with the purposes of this Phase. It may be argued that once there is an intruder (the researcher) on the scene, there is bound to be a change of natural behaviour among the subjects, no matter how I tried to be part of the schools I visited. I do not see how my

presence could itself not have affected the natural classroom atmosphere in the schools, especially given pupils' first contact with a researcher. I was also aware of the difficulties of classroom observations. For example, the teacher is likely to prepare her lessons differently, knowing that I will be present. My presence in the classroom was likely to alter the normal behaviours of both teachers and pupils.

An observation schedule was used, and interview schedules were developed for teachers and pupils. In part, the schedules were to ensure that similar information was gathered from all 21 teachers and classes.

The Classroom Observations

In this case of classroom observations involved sitting in the classroom and recording features of activity and interactions, specifically focusing on delivery of problem-solving. As Skager and Weinberg (1971) point out, direct observation is of behaviour, but the meaning of behaviours has to be inferred. In these inferences, I depended on my own experience as a teacher and teacher educator, and relied on theoretical concepts that underpinned the observation schedule. I did all of the classroom observations myself, in order to improve consistency in the uses of the schedule.

While focusing on problem-solving and higher order thinking skills, participation and monitoring/assessment, general issues of classroom management, goal direction and lesson planning were also observed. An important source in the design of the observation schedule (see Appendix A) was the set of "productive pedagogies" of the Australian School Reform Longitudinal Study, or SRLS (Ailwood et al, 2000), which focused on opportunities to learn, or opportunities to achieve outcomes such as problem-solving, critical thinking and metacognition. The SRLS developed and tested twenty items which contributed to four scales: intellectual quality, relevance, supportive classroom environment, and recognition of difference. Intellectual quality (including Higher Order Thinking Skills, metacognition and participation) was seen as the central concern, with relevance, a supportive classroom environment and recognition of difference contributing

to intellectual quality. Attention was only paid to the qualitative aspects of the opportunities provided to the pupils (e.g. activities, questions and the working environment), intentions of whether they were supportive of problem-solving.

Interviews

Interviews were considered important in understanding the teachers' goals and plans and the choices they made, including the emphasis they give to methods of teaching which promoted HOTS.

Semi-structured interviews were conducted among the teachers observed and the pupils taught. Both teacher and pupil interviews were focus group interviews and/or individual interviews. In each school visited, two male volunteers and two female volunteers were interviewed. However, in two schools the pupils demanded that they be interviewed as a whole class. Semi-structured interviews were considered suitable for this study because it was expected that the questions were just introductions of the themes which would arise from the teachers. Therefore the initial responses of the teachers were supposed to guide me to the questions to follow rather than leave me to run the show. However, I was also aware of the possible bias that may have occurred in selective listening and recording, influenced by my efforts to stick to the purpose of the research.

During the interviews in this Phase, the questions were at times not asked in the sequence in which they appear in the schedule. Also, the same question was asked slightly differently to the same teacher for the purpose of confirming the information given by him, For: example: The question 'Does the syllabus help teachers to present lessons in the form of problems?' could also be phrased 'Does the way the syllabus is presented help the teachers present the lessons in a problematic form?'

Teacher interviews (see Appendix B, Part B) focused mainly on the following:

- Teachers' understandings and interpretations of problem-solving and how they encouraged the development of this skill in pupils, and if they did not, why not.

- Whether they thought the training they received at the Lesotho College of Education (LCE) helped them in this regard.
- Whether they felt problem-solving was expressed in the curriculum (In this case, science) and assessed by the common national Primary School Leaving Examinations (PSLE).
- Whether their usual mode of lesson presentation (large, small group or individual presentation), in this case group work was used as a vehicle for problem-solving.

Pupils' interviews (see Appendix B, Part A) focused on the following:

- Usual classroom presentation that they receive (large, small group work or individual); by individual, reference was not made to activities such as copying notes.
- The preferred mode of presentation and the reasons for pupils' preferences.
- Strategies that pupils use to solve problems in science lessons and the role that their teachers take in this respect.

During the observations and the interviews the use of a tape recorder was optional. It was noted that teachers were more willing to use of the tape recorder when interviews were conducted in a group rather than during individual interviews.

Phase 2: Lesson scenarios

This Phase was designed to probe more deeply teachers' understandings of problem-solving, by presenting seven brief lesson scenarios (see Appendix C, Part A), in which problem-solving was used in different ways. The purpose of this Phase was to work more closely with the teachers and delve into their understanding of HOTS by encouraging them to think more deeply and to reflect on their work. By reflective and critiquing each other, teachers were developing critical thinking skills themselves. Hence the probability of passing these skills to the pupils would be increased.

The scenarios were related to Class 6 syllabus topics in science. The ‘problems’ included three social problems (e.g. an argument between two women about how to dispose of waste water), two experimental problems (e.g. purifying water for drinking); a puzzle (about how to get into a locked house to rescue a child), and two classification problems (e.g.. whether things such as a cut branch were ‘alive’). Teachers were given time to read the scenarios, and then interviewed (see Appendix C, Part B) about:

- Which ones they considered to be good examples of ‘problems’ and why, and how they thought these lessons would ‘work’ with their pupils.
- How much they structure (wide open, broad framework or guidance) they thought should be given to pupils in a problem-solving activity.
- Why most classroom presentations are largely large group and if they thought this is a good practice or not, why it is considered a good practice or not.

Since one way of teaching for problem-based learning and problem-solving is the use of context, which can be achieved by the use of a scenario, puzzle or query, I chose to use the first two. These particular scenarios and a puzzle were selected because of their relevance to real-life experiences in Lesotho, especially in rural areas where the methods of sanitation are poor (e.g.. scenarios 1,2 and 3,). Similarly, for the puzzle in scenario 7, most of the Basotho houses are thatched and it is not uncommon for a house to catch fire because of some incident to do with cooking with a paraffin stove or lightning during thunderstorms. Most of the schools selected were from the rural areas where incidents such as these are likely to occur.

The sample for Phase 2 was chosen for convenience. It consisted of twenty-five (25) teachers, of which fifteen (15) were participants in Phase 1, and ten (10) came together from a range of Lesotho districts to attend a workshop. This sample was representative of the primary school teachers across country in that there was a teacher from each of the ten districts of Lesotho. The reason behind this sampling was the findings from the previous Phases: no patterns of difference were evident in terms of teachers’ training

(through in-service) or their school's location, structure and management. This does not imply that background and situation did not count, just that in the earlier sample of twenty-one (21) teachers, patterns were not obvious.

Phase 3: Lesson planning and preparation

From the initial twenty-one (21) schools, I selected three (3) schools that were easily accessible in terms of travel and communication. This was a manageable group. Also with these three (3) schools, participation of teachers had been regular in the previous Phases as compared to other schools; the same teachers have participated throughout the two earlier Phases. Three other teachers, one teacher from each of the three schools who had been involved in Phases 1 and 2 met me and developed a detailed lesson plan (See Appendix D) based on one of the scenarios discussed in Phase 2.

The purposes in including teachers in the planning of the lesson was as follows:

- To probe further their understanding and interpretation of problem-solving.
- To see if they could teach for problem-solving.
- To get the 'inside' of their thinking and ideas.
- To encourage interactions among teachers share ideas as well as common problems encountered and how these could be solved.

The choice of who comes for planning and who will teach the lesson was left to the teachers, because it would also depend on the principal of the school and the assignments and allocation of duties to individual teachers in schools. To ensure that my methodology met the frameworks I aligned myself with, my sampling had to be reduced from a large to a small group in order to encourage effective social interaction among teachers, hence the choice of three (3). The scenario that the teachers chose to develop was a classification problem: whether soil, water and fire were 'alive' or not. This lesson was selected after a lengthy discussion between the three teachers and myself as to which lesson was to be developed and why. It was noted that among the lesson scenarios the teachers selected

conceptual problem-solving – a type of problem quite closely aligned with the traditional curriculum.

Although the lesson was planned together and the teachers played a major role in the planning, I requested that the lesson to be planned should not require any particular materials to be used. This was because teachers and pupils often associate the use materials and activity in the lesson with problem-solving.

Phase 4: Teaching, classroom observations and interviews

Teachers then taught the lesson in their schools. Using the observation schedule described in Phase 1, I and the other four teachers who had been participating in the project in the earlier Phases and the principal (in 2 schools) observed the lesson taught. I did so as well. Before the lesson, in order to maintain uniformity, we held a pre-conference to agree on what we would be watching and recording. Two of the teachers who taught the lesson had volunteered and one had been nominated by other teachers. In each of these lessons the four five observers joined different groups during group work among the pupils. The success of the lesson was measured in terms of observable activity/discussion among pupils that is indicative of reasoning, critiquing, sharing ideas etc. These skills were identified by teachers throughout the study as characteristic of problem-solving. The types of questions and activities given by the teacher that would require these skills from the pupils were also observed.

This period of was followed by a group interview (see Appendix E Part B) between myself, the presenter of the lesson and the other four observers, to discuss what the teacher and learners were doing during the lesson and why; whether the lesson was successful or not; the HOTS that pupils used and how such teaching/learning strategies could be improved. We also discussed why problem-based teaching methods were used (or not) in ‘normal’ teaching. The purpose of the group interview was to dig further into teachers’ ideas on problem-solving as well allow interactions and reflection on practice in order to share and learn from one another.

Phase 5: Teacher workshop

I organized a one-day workshop for the fifteen (15) teachers from the schools whose teachers participated in the study throughout the four initial Phases. There were two facilitators, one from the university of Durban-Westville (South Africa) and the other from the University of Queensland (Australia). Another group that participated in the workshop was a group of secondary school teachers who were involved with a fellow D.Ed student on a different project.

The purposes of organizing the workshop at this stage were as follows:

- After almost 2 years of interactions with teachers it was worth coming together and reflecting on what had transpired throughout the project period.
- As an ethical consideration, I felt it proper that, due to the length of the period that these particular schools and teachers afforded me and catered for my study in their tight schedules, the project should also benefit them.

The theme of the workshop was 'The use of a learner-centred approach and problem-solving in the classroom'. In the workshop teachers explained what they understood by learner-centred methods and problem-solving teaching/learning although they maintained that they were not able to use these strategies given policy dictates and restrictions, conditions of work, expectations etc. Teachers explained that the concept of power was new to them. During the workshop teachers talked about how they viewed learner-centred and problem-solving in view of power sharing in the form of written texts and drawings. Written texts, notes I took during the discussions and drawings were used as the source of data to map how teachers viewed themselves and their roles as well how they thought they were viewed and the expectations of them by the larger community.

The methods helped me to understand teachers' knowledge, beliefs, and understandings/perceptions of their roles in the teaching/learning situations and how they were viewed,

(their expected roles) by the community they served. I also used teachers' written texts and drawings in order to understand how teachers constructed their identities.

Phase 6: Classroom observations and teacher interviews

Following the workshop I went back to the schools to observe the teachers teaching and to interviewed them. I selected five teachers from the three schools that had been participating throughout the project. The five teachers selected were those who had not missed any session in the project and were teaching Classes 6 and 7, targeted from the beginning of the project. The purposes were:

- To probe further the reasons why teachers do not teach for problem-solving and why they do not change their practices.
- To map teacher change.

Thus sources of data in this Phase included mainly observation schedules and interview transcripts. Similarly in this Phase both observation and interview schedules were self-constructed. The source of information used in both schedules was what transpired during the interviews and discussions in the earlier Phases. With the observation schedule what was mentioned as characteristic of teacher and pupil activity and the typical language used in the problem-solving lesson, became the focus of the schedule.

3.4 General strategies

I found it justifiable to use interviews in this study for both the teachers and the pupils, because I would hear from the subjects themselves about their classroom experiences, that is, their direct experiences. Interviewing teachers individually, encouraged them to reflect and partly to solve some of their problems, while group interviews engaged them in both social interaction and reflections on their practice. A further justification for interviewing pupils was that most of the efforts, developments and changes that are made in the educational arena are done in the name of the learners. However, very little consultation is done with the learners. Learners do not have a say in education at any

point and time, and they are the most powerless in this arena. Yet claims are made that whatever is done, is done for the benefit of the learners. By justifying my inclusion of the learners in the interviews, I am not distancing myself from the injustice that is done to the learners: for permission was not sought from the learners initially to be involved in the study. With the pupils it was not research *with* but research *on*.

My position as researcher shifted in the course of the study. In Phases 1 and 2, I chose to be a somewhat 'distant' observer and interviewer. In Phases 3-6, I was more a participant, moving for example to more conversational, and interrogatory approaches in interviews, and from individual interviews (in Phase 1) toward group interviews. In all Phases, I held back from 'teaching' and/or working as a resource-person. For example, I attended the workshop as a participant, not a leader or facilitator: external facilitators from outside the country were used. This position was consistent with the research purpose to find out teachers' knowledge and beliefs, and the reasons for the choices they made.

I found it legitimate for my methodology to engage teachers in collaborative practice and form learning communities by giving them opportunities to interact with me, with each other, and with their pupils to reflect on their practices. It was in these group discussions and interviews that teachers displayed their teaching culture, their beliefs, norms, values, experiences as well as expectations from themselves as teachers and the community (stake holders). All these revealed the identities constructed by teachers.

3.5 Data collection

In this study data was collected using different strategies in different Phases, with each Phase shaped by the preceding one. The results from Phase 1 prompted me to design lesson scenarios to probe even deeper into teachers' understandings while Phase 3 was intended to bring teachers together to interact with one another, reflect on their work and support one another. In Phase 4, the lesson planned was taught and critiqued and teachers still maintained they were not able to use problem-solving. It was not until Phases 4 and 5

that I really understood that their knowledge, beliefs and skills were good enough to teach problem-solving. This compelled me to collect more data to probe further into teachers' reasons for not using problem-solving even though they had shown a partial knowledge and understanding of it. This led to a change of strategy: this time I used an intervention strategy, and organized a workshop for teachers.

3.6 Ethical issues and research design

Lesotho is a small country, but poor, so that roads and communication systems are not well developed. While I wanted to sample schools from all districts, public transport and accommodation facilities limited my intention. Further, because some of the selected schools did not have telephones, arrangements for some schools had to be made by mail. This meant that I had to accommodate school requirements when I arrived. Some teachers missed appointments due to absence, other duties and family commitments. Further, principals, in their wish to increase involvement in the project (as an opportunity for staff development), or for other reasons, sometimes substituted a different teacher from the one I had expected. I saw these issues as ethical issues in the Lesotho context: a tension between the scientific requirements of my research, and the judgments and operations of the schools. I judged it appropriate to accommodate the schools and teachers much of the time.

The 'standard' demands of sampling and participation would have been contrary to the expressed needs and wishes of the participating schools and teachers, and contrary to the logistics of life in Lesotho. They would also have been contrary to my theoretical framework, with its concerns for critical theory and situated learning. The situation was part of the data in this study.

To honour my subjects' preferences, I agreed with the teachers from the onset that real names for the teachers and the schools would not be revealed in the report, only the letters of alphabet and the numbers or false names assigned. Although this plan was helpful in that teachers responded and expressed their experiences and views freely, it

became problematic during data transcription as it was difficult to attach the symbols or numbers to the actual persons. Hence, the findings from analysis of Phases 1 to 4 reported as an analysis of the teachers as a group instead of as individuals.

I was also fully aware of the issue of the involuntary participation of the pupils (Vaughn, Schumm & Sinagub, 1996). Given the lack of social power of the pupils, they may not be able to express their feelings if they did not like my presence in their class, unlike the teachers who could have freely denied me the opportunity. However, this was balanced with the interviews where the pupils were to volunteer to be interviewed.

I also assumed that because of the nature of the study, there would be some interest displayed by both the pupils and the teachers to participate. Indeed this was evident in some instances, where the number of teachers began to increase in each school, with teachers feeling that they would also benefit from the study even though they were not part of the project. Also the head teachers kept on changing teachers in the project because they saw some value in the topics that were discussed during the meetings. This ethical responsibility had to be considered as part of the validity of the results.

While it is true that initially my intention was to work with teachers who had just completed their training with the Distance Teacher Education Programmes (DTEP), the observations in Phase 1 indicated that the project should focus on teachers in general, not just those who had trained through DTEP. This was evident when I began visiting schools and asked teachers who did not qualify from DTEP if they could allow me to visit their classes and do not mind help in any way. These teachers welcomed me. However, this activity was interpreted by some as interference in their private lives, because they were not in the contract but joined of their own will, through interest and invitation. I observed that teachers had similar practices whether trained through pre-service or DTEP. The above change or shift of focus on teachers had impact on the literature reviewed since there had to be a shift from DTEP teachers to teachers in general.

It is also noted that at some stage I made pre-arrangements for lengthening the class periods, which is not a norm. This by itself does not portray a natural setting since teachers do not under normal circumstances teach for two or more hours as the length of a period. Also, the presence of four more teachers and myself in the classroom was not normal for the pupils, impacting on their behaviour in one way or the other.

The research extended over almost two years. This was important in the research design, in that it allowed time for the participants to reflect on their experiences and discussions, experiment, and build trust with one another and with me. While more frequent visits to the schools might have been advantageous, they posed logistic difficulties for me, and perhaps might have been too intrusive for the schools.

3.7 Validity

Given my purpose in this study (that of understanding why teachers do not teach problem-solving) and the interpretive framework, I encouraged teachers to be reflective and critical, and to experiment with lesson designs as part of the data. In this framework, validity is a proper concept: I wanted to achieve data that is 'true' for the participants. I achieved this by planning the six (6) Phases of data collection, to get deeper and deeper into teachers' thinking and explanations. At the same time, their knowledge shifted during the six Phases, and my sample got smaller. This raises issues of generalisability. The participants in Phases 2 to 6 were self-selecting and were more inclined to express their personal positions, and take responsibility for their ideas and actions. My findings from Phases 3 to 6 were generalisable in the insights they offered, not necessarily in any statistical sense. They held on their story (on why they do not teach problem-solving) throughout the project. Also, I can refer to generalisability in the sense that situations in which teachers were more or less similar (e.g. one teacher teaching all the subjects in the curriculum, heavy numbers of pupils, and the bureaucratic structures that they operate within) therefore had similar problems. It was important after Phase I to select almost similar problems; however, they were slightly different due to different managements by the principals (e.g. the principal who felt the importance of involving same teachers all

the time as requested, against the others who prioritised schools engagements over the project).

From Phases 2 to 6, a group of teachers understood the consequences for themselves of involvement in the project. They saw it as a development project for them as much as it was helping me in my study. Through participative processes teachers also had large control over the way the project progressed and developed and over the consequences they saw as important to them. Through the responses they offered in Phase I the strategy for data collection had to change from just observation and interviews to lesson scenarios, lesson planning to teaching, and attending the workshop.

The third limitation mentioned earlier arose from principals changing teachers who attended interviews. Truth validity in these situations had to be balanced against consequential validity for the teachers and schools, and the ethical dimensions of the research.

3.8 Methods of analysis

Observation schedules were used for the classroom observations. They were analysed quantitatively, by tallying frequencies from the schedule. Interview transcripts, from all Phases (1 to 4) of the study, were analysed and coded using systemic network analysis, with the codes and network arising from the data (Bliss, Monk & Ogborn, 1983). Teachers' drawings and writings (from the workshop, Phase 5) and notes taken during the discussions, were used as an important source of data, and were analysed.

Three methods were used in this study. First, from the observations in Phase 1, I used the quantitative method to tally almost similar occurrences and calculated the frequencies of what actually happens in the classroom setting in the name of problem-solving. With interviews from Phases 1 to Phase 4 I used systemic network analysis to code similar responses, to identify themes or categories generated from the data and in Phase 5 examined teachers' written and drawn texts.

As Doucet and Mauthner (1998) point out, dilemmas face researchers in using, adapting, and choosing particular methods for particular contexts of research projects, and reasons and methods for choosing particular methods for data collection. I used different methods, with the methods of analysing my data guided mainly by the methods of data collection and the different situations in the Phases of data collection. My methods of data collection and analysis were all from an interpretive perspective, with the school situation as my frame of reference

In an effort to understand the teachers' lives and their experiences I had to keep to the themes/categories that were generated from their earlier responses as the basis for my analysis. Central to qualitative research is the notion of listening to respondents and understanding their lives and on their own terms (However, through questions and selective listening I had to ensure assure that I kept the focus on my purpose (Doucet & Mauthner, 1998).

In this study data from interview transcripts from the first four Phases of the study were analyzed and coded. In coding data in this study I went through teachers' responses on how they defined and interpreted PS and found that they did so in terms of: teaching/learning methods, teacher'/learner' roles and gave each one of these a code. I used numbers as codes (Burroughs, 1977).

The coded groups (categories) were further divided into subgroups. For example, "Definition of problem-solving" which was coded as methods of teaching/learning and learning giving the code 1 was further categorised into; discovery, learner-centred and construction. Systemic network analysis defines categories and elaborates them through sub-categories, so that logical relationships within the data are identified (Bliss, Monk & Ogborn, 1983). This study reports on ideas that emerged for all participants considered together, not separately for individuals, or separately for teachers in one or another Phase of the study. I chose to use systemic analysis because it allows one to group themes/categories but also to respect individual respondents' voices. From the interview

responses in Phase 1, I intended to hear both from the teachers and the pupils, on their classroom experiences and why the teachers decided to teach or not for problem-solving. The focus of my study guided my questions, which in turn guided the responses that teachers provided – although there was some freedom for teachers to go beyond the questions in their responses. Teachers' responses became the major basis for the themes used for the three subsequent Phases in this study. In Phase 1, all the sentences were coded. In the other three Phases only the sentences that matched the already existing themes were coded. I selected only those that fit my system.

The themes or categories that emerged from data reflected the reasons for doing or not doing problem-solving, they did not reflect issues of beliefs, identity, personal ambitions or structures. However, these reasons became the basis for later interviews. The network analysis applied specifically to Phase 1 and the reasons offered there became the basis of later interviews that probed the reasons and situations more carefully. Thus, the later interviews (for Phases 2, 3 and 4) were to elaborate on ideas from Phase 1. In later Phases while I based my work on the initial framework, I did not seek to quantify responses using the network but sought instead to gain insight into my data.

In this network sixteen groups emerged and out of these sixteen groups five categories emerged from the responses. The first category, 'awareness and understanding of problem-solving', constitutes of identification, definition and the value of problem-solving.

The notion 'definition' was further sub-categorized into mental activity, methods of teaching/learning, as well as contextual factors. From methods of teaching/learning emerged learner-centred/teacher-centred, discovery and constructivism.

The second category, 'policy' contained four sub-categories: curriculum, assessment, time, and management. The third was 'knowledge' '(subject and public knowledge)', subjects expressed their lack of knowledge in terms of familiarity with skills and content, lack of content which was described as concepts and skills, and level of difficulty and

competency in handling the subject. In the fourth category, 'behaviour', the sub-categories were laziness, non-commitment, expectations, un-preparedness, communication and reflective teaching. Lastly, 'condition' contained class size, resources, and support. Beliefs did not constitute a usable category, in that they are expressed in all categories.

From the discussions I had with the teachers and the notes I made during the discussions in Phase 5, I established that the teachers had good insight into learner-centred education, problem-solving, and the kinds of lesson designs and activities involved. They also reiterated 'reasons' for not doing these things, pointing especially to situational constraints. These discussions and the earlier ones provided me with lots of information on teachers' knowledge, beliefs, and perceptions of themselves and their schools.

The issue of power was introduced which it was a new idea for the teachers. Teachers were given an activity. To make meaning of their perceptions of themselves and how they think they are perceived by others in the community as well as their relationships to both learners and the community at large: Their attitudes towards problem-solving and learner-centred teaching and power relations were examined through their written and drawn texts: 'a letter to a parent' (see Appendix F); 'structure of the school community', 'a bird and a dog having dinner together', 'a little girl picking flowers' (see Appendix F). From these texts teachers reflected on their perceptions of what power relations should be like in a problem-solving and learner-centred classroom. Teachers reflected on self, examined themselves critically, then deconstructed and shifted positions from their held beliefs and experiences. This led them to construct new knowledge, perceptions and identities of self with regard to roles and power relations (McDermott, 2002) in the classroom.

3.9 Conclusions

This chapter described the methods and procedures used in this research, as well as the instrumentation used. It then justified the methods, design, procedure and instrumentation

used. I also described how data were analysed. I this study were also described. The limitations, methodological issues and challenges as well as the ethical considerations pertinent throughout this study were central to this chapter.

3.10 Projection for the next chapter

The next chapter, Chapter 4, presents the data gathered and the analysis. The chapter then presents a summary of the data in the form of figures, tables, and quotations from the respondents, as well as some selected transcripts from classroom observations and the teachers' workshop.

CHAPTER 4

Data Presentation and Analysis

4.1 Phase 1

Classroom observations

From classroom observations and interviews, the teachers generally associated problem-solving with doing activities or experiments. For example, on my arrival I reminded teachers of the purpose of the visit, that the expectation was to see them engaging pupils in problem-solving (PS) in their lessons. However, the lessons conducted had little sign of problem-solving. Most of the lessons were conducted in choral form or an activity form that did not encourage problem-solving. The two cases below are illustrative. Teacher X was conducting a lesson on acids and bases and teacher Y a lesson on forces. The lessons went as follows:

Teacher X's lesson

The teacher began by greeting the class and introducing me to the pupils. She then asked the pupils to take their seats. She took her bag and started showing the pupil materials she had brought to class. She asked the class to name the materials. These were; toothpaste, 'eno' (fruit salts), soap, an orange, and tartaric acid. Pupils named all the materials.

Teacher Holding, the items up one by one: an orange, and tartaric acid. To the pupils *'how do these taste?*

Pupils *Sour* (shouting from different angles of the classroom).

Teacher *They taste sour.*

Pupils In a chorus: *they taste sour.*

Teacher Holding soap she asked, *how does it feel?*

Pupils *Slippery.*

- Teacher** *It feels slippery*
- Pupils** In a chorus: *It feels slippery.*
- Teacher** *Can you tell all the things that you know that taste sour?*
 (Pupils start whispering among themselves).
- Teacher** *Bohloa.*
- Bohloa** *Sour porridge.*
- Teacher** *Yes Thabang.*
- Thabang** *Sour milk.*
- Teacher** *Yes Moliehi.*
- Moliehi** *Vinegar*
- Teacher** *Thetso*
- Thetso** *Jey's fluid.*
- Teacher** *Jey's fluid?*
- Pupils** The whole class in a chorus: *Y-----es maaaam.*
- Teacher** *What is it used for?*
- Pupils** The whole class *'For curing cold maaaam.*

The teacher, showing some concern, asked the class to bring empty containers of Jey's fluid so that they could check whether it is a cure for colds. She then introduced the words 'edible' and 'sour tasting'. She warned the pupils about the dangers of improper use of chemicals and commercial products.

The teacher then introduced the words 'acids' and 'bases' and indicated to the pupils that soap and toothpaste are examples of bases while all the sour tasting things are acids.

- Teacher** *Can you now give me the examples of bases that you know?*
- Teacher** *Yes Lineo.*

- Lineo** *Bicarbonate of soda.*
- Teacher** *What do we use it for?*
- Teacher** *Yes, what do we use it for.*
- Pupil** *We use it for cooking food which take long to cook.*
- Teacher** *Which is the other example of a base?*
- Pupil** *Eno.*
- Teacher** *How does it taste?*
- Pupil** *Sour.*
- Teacher** *therefore is it a base or an acid?*
- Pupil** *it is an acid.*

The teacher wrote on the board: *acids taste sour and bases feel slippery*. Then she wrote some sentences with missing words for the pupils to complete.

1. feel slippery (Acids, Bases)
2. taste sour (Acids, Bases)
3. Give two examples of bases
4. Give two examples of acids

The teacher asked the pupils to write the answers in their books. While they were writing she went around checking and marking. After some few minutes she asked volunteers to come and write the correct answers on the board. Almost half the class came rushing to the board and the teacher had to point out individuals who would do the writing.

For this lesson, above materials are available, although the instruction was in choral form. One pupil posed a problem, which the teacher acknowledged. She gave some information to the pupils and referred the problem to the next lesson, then continued with her choral instruction. The teacher intended to address the problem, but not as a

way of teaching so much as for her concerns for correct knowledge and health. Postponing the problem to the next period enabled her to proceed with her planned lesson.

Teacher Y's lesson

The teacher began by introducing me to the class, then asked the pupils to suggest different types of forces they knew. The pupils cited magnetic force, electrical force and gravitational force. While they shouted from their seats the teacher wrote the answers down. He then informed the class that they were going to learn about frictional force. He asked one pupil to pull the desk. After the pupil had pulled the desk the teacher asked the pupil whether the desk felt heavy or light. The pupil responded that the desk felt heavy. He then asked the pupil why the desk felt heavy. Before the pupil could respond the teacher explained that the desk felt heavy because of friction. He asked another pupil to pull the chair, and pull it across different surfaces, some smooth and some rough. He asked the pupil whether she applied more force on the smooth surface or rough surface. The pupil replied that she applied less force on the smooth surface. The teacher further asked the pupil to identify on which surface the work was easier.

Informal conversations were simultaneously taking place in the class, which the teacher ignored.

The teacher asked another child to repeat the activity. On completion the teacher asked the pupil why she could apply less force pulling the chair on the smooth surface. The pupil replied that it was because there was no friction. While the answer was given another pupil shouted that it was because there was less friction.

The teacher asked the whole class to go outside to pull and push different objects on different surfaces. There seemed to be established groups and these groups had names: Arguments, Scientific, Sun City and No Name. Without instruction from the teacher, pupils grouped themselves and worked together. The teacher moved around the groups. When the pupils came back into the classroom the teacher, together with the pupils,

discussed what they did. The teacher wrote the points on the board as the pupils offered them.

Teacher *Where do we have more friction?*

Teacher *Potlako*

Potlako *On the rough surface.*

Teacher *On the rough surface there is a lot of friction whereas on the smooth surface there is little friction.*

Pupils *In chorus: On the rough surface there is a lot of friction whereas on the smooth surface there is less friction.*

The teacher then wrote the following points on the board:

- On the rough surface we applied more force whereas on the smooth surface we applied less force
- On the rough surface there is a lot of friction whereas on the smooth surface there is little force needed

The teacher and pupils repeated the above points in a chorus, three times.

The teacher then asked: *Why does a wheelbarrow make noise when carrying two drums of water?*

The pupils replied that it was because of friction [in the axel]. He asked what they normally do to reduce the noise.

Pupil 1 *Grease.*

Pupil 2 *We oil it.*

Teacher *Yes, we grease or oil it.*

Teacher *Why do we grease or oil it?*

Pupil *Make friction.*

Teacher *We oil or grease to reducing friction.*

Teacher *What is the purpose of reduce the friction?*

Teacher *We reduce the friction in order to make the work easier.*

Teacher *In real life when moving an object on a rough surface we need more force therefore we have to smoothen the surface to make our work easier. The example in an every day life situation is the use of the wheelbarrow.*

Teacher *Right, pupils, this is the end of today's lesson. The next lesson will be on measuring force.*

Four things that were common in these two lessons were the choral form (including the level of teacher direction in the discussions); the use of materials, the involvement of the pupils in activity and/or discussion, and the contextualising of the learning. The chorusing seemed to be standard practice, in that the teachers and their pupils engaged in it without any instruction from the teachers. The use of materials and activity, and the contextualisation of learning, given the purpose of my visit, could be explained as the teachers' understanding of problem-solving or problem-based teaching.

In some lessons where a problem emerged during the lesson, the teacher usually ignored that problem. For example, one teacher was conducting a lesson on magnetism and asked the pupils to go out and suspend magnets from the branches of a tree, with the intention of showing that a north pole points to the north. The class went out and chose an old tree, formed groups and suspended their magnets. The magnets faced different directions. The children started whispering among themselves, looking at the directions the magnets were facing. Only one magnet among five was pointing in the North-South direction. The teacher was aware of the situation and also that the pupils were aware of it and whispering. Regardless, the teacher said to the pupils, ignoring the whispers:

What we have seen is that when a magnet is suspended and left hanging it stops and faces itself to the North-South direction.

The pupils continued to whisper among themselves, showing some dissatisfaction. It was evident that the teacher was aware of the discrepancy and the pupils' concern, yet she continued to ignore it. She said instead: *Tomorrow we shall deal with parts of the magnet which exert greater attraction*, then ordered the pupils back to the classroom. There were two possible explanations. Firstly, she might have ignored the pupils because of her own lack of knowledge, unsure how to move forward to find an explanation. Secondly, timetable requirements became her priority, requiring her to wrap up the lesson and move on.

These instances are typical of the 21 lessons observed in Phase 1: in most cases, the teachers had a plan with clear learning goals, the classes were well managed, and the pupils generally well-behaved and paying attention. There were generally good relationships between teachers and pupils, and among pupils. There were activities that required the pupils to offer ideas, and work with materials and each other, but discussions and activities were all tightly controlled by the teacher. The choral form of response was a common way of building class unity, and helping sustain involvement. Teachers in almost all classes sought to relate the science they were teaching to the children's experiences either through experiences in class, or their recall of experiences beyond class.

These characteristics emerge from analysis of the observation schedules for the 21 classes. Table 4.1 shows that the great majority of the classes observed used large group (whole class) tasks most of the time. Some of the classes used small group tasks most of the time. No class used individual tasks, whether worksheets or individual writing, drawing or reading tasks. While most classes used some mix of whole class and small group tasks, none used individual tasks (beyond copying from the chalkboard and making notes).

Table 4.1: Common arrangements of pupils' working

The percentage in row 1 is a percentage of classes; the percentages in rows 2 and 3 are percentages of pupils' interviews, from all classes combined.

	Large group tasks	Small group tasks	Individual tasks
Observed classes, and predominant mode	86%	14%	0%
Pupils' perceptions of usual approach used	67%	33%	0%
Pupils' preferences	0%	68%	32%

Ratings of opportunities for learning particular skills in particular ways are summarized in Table 4.2. The availability of opportunity in each case was rated on a scale from 1 to 5, with 1 denoting few opportunities and 5 denoting many opportunities. As explained in Chapter 3, judgements of 'opportunity' sought to combine qualitative and quantitative attributes. For example, attention to 'problem-solving' as an outcome could have received little direct teaching time, but was important in framing discussions and activities during the class; alternatively, or it might have received more time, through a specific task and discussion. A class was rated highly on this scale if a spirit of problem-solving pervaded much of the class, or if tasks were given that were directly oriented to problem-solving.

Ratings indicate the emphasis given in a class to the characteristic described; percentages indicate the percentage of classes that were given a particular rating

The ratings in Table 4.2 reflect the characteristics illustrated earlier, from the classes on acids, forces and magnets. While lesson objectives were generally clear, they were seldom geared towards problem-solving. While Pupils were often assembled in groups: None of the lessons employed cooperative learning: academic interactions between the learners were minimal, often in the form of whispers and asides that gave the impression that pupils were not supposed to talk among themselves. (This was illustrated earlier in

the lessons on magnets) The science in the lessons was often contextualised, but within structures and conversations tightly controlled by the teachers: there was little attempt to explore or build on pupils' experiences and ideas.

Table 4.2: Opportunities provided for classroom learning

	FEW opportunities provided 1	2	3	4	MANY opportunities provided 5
PS Objectives oriented	52%	48%	-	-	-
Cooperative Learning	81%	19%	-	-	-
Learner-centered instruction	52%	43%	5%	-	-
Pupil-PUPIL interactions	24%	71%	7%	-	-
Level of participation	15%	62%	10%	10%	-
Teacher facilitating	76%	24%	-	-	-
Teacher instructing	0%	5%	5%	71%	19%
Pupils organising learning activities	52%	5%	43%	5%	-
Pupils making their own findings	100%	-	-	-	-
Activities contextualised	-	24%	71%	5%	-

Interviews with pupils

One purpose of the interviews with pupils was to ascertain the 'usual' approaches in their classrooms. Their judgements were similar to my classroom observations, as discussed earlier (Table 4.1). However,, in spite of reasonable levels of participation (Table 4.2) and high levels of compliance, the pupils had no hesitation in expressing their preference for different approaches: 68% of the pupils pointed to small group presentations as their

preferred way of learning, 0% to large group/whole class presentation, and 32% to individual work .

Interviews with teachers: Conceptions of problem-solving and problem-based learning

When asked what problem-solving meant to her, one teacher replied:

It means coming up with a solution.

When asked: *Do you give activities that require problem-solving from the pupils?* the teacher responded: *Yes*. Asked for instances, she offered:

I sometimes give them practical work to do. This is the time when I give them that opportunity.

Another teacher, asked to give an instance of a lesson that required problem-solving skills, said:

I used to make experiments with science kids, e.g. magnets and solutions.

Beliefs that performing activities or experiments and using materials were central to problem-solving were common. While these conditions were often seen as sufficient, sometimes activities and materials were seen as part of a larger concern. For example, one teacher defined problem-solving as thinking, coming up with a solution and making discoveries. To engage pupils in problem-solving she said she normally gave them materials to use so they could find things for themselves. However, their discoveries were to be closely guided. She explained:

Sometimes I use materials that help them to come up with solutions, and sometimes I ask them to touch the materials, like as you say we are doing the water as the magnifier, we are using the water and the money and I ask them to do that to put the money in the water in order to be clear that water is the magnifier.

When asked what else she does apart from giving the pupils materials she said:

Other than giving them materials I try to explain to them thoroughly what I want them to do and I again ask them to try after their trial and give them what I want. So they tried.

To this particular teacher, problem-solving meant pupils accessing materials, the teacher modelling the required behaviour, and the pupils imitating the teacher.

The interviews often conveyed meanings of problem-solving that indicated partial understanding by the teachers. I classified their interpretations as follows:

- Discovery methods of teaching

To me, problem-solving means in a way, a method of teaching pupils, being the same as may be discovery method.

This means that pupils have to find things for themselves.

In problem-solving you should not spoon-feed the pupils, you have to let them work out things for themselves.

- Requiring thinking from the pupils

I think problem-solving means to probe pupils minds. You just want them to think deeply, to use their common sense to answer the questions.

It means think or make discovery on how to solve that problem.

- Pupils coming up with a solution

Problem-solving means coming up with a solution

Interviews with pupils: Pupils' views of problem-solving.

The pupils had their own views of problem-solving. When asked what they would do to try to solve a problem, 68% said they would seek help from teachers while 21% said they would work together in a group to come up with a solution. 5% indicated they would be seeking help from home while another 5% would be conducting experiments.

Table 4.3: Pupils' alternatives to solving problems

SC	SP	ST	UD	DP	P
6 *	5	3	3	6 *	1
25%	21%	13%	13%	25%	4%

SC Seeking help from other children
SP Seeking help from parents
ST Seeking help from teachers
UD Using a dictionary
DP Discussing
P Praying

25% of the responses pointed to seeking help from other children as an alternative to finding solutions to problems while 21% reflected parents and 13% teachers. 13% resorted to the use of a dictionary, 25% discussed their options in groups and 4% turned to prayer. The high percentages for the alternatives of seeking help from other children and discussing in groups, indicate a major shift from seeking help from teachers, which is evident in the first choice. The preference to work in groups is indicated in table 4.1.

It is evident from Table 4.3 that as the pupils are given more and more choice and freedom they are more and more shifting from seeking help from the teachers which may be explained in that probably in first incidence where most of the pupils pointed to the teachers for seeking help from responses were because that was what is the norm and the expectation that the teacher will always provide the solution or is regarded as the source of information.

Teachers' conceptions of learner-centredness and cooperative Learning

Along with my questions about problem-solving, I asked teachers for their conceptions of learner-centredness and cooperative learning. I wanted to be able to place their views of problem-solving in relation to ideas of social constructivism, power sharing and critical theory as approaches to learning.

Learner-centeredness, as most teachers explained it, meant learners playing major roles in the lesson activities, and building in learners' interests. Definitions in terms of knowing the learners well were less evident. Teachers usually defined cooperative learning as pupils sharing ideas, engaging in discussions among themselves and working together.

In spite of these definitions of learner-centredness and cooperative learning, very few of the observed lessons catered for individual differences in pupils

She did try to built on pupils' knowledge and interests, or encourage cooperation beyond the sharing of materials. Mostly, the teachers played the major role in management and information, as in the examples described earlier.

Teachers' knowledge

To explore teachers' knowledge of subject matter, pedagogy, assessment and policy, I framed questions in terms of teacher education programmes (which all participants had recently completed). In response to question on the helpfulness of training at the Lesotho College of Education, all respondents felt that the training had helped in their understanding and interpretation of the syllabus. One teacher responded as follows:

Has the training you received at the College helped you to understand and interpret the primary school syllabus?

I should say it has helped me to interpret the syllabus well because at the college as far as science is concerned most of the job was done practically. We did practical work that is very good rather than talking about things that we can't see

and we can manipulate. We were always in the science lab, making experiments, finding, getting findings from what we were experimenting so this has motivated us a lot because if I teach some topics of science here at primary school I have realized that if there are no materials you can't experiment things. The children are not going to be able to know or grasp what is being taught. As some questions may emerge. Show the pictures, what is happening in the picture. Then if those children have done the experiments in each class or practical work, they will be able to say this experiment show this and this.

Almost all (90%) of the respondents said they were familiar with the aims and objectives of the primary school syllabus, while 10% said they were not. Given that the Primary School Leaving Examinations (PSLE) loom at the end of Class 7, it was perhaps not surprising that all of the teachers said they were familiar with the examinations and had seen past question papers. One teacher commented:

Yes I am familiar. Sometimes I even compare them. I take previous papers and compare them with the recent ones, to see what the mode of asking questions may be.

I asked teachers whether they felt that the questions on PSLE required problem-solving skills from pupils. The teachers' responses varied. Most teachers (71%) felt that the questions for PSLE required both facts and problem-solving: 19% felt that PSLE questions required experimentation, and 10% felt that the questions were essentially of the recall type.

Sometimes they [pupils] need to remember the facts but sometimes in different subjects they require problem-solving skills.'

To attend the questions? it's just remembering, it's just to recall.

I don't think they require problem-solving skills from the pupils because they are multiple-choice questions. They encourage/make the pupils to guess rather than

think. So these types of questions do not allow the pupils to express their knowledge to find if they can do things for themselves.

The questions are varied although because they are multiple choice questions pupils may be lazy to use their common sense, but as you look at the question it requires the pupils to think.

I can say, the way they ask questions they vary them although because the questions are multiple choice questions some of the pupils may be lazy to use their thinking/common sense. But as you look at the question it requires the pupils to think.

4.2 Phase 2

As explained in Chapter 3, seven lesson scenarios were presented to 25 teachers, 10 of whom were selected from a teachers' workshop. These were from the ten districts of Lesotho and the other 15 teachers from Phase 1. The scenarios were designed to enable deeper probing of the teachers' understanding of 'problem' and 'problem-solving'. The seven scenarios are summarized in Table 4.4.

Table 4.4: Lesson scenarios to probe teachers' understanding of problem-solving

Scenario number	Title/ description	Type of problem
1	Quarrelling ladies Two ladies are quarreling about the disposal of dirty water outside their houses	Social/environmental
2	Lecture on disposal of dirty water	Social/environmental
3	Description of unhealthy area due to frequent disposal of dirty water	Social/environmental
4	Classification of substances which are difficult to classify as solids or liquids	Conceptual/ theoretical
5	Classification of living and non -living matter	Conceptual/ theoretical
6	Method of separating salt from water	Practical/ technical
7	Saving a child from a house in fire	Puzzle

The lesson scenarios 1 to 3 were social and environmental problems, practical and context-based. In lesson scenario 1, two ladies were quarreling over the method of disposing of dirty water and pupils were to brainstorm how they would resolve the misunderstanding between them. Lesson scenario 2 was introduced by telling the pupils that they were going to learn about methods of disposing dirty water. The pupils were then told about methods and comparisons of the methods, which they copied in their books. The lesson concluded with the pupils completing fill in the blank questions. In lesson scenario 3, pupils were given a description of a place where dirty water is poured frequently, and which developed into a ditch of dirty water and breeding place for flies and other small animals. The pupils were asked whether this was a good practice. They were then given alternatives from which to choose the healthier ways of disposing dirty water.

Lesson scenarios 4 and 5 were conceptual, theoretical and context-free problems, centred on problems of classification. In scenario 4 the pupils were asked to list all the substances that they would find difficult to classify as liquids or solids and to justify why they would argue that these substances are liquids or solids. Lesson 5 was an assessment lesson. After completing a topic on the definition of living things, pupils were to classify as living and non-living, a flower in a vase, a branch on the table and fire. They were to provide some reasoning for their classifications.

Lesson scenario 6 was a practical, technical problem where pupils were to imagine being thirsty and that the only available water was salty. The pupils were asked whether they would drink the salty water and what they would do to get the salt out of the water.

Lesson scenario 7 was a puzzle. A parent was leaving her child in the house and as the adult left, the door locked itself. The house caught fire. What could the parent do to rescue the child from the house?

The teachers quickly decided that all the lessons except scenario 2 were problem-solving. The teachers unanimously believed scenario 2 was not problem-solving, in spite of its use of activity,

Lesson 2 is not a good lesson because...I do not like the telling word.

Lesson 2 is a poor lesson because most of the activities are done by the teacher, the pupils are not engaged, the lesson is teacher-centred.

I do not appreciate the approach used in lesson 2 because the teacher is spoon-feeding the pupils, it is too straight-forward.

The lesson is not allowing the pupils to think for themselves, it is teacher-centred rather than learner-centred.

Teachers not only identified the other scenarios as problem-solving but also gave their reasons:

In lesson 1 the teacher wanted to give their pupils something to think about

By engaging them in discussions pupils will ultimately agree on the solution of the problem

Brainstorming, supporting, arguing and giving reasons all are leading to problem-solving.

In the case of lesson 3, all the teachers saw it as problem-solving and noted that the problem was similar to lesson scenario 1: there is a problem of discovering proper or healthy ways of disposing of dirty water. One teacher was an exception, and said, on second thoughts:

In fact lesson 3 is not problem-solving In there is no problem-solving. At a glance one may think that there is problem-solving, but when you look closely at it, it is not problem-solving; there is nothing to be solved. They are given method.

For lesson 4, the teachers' justifications as follows:

The teacher gave the pupils work where he/she said they justify. The word 'justify' shows problem-solving.

Because it involves brainstorming.

Because pupils are given chance to justify, argue and demonstrate.

Lesson 6 required the pupils to think of the method they could use to separate salt and water while for lesson scenario 7, teachers said the pupils would have to think how to get into the house and save the child.

As well as deciding which scenarios demanded problem-solving, all teachers saw differences in the kinds of problems involved.

Lesson scenario 1: Bad practices of disposing dirty water, A quarrel between the two ladies.

Lesson scenario 3: 'Unhealthy ways of disposing dirty water.'

In lessons 4 and 5 the problems were seen as problems in classifying matter, and in lesson 7 the problem was that of entering the house to rescue the child.

Teachers showed also that they were able to look at the problems from different perspectives. For example, lesson scenario 1 was viewed from in three perspectives, social, cultural and health-related. The cultural view of lesson 1 from teachers may be indicative of the influence of African traditional beliefs. For example, one teacher commented:

The inclusion of or involvement of children in adults' quarrels is improper culturally, although this is a good problem-solving lesson but it is not an accepted way of doing things in our culture.

This particular teacher was invited to revisit the lesson scenario but did not change his view about the lesson. Even though he appreciated how good the lesson could be, his cultural beliefs ruled out the lesson. This teacher identified himself with a certain culture and felt very strong about its norms. Another teacher who also had a cultural view of lesson scenario 1 looked at the scenario differently, from the belief that people are not supposed to walk across/over somebody's dirt because they would be bewitched.

When teachers were asked how the problems were different, they commented mainly on lesson scenario 7, which they said was not appropriate because it was not subject-related. Although teachers appreciated that lesson scenario 7 was good problem-solving their goal was to emphasize science knowledge. Their responses thus suggested orientations to problem-based learning, more than to problem-solving.

Definitions of problem-solving

Almost all the teachers agreed that the pupils should be the ones to solve the problem in a problem-solving lesson:

The pupils should solve problems so that they do things for themselves and this is going to help them because they forget easily. Even in life they will be able to solve the problems they come across. This training is for future life.

The pupils, the teacher will come as assistant or to conclude.

When asked *Why?* the teacher commented as follows:

Because we should train them to think about the problems about solving the problems.' 'Ba tle ba khone ho itjara' (They should be independent). Most of the work should be done by the pupils I should guide them but for this kind of activity in Lesson 1 it would take long time for them to respond. Therefore I give would them guidance.

Table 4.5: Teachers' awareness and understanding of PS and its educational value

	Responses
Identification and justification	<ul style="list-style-type: none"> • Lessons 1: 4, 6, & 7, because they involve Brainstorming • Lesson 4: because it is an activity, words justify, argue and demonstrate • Lesson 1: because you must support, and argue and give reasons; discussions and brainstorming
The problem	<ul style="list-style-type: none"> • Lesson 1: Disposing dirty water all over, quarrel between two women, • Lesson 3: Pouring dirty water all over the place • Lesson 4: Difficulty in classifying matter, finding whether substances are solids or liquids • Lesson 5: Classification • Lesson 6: Separation between salt and water • Lesson 7: Locked door, and deaf person
Definition	<ul style="list-style-type: none"> • Discovery method of teaching • Learner centered teaching • Finding things for oneself • Making decisions • Coming up with solutions • Thinking
Educational value	<ul style="list-style-type: none"> • Autonomous learning • Helpful in real life situations

Generally the teachers, in their responses to the lesson scenarios, indicated awareness and understanding of problem-solving and its educational value. This is shown in Table 4.5. 33% of the teachers accurately identified problem-solving and types of problem-solving in the scenarios, 52%, in the light of the scenarios, offered reasonable definitions of problem-solving. 11% defined it in terms of mental activity, 75% in terms of methods of teaching, and 14% related it to contexts. I classified some 25% of the definitions as learner-centred approaches, 13% discovery methods and 62% as constructivist methods, although these categories overlap. 48% saw educational value in problem-solving and/or problem-based lessons, through developing pupils' independence, and helping them in real-life situations.

To me problem-solving means the method of teaching pupils being the same as discovery method.

In problem-solving, lessons should be more learner-centred not teacher-centred.

To these teachers, child-centred methods are characterised by pupils' participation, activities, manipulation of materials, and thinking (which they defined in terms of using common sense and doing things without help while the teacher supports the learner). Discovery methods in contrast were seen as the acquisition of new knowledge by modelling the teacher's behaviour as well as working in groups, sharing ideas and discussing. Their view of teachers' roles in discovery methods centred on guiding pupils and the discovery process.

The classroom activities they associated with problem-solving included finding things for oneself; concluding; justifying actions; supporting with reasons; arguing; giving own opinions; brainstorming; analyzing; applying prior knowledge and experiences in new situations; discussing; sharing ideas and questioning one's own and others' views. Teachers also defined problem-solving in terms of the roles played by learners and teachers:

The teacher should give the problem, supervise, asking questions to clarify and give support.

The pupils should solve the problem because they are the ones who should give reason and bring their opinions.

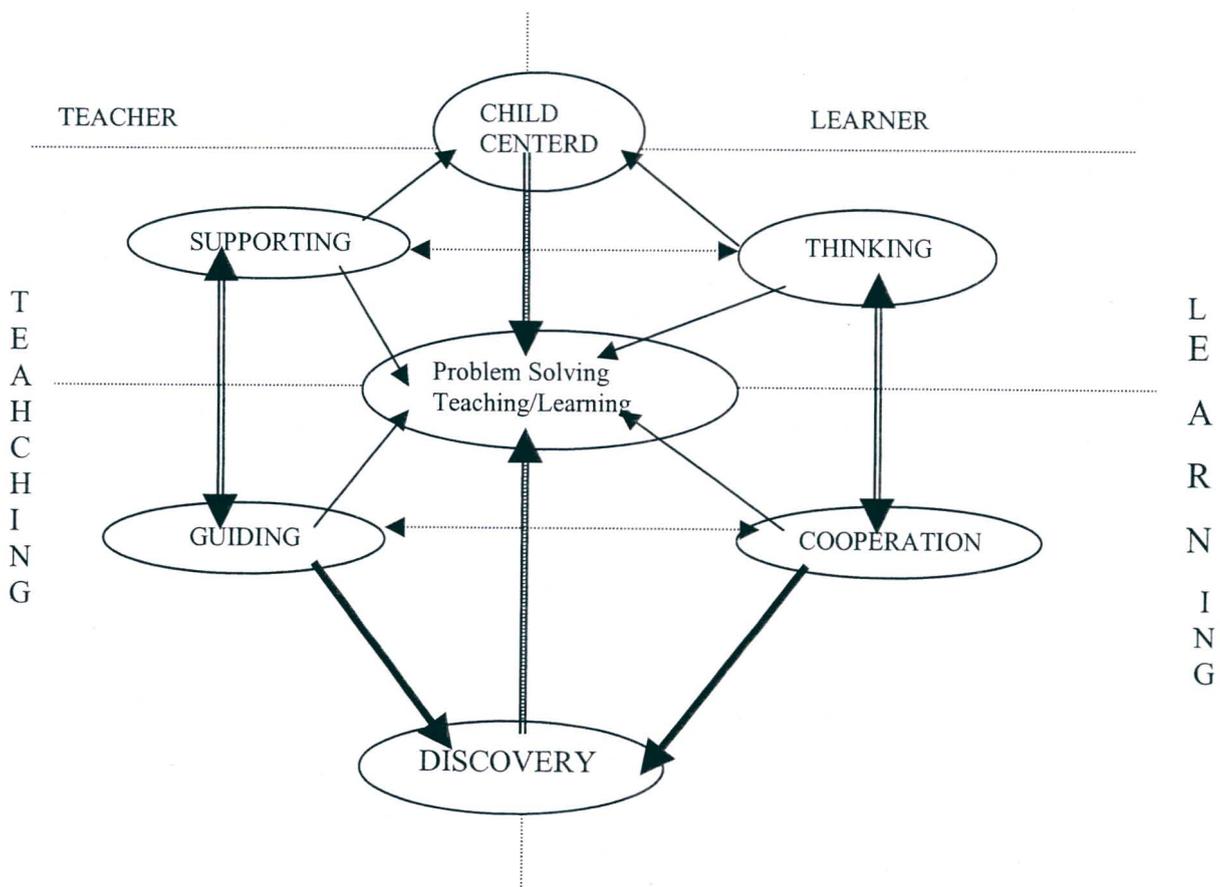
Pupils should be given broad guidance because if always follow instructions it makes pupils lazy to think.

The teachers' definitions are summarized in the model in Fig 4.1. The model shows the relationships between teaching and learning, teachers and learners, with problem-solving viewed as a means of learning (problem-based learning) as much as an end in itself, and hence linking naturally to child-centred approaches and discovery methods.

During explanations on how they understand and interpret problem solving teachers explained it as teaching and learning. Their definition implied a joined venture between a teacher and the learner with each of them having her/his role to perform. The teacher's

role being that of supporting and guiding while that of the learner thinking and working with other learners cooperatively. Teachers also define problem-solving as teaching-learning method listed child-centred and discovery methods as associated with problem-solving. Hence implying that problem-solving incorporates mental activity, teaching and learning method and the expected roles to be assumed by both the learner and the teacher in a problem solving lesson. Figure 4.1 therefore summarises how the teachers collectively understood and interpreted problem-solving.

Fig. 4.1 Model of Problem-solving as defined by the teachers



Reasons for not using problem-solving

Would these scenarios work?

Generally teachers felt that the lesson scenarios would not work for their classes. Their first concern was that the pupils would not be able to perform such tasks.

These children are not used to the approaches used in the lessons such that they think.

I don't think there is a single child in my class who would do problem-solving.

Lesson 1 would not suit my pupils because they are not in transition – children think that they come to be told everything. School is where they get all the information. Lesson 1 would also not work in my class because most of my pupils would fail to cope since they are slow learners who even appear to have not been introduced to thinking. They think a teacher is the power of information into them as containers. They don't relate school with real life.

Lesson 2 will be suitable for my pupils because of familiarity. They are used to telling method not discovery method.

More guidance would be needed for my pupils and pupils' prior knowledge to the topics dealt with.

Lesson 4 would not work for my class because of language barrier. I should have taught liquids and solids earlier.

However, with further questioning, some teachers shifted from the children to other factors as their reasons for not teaching problem-solving. For example, when this last teacher was asked why pupils were not familiar with discovery methods, she explained that teachers did not have teaching/learning materials and that some teachers were lazy.

Then she suggested that lesson 3 (on dirty water) would be suitable for her class, because conditions described in that scenario affected pupils in real life. The teacher added that she would take the pupils to places where there were such conditions and ask if the pupils were happy with the situation. She would then prompt them into deeper thinking. She decided that lesson 4 (classifications) was suitable for her class, but the pupils would need to have prior knowledge of solids and liquids. She felt that lesson 5 (salty water) would be difficult, and then suggested modifications:

I would refer them to a common practice at home of cooking salted vegetables. I would ask the pupils if the vegetables that stick on the lid when cooking taste salty. Then I would ask them why they think those vegetables do not taste salty. Alternatively I would conduct an experiment where the pupils will be instructed by the teacher.

Another teacher, when asked whether the lessons would work with her classes, said:

Ye----s but it is not easy, I can do it but it is not easy, the children are too many, we have not engaged them regularly

When asked why they were not engaged them regularly, she said:

Palo, Numbers – when they are many you have to group them and control them or demonstrate or even do guided discovery. When the groups are many it will not be easy to see what other groups are doing. I would rather demonstrate.

A third teacher added:

These would not work/succeed because it would involve discussion which would take a long time. I would not be able to control them. They would want to talk all at the same time.

She was asked to explain

It would take time to finish because every body would participate

A fourth teacher, when asked how often she gave her pupils activities that required problem-solving, said:

We are not using problem-solving because of the large numbers of pupils in our classrooms there are too many pupils for such lessons. We also lack resources, the timetable is also packed.

During the course of the interviews, all of the teachers realized that they had quite good understandings of problem-solving, and of the different lesson scenarios. They knew also that they did not offer lessons such as these, for a number of reasons: lack of knowledge, policy issues (especially syllabuses and exams), time and timetables, class sizes, resources and conditions. These are considered in some detail below.

Lack of knowledge

A number of teachers pointed to content knowledge, pedagogic knowledge and confidence:

On my side, especially in science I don't think feel confident enough. We took short time [in teacher training]. I do not think we got enough content as well as methodology because of the three components science (Physics, Chemistry and Biology).

The syllabus reflects problem-solving but there are some topics, which are very difficult to understand. It is difficult for the teacher to give instructions and difficult to the pupils to follow the instructions.

Sometimes they teach the way they teach because they are incompetent', they lack methods of teaching and they do not have enough content.

Most of the lessons are run in a choral form because we are not used to this problem-solving.

24% of the responses pointed to a general lack of familiarity with problem-solving methods, 28% to content and 36% to the level of difficulty of content. Some 12% referred broadly to a lack of competence.

Curriculum constraints

Teachers felt great pressure to 'cover the syllabus', a concern linked naturally to examinations, timetables and times.

We are expected to finish the syllabus, we aim that by the end of the year we have covered the syllabus.

People complain of inability to finish the syllabus.

We disregard pupils views because it is time consuming, we have many subjects, we try to finish the syllabus.

The time is not enough for us to finish the syllabus.

If you fail to finish the syllabus you can go to an extent that you drill them using the past exam papers.

You have to finish the syllabus such that your pupils should make it at the end of the year

11% of the responses which saw curriculum constraints against the use of PS were associated with the need to complete the syllabus. A small number claimed that the syllabus did not require problem-solving, though a similar number offered that it did.

Examinations

Examinations were seen as important not only because of the time requirement to cover the syllabus and prepare for the exams, but in terms of the kinds of question asked.

We have to finish the syllabus because the pupils will have to write the examinations at the end of the year.

If you do problem-solving it would be in the earlier years, it would not be towards the examinations.

I don't think examinations require problem-solving skills from the pupils because they are multiple-choice questions. They encourage pupils to guess rather than think. So these types of questions do not allow pupils to express their knowledge to find if they can do things for themselves.

If I compare the requirements of the examinations I can see questions require more facts recalling than the problem-solving skills rather it would be experimentation.

The way examinations are asked at the end of primary school also encourage the way we teach. They do not encourage any thinking.

To answer the examinations pupils need just remembering, it's just to recall.

Some 10% of the teachers' responses suggested that problem-solving is not assessed in the final examinations, and hence there were more important things to do in class.

Time and timetables

Teachers had two concerns about timetables: the number of subjects to be fitted into the week, and the duration of classes (usually 30-40 minutes).

The time table is too packed, we are overloaded, sometimes we are in a hurry to complete the syllabus, also the time for lesson period is too short to engage them in problem-solving, it will require them to do group work and discuss and you have to go round the groups to monitor their work if you have say 40 pupils and divide them into groups of 5 you have 8 groups, how many minutes do you spend for introduction? How many do you allocate for each group? How many does each child get? So for me I resort to large group presentation and I am sure all the 40 pupils get the 40 minutes of my lesson. We also lack support from the parents.

I do give them [problem-solving activities] but not regularly. I prepare to give them 4 subjects per day but there are supposed to be six subjects per day but we don't afford it, pupils need a lot of time. Pupils are slow. Which is just that you have the problem with the timetable itself. But if you try to follow the timetable pupils will not gain. This also affects the way we teach them.

As a teacher I should guide them and give instructions...Guiding saves time. I do not recommend wide-open instruction for the purpose of managerial and time management.

We teach in large groups and in a choral form because of time, the time allocated for a period is too short, you cannot do anything in 35 to 40 minutes.

The other problem is this one of too many pupils in our classrooms and yet the period for one lesson is so short. You cannot do any good teaching in 35 to 40 with about ninety pupils when you want to involve them.

Class sizes, resources, and support

Teachers explained that the conditions under which they worked were not conducive to problem-solving. As well as issues of resources and class sizes, they mentioned internal and external support.

The lessons can work for my class but it is difficult, I can try but it is not easy. Children are too many. We have not engaged them regularly. 'Palo': large numbers. When they are too many you have to group them and control them or demonstrate or even do guided discovery. When the groups are many It will not be easy to see what other groups are doing. I would rather demonstrate.

These big numbers and the number of subjects per one teacher are the source of problems in schools like ours. For example, private schools work better than us and produce better results but we are all trained in same College. Many factors contribute. The first and important one is big numbers.

We have large numbers. In small groups if you have five groups of ten pupils in 40 minutes and divide the time by five, you help each group in 8 minutes and how many do you allocate to each child, roughly less than a minute but in a large group each child gets the 40 minutes.

58% of the responses pointed to large class sizes as a major inhibitor of problem-solving. 22% noted the lack of the resources and 19% the lack of support for teachers to carry out their duties diligently.

If the head teacher would agree with subject teaching maybe things would be better, but still with these numbers it would still give problems.

We should reflect on our teaching as well as support each other, get support from others if you are not sure of a certain topic or concept.

Regular observation by other teachers will make us prepare well

People complain that they do not get support from parents and education is meant to meet societal needs and problems.

Of the responses that referred to a need for greater support, 83% pointed to internal support (personal and administrative support), while 17% pointed to external support (the Education Department, NGOs and parents). Of those who referred to inadequate internal support, 40% found a lack of personal support, while 60% believed that administrative support was lacking.

4.3 Phase 3

Phases 3 and 4 involved 15 teachers from three schools, schools that had been part of Phase 2. From the scenarios in Phase 2, teachers were to select one and develop it into a detailed lesson plan, which would be presented by one teacher in each school (as Phase 4), while other teachers and I observed. The three teachers who would present the lesson chose scenario 5, the classification of living and nonliving things. Their reasoning emanated from eliminating some options, and favouring others.

Teacher 1: *I think lesson 1 is not syllabus related therefore we should not do it.*

Teacher 2: *It is related to the syllabus.*

Teacher 1: *I don't understand how the quarrels are related to the syllabus which part of science is that?*

Teacher 3: *No, I think it is not the quarrels but I think it is the proper method of disposing dirty water.*

Teacher 3: *Yes, healthy ways of disposing dirty water, but the topic does not appear regularly in the examinations.*

After discussions like this, the teachers agreed that scenarios 1 to 3 were out. All 3 agreed that lesson 7 was also out because it was not syllabus-related. They agreed among themselves that lessons 1, 2, 3, 6 and 7 related to things that happen or take place in real-life situations, but saw some difficulties. For example, one teacher commented (on scenario 6):

I would like to remove lesson 6 from the options because there are places where the water is salty from the springs and the taps and people in those areas drink it as it is, so what if the pupils give that example and find it not a problem but a normal thing to drink salty water?

Lesson scenario 5 was agreed upon for the following reasons, the topic 'living and non-living things' would have been taught in almost all the schools; there would be no materials needed to conduct the lesson; the topic regularly appeared in the examinations and it was syllabus related. I asked the teachers why they chose the lesson that would have already been taught in all schools and they explained that it allowed all the pupils to have the necessary pre-knowledge to engage in problem-solving.

In the lesson that was developed, the pupils were to justify why they would say fire, water and soil were alive or not alive. A sample of questions was prepared to be presented to the pupils.

4.4 Phase 4

Back in the three schools, one teacher taught the lesson while four other teachers from that school and I observed. I made arrangements with the principals for an extension of the normal period if need be.

In school A the teacher introduced the lesson by reminding the pupils that all things were divided into two groups, that is living and nonliving things, and she asked the class to remind her of the reasons they would say some things were alive while others were not. She directed her question to a particular pupil:

Teacher: *Thabo, why do we say that some things are alive and others are not alive?*

Thabo: *Living things respond and non-living things do not respond, living things die and non-living things do not die.*

The teacher continued:

You are right. What if I am using chalk and it gets finished. Is it not dead?

He did not wait for a response from the children, but went on to ask next question:

Teacher: *Pule why do we say some things are alive and others are not alive?*

Pule: *Living things excrete, breathe, grow, reproduce and feed and non-living things do not excrete, breathe, grow, reproduce and feed'.*

The teacher further asked,

Teacher: *What do we call all these?*

Pupils (in chorus): *We call them characteristics.*

Teacher: *Give me a list of things that are living and things that are not living.*

The lists of living and nonliving things were assembled. The teacher asked the pupils to get into their small groups to and assigned the different groups justify whether soil, fire or water was living non-living. In time, this was followed by group presentations and a lengthy discussion by the whole class. Discussions were brought to conclusion by one of the pupils who said:

But fire, water and soil are not alive because they do not have all the characteristics of living things but only some of the characteristics.

He supported his argument by referring to other pupils' statements:

Saying that water is alive because animals live and plants live in it is wrong because water is not alive. What is alive is those plants and animals. Water does not have all the characteristics of living things, it flows, flowing does not mean moving, water is just the habitat of some animals people cannot live for longer periods in water. It is not alive.

Another pupil complained: But fire multiplies. The first boy responded:

Yes, it multiplies like plants and animals, but it does not leave young ones when it dies or gets finished. No, it does not die, but gets finished and leaves ash. Can you say ash is the child of fire? Ash is different from fire. Does the cow go to the toilet? You see it is the same with soil, only plants are alive not soil, therefore soil, water and fire are not alive.

The teacher took it from there to summarize the lesson, building on what the boy had said.

School B

The teacher began the lesson by asking the pupils to give him the names of things that they knew. The pupils named the following: book, stone, chair, door, stick, desk, pen, and window. The teacher continued and asked the pupils if those were the only things they knew in their lives. Before they could respond he asked:

Teacher: *Among the list, which ones do you think are alive?*

Pupil: *Stick*

The teacher asked whether the rest of the class agreed. The class replied in a chorus:

Pupils (chorus) *Yes, sir.*

He then asked:

Teacher *In our lives is it only the stick which is alive?*

The pupils replied in a chorus again and said:

Pupils *No, sir.*

Teacher *Then give me the examples of things that are alive.*

The pupils raised their hands and listed the following; cows, humans, trees, chickens....

The teacher said:

Teacher *Let's go back to the stick, is the stick alive?*

The pupils replied:

Pupils *Yes*

He continued: *Can you give me the names of thing that are alive?*

The pupils listed the following; insects, fruits, reptiles, birds, fish, amphibians...

Teacher *Then what about things that are not alive?*

The pupils provided the following list: book, ruler, stone, desk... The teacher then asked the pupils to give reasons for why items they listed as alive were alive' and they listed all the characteristics of living things. Then he asked the pupils to break into groups and to choose among fire, soil and water and discuss whether it was alive or not.

After small group discussions the teacher conducted a large group reporting session. During the first group report it appeared that members did not come to consensus, and other members were not ready to give in to the one who was to report. The whole class was then drawn into the discussion on 'water'. Before any conclusion was reached, the teacher asked the class to suspend the discussion on water and move on to soil, in order to

give other groups a say. Groups that had considered 'soil' similarly had trouble reaching consensus. The teacher again suspended discussion, to allow the discussion of 'fire'. Here the idea emerged that 'some things were more alive than others'. After lengthy discussions, the teacher drew attention to this idea by citing examples from earlier discussions and building on those to round up the lesson:

You remember Thabo said fire is alive because it does not eat, it does not breathe, it does not move, it does not have feet, it does not bear young ones like a person, it is wood which makes food for it when you keep on adding wood. It is not alive like people and animals because it does not do things that are done by people and animals. It does not possess things that people possess. What Thabo is trying to tell us is that fire does not have all the characteristics of living things like animals and plants. Then what about soil and water? Similarly, water and soil do not have all the characteristics of living things therefore we cannot say they are alive.

School C

The teacher began by telling the pupils that they were going to learn about living and non-living things and pointing to a few articles in the classroom. She explained that there were two classes of things, living and nonliving. She asked them to give examples of living and nonliving things. Then she asked the pupils to list the characteristics of living things. The teacher then wrote fire, soil and water on the board and said to the pupils:

Right, now I want you to tell me if these three are alive or not, but you are going to work in your usual groups. I want each group to choose which one they would like to discuss, and please try to choose different thing from the group next to you.

After the small group discussions, the teacher called the groups to present their ideas to the class. As in school B, pupils had not come to consensus, so the discussions started again, in the large group. In the midst of this, the principal warned the teacher that the discussion on a particular aspect was taking too much time, and suggested that she move on to the next issue. From then on the teacher kept looking at her watch, timing each item being discussed.

According to the research plan, in all schools, the teachers would introduce the lesson and pupils would work in groups, while I and other teachers observed then joined the groups to record their conversations. The pupils responded well. All lessons continued for more than two hours, with neither pupils nor teachers showing fatigue or deteriorating interest. Samples of pupils' discussions are presented below.

Group 1

Pupil 1: *Water is alive because it moves, it grows and again it moves from one place to another. Soil is alive because when you pour water in the soil there are bubbles given out and it moves during windy days like in August. Fire is alive because after lighting it, it makes a big flame and the flame grows and after growing it gets smaller and smaller until the fire dies and ash is left. Again fire is alive because when the wood you use gets finished you will never see it.*

Pupil 2: *Water is not alive but we can help the crops to grow also when we put it there we cannot find it missing. Soil not alive but we can help the plants grow.*

Pupil 3: *Soil is alive because plants grow in the soil, because plants will eat vitamins which will be added in the soil. Water is alive because it helps the animals with drinking water and the plants absorb the moisture in order to grow. Fire is alive because it will burn until it dies off again lighting one twig leads to burning the area of woods.*

Pupil 4: *Soil, water and fire are not alive. Water does not move but flows because it moves because of dongas and slopes. Soil is not alive because even if it moves it does not move any far. Fire is not alive because it does not make itself it has to be lit by a person.*

Group 5

Pupil 1: *Fire is not alive because it does not grow, eat, and breathe. It is not like a person. A person moves, eats and does everything.*

Pupil 2: *I say fire is alive because if you put wood and light it will burn, it eats because if you put three woods they will get finished, showing that fire is alive. Also if you light a small fire it will burn until it covers a large area showing that it grows.*

Pupil 3: *Fire is not alive because when you do not put more wood it does not continue burning. Also it does not have a mouth to eat with, while animals have mouths to eat with.*

Pupil 4: *Fire is alive because it moves and eats. Like a person, fire dies.*

Pupil 5: *Fire is alive because it has living things, like it moves and it dies.*

Pupil 6: *Fire is not alive because it does not have the off-springs, you cannot see its off-springs like you can see a person's children, fire only reproduces when it has been lit. Also fire does not have feet like a person.*

Pupil 7: *Fire is alive, it reproduces, if you say fire cannot be there if a person does not make it, even a child is made by a person, therefore fire reproduces and is alive.*

Large Group

Pupil 1: *Soil is not alive because if you do not put water in the soil plants do not grow.*

Pupil 2: *Soil is alive just like in the case of person, and [with a] person there will be a baby, therefore soil and water gives life.*

Pupil 3: *If you put seeds in the fields they grow into plants without watering.*

Pupil 4: *But it rains.*

Pupil 5: *We would not be alive if it was not because of soil, it is alive, we grow plants that we eat on the soil.*

Teacher: *Think of Thaba-Bosiu.*

Pupil 1: *It used to be alive it is now dead.*

Pupil 2: *The mountain is alive because some plants are alive on it, therefore all mountains are alive and all soil are alive.*

Pupil 3: *Those who are saying soil is not alive they do not know that soil is alive, just as soil does not know that we are alive. Soil is alive because plants grow on the soil.*

Pupil 4: *But something alive dies.*

Pupil 5: *If I was dead there would be no baby coming from me therefore grass grows on the soil showing that soil is alive.*

The teacher put the following statement and asked the pupils what their views are about the statement. *Some things are more alive than others for example, donkey and train*

Pupil 1: *The train is more alive than the donkey because it is stronger, faster and can carry more people.*

Pupil 2: *The donkey is more alive than a train because it can jump eat and grow.*

My analysis of the lessons/ pupils' ideas and arguments

- ***The need for a clear conclusion***

In all three schools, during the summaries of the lessons pupils came to the conclusion that even though fire, soil and water have some characteristics of living things they do not possess all the characteristics. Interestingly, none of the classes saw the difficulties in the very nature of classification, or in the meanings of the standard criteria. Nor did the teachers (or anyone) point to the resolution that comes from the idea that all living things contain biological cells, or whether this was a satisfying resolution. It was interesting too that pupils based their comparisons and models of living things on humans more than other animals and plants.

- ***Processes of problem-solving***

It was evident from the pupils' discussions and reports that they followed a broad strategy in problem-solving: Understanding the task, and the problem involved; brainstorming possible solutions; making reference to existing knowledge; exploring more possible solutions; making comparisons; arguing from evidence and logic; discarding the irrelevant and that which does not fit; and making decisions by agreeing.

- **Post-lesson discussions**

After the lessons the teachers (those presenting and those observing) and I, came together to discuss the lessons. All felt that the lessons had gone well.

The lesson went well, although I think I did not push the pupils enough to where I wanted them.

Children were free to talk.

Participation of the pupils, lesson not teacher-centered but learner- centered

The lesson was an achievement in that children were brave to stand up and talk which is normally rare.

Table 4.6: Summary of the teachers’ comments/responses on the lessons taught

Focus of the question	Responses
Strong points of the lesson	<ul style="list-style-type: none"> • Pupils were free to talk • Less guidance by the teacher • More pupil discussion and interactions • Autonomous learning
Reasons for success	<ul style="list-style-type: none"> • Teachers creativity
Points to be strengthened	<ul style="list-style-type: none"> • Give pupils more time to think
Ways of strengthening the points	<ul style="list-style-type: none"> • Encourage pupils to relate prior and present knowledge • Do not give information to pupils • Practise learner-centred teaching • Encourage pupils to question their own ideas • Encourage and give pupils time to think • Refer to prior knowledge and culture
HOTS used by the pupils	<ul style="list-style-type: none"> • Reasoning skills • Critical thinking • Discussions • Sharing ideas
Improvements of pupils’ strategies	<ul style="list-style-type: none"> • Teachers’ creativity

The analyses and discussions are summarised in Table 4.6. As in Phase 2, the teachers demonstrated good knowledge and skills in defining problem-solving and HOTS, and thinking about how teaching and learning might be organised. Teachers readily picked up

strong points of the lessons and the HOTS used by learners and suggested ways in which the lessons could be strengthened. Their suggestions for strengthening leaned towards learner-centred, constructivist approaches, and greater power sharing in the classroom. In this sense, their suggestions question the norms of their schools and teaching. Further, they saw improvements in the pupils' strategies as being largely the teachers' responsibility. This could be viewed in two ways: perhaps the teachers were identifying themselves as having dominant power in the classroom, or perhaps they were reflecting back on their practices and seeing ways the classrooms could change.

Based on their experiences during these lessons, the teachers (observers as well as presenters) felt that there were lessons for their science teaching generally:

Science lessons could be improved by relating them to real life situations.

Work on our low expectations of pupils, we have low expectations of pupils, we do not give them time to think and give us their views.

Create a problem give it to the pupils, and wait patiently for their responses.

Give chance to pupils to think widely.

Make allowance for the loose arrangement in the classroom to give freedom to the pupils

4.5 Phase 5

Phase 5 consisted of a workshop, conducted by external facilitators. This incorporated learner-centred education, constructivist learning, and problem-solving. As in Phases 2-4, the teachers showed considerable understanding of the theoretical ideas, and their implications for practice. As in the earlier Phases, they also raised questions surrounding resources, time, examinations and large classes all major constraints to the use of problem-solving in their lessons. Teachers defined good science teaching and use of problem-solving as giving pupils opportunities to think creatively and critically to share

ideas and to contextualise lessons in the pupils' experience and interests. It was evident that they saw classroom activity as a joint venture between the pupils and the teacher, in a stimulating classroom environment. It was clear also, that though they believed in learning by doing and engagement in discussions, they nevertheless saw themselves as the source of knowledge and the determiner of what went on in their classrooms.

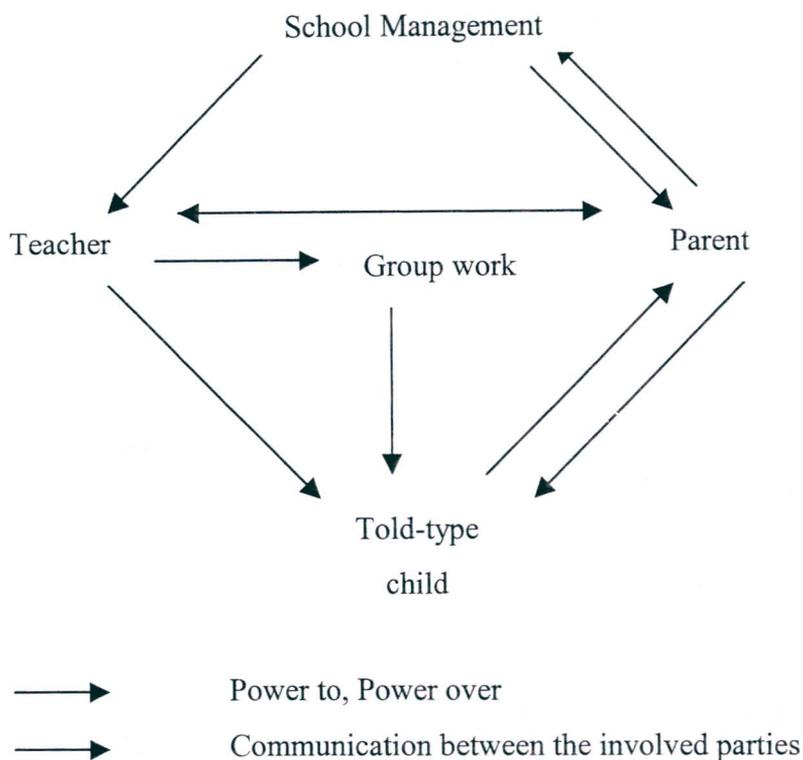
The facilitators raised issues of power sharing in the classroom, the extent to which teachers and pupils shared authority for knowledge, administration of tasks, the design of work, and the choice of content. This was a new way of thinking about teaching and classrooms for most of the teachers, and they enjoyed it. Even though teachers (in the earlier phases) have indicated some understanding of what problem-solving learner-centred teaching entails they still insisted that they cannot teach problem-solving. After being introduced to the concept of power teacher through their conceptual map of the relation between and learner-centred education teachers gave a picture of the condition under which they operate in relation to problem-solving hence implying the limited power they have in those who have the stake at school level which is indicated in figure 4.2 below. When asked to pictorially or otherwise make a representation of power sharing at classroom level or in the school, it was evident that they saw school structures and role expectations as important determinants of their work. The four groups produced the pictures below:

Group 1: Power and communication flows

According to the teachers in Group 1, power relationships in the school are important to what happens in the classroom. The management (the principal, the management structures and rules) has power over the teachers in laying down what should happen in the classroom. There is distribution of power between parents and management and between teachers and parents, but between teachers and pupils the teacher has power over groups (group work) and individuals (the 'told-type child'). The pupils have little say with teachers or with management, except by reporting what happens at school to parents. The only communication between parents and the teacher was when the teacher

reported on the progress of the pupil or the parent requested a meeting. In group work, the group has power over the told-type child, but not vice versa.

Fig. 4.2 Power relationships at school level, Group 1



The teachers' inclusion of group work in the structure suggests that they feel that problem-solving can use group work as a teaching strategy. However even for groups of pupils, the idea that power is invested in the teachers is strong. In the absence of an arrow pointing from group to teacher, as well as from the (individual) 'told-type child' to the teacher, is significant. The choice of the phrase 'told-type child' is itself interesting, and consistent with the teachers' beliefs expressed in Phase 4: *'We believe they [pupils] have come to school to be taught'*. This belief emerged also for Group 2, described below.

Group 2: A letter to parents

In its representation of power relationships in the school, produced a letter written by a teacher to parents informing them about a new learning approach, in which pupils would take more initiative and responsibility, and the teacher less. The group's choice to represent their ideas in such a letter indicates the need they felt to justify to the parents the new methods, and their feeling that parents believed that learning depended on solely what the teacher did, and the instruction the teacher provided.

Dear parent

We humbly bring to your awareness that there is a new learning approach whereby the learners have to be fully involved in the learning activities thus solving problems by themselves, and finding out things for themselves. In this case the teacher participation is limited, that is why it appears as though the teacher is doing less work. As my co-worker I request your cooperation and encouragement to the children.

Yours sincerely

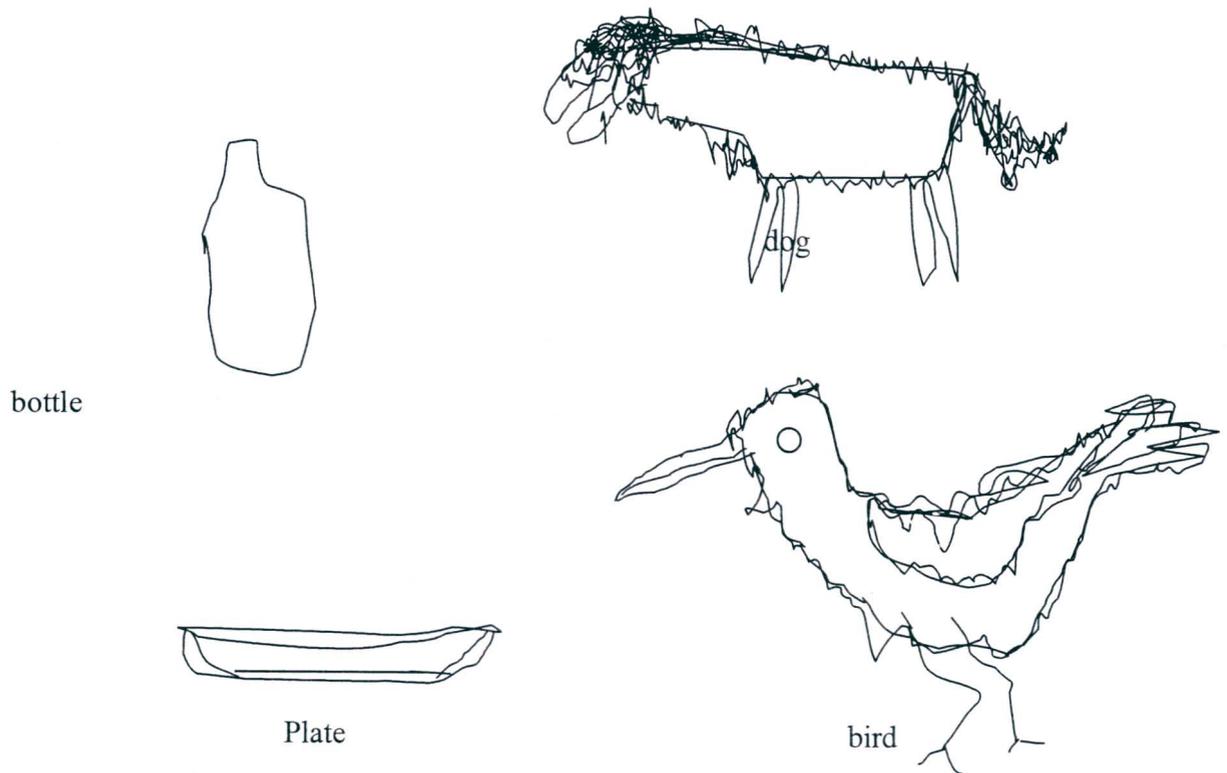
.....

Group 3

Group 3 produced an allegory of a bird and an animal/dog (see Fig.4.3 below), in which a waitress is giving them food in inappropriate containers. The participants explained their picture in different ways. In one interpretation, the waitress represents policies in the form of curriculum, examinations and the time allocation for the lesson period, while the inappropriate containers denote conditions in schools, such as large numbers and limited resources. In a second interpretation, the waitress represents the teacher, handing out knowledge to pupils who cannot get to it, because it is being given in wrong ways to the different individuals.

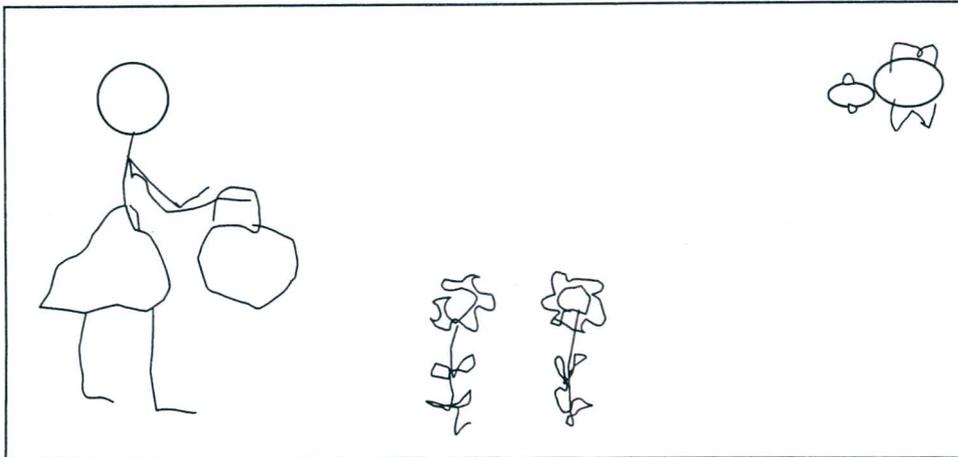
Fig. 4.3: Delicious healthy dinner that is difficult to taste

What a delicious and healthy meal but unfortunately we can't have it due to the containers:



Group 4: A girl picking flowers

Fig. 4.4 A girl picking flowers



Group 4 drew a scene where a little girl is picking flowers in a garden and a bee is facilitating pollination (see Fig.4.4 above). The group explained that the teacher was the bee, the flowers are the curriculum (subjects and/or desired outcomes), and the girl represented the pupils. The teacher would only be a good teacher if she produced good results, looking after the syllabus and the curriculum. The interesting symbolism of the teacher as a bee, a bee that is very busy, but whose work is circumscribed is important. The bee did not design the garden, or choose the flowers, is not the gardener and has no control over the weather. This metaphor is reminiscent of one teacher's comment in Phase 6, concerning pressures to revise before examinations:

The principal's interest is that pupils pass the examinations. I am behind in the syllabus, time is gone. At some point I will have to use the past question papers to revise to help the pupils to pass.

Also interesting in this metaphor is the idea of the pupil as a girl in a garden, able to choose which flowers she likes, and even the attention she gives to the bee. This is contrary to the power relationships expressed by Group 1, but can be seen as shifts in the roles of teachers and pupils that arise in learner-centred education and problem-based learning.

4.6 Phase 6

As a follow-up to the workshop I went back to the schools to observe and interview the teachers from Phases 3-6. My purpose was mainly to gather teachers' reflections on problem-solving at this stage, and to observe their day-to-day classroom practices. I wanted to see whether and how their knowledge, beliefs and practices had changed in the light of their experiences and deeper thinking. I used again the observation and interview schedules from Phase 1.

Teacher 1 (School A)

The teacher was observed teaching mathematics to 60 pupils because science was not in the timetable on the day of my visit. All the pupils had self-made cardboard clocks that they used to set the hands when the teacher wrote different times on the board.

Teacher 5 (School C)

The teacher was leading a class with 76 pupils, and another teacher was there to help. The topic concerned the solubility of common powdered substances. The teacher asked 6 pupils draw some water from a tap that was about 30 meters from the classroom. When they came back she gave the same 6 pupils containers with different powdered substances and asked each of them to stand at the end of a row of pupils, showing what they had in the containers so that the whole class would be aware of the powders that would be used. The names of the powders were listed on the board. In six groups, the pupils were to mix the powders with water and record what they saw. Since groups were given different powders, group reports were written on the board. The teacher asked group representatives to pass the mixtures around so that other pupils could see the results. The class concluded that some powders mixed well with water while others did not. The teacher introduced the phrases 'disappear' and 'does not disappear' then said:

Ok class: For the powders that mix well in water we say they disappear in water and those that do not mix well in water we say they do not disappear in water. Today we are going to learn new words, for powders that disappear in water we say they dissolve in water and that they are soluble in water. For those that do not mix well we say they are not soluble in water and that they are insoluble in water.

The teacher then wrote on the board and underlined the phrases 'mix well', 'do not mix well', 'disappear', 'does not disappear', 'dissolve', 'does not dissolve', 'soluble' and 'insoluble'. She drew a table showing those that mix well and those that do not mix then under mix well. She wrote the words 'disappear', 'dissolve' and 'soluble' under 'those that mix well', and 'does not disappear', 'does not dissolve' and 'insoluble' under the

others. She asked the pupils to name common substances that they knew from their homes were soluble and insoluble. The teacher concluded the lesson by asking the pupils to bring those substances to school the next day so the class could test them. Then the pupils cleaned up their desks.

The third (School C)

The lesson had 39 pupils and two teachers. The topic was 'liquids in our homes'. The lesson began by Teacher 3 asking the pupils to list all the liquids in their homes and the list was written on the board. Pupils, in groups, were asked to classify the liquids into those that were dangerous, not dangerous, edible and non-edible. In time, group presentations were made, after which the teacher distributed chart papers to the groups and assigned the groups to write their results on charts for display in the classroom.

Teacher 4 (School B)

Teacher 4 led a class of 57, with another teacher to help. It was difficult to tell what the objective and the topic of the lesson were from the way the lesson went. For the first 10 minutes the teacher asked pupils questions on vertebrates and invertebrates while in the following 10 minutes she asked questions on acids and bases, then properties of air. For the subsequent 20 minutes the class considered reproduction in plants. There was no summary of the lesson, which took exactly 40 minutes.

Summaries of my observations of the lessons are presented in Table 4.5. From this table it is evident that few opportunities were provided for the pupils to engage in problem-solving, or see knowledge and learning as problematic. In practice, these lessons were not greatly different from those observed in Phase 1. Even though the teachers had shown in earlier Phases considerable understanding of HOTS, their educational value, and ways of teaching them, very little was done in the name of HOTS as a result.

After the five phases of data collection, with teachers shown some knowledge and appreciation of problem-solving, I decided to use some of the attributes mentioned by teachers as indicating problem-solving. These were mainly based on teacher/pupil activities in terms of verbal communications and/or discussions (see Table 4.7 below) and went back to schools (Phase 6) to observe them teaching. In few lessons, few of those were evident and teachers.

Table 4.7: Attributes of problem-solving observed in Phase 6

Attributes of Problem-solving	Teacher1	Teacher 2	Teacher 3	Teacher 4	Teacher 5
Pupil Activity					
Brainstorming	x	x	x	x	x
Discussions	x			x	x
Planning					
Applying					
Arguing					
Questioning					
Sharing Ideas					x
Justifying					
Giving opinions					
Making Decisions					
Concluding					x
Finding Out					
Teacher Activity					
Support	x				x
Guide					x
Contextualising	x	x	x	x	x
Give reasons					
What if					
Think of Solution					
Imagine This					
What do you mean?					x
How can we find out					

It was noted that in three of the classes, two teachers were present in a class where the numbers of pupils were large. This arose from shortage of classrooms. However, in these cases, the second teacher took no part in any class activity, working instead on her own work.

Following the classroom observations, I conducted group interviews with those teachers who were part of the project and were able to attend the interview sessions (including teachers whose classes I had observed, and others whom I had not observed).

In School A, the teacher who had taught the mathematics lesson explained that she did not consider problem-solving when planning the lesson because it took a long time, and examinations were approaching. When asked whether it was important to use problem-solving, she said:

Yes, because if pupils do things by themselves/solve problems they understand better than when they are told. Generally in life the child will not have problems when she encounters them if I teach that way.

I reminded teachers that, in earlier meetings, many of us had said we were not able to use problem-solving because lesson periods were too short. How much time (length of period), I asked, is enough for problem-solving? The teacher replied:

Double period/80 minutes, take two periods and make them one period eh..h but I think time may not be the factor because there is something one can do about time. If one has 40 minutes on Monday and 40 minutes on Thursday you could combine them.

Then I asked her about support. What kind of support did she think she needed, to use problem-solving in her lessons? She replied:

We do not have resources, we depend on what the pupils bring from home and most of the time few pupils bring materials from home. We need support from the parents and the principal. The principal should see to it that we plan and teach the effectively, the principal should arrange ways of raising funds to purchase materials or raise school-fees. She should also talk to parents and show them the importance of supporting us.

On the issue of class sizes, I asked what she thought would be the ideal class size for her to be able to use problem-solving in her lessons. She said:

I had 66 pupils at the beginning of the year but they are now 60. I think the number of pupils should not exceed 40. Even though it is found that too many pupils do not have any impact on our failure to proper teaching because Sefateng primary school for example has similar situation like our school, that is, big numbers of pupils, but they produce better results than we do therefore the resources are the main problem. Other schools do request their pupils to pay more school fees, therefore are able to buy the resources. Another problem is content knowledge. It is difficult to teach what you do not know. There is lack of workshops and cooperation between the teachers. We teachers we talk only about general things not about the subjects we teach. We feel others will say I don't know, if the topic is difficult, or I don't understand the concept I could ask another teacher to support me but we do not do it.

When asked why teachers do not support one another more, she said it was allowed, but that most teachers did not do so because they did not want to reveal that they did not know.

Finally, I asked for criteria she would use to judge the best teacher of the year, looking specifically at problem-solving. She listed the engagement of pupils in the lesson, whether the lesson was learner-centred and whether assessment required problem-solving skills.

Two other participating teachers in School A, although I had not observed their classes, requested a session with me to reflect on their experiences. They said that after attending the workshop, they had decided to wait until they had completed the syllabus and then would try using problem-solving.

I decided to try it on the topic geometry. I wanted to see whether it would work. I applied it in geometry. It was their [the pupils'] first time. It makes children that are eager to learn. We would go up to 5.00 p.m. without realizing that it's getting late. I started by giving them these [problems] without introducing to them how to

work them out, and they worked with all the interest until they got the right answers without any help.

The second teacher said:

I left the topic magnetism for this purpose. We were working with magnets. After agreeing that South pole of the magnet points to the South and the North pole points to the North and that like poles repel while unlike poles attract, I posed a question, why should the north pole of the magnet point to north? I asked them to discuss and give me a good reason to explain that. Pupils found the explanation themselves after some time talking among themselves. Some said it is because it is looking for North pole while others said it a North-wanting pole, others said it was a North-liking pole. All I had to do was to give the right term 'north seeking pole.'

As to the suitable length of a lesson, both teachers felt that 50 to 60 minutes was enough, though they explained that it depended on many factors such as the ability of the pupils and pre-knowledge on the topic. Regarding the support that they need in order to use PS one said:

Resources, we need the support from the principal to purchase the materials. We also need parental support the parents need to tell their pupils that the teacher is there to support not to do everything for the pupils, a positive parent should always check her/his child's work on daily basis.

Colleagues, we should work cooperatively as teachers to support each other in area of need.

The curriculum should be explicit and elaborate enough for some teachers may not be too knowledgeable in some topics.

Also the timetable does not allow us, at times you feel you are bound to abide by the timetable in case the inspector walks in and finds you not following it. Some people say hang the timetable and teach your voice.

In School C, the teacher who had presented the lesson said she had decided not to use problem-solving, though she saw its importance. She observed that she always explained too much to the pupils due to the lack of materials:

I do not have materials to throw to the pupils to work independently and think for themselves. There are many pupils and many subjects to teach within short lesson periods, you know I sometimes teach 4 subjects in a day instead of 6.

She felt the ideal class size was 35 pupils, because with that number adequate materials could be available. The length of lesson period that was adequate for use of problem-solving was 80 minutes. For support, she suggested regular workshops by subject specialists, and for problem-solving to be expressed more explicitly in the syllabus.

In School B both the observations and the interview were not very successful because two teachers who were involved in teaching had not been taking part in the project in the earlier Phases. All the teachers who had been involved had been assigned by the school to attend (workshop/seminar) in preparation for a national science fair for schools.

While lack of content knowledge is not evident, teachers were talking reasonably about problem-solving, specifically when addressing certain issues: the criteria for judging the best teacher of the year in the use of PS and the reasons given for using PS. However, regarding the objectives of the lesson and making PS part of the objectives, teachers did not do it and their reasons remained the same: time, support, large classes and overload.

The other section of the interview schedule concerned itself with the time needed by both the teacher and the pupils to engage in problem-solving, the support needed by the teacher, the ideal class size and knowledge needed to engage the pupils in problem-solving activities and teachers' responses. The latter are summarized below:

Teachers expressed the kind of support they needed in order to use PS: internal support from one another in the form of collaboration and cooperation' and external support as from the parents, principals and subject specialists in the form of workshops. It is obvious that teachers recognise the importance of community of practice and reflective practice given the frequency in which cooperation between teachers and regular workshops appeared in their responses. It may be argued that teachers were shifting from their former experiential (learned behaviour) knowledge of what teaching is all about, to seeing teaching as reflective practice. Also the only opportunity to achieve reflective practice was in collaboration and cooperation with one another either in school setting or workshops, where they would be able to interact with others and subject specialists.

Although teachers said that regular workshops could be of some help to them as well as increase cooperation. When asked if they had shared information from this research project, all the teachers indicated that they had only just talked about their experiences with me, and had not disseminated the information in any way which could be called professional or academic.

Data presented in Phase 6 revealed very little difference between that of the earlier Phases in that very little practice was done by teachers in using PS as the method of instruction. Although two teachers claimed their lesson plans were objective-oriented they were not found to be so. Three teachers admitted that they did not include PS initially when they had planned the lessons. The responses in the interviews specifically on judgment of the best teacher of the year justify the understanding of PS among the teachers. With regard to the interview focusing on the external conditions that some teachers maintained did not allow them to use PS, the data reflected contradictory reasons to the ones cited (support, time and class size). After long discussions during the interviews, teachers started to personalize responsibility. They shifted the blame from the conditions (large classes, time, support) to themselves. This could have stemmed from the disappointment they felt that after two years involvement in the project, they had

chosen not to teach for problem-solving. This was evident in comments that came up during the interview:

I have also realized that when they are kept busy the number does not matter.

In fact time may not be the problem because there is something that one can do about the time, if one has 40minutes on Monday and 40minutes on Tuesday you can combine them and make them one period

We do not use the available resources, the science kits have been in there for about four years and the principal has informed us about them and also indicated that we should check what we can use but we have never done that. Maybe if we did we could have found materials that we may use and we would not be complaining about lack of materials. If we found materials that we are not familiar with we would then ask to be workshopped on how to use them. We are also partly to be blamed for what we are.

4.7 Summary and conclusions

Generally the results presented in Chapter 4 reveal that teachers do not teach and support HOTS. This was evident in Phase 1 of the study. In Phases 2, 3, 4 and 5 teachers showed some understanding of HOTS when they identified the lesson scenarios which were problem-based, the problems in the scenarios and also listed the educational value of HOTS in terms of teaching/learning methods, thinking ability and context attached (Phase 2). The understanding was also evident in Phase 3 and 4 when the teachers took part in the lesson planning (Phase 3), teaching and lesson critiquing (Phase 4). In Phase 4, teachers were able to pick up the good qualities in the lessons taught, and the skills that pupils used to solve problems, and suggested ways in which to improve the lessons. In Phase 5 the teachers were able to list the characteristics of learner-centred and problem-solving lessons. However, Phase 6 not very different from the earlier Phases even though the teachers started talking sensibly about learner-centredness and problem-solving.

4.8 Projection for the next Chapter

The Chapter that follows, Chapter 5, considers the findings and interpretations of the data gathered in this study. It summarises the whole study. The findings are presented according to the relevant phases in the study. The chapter also reviews the literature relevant to supporting or critiquing the findings of the study. The researcher's interpretations are also presented in this final chapter.

CHAPTER 5

Findings, Interpretations and Discussions

5.1 Introduction

This chapter presents the findings in relation to the research questions:

- What do teachers understand by ‘problem-solving’?
- How do teachers promote problem-solving in science lessons?
- Why do teachers make the choices they make, in relation to problem-solving?
- Why do teachers change or not change their practices?

The chapter also presents the theory generated from data interpretation and analysis in Chapter 4. It is hoped that the findings of this study will encourage teacher-training institutions to revisit their curriculum to incorporate higher order thinking skills explicitly. It is also envisaged that policymakers will ensure that policies to be implemented by the teachers are not conflicting, in order to enhance quality primary school education in Lesotho.

5.2 Main Findings

Generally it was found that teachers choose not to teach problem-solving, even though they have reasonable knowledge of what problem-solving is, evident from figure 4.1 (p98), how to do it, and how well it can work (see Phases 3 and 4). They explained this choice in terms of children’s abilities: policy constraints (time, curriculum, examinations) conditions (class sizes, a lack of resources, support, and knowledge; behaviours; expectations from school management and parents, and norms of what schools do.

5.3 Research Question 1: What do teachers understand by problem-solving?

There were interesting responses to the research question ‘What do teachers understand by ‘problem-solving’’. Phase 2 showed more clearly that teachers understand PS and how

it can be achieved. This is evident in the way they define problem-solving (in terms of teaching and learning methods and in relation to context), their ability to identify problem-based lesson scenarios from non-problem-based scenarios. The reasons for not doing it were as in Phase 1, except that, in the first instance, they blamed the children.

Phases 3 and 4 showed that teachers can develop a lesson using problem-solving, present it reasonably well, see how pupils engaged with it, and critique it. However, the lessons took a considerable amount of time (some two hours). The reasons for not doing it shifted from 'children' to school and policy factors. Some teachers now attributed their resistance to internal personal factors: *I could if I really wanted to.*

5.4 Research Question 2: How do teachers promote problem-solving in science lessons?

This research question, exploring 'What do teachers (and their classes) do in their science classes, and to what extent do they promote problem-solving', was central to the research. Observations from Phase 1 showed teachers do not promote problem-solving even though their knowledge was adequate. The essential thrust of their lessons was to 'transmit' particular knowledge, especially through choring definitions and 'completing sentences'. In support of this finding, Christensen (1995) points to the unchanged traditional patterns of science education for most of the last century. He further points to the classroom that presents environments where learners learn by rote and repetition from teachers. Analysis of teachers' reasons resulted in five categories. By and large the reasons they furnished were external, such as time, and even when they were internal, such as being lazy, the explanations were expressed in third person and not first person. Clearly there was some reluctance to take personal responsibility for their stance.

Phase 1 was a baseline and teachers held their story from Phase 1 throughout the project. As researcher I engaged in Phase 1 of the research process and the findings from phase 1

led to change in the approach to developing lesson scenarios with which I discussed with the teachers.

5.5. Research Question 3: Why teachers do or not teach problem-solving?

In response to this research question, teachers mentioned the following constraints consistently from Phases 1 to 4; policy constraints, lack of knowledge, school conditions, and teachers' (and pupils') behaviours and attitudes.

Policy constraints

Data revealed that constraints such as syllabus, time, timetables, class sizes, classroom management restrict teachers from the use of problem-solving. Some reasons are external to the school (syllabus, timetables, examinations); others are internal (time-management, colleagues and support, school management and micro-politics (e.g. the head-teacher has power over the choices that a teacher has in her classroom)). Macro-politics also make a difference, e.g. the introduction of Free Primary Education swelled student numbers, but also encouraged parents to withdraw from financial and personal responsibilities.

The absence or a very small percentage of Problem-solving in the syllabus and the examinations also makes teachers less committed to its use. Responses that indicate this lack of commitment included:

If I compare the requirements of the examinations, I can see [exam] questions require more facts than problem-solving,

We are restricted by the syllabus so that pupils will be able to write the examinations.

These comments confirm Nisbet's (1990) suggestion: if thinking skills are placed in the examinations, this could impact on the curriculum and hence instruction.

With respect to time, as one teacher stated, *You know, we know what we are supposed to do, but because of time we teach the way we teach*. Hargreaves (1994: 95) comments:

“Teachers take their time seriously. They take it as a major constraint on what they are able and expected to achieve in their schools”. No time, not enough time, need more time. Hargreaves further asserts that:

‘Time is a fundamental dimension through which teachers’ work is constructed and interpreted by themselves and those who administer and supervise them that time is not just an objective and oppressive constraint but also a subjectively defined horizon of possibility and limitation. Teachers can take and make time. Just as much as they are likely to see time schedules and time commitments as fixed and immutable.’ Hargreaves (1994: 95)

What Hargreaves (1994) asserts is evident in one of the teacher’s comments that at times people say *Hang the timetable and teach your voice*. This is indicative of the complexity of teachers’ thinking and decision-making, and justifies why teachers make certain decisions and not others. Why and when do they decide to hang the time-table?

Anderson (undated), on the issue of policy constraints (curriculum/time), confirms that teachers fail to teach well because of factors beyond their control, such as having to ‘cover’ a lot of content which in turn leaves no time for discussions with the learners. However, contradictory to the findings in Cohen and Hill’s (2000) study of the relation between instruction and policy, the teachers in their project were found to provide a key connection between policy and practice. They tend to consider just what the policy stipulates for instructional practice. Thus policy impacts directly on the practice of teachers and indirectly on the learners’ achievements (van de Berg, 2002). The bearaucratic social structure presented and drawn by teachers during the workshop (Phase 5) in my study, shows the community and context in which the teachers work, and the expectations of teachers from different community members at different levels of the structure (this may represents institutional politics), which influence judgments that guide their decisions and hence what they do in the classroom.

A critical idea is that policy demands can be contradictory e.g. short lesson periods, large classes and tight centrally controlled syllabuses count against learner-centred education and problem-solving. Individual differences, including the choices and decisions made as to how far one can manipulate the syllabus and timetable in order to teach Problem-solving add to the complexity of the situation. The school as a social institution has its own rules and expectations that may be contradictory to those of individual teachers who may wish to engage in Argyris's (1997) double-loop learning. Again, how much power does it give to teachers to exercise their professional expertise and decisions? The shortage and availability of resources, do the resources make it possible for implementing learner-centred and problem-solving teaching must be considered. Teachers' personal knowledge and lives, the subjects that teachers teach and the learners, are complex. Over and above these comes policy and management contexts are confusing and, teachers consequently tend to make decisions based on who they are. Rational decision-making is impossible in these circumstances.

Knowledge

The problem with 'knowledge' as a constraint is that so many kinds of knowledge are involved: content knowledge, problem-solving knowledge, pedagogic knowledge, management knowledge, policy knowledge, knowledge of children, self-knowledge etc. There are also degrees of knowledge all teachers, for example, have some content knowledge and some self-knowledge and some knowledge of policies. But more than this is needed for quality decision-making. The knowledge that teachers lacked in this study was of their pupils. They had little knowledge of them as individuals, which is important in learner-centred and problem-solving teaching. Collectively their knowledge was inadequate, insofar as they thought children could not and would not wish to engage in problem-solving.

Notions of knowledge and belief are also confusing and perhaps contradictory: which knowledge, which belief, is appropriate and when? This is the heart of situated cognition and social judgment theory (Sherif et al, 1965).

Behaviours and attitudes

Teachers referred to (teachers') laziness, non-commitment, and lack of motivation to do things they knew would be good to do, such as problem-solving, collaborative work and reflective analyses of their own work. Again the complexity of teachers' decision-making comes to bear. The findings in this study are indicative of the identities constructed by teachers of themselves and learners. In these examples, teachers are not distancing themselves from their behaviours. However, with laziness as a reason, they did: not a single teacher said *we teachers are lazy*, choosing instead to say *Some teachers are lazy, they do not give themselves time to prepare or they do not prepare*. This could be explained in terms of Heider's (1958) (internal and external) attribution theory. Life is a mix of personal, social, and physical aspects. Conceptions of identity take these into account, as do attribution and social judgment theories. The behaviours the teachers mentioned also support studies by Schon (1983), Smith (1995), and Schroeder (1996).

Conditions

Resources, timetables, class sizes, support and the heavy workload are real constraints. So is the 'norm' that teachers work individually. There is a collective identity, but it is not a collegiate one. It is interesting to note that the teachers believe in collegiality, but don't practice it; they cite instead the demands of the school day (with little time for teachers to work together, and even competition between individuals). Teachers from the workshop made no attempt to share their learning with others in their schools.

The interesting thing here is the complexity of internal attribution (personal responsibility) and external attribution, in terms of a methodological achievement: over time, teachers moved from external to internal attribution (at least a little), though the reality of external constraints was always there. The findings confirm van de Berg's (2002: 601) assertion that:

Working conditions such as failure to provide essential instructional resources, lack of administrative support influence teachers' classroom instructional practice, 'teaching has been characterized by role conflict, ambiguity and heavy workloads, and that classrooms are a place where many people with different skills and preferences must make use of a relatively limited supply of resources and materials to attain social, institutional and personal goals.

The value of professional collaboration (Goodland, 1991; Swafford et al, 1999; Andrews & Lewis, 2002), described by teachers as support from colleagues and cooperation between teachers, is consistent with the socio-cultural approach to teacher change and development (Swafford et al, 1999), and not unnoticed by the teachers.

Conceptions of power and powerlessness

Two aspects emerged from the workshop: the fact that teachers generally felt powerless, with pupils having even less power, and confusion about how powerless teachers really were and why they did not claim power to change their own teaching and their schools.

The conflict between individualism and collegiality was a problem: teachers saw in the workshop (Phase 5) how they could learn from and with each other, and that this opened options and opportunities for them, yet in Phase 6 they still worked on their own, as individuals. This has to be addressed at the school level, with time and space, management structures and requirements of teachers working together. There is a similar conflict of belief and practice in classrooms: teachers see the value of constructivist approaches, problem-solving and collaborative learning, but do not practise it. There are many pressures on teachers, and they make their choices based on a wide range of considerations. Past practice and what they know will 'work' for them (in the situation) are important.

Notions of attribution relate to concepts of power/powerless. But power too is a complex idea: for the teachers, the power not to do problem-solving was something they enjoyed.

Or perhaps they felt that the consequences of the fairly strong structural arrangements in the bureaucratic structures (inspectors, syllabuses, timetable, common examinations, and prescribed text books) would be too severe for their lives and their identities. Perhaps the lack of rewards in the form of career advancement/ promotions for being a good teacher, detracted teachers from investing their energy in problem-solving.

5.6. Helping teachers to change: research as means

From Phase 1, I assumed that teachers lacked commitment and/or some knowledge or skills through insufficient training. However, in the Phases that followed, I ruled out that assumption and had to engage in different approaches to find an explanation as to why teachers did what they did. Teachers did not use problem-solving and did not talk sensibly about it in Phase 1, even though they knew I was coming to observe them using it. There had to be explanation for this behaviour, such as the following:

- Teachers did not attach any value to problem-solving or even if they did there were other competing priorities such as policy requirements and expectations
- Teachers valued problem-solving, but made a reasoned decision and choice not to do it given the pressures exerted on them from expectations, conditions, policy demands and perceptions of what teaching is all about.
- Teachers were bound by norms and expectations from the community.
- Teachers used the situation to verify their beliefs about teaching, to impress me and/or to gain my sympathy.

Realizing that the motivations may be more complex than they appeared to be, the challenge was then to use research to explain why teachers did not teach and support problem-solving. In order to find the explanation I engaged them in social groups through group discussions and interviews. These encouraged and created opportunities for social interaction, where teachers reflected on their practices. By interacting with each other in the discussions of lesson scenarios, planning a lesson together, and observing and critiquing a taught lesson, teachers were able to work collaboratively. In this case they were able to learn from one another in a learning community. They were also able to

reflect on their practice, and hence reconsider beliefs about the nature of teaching, their roles as teachers and hence their behaviours and practices.

The two-years period spent interacting with the teachers, and my shift in position from that of (distant) researcher to co-worker with the teachers, brought about changing approaches. There was also an impact on the teachers themselves. They began talking sensibly about problem-solving, as well as their roles as teachers. Though it was not my intention to change teachers, or have teachers change their curricula, in a way the interventions through my methodology brought about some changes in them.

5.7 Research Question 4: Why do teachers change or do not change?

By Phase 6, the project had largely disarmed most of the teachers in their explanations for not doing problem-solving. Their knowledge of and beliefs in problem-solving were satisfactory, at least as a starting point, and this applied to their skills as well. Timetables, covering the syllabus, and large classes were constraints but provided some room for movement at least some times; examinations were a major issue, but all teachers recognized that examination results are only one indicator of learning, and that much more important learning can happen as part of the curriculum experience. While lack of support was an issue, even when teachers were available to support one another they didn't. The teachers in Phase 6 had had deep involvement with the project over a long period, supporting each other as a group and as subgroups within their schools. Yet classroom observations and interviews in Phase 6 showed that while some teachers had changed, most had not moved far in their practices (though all of them had moved in their knowledge and beliefs). One interesting possibility here is that the teachers, having found that they could teach problem-solving, were content: this self-knowledge was affirming in itself, and sufficient.

The change/ no-change of teachers did not relate easily to situational factors, such as the involvement of the principal, the location of the school, the governance of the school, or the nature of teacher training. Given that all of the teachers had reasonable knowledge

and skills, and saw the value of problem-solving, the fact that some followed through into changed practices (in collaboration with colleagues and in classrooms) and others did not point to the importance of personal choices.

The research data on large classes are unclear. No doubt, the social and management environment is different for smaller classes, with more time to work with groups and individuals, and more time to get to know students. However, the influence on achievement is less clear, mostly because achievement depends in large part on what happens in the classroom. If teachers teach a small class as though it were a big one, only small differences can be expected.

The reflections of teachers in Phase 6 were different in kind from the earlier phases, perhaps because they felt they had let themselves (and me) down by not using problem-solving in the observed lessons, in spite of the project. For whatever reason, the teachers in this Phase were more inclined to take responsibility for, or at least reflect wryly on, their own lack of change.

The theories of learning constructivism, critical theory and situated cognition, and notions of identity apply to teachers just as they do to learners. Thus teachers' beliefs and knowledge (including self-knowledge) are critical, and the starting point of learning. This is especially so for the strongly held beliefs that Sherif et al (1965) call "anchor positions". In a simple constructivist position, changing knowledge and beliefs constitutes learning and should result in changed practices. This is the basis of most teacher education programmes.

The situation in which teachers operate including management structures and demands, and the groups and ideas with which they identify are important. Their beliefs can as a result be changed or affirmed or overridden. Further, concepts of 'knowledge' and 'belief' are more complex than usually regarded in teacher education. There are many knowledges involved in the teachers' choices, and many beliefs. These knowledges/beliefs operate at different levels (e.g. Anchor positions vs minor beliefs; or beliefs that

are relevant in different domains), and can be contradictory. Further, people do not necessarily act according to their professed beliefs. Changing teachers' beliefs is important (though often difficult), but not sufficient, because other factors in the situation are also important, such as identities and group norms. However, identity is not only about conforming to group norms; if it were, there could be no real change. An individual or group may define herself/ themselves (or be selected by others) as leaders, or what Giroux (1992) calls "social agents".

Argyris (1997) makes the distinction between single-loop learning (mostly conforming) and double-loop learning (questioning, changing). The extent to which a situation encourages single- or double-loop learning can be manipulated (especially by management). We can have a school climate (or a classroom climate) that encourages and supports double-loop learning (e.g. a principal who tries to include as many teachers as she can in the project, probably in the hope that teachers will learn from the project, as opposed to one who stops the class to remind the teacher that too much time has been spent on one issue and suggests moving on to the next issue). If this cannot be achieved at the level of the whole organization, it might be achieved by a subgroup, which can perhaps, in time, become a leadership group.

Notwithstanding the roles of structures and norms, identity has individualistic dimensions: two teachers in the same setting, with the same knowledge and similar beliefs, make different choices. Social judgment theory helps: the choices tend to be ego-centred, evaluating options in terms of the consequences for the individual. For example to take on problem-solving has consequences for work style, time management and covering the syllabus, but also for the teachers view of him/herself. Another teacher might judge differently. These judgments are only partly rational, because of the complexities and dilemmas involved, and because ego by definition is not rational.

The notion of perceived power is relevant, as shown in the workshop data (Phase 5). The teachers presented themselves as having limited power over anything except the pupils, and feared that changes in power would cost them this too. Yet, in Phase 6, the same

teachers clearly expressed their power, by refusing my request and expectation that they present a lesson demonstrating problem-solving. The ego involvement of choices and identity kept coming up again and again. The five teachers in Phase 6 were happy that they had shown that they could do problem-solving if they wanted to, and this was perhaps enough for their views of themselves and others' views of them.

The teachers saw themselves as victims of circumstances (e.g. feeling that they were overloaded with both large classes and the number of subjects they taught but also held beliefs about their own impotence. As one teacher quoted, *You can't stop a flowing Caledon river with a teaspoon*, meaning you cannot make a difference in teaching if you are the only one doing problem-solving so why bother?

All of this can be linked to problem-solving with the implications of who defines the problem (at school and classroom level), and whether/ how the problems addressed are relevant. For example, Argyris double-loop learning, or Giroux's (1988) social agency/emancipation define a problem differently from a single-loop, technicist perspective. One teacher defines her 'main problem' differently from another teacher.

5. 8 Discussion and conclusions

The central conclusion is that teachers make decisions, intentionally, amidst a complex of competing demands, expectations, knowledge and beliefs. These range across personal knowledge, values and beliefs; policies and conditions; norms, expectations and identities.

Teachers make their choices in complex environments. Knowledge and beliefs about good teaching, and abilities to do it, are insufficient to enable change. So too are reflection and analysis. Choices are made with a view to the consequences of change, and in this sense are intentional, if not rational.

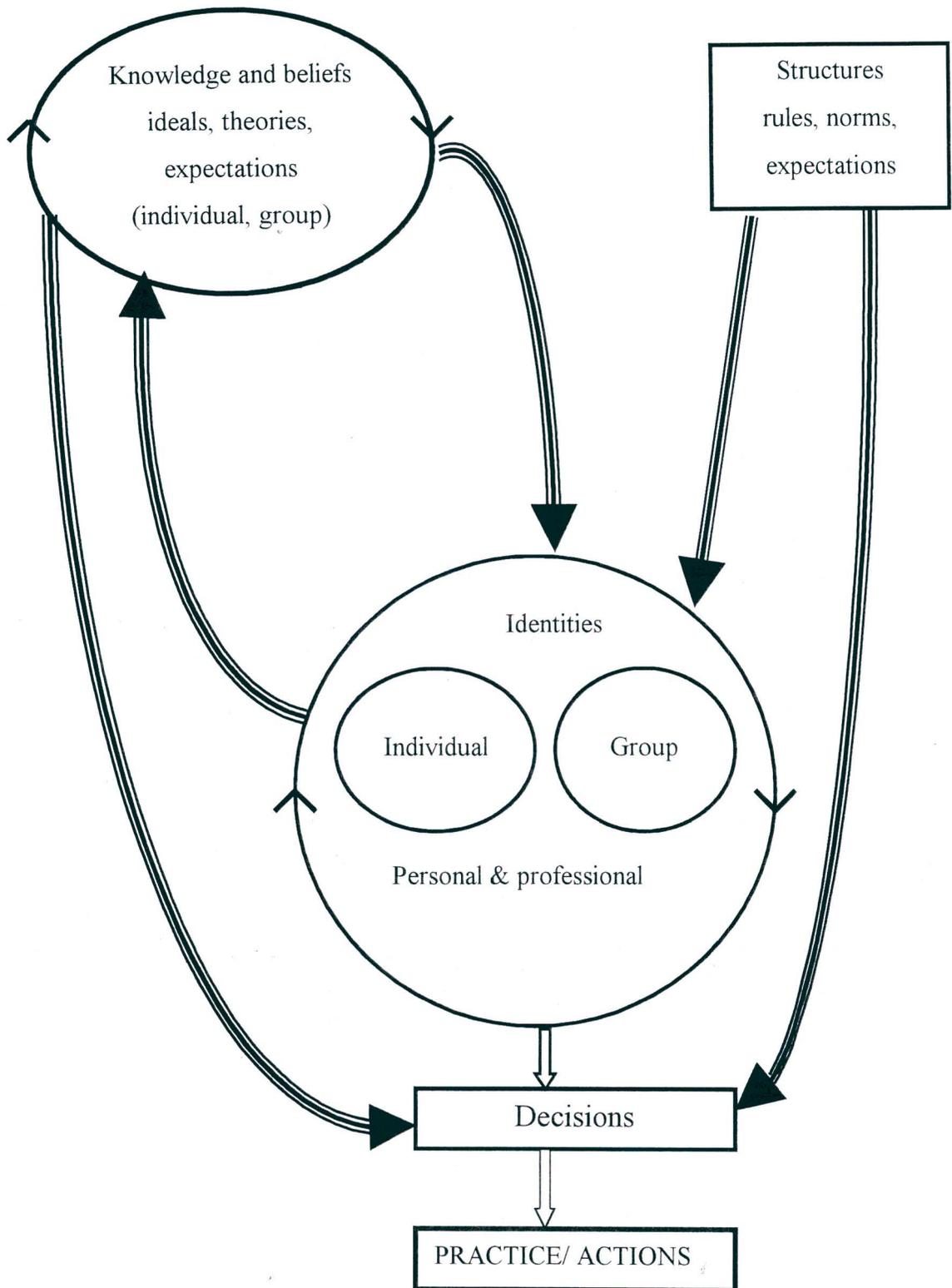
Teachers' choices are largely ego-centred, depending on what they can already do well, the effort required, their views of themselves as teachers, the views of others, the extent to which they want to change and what they want to change to, and where they place classroom practice in their lives in and beyond the school.

The claims teachers make about the constraints that operate in schools need to be taken seriously. While the reasons they offered shifted in qualitative ways during the six Phases (from children, to conditions, to personal factors), their concerns for the effects of examinations, covering the syllabus, time, timetables and large classes were maintained from beginning to end. In the face of these constraints, changes in knowledge and belief are insufficient to effect changes in classroom practice. We also have to change the rules, structures and expectations of schools.

Teacher development programmes that are focused on beliefs, knowledge and skills have a part to play, but they are insufficient. Simple constructivism, as a learning theory is insufficient. Critical theory cannot take hold unless the teachers identify themselves as 'social agents'. Teachers' learning is situated, in complex social and physical situations. Theories of identity and social judgment help.

Considering the findings and interpretations made in this study, I propose a framework that explains why teachers make the choices they do and put them in practice. Teachers work in complex situations within structures that are governed by rules, norms and expectations. There are also many types of knowledge and beliefs (each with its ideals, theories and expectations), which guide teachers as individuals and as a group. Finally, it is through these knowledge and beliefs that teachers construct their identities (as seen by self and others) as individuals and within a group; and within these identities (both as personal and professional) there are norms, ideals and expectations that teachers have to consider in order to make choices and put them into practice, hence the following proposed model.

Fig 5.1: Model of situations that affect teachers' choices and actions



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2002
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School of Educational Studies
FACULTY OF HUMANITIES

Office of the Director - Dr RENUKA VITHAL
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E-mail: rvithal@online.udu.ac.za

April 17, 2002

To Whom It May Concern:

Re: PhD studies, Maseapu Moeletsi

This letter is to certify that Maseapu Moeletsi is registered as a PhD student in her second year at the University of Durban Westville

She has completed her research proposal, on *The Effectiveness of distance teacher education in Lesotho*, in which she will be looking especially at the achievement of higher order thinking skills. Her proposal has been accepted. She is currently developing her research arguments and refining her methodology.

Yours sincerely,

Dr Renuka Vithal
Head, School of Educational Studies.

Part C

N.T.T.C
P.O. Box 1393
Maseru
Lesotho

The Principal Secretary
M.O.E
P.O. Box 417
Maseru
Lesotho

Dear Sir/Madam,

Re: Conducting Research in your school.

I am currently a student at the university of Durban Westville at Durban in South Africa, pursuing doctoral studies in Education and about to engage in research. My research topic is 'the effectiveness of distance teacher education in Lesotho'. I would like to work with primary school teachers who have trained through in-service education. I therefore seek your permission to work with these teachers.

I would appreciate your anticipated help in this matter.

I am

Yours sincerely

M'aseapa Moeletsi



Part D

N.T.T.C
P.O. Box 1393
Maseru
Lesotho

Dear Teacher

I am now a student at the university at the Durban Westville at Durban pursuing doctoral studies in Education and about to engage in research. My research topic is ' the effectiveness of distance teacher education in Lesotho. I would like to work with you in my project. If you are willing to work with me, please fill in the attached form and return it.

Please find enclosed, self-addressed and stamped envelope

I am

Yours sincerely

Maseapa Mofetsi



Name

Class teaching at present

School

Physical address of the school

Telephone

Directions to your school.

Rough map (if you think it will be difficult for me to find your school).

Part E

N.T.T.C
P.O. Box 1393
Maseru
Lesotho

The Principal
.....
.....
.....

Dear Sir/Madam

Re-conducting Research in your school.

My name is Maseapa Moeletsi, a Lecture at N.T.T.C. I am also studying part-time with the University of Durban Westville. I seek permission to work with one of your teachers Mr/Mra in my research project.

I wish to appreciate your anticipate help in this matter. Please find attached a letter of granting me permission to carryout this research in your school.

I am

Yours Sincerely

Maseapa Moeletsi





Ministry of Education

Our Ref. ED/P/25851

6th May, 2003

*Mrs. Maseupa Moeletsisi
LCE
P.O. Box 1293
MASERU 100*

Dear Madam,

Subject : RESEARCH IN PRIMARY SCHOOLS

Your letter dated 24th April, 2003 on the subject cited above bears reference.

Permission is granted for you to undertake your study in our primary schools and also for you to use our documents in the Ministry.

Please find attached a letter of introduction to school principals.

I hope you will share your findings with both the schools and the ministry when you complete your study.

Yours faithfully


*NTSERE KOKOME (Ms)
PRINCIPAL SECRETARY (ii)
MINISTRY OF EDUCATION AND TRAINING*

APPENDIX B: PHASE 1 INSTRUMENTS

PART A: OBSERVATION SCHEDULE

Section A

Background information

School's location--urban----Rural----- Teacher----Female----Male: _____

Subject----- Class-----

Section B

Opportunities provided for classroom learning. The scale used to rate the aspects below ranges from 1 to 5, with 1 denoting less opportunities while 5 denotes more opportunities provided.

1.Objective(s) of the lesson imply problem-solving	1	2	3	4	5
2.Classroom atmosphere denotes cooperative learning	1	2	3	4	5
3. Classroom atmosphere is learner-centered	1	2	3	4	5
4.Interactions between the learners	1	2	3	4	5
5.Language usage is predominantly Sesotho	1	2	3	4	5
6. Language usage is predominantly English	1	2	3	4	5
7.Level of pupils' active participation	1	2	3	4	5
8.Teachers' role is that of facilitator	1	2	3	4	5
9. Teacher's role is that of instructor	1	2	3	4	5
10.Organisation of learning activities (problem-solving)	1	2	3	4	5
11. Types of tasks given to pupils are objective-oriented	1	2	3	4	5
12. Types of tasks challenges pupils to find their own solutions	2	3	4	5	
13. Activities presented in a form related to the real life situations	2	3	4	5	
14. Types of assessment used to assess performance (oral form)	2	3	4	5	
15.Types of assessment used to assess performance (written form)	2	3	4	5	
16. How does the teacher express himself/herself	1	2	3	4	5
17. Indicators that this was a successful lesson	1	2	3	4	5
18. Indicators that this was an unsuccessful lesson	1	2	3	4	5

PART B: PUPIL INTERVIEW SCHEDULE

1. What makes your day in a science class at school?
2. What activities do you like most in science class?
3. Why do you like these activities?
4. Do you think the science you learn at school helps you with life outside school?
Please explain by stating a few examples.
5. How does the science you learn at school help you with life outside school?
6. Which of the class learning arrangements do you prefer most?
 - (a) Individual work
 - (b) Small group work
 - (c) Large group work

Explain why you prefer.

Explain why you do not prefer.

7. Which one of the above learning arrangements occurs frequently in your class?
8. Which language is used most frequently in your class? Sesotho or English?
9. Which language do you prefer to be frequently used during lessons? Give reasons.
10. When faced with a problem in the science class, what do you do to come up with a solution?
11. How does your teacher help you to solve your problems in the science class?

PART C: TEACHER INTERVIEW SCHEDULE

1. What does problem-solving mean to you?
2. Do you provide opportunities for problem-solving to your pupils? If yes, explain how you do by giving examples.
3. (a) Do you have a primary school syllabus? If yes, does it require the teacher to engage learners in problem-solving? Give examples.
(b) If no, what guide do you use for teaching?
4. Does the guide you use require the teacher to provide pupils opportunities for problem-solving?
5. (a) Do you have the syllabus that teaches towards the primary school leaving examinations?
(b) If yes, do you use it?
(c) How does it help assisting pupils in problem-solving?
6. (a) If no, what do you use? (Explain)
(b) How does it help the pupils in problem-solving?
7. How do you feel about your training at the college? Has it prepared you to interpret the science syllabus?
8. Are you familiar with the objectives of the primary school syllabus?
9. (a) Can you mention a few objectives stated in the syllabus?
(b) In your view, do they imply the use of problem-solving skills?
(c) Cite one example.
(d) Do they encourage you to present science problems to pupils so the pupils come up with their own solutions?
10. Do you feel that the college has prepared you enough to interpret and use the syllabus?
12. Did it help you to interpret and use it in a way to encourage children to come up with solutions in your science lessons?
12. Does children's culture affect the way they come up with solutions to problems they encounter in science?
13. Does the syllabus promote science learning/teaching presentation as problematic? Please cite a few examples
15. Does the syllabus promote science learning/teaching within the context of problems? Please explain.

APPENDIX C: PHASE 2 INSTRUMENTS

PART A: LESSON SCENARIOS

Lesson scenario 1

Mr. Liphoto's lesson

Mrs. Moloto and Mrs. Leemo are neighbours and are quarrelling about the way each one of them is disposing dirty water. Mrs. Moloto has made a ditch and pours the water in that ditch. Mrs. Leemo disposes of the water at different places. Each of these ladies claims that her own practice is a good one and the other lady's practice is unacceptable. They have quarreled over this issue over and over such that they do not speak each other any more. Mr. Liphoto gives this scenario to his pupils and asked the pupils to brainstorm how they would resolve the misunderstanding between the two ladies. In order to do that, the pupils have to support or argue against either of the two ladies giving their reasons.

Lesson scenario 2

Mr. Morena's lesson

The lesson was introduced by telling the pupils that they are to learn about different methods of disposing dirty water and the problems caused by bad practices of disposing dirty water.

Mr. Morena gave the class a list of different methods of disposing dirty water and asked the pupils to copy the list in their notebooks. He further introduced the pupils to the problems brought by bad practices in disposing dirty water.

He concluded his lesson by writing the few fill-in questions based on the lesson.

Lesson 3

Mr. Selepe's Lesson

Mr. Selepe presented the lesson as follows:

Suppose you lived in the community where people pour dirty water all over the place, and this water forms ponds where flies and other insects live.

He asked: is this a good practice?

Which of these methods are healthy ways of disposing dirty water?

- Ditch making
- Septic tank
- Disposing at different places

Lesson 4

Miss Nthabane's Lesson

Miss Nthabane asked her class to list all the substances that they would find difficult to classify as liquids or solids. Then she asked the class to justify why they would say the substances were liquids and why they would say they were solids.

Lesson 5

Mrs. Maruo's Lesson

Mrs. Maruo has just completed the topic on characteristics of living and non-living things. Assessing her students, she listed the following on the board and asked whether they are living or non-living:

- Flower in the vase
- Branch on the table
- Fire

Lesson 6

Mrs. Selomo's Lesson

This lesson began with questions:

You are thirsty; you find that the only glass of water available is salty.

Would you drink the salty water?

Would you enjoy it?

What would you do to get the salt out of water?

Mrs Selomo then left the pupils to discuss and come up with ideas on how best they could get drinking water from this salty water.

Lesson 7

Mrs. Mosi's Lesson

Suppose you left a child in the house with fire on in the fireplace. You mistakenly locked yourself outside and the house caught fire with the child locked in. What would you do to get the child out?

PART B: TEACHERS' INTERVIEW SCHEDULE

Look through the lessons here....

1. Are there any similarities or differences in these lessons?
2. Which ones would you call 'problem-solving'? Why?
3. What is the problem? How are these problems different from each other?
4. (a) For each of these, how well do you think this would work with your class?
(b) Why/Why not? Imagine it in your class....
5. Consider how a problem is presented: the water examples –
(a) Should the teacher solve it or kids solve it...
(b) Which way is better? Why?
(c) Which way would you use? Why?
6. How much structure should kids be given (e.g. copy the teacher; follow instructions; given a broad framework/guidance; wide open)?
7. Is the objective to learn science in the course of solving the problem? Or to develop skills in 'problem-solving'?
8. Consider the following; which should be the case and why, regarding science teaching?
 - Programme goals in which the curriculum is structured around problem content
 - Programme goals in which the strategies and techniques of problem-solving are emphasized
 - Problem-solving in the context of a method of teaching
 - Problem based content/activities
9. In actual fact what do you mean by problem based learning and/or problem-solving?
10. In most of the primary school classrooms teachers present their lessons in a large group in choral form. What could be the reason for this practice, is this a good practice? Why/why not?

APPENDIX D: PHASE 3 INSTRUMENTS

PART A: LESSON PLAN

Subject	Science
Topic	Living and Non-Living Things
Objectives	Pupils will be able to: <ul style="list-style-type: none">• Critically discuss characteristics of living and non-living things• Identify characteristics of living and non-living things• List objects according to living and non-living
Materials	None
Organisation	Large/small groups

Introduction Will depend on individual teacher but the pupils will be made aware that they are expected to discuss, argue and give reasons for their arguments.

Development

Teacher Activity

- Present the attached questions to the pupils

Teacher Activity

- Present the attached questions to the pupils

Pupils' Activities

- List things they think are alive/not alive
- Discuss and argue whether soil, water and fire are alive
- Support their arguments with reasons
- Support their reasons why they think water is/is not more alive than soil
- Support their reasons why they think/do not think some things are more alive than others
- Support with reasons why they think/do not think everything is alive

Summary/conclusion

Will be done by the whole class and the teacher from pupils' views

APPENDIX E
PHASE 4 INSTRUMENTS

PART A: QUESTIONS TO BE PRESENTED TO THE PUPILS DURING THE LESSON

1. (a) Let us think about things that are alive, let us list them.
(b) Why do we think that they are alive?

2. (a) Let us list those things that we think are not alive, let us list them.
(b) Why do we think that they are not alive

3. One pupil from Masilabelong/Selibeng/Likolobeng said water, soil and fire are alive.
(a) What do you think?
(b) Why would you say that these are alive?
(c) Why would you say that these are not alive?

4. (a) Do you think that some water is more alive than other water?
(b) Why would you say some soil is more alive other soil?
(c) What about fire?

5. I think everything is alive; my example is Thaba-Bosiu, (our famous mountain), but some things are more alive than others. My examples are:
 - (a) (i) Rock - River
 - (ii) Person - Lion
 - (iii) Donkey - Train
 - (iv) Dam water - River water
 - (v) River water - Water fall
 - (vi) Dust on the ground - Dust in the air

PART B: TEACHER INTERVIEW SCHEDULE

1. (a) What were the strong points in the running of the lesson ?

(b) Why do you think these were the strong points of the lesson?
2. (a) Which points do you think needed strengthening/improvement?

(b) Why do you think they needed strengthening/improvement?

(c) How would you strengthen/improve them?
3. What did you see happening?
4. What were the pupils learning?
5. What answers did the pupils give?
6. What strategies did the pupils use to solve the problems?
7. What higher order thinking skills did the pupils engage in?
8. How can you improve on the strategies that the pupils use to solve the problems?
9. How did the pupils go about solving the problem?

APPENDIX F PHASE 5 REPORT

Summary report on the workshop for teachers

Facilitators: Prof. Cliff Malcolm and Prof. Warren Beasley

Participants: 11 primary school teachers involved in my project and three other teachers involved in the project of a fellow PhD student.

The workshop began with the Introductions by the facilitators and the teachers. The participants were asked to give a list of what they expect to gain from the workshop (in relation to the research projects they have been involved in). These were listed as getting help in facilitating the following in their classrooms:

- Materials for use in the classrooms
- How to do problem-solving in the class
- Evaluation methods
- Managing time
- Language use in the class for easy effective communication with the pupils
- Effective use of group work in the classrooms (especially with large classes).

It was clear from the discussions that the main concerns for the teachers were:

- The length of the lesson period, during which they were to teach an individual subject was short, hence the difficulty in teaching science properly.
- The number of pupils in the classrooms was too high and this impacted on classroom management.

They lacked materials to use in the science classes and this affected their engaging pupils in actually doing things for themselves.

The facilitators asked the participants to list the characteristics of learner-centred/problem-based classrooms:

- Pupils doing different tasks about the same topic
- Pupils being involved in different pathways but to a common goal.

- Sharing of ideas
- Teachers valuing the difference in pupils.
- Context-based teaching
- Teachers sharing power with the pupils in the classrooms

The facilitator asked the teachers who chooses the topic for the lesson in the classroom. It was evident that it was the teacher who chooses the topic. The facilitator then introduced the strategies for sharing classroom control as:

- Forming groups to allow open discussion
- Allowing pupils to generate or find resources to answer the task
- Allowing pupils time to generate solutions
- Using projects to focus pupils learning

The facilitator asked the participants what were old methods of learning and the participants named the following:

Old things

- Learning by doing
- Learning by discussing
- Using all senses
- Individual differences (identified as family, rural, talents etc)

New things

Power sharing (was viewed through the following perspectives: knowledge, control, thinking for themselves, management). It was agreed, by both the participants and the facilitators that monitoring was very difficult, especially with the large numbers of pupils. Monitoring was defined in terms of management and thinking.

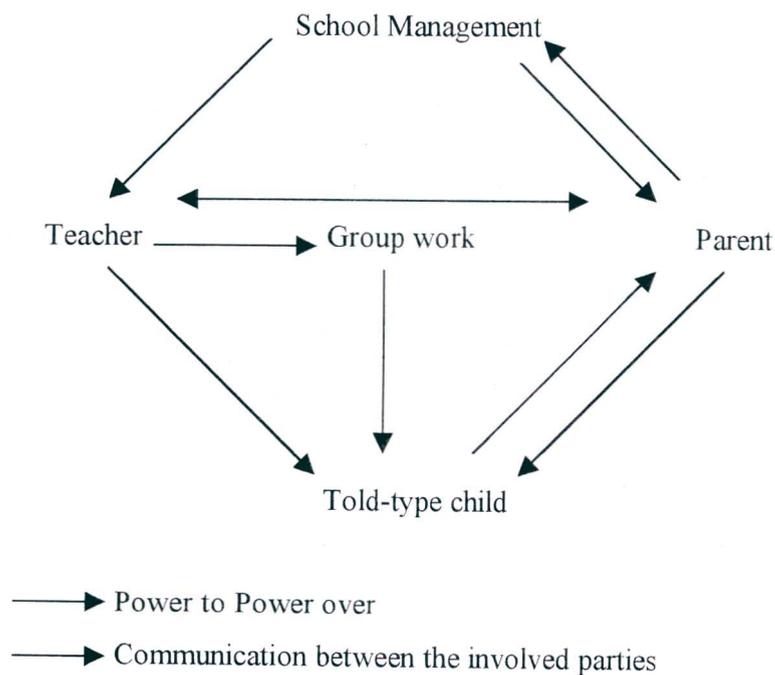
Participants' attention was drawn to the beliefs about 'What is a good teacher?' and 'What a good teacher does'? This was discussed by both the participants and the facilitator.

The facilitator then moved to discussion on power and began by asking what power was. He then discussed two ways in which power can be viewed: power to and power over.

He indicated the difference between the two. Classrooms are characteristic of power over rather than power to, and there is a need for change. Teachers need to be prepared to release power to their pupils. Power was described in terms of: knowledge, techniques, structures/rules, management, process outcomes, what is worth learning.

Participants were given an activity. They were to draw a picture on one of the above aspects of power in the classroom, relevant to learner-centered education/problem-solving. The activity was done in groups. Four groups were formed and both primary and secondary school teachers mixed together in the groups.

Group 1: Power- learner-centred education introduced at school level



Group 2: One animal and one bird eating.

There are two friends (a bird and a dog). Two friends went out for a meal. They asked for two dinner plates. When the two plates were brought, the waitress brought two different containers with the same type of food. The animal was given a bottle while the bird was given the plate. How are they going to eat? Who is going to eat in the flattened container and who is going to eat in the bottle container? What will be their conclusion?

Group 3 Power-Flowers and bees demonstration

The drawing of a little girl with a basket picking flowers in the garden was explained as power given to the learners to choose their own curriculum. The bees represented the teachers who fertilized the curriculum for the learners to receive.

Group 4 A letter to the parent from the teacher

Dear parent,

We humbly bring to your awareness that there is a new learning approach whereby the learners have to be fully involved in the learning activities thus solving problems by themselves, finding out things for themselves. In this case the teacher participation is limited, that is why it appears as though the teacher is doing less work. As my co-worker I request your cooperation and encouragement to the children.

Yours sincerely

It was explained that if parents knew what the pupils have been doing at school and the pupils always reported that they were the ones who were doing the work, parents would complain that teachers were not informing them.

APPENDIX G
PHASE 6 INSTRUMENTS

PART A: CLASSROOM OBSERVATION SCHEDULE

School-----

Teacher-----

Class-----

TIME IN MINUTES

	0-5	5-10	10-15	15-20	20-25	25-30	30-35
Attributes of Problem-solving							
P/A							
Brainstorming							
Discussions							
Planning							
Applying							
Arguing							
Questioning							
Sharing Ideas							
Justifying							
Giving opinions							
Making Decisions							
Concluding							
Finding Out							
T/A							
Support							
Guide							
Contextualising							
Give reasons							
What if							
Think of Solution							
Imagine This							
What do you mean?							
How can we find out							
Suppose							

PART B: TEACHERS' INTERVIEW SCHEDULE

1. What is the objective of the lesson?
2. Have you achieved it?
3. Did you have Problem-solving in mind when you planned your lesson?
4. Why/why not?
5. Which part of the lesson indicates problem-solving in your view?
6. What indicates problem-solving in that particular part?
7. Is it important to you to use problem-solving?
8. Why/ Why not?
9. How much time do you think is enough for you to use problem in a lesson?
10. How long should pupil activity be given in a lesson for problem-solving?
11. What kind of support do you think you need to use problem-solving in your lesson?
12. How many pupils do you have in your class?
13. What is your ideal class size?
14. During the final interviews some teachers said they do not engage their pupils in problem-solving because of lack of knowledge.
 - (a) Is it the knowledge of science concepts or how to use problem-solving?
 - (b) When we talk about content what are we actually referring to?
15. Under normal circumstances, when would you do your preparation? How long would it take you to prepare for a 40 min lesson?
16. If the Ministry of Education was to give Awards for "The best teacher of the year" and the award was for the teacher who uses problem (PS/ PBL/T) and you were to be a judge what would you be looking for?
18. What have you really gained from this project?