AN ANALYSIS OF HOW TEACHERS USE

CHILDRENS' PRIOR KNOWLEDGE

IN STANDARD 5 LESSONS

Submitted as the dissertation component (which counts for 50% of the degree) in partial fulfilment of the requirements for the degree of Master of Education in the Department of Education, University of Natal.

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My outlook has changed as a result of what I have received from the staff of the Department of Education and I am fortunate to have been a member of the group which met during the two years of the course.

My prayer is that what is contained in these pages will be able to maintain my momentum in my working with student teachers and others towards a new approach to education in kwaZulu-Natal in the years to come.

DECLARATION

I hereby declare that this dissertation is my own work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Education (Curriculum Development) in the Department of Education, University of Natal, Pietermaritzburg. It has not been submitted before for any degree or examination in any other university.

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CONTENTS

CHAPTER 1 - INTRODUCTION.

1.1 THE QUALITY OF TEACHING IN SOUTH AFRICAN SCHOOLS.

In the Republic of South Africa the quality of teaching in many schools, irrespective of their historical background, has been affected by a wide variety of issues with very different origins. The previous Department of National Education, working from a position based on Fundamental Pedagogics, dealt with issues related to the curriculum by deciding on the content of the syllabuses and how it should be taught. This resulted in a way of teaching which followed a "recitation script" (Gallimore & Tharp, 1991, p. 175). The approach was adopted in both the traditionally "black" and the traditionally "white" departments of education. The effect has been noticeable in both classroom teaching and in the way in which teachers have been trained. The prescriptive nature of the syllabuses has markedly affected all educational practice.

The frequency of large classes in most "black" schools has also aggravated the problem. Teachers have resorted to using methods, which enabled them to maintain discipline as well as teach their children. The most frequently used method being that of rote learning. As a result, many pupils have lost the desire to learn and are not motivated to do their best.

1.2 THE WAY FORWARD.

The African National Congress in their Reconstruction and Development Programme (RDP) (1994) states that the way forward is to "create an education

and training system that ensures people are able to realise their full potential in our society, as a basis and a prerequisite for the successful achievement of all other goals" (p. 59). Education within the new political dispensation will need to be carefully planned in order to satisfy the needs of the pupils, parents, community and nation. Central to the achievement of the purpose of the RDP is what the teacher does in the classroom.

1.3 **THE PURPOSE OF THIS RESEARCH**.

While there are no easy answers to the problems within education, there are some important pointers to the way forward. In this research project a theoretical framework based on the work of Vygotsky and the interpretation of his work by Tharp & Gallimore (1988) and Gallimore & Tharp (1991) was considered. The *means of assistance* as described by Tharp & Gallimore have a different emphasis to the methods which are associated with fundamental pedagogics and enable the teacher to move away from the recitation script.

The intention of the research was to investigate the extent to which teachers were already wittingly or unwittingly making use of the means of assistance in their teaching. Perkins (1992, p. 45) points out that teachers already know a lot about what can enable teachers to facilitate meaningful learning. In his Theory One he says "people will learn much of what they have a reasonable opportunity and motivation to learn," given that teachers fulfil four commonsense conditions in the provision of reasonable opportunities for learning. These are described in Chapter 2.

Teachers, in their interaction with their pupils, are faced with challenges, which are not beyond them. They do, however, need guidance in how to proceed forward using the resources which they have and in how to deal with the wide

range of abilities and resources of knowledge which their pupils already have and which should form the basis of their education.

To be able to assist teachers in the use of the prior knowledge of their pupils, including both knowledge that certain things are true and of how to do things, it was necessary to discover the extent to which teachers were already using the prior knowledge of their pupils. This gave rise to the central question which was examined in this research: how do teachers use the prior knowledge of pupils to enable their understanding of new knowledge. The nature of prior knowledge and its importance will be examined in Chapter 2.

The research was conducted within the context of the teaching of mathematics although it could have been conducted in any of the subjects included in the school curriculum. It was the not the *content* of the subject which was important for the research but the *process* of teaching and learning within the subject.

1.4 **AN OVERVIEW OF THE DISSERTATION**.

In Chapter 2 a number of theoretical viewpoints concerning the nature, importance and use of prior knowledge are considered. This provides a context within which to discuss the *means of assistance* as described by Tharp & Gallimore (1988) and Gallimore & Tharp (1991). Chapter 3 deals with methodological considerations, which are relevant to a qualitative approach to research and the nature of classroom observation. The positive and negative aspects of structured and unstructured approaches are discussed. In Chapter 4 the process involved in the design of the research will be discussed. This includes a consideration of the question being researched, the variables which were included in the design of the observation schedule and a description of the context

within which the research was performed. Chapter 5 is an analytical consideration of the data gathered during observation of the teachers in their classrooms. This was done in terms of the variables contained in the observation schedule. Chapter 6 contains the conclusion drawn from the analysis of the observations. Included in this chapter are some conclusions concerning the implications of the research and some suggestions for further research.

CHAPTER 2 - THEORETICAL CONSIDERATIONS

2.1 INTRODUCTION.

The argument which will be pursued in these theoretical considerations is that whatever approach teachers may follow in their teaching, for example whether it is a child-centred or teacher-centred approach, the success of the lessons which they teach will depend on whether their lessons are built on the foundation of knowledge which the pupils already have. David Perkins (1992), in his examination of teaching and learning, referred to in the introduction, says that it is not the *method* that is important as much as *how well* it is followed and *what* is taught through the use of that method (p. 44). Perkins suggests that there are four commonsense conditions which must be fulfilled if learning is to happen (Ibid., p 45.):

- *Clear information*. This includes first, clear information given to the pupils through descriptions and examples and the monitoring of their understanding of that information. Secondly, clear information about the processes involved in the subjects being taught is given for instance by the teacher through thinking aloud while teaching.

- *Thoughtful practice*. Opportunity is given for the pupils to engage actively and reflectively in whatever is to be learned.

- *Informative feedback*. Clear, thorough counsel is given to the pupils about their performance, helping them to proceed more effectively.

- *Strong intrinsic or extrinsic motivation*. The pupils are amply rewarded in the activities in which they participate, either because they are very

interesting and engaging in themselves or because they feed into other achievements that concern the pupil.

It is the contention of the researcher that it is implicit in these conditions that learning is dependent on the prior knowledge of the pupil and that teaching should both provoke the use of that prior knowledge by the pupils and enable them to build on it. This prior knowledge is, however, not just a series of facts, which have been learned, and which are regarded as true and worthwhile. Prior knowledge includes a knowledge of how things are done. An understanding of prior knowledge as both knowing "that" certain things are true and knowing "how" to do certain things enables teachers to move away from an approach to teaching which sees knowledge as something that needs to be learnt by rote. Ausubel (1968, p. 127f) argues that "the existing cognitive structure itself ... is the principal factor influencing meaningful learning and retention" and that "when we deliberately attempt to influence cognitive structure so as to maximise meaningful learning and retention, we come to the heart of the educative process".

The importance of prior knowledge in the learning process is also recognised by theorists who follow the approach of fundamental pedagogics. Duminy & Söhnge (1980), in their discussion of the steps in teaching, state that the first of five steps through which every lesson should proceed is that of *preparation*. In this step the pupils are to be prepared for the new content which is to be taught; that the aim of the lesson is clearly stated and that "the pupil's relevant previous knowledge and ideas are called upon in order to ensure his maximum susceptibility to the lesson which follows." (p. 109) When teachers plan a lesson, a section of the lesson should be devoted to the establishment of links between the new content to be introduced and the previous knowledge of the pupils. The difficulty

with this approach is that it remains linear as it progresses from one step to the next in the same way as the syllabus with which the lesson is associated; each section building on what went before. Perkins (1992) in his four conditions points out that the processes of teaching and learning are cyclic in that previous knowledge is revisited when informative feedback happens.

Students at most teachers' colleges which operate within the paradigm of fundamental pedagogics are drilled in an approach which implicitly takes into account the steps outlined by Duminy & Sönghe . The lesson evaluation performed at the college at which the researcher is a lecturer explicitly requires that student teachers establish links between the new content of their lesson and the previous knowledge of the pupils. The evaluation proforma which is used requires that these links should be made in the introductory phase of the lesson (See Appendix 3). How this is done by the student teacher depends on the subject being taught and the type of lesson.

Experience gained by the researcher through lesson observation, however, shows that although this may be a requirement for each lesson, many student teachers are not adequately able to make these links between the knowledge which the pupils already have and the new knowledge which they are about to receive in the lesson. First of all, they appear to find it a difficult task to find out what the children know and secondly they do not know how subsequently to build on that knowledge.

In the survey of the literature relevant to this inability to effectively use the prior knowledge of children by many student teachers (Tharp & Gallimore, 1988; Pressley, Symons, McDaniel, Snyder & Turnure, 1988; Pressley, Wood, Woloshyn, Martin, King & Menke, 1992; Pirie & Kieren, 1992; Vygotsky, 1978;

Willoughby, Waller, Wood & MacKinnon, 1993; Woloshyn, Wood & Willoughby, 1994) there are a number of related areas of concern which are considered. The first of these concerns is that of the *nature* of prior knowledge which cannot stand alone and must be seen in relation to other knowledge. The contribution of Gallimore & Tharp (1988) to this discussion is important because of their explanation of Vygotsky's concept of the Zone of Proximal Development (ZPD). In their discussion they point to a link between prior knowledge and the actual knowledge which children have as they enter a ZPD. The two concepts are not necessarily synonymous because prior knowledge can be fixed whereas the actual knowledge which a child has is associated with an actual developmental level which is in the process of development towards a level of potential development. For the purposes of this research the two terms are regarded as being effectively the same. Within the socio-cultural approach to the understanding of learning, the context from which Vygotsky works, the importance of prior knowledge is evident and will be discussed later.

The second concern, which is raised by Gallimore & Tharp, is that of *how* the actual development level or prior knowledge may be used to assist in teaching. Pressley, et al., (1988), (1992); Willoughby, et al., (1993) and Woloshyn, et al., (1994) in their research into the use of prior knowledge in Elaborative Interrogation show how this prior knowledge can be effectively used to aid learning. In their work on *ways of assisting learning*, Tharp & Gallimore (1988), emphasise the importance of the actual development level or prior knowledge of the learner if these means are to be effective. Also important in the discussion of the use of prior knowledge is the contribution of Freire (1987, 1989) and the dialogical processes, which he sees as being essential to effective teaching.

The third area of concern is that of the subject within which the research was done. It is, initially, important to point out that it was not necessary for any particular subject to be specified since, as children proceed through ZPD's in *any* subject, their prior knowledge is an essential part of every learning process and the means of assistance may be used in the teaching of *any* subject. It was, however, felt that a particular subject should be chosen because it would give continuity to the research from lesson to lesson. Some discussion about the importance of prior knowledge in the teaching of mathematics will be included. In this regard the research of Pirie and Kieren (1992) and Cobb, Yakel & Wood (1992) into the constructivist approach to the teaching of mathematics is discussed. All of these research documents stress the importance of prior knowledge in learning.

2.2 THE ZONE OF PROXIMAL DEVELOPMENT (ZPD).

Lev Vygotsky generated a way of understanding the development of mind which is different to that later formulated by both behavioural and cognitive psychologists. In his answer to the question about what "internal" rules govern the functioning of the mind (Williams, 1989, p. 108) Vygotsky describes cognitive development as a process which takes place within the social context. The structures which govern behaviour are not internal resources which are individually and internally developed they are the result of social interaction.

In the process of the development of these internal structures pupils move through a cognitive zone which Vygotsky refers to as the Zone of Proximal Development (ZPD) and describes as:

"the distance between the actual developmental level as determined by individual problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more

capable peers" and, "those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state." (Vygotsky, 1978, p. 86; italics in the original.)

In the ZPD the pupils are initially independently able to use certain skills in their problem solving (which Vygotsky calls the "actual developmental level" and is understood as being the same as the prior knowledge of the pupils) while at the same time they are not capable of using other skills without the assistance of (or in collaboration with) another person who has previously developed the capabilities that the pupil now needs to develop.

The *range of skills* which a pupil can use *without assistance* is not of consequence when testing a child's performance since a pupil may be able to use those skills in some contexts without assistance while only being able to use them in other contexts with assistance. Skills are context specific. Vygotsky (1978, p. 85) also argues that because batteries of tests only determine whether a child is able to perform a certain task at a particular time or not, they do not measure just how *close* the child might be to performing the task if given assistance. Tharp & Gallimore (1988) confirm this point when they argue that the ability of the child is wider than may be determined according to his or her development level through the use of standardised tests (p. 30). The new development level, which results from the assistance given to the child, enables the child independently to solve problems at that new level and becomes a foothold which can lead to further development. It is this further development which Vygotsky refers to as *the level of potential development*.

The ZPD, as described by Vygotsky is an "internal course of development" (Vygotsky, 1978, p. 87) and is not specifically linked to the development of

language or any other particular school subject. It is associated with any context within which individuals are in a process of development from one level of competence in a specific skill to another. Whether the individuals are playing golf or solving a complex mathematical problem, a ZPD distinguishes the distance between what they can do on their own and what they will be able to do with the assistance of a more capable other. The ZPD is also not to be understood as a discrete zone which all individuals possess at a particular stage of their development. A ZPD may be evoked at any stage of development, at any level of competence and in more than one different area of competence. The same person, for instance, may be capable of using one method for the solving of problems in Mathematics and have difficulty in using a different method for analysing a poem. It is usual that children will have uniquely different ZPDs while at different ages and coming from different cultural groups (Tharp & Gallimore, 1988, p. 31).

The importance of the ZPD for Vygotsky is that it identifies a gap in understanding or capability in which a teacher may give assistance to pupils so that they will be able to increase their ability and understanding and be able to perform the tasks on their own. When the teacher's responsibility is described in this way then it is possible to talk of teaching as the assistance of a person by a teacher or more capable other through a ZPD (Tharp & Gallimore, 1988, p.31).

The giving of assistance in a ZPD is as important for the development of adults as it is for children. After a period of time, an adult may forget how to use a particular skill and needs to return to an earlier stage of development and work through a previously completed ZPD. In this case a new ZPD has been identified in which assistance is required. An example of an adult ZPD occurs when parents

are required to assist their children with their homework. If they have not used the skill required to do mathematical equations they may need assistance to rekindle the skill. The children themselves may be able to render this assistance by filling in the gaps in the knowledge of the parents.

The stages in the progression through the ZPD can be represented by means of a diagram (Fig. 1) which shows how the child moves through a ZPD with the assistance of an adult or a capable other.

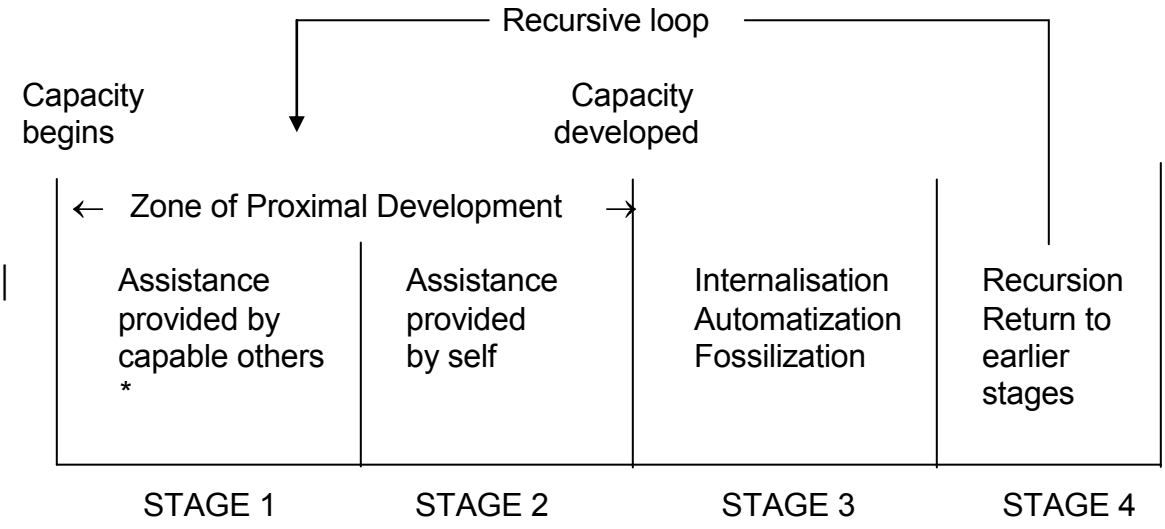

FIG. 1. PROGRESSION THROUGH THE ZONE OF PROXIMAL DEVELOPMENT
(Modified from Tharp & Gallimore, 1989, p. 35)

In the first stage the child is not able independently to perform certain tasks and relies on assistance being given by others. As these capable others assist the child they regulate what the child learns and come to understand the progress of the child through discussion with the child. When they believe that the child has reached a point at which self-regulation can happen then they withdraw and allow

the child independently to continue. Vygotsky (1978) argues that it is a feature of learning that it "creates the zone of proximal development" in which the child interacts with others through the use of a variety of internal processes in co-operation with these others. Only when these processes have been internalised can the child regulate his or her own learning (p. 90).

In the second phase the child no longer is dependent on interaction with capable others and operates alone in the solving of problems. A movement has taken place from an external plane of activity which was dependent on the co-operation of the child with a capable other, to an internal plane of activity which is private to the child. This control, however, is not fully autonomous and can be described as happening as a result of what the child has gained from the persons who have previously been of assistance to the child. The voice of the teacher becomes the voice of the pupils as they "speak to themselves" (Gallimore & Tharp, 1991, p. 186). The teacher no longer has to be in direct control of the learning of the pupils. They can have control of their own learning through their self-directed speech.

The third stage is entered when the child can now perform the task automatically. The developmental level which marks the end of the ZPD has been reached and the child no longer needs assistance. To give assistance would be a nuisance to the child.

The fourth stage is one in which the skills and understanding lose their automatic character and the child needs assistance in order to restore competence. This may happen as a result of changes in the external circumstance of the child or as a result of internal factors which disrupt or render performance by the child ineffective. The assistance that is needed may be of short duration

depending on the circumstances and may be in the form of a prompt to trigger off the activity or if necessary of longer duration when the skill or understanding required is more complex.

2.3 **THE NATURE OF PRIOR KNOWLEDGE**.

The progress of a pupil through a ZPD is dependent on the pupils' being assisted by an adult, such as the teacher or a capable other person who might be another pupil who previously has mastered the knowledge or skills under consideration in the lesson. As was shown in Fig. 1 above this assistance of a pupil has as a point of departure the *actual developmental level* of the pupils. At this development level (indicated by the asterisk in the figure) the pupils are competent in a variety of skills and have acquired a degree of knowledge which they are capable of using without assistance or with a minimal amount of assistance. It is this *actual developmental level* which constitutes the prior knowledge of the pupils and consists of knowledge *that certain things are true* as well as knowledge of *how to do certain things.*

The prior knowledge which the pupils have acquired is initially the result of everyday experience and is on the threshold of further development. It may, therefore, be described as being unsophisticated and naïve, or in the words of Panofsky, et al. (1991) it is "spontaneous" knowledge (p. 251). In this form, prior knowledge is at the root of a ZPD and is essential, as an *actual developmental level*, for progress through a ZPD.

As pupils build on their naïve knowledge in interaction with others during their progress through a ZPD they move towards a position of self-regulation of their learning. When they are able to regulate their own learning the knowledge

which they have acquired is no longer of the spontaneous form of everyday knowledge but it is in the form of "schooled" knowledge which has been developed through the assistance of others during the pupil's progress through a ZPD. The process of development from naïve knowledge to schooled knowledge enables the pupil to change from a position of understanding which is dependent on the direct experience of objects through the senses to one in which he or she is able to describe the objects of experience in a systematic and logical manner.

In the progress of the pupils through successive ZPDs their knowledge becomes increasingly differentiated into what has been identified by Derry (1990, p. 348) as *declarative knowledge* and *procedural knowledge*. The teacher's awareness of this differentiation within the body of knowledge which the pupils have acquired enables the construction of learning environments in which the pupils can build on their prior knowledge (Ausubel, 1968, p. 127f).

The importance of the prior knowledge of pupils is often emphasised as an important part of a lesson, the introductory step of which is designed to link the new content to be taught with what the children already know. Experience gained through the observation of lessons shows that although this approach gives structure to the lesson, student teachers in particular become rigidly bound to it as a method and are not easily able to move away from it. As teachers gain experience, however, they are better able to adapt to the contingencies of the situation in the classroom and are more able to use the prior knowledge of the pupils and assist pupils in their learning.

When teachers attempt to identify the prior knowledge of pupils in a lesson it is usually through verbal means that they do so. The pupils are required to show that they know something through the means of verbal statements in response to

questions directed towards them by the teacher. In this way the teacher is able to identify the *actual developmental level* of the pupils and is then able to assist the pupils in their ZPD (Panofsky, et al., 1991. p. 252). Teachers often do not know how to use questions to identify the development level of the pupils and sometimes the questions they use merely suggest a direction in which the lesson is going to proceed.

The importance of the use of prior knowledge in a lesson has been demonstrated by Willoughby, et al. (1993) In their research they show that the prior knowledge of a group of students (in their case university students) has an effect on the retention of facts over periods longer than one month from the time of the first test given to the students. They also found that a method of teaching which involved the repetitive use of "why" questions in contexts where material was taken from areas of knowledge with which the students were familiar also promoted the retention of the information. In other experiments done by Pressley, et al. (1992), also with university students, concerning the technique of *elaborative interrogation,* which involves the repeated use of "why" questions, similar results were obtained. Both Willoughby and Pressley point out that students often do not adequately deal with material to be learnt by relating the new content to previously learnt material. If, however, the students were encouraged to establish this connection by having to answer questions on the material, then their retention of the material was improved (p. 92). The asking questions in order to facilitate meaningful learning has the important affect of enabling both the retention and the understanding of the material.

The important conclusions which can be drawn from these studies and which are of significance for this study are:

1. The use of "why" questions is important for the retention of information as well as providing pupils with the opportunity to respond from a base of previous knowledge.
2. Information is most efficiently retained when the information to be retained is either familiar to the students or can be related to information, which is familiar to them.
3. The strategy by which the information is taught is pivotal to the successful retention of the material (Derry, 1990, p. 348).

When seen in the light of the ZPD of the students concerned (in the Pressley, et al. study, 1992), elaborative interrogation initiated a process of thought which may not otherwise have happened. As a result of this initiated process there was interaction between the students and the person asking the questions even if it was indirectly through the questions. Although not intentionally done, the situations created by the researchers provoked the students' ZPDs and the process of self-regulation which ensued enabled the deepening of their understanding of the concepts involved and their movement to a new level of actual development.

2.4.**THE ROLE OF MEDIATION IN THE ZPD**.

Vygotsky called the process through which assistance is given *mediation*. A capable other person enables the pupil, whether adult or child, to move through the gap between incompetency or partial competency, to competency. The mediator is the person who stands between the point of incompetence and that of competence with the pupils in order to assist them on their path to competence. The nature of the assistance given is at first dependent on the competence of the mediator to be able to discern the needs of the pupil and to know the goals

towards which the pupil is to be moved. Williams (1989, p. 115) points out the difference between the approach of Vygotsky and the purely cognitive approach to the role of the mediator in the assistance of a pupil. In the cognitive approach the adult *accesses* the skills that the pupil needs for operating at the required level in order to perform a task (he gives the example of doing a jigsaw puzzle) from his or her internal resources. These cognitive skills, which are thought to be innately present, must be identified before the pupil will be able to do the jigsaw puzzle. Vygotsky's view on the other hand, is that the pupil does not have the skills innately and that they are formed within the context of an interactive process through the mediation of an adult or competent other person. The adult may know what skills are needed in order to do the puzzle but cannot *draw them out of the pupil*. Instead, through interaction with the pupil, within the pupil's ZPD, the adult assists the pupil in the development of the skills within this ZPD.

Greenfield (1984), referring to Wood, Bruner, and Ross (1976) describes this mediatory process as being like the erection of a scaffolding which enables teachers to support their pupils in their development and which facilitates the extension of their knowledge and skills. This scaffolding is constructed on the foundation of the pupils' prior knowledge with knowledge of the potential of the pupils. Greenfield points out that this scaffolding is the minimum that is necessary for the required development to happen. The task itself is not necessarily simplified, but the pupils' role within the task, as the skills are developed, is adjusted according to current capacity to perform on the task (p. 118f).

She points out the difference between this approach and that of the behaviourist school of thought in which skills are reduced to smaller components, each of which is first learnt before the complete task is able to be performed. In the

Vygotskian approach the skills, which enable the pupil to perform at the required level, are available within the social context and they become part of the pupil's repertoire of skills through the mediation of the teacher (Vygotsky, 1978, p. 163). The mediatory role of the teacher is such that it does not compel the pupil to learn as a result of the scaffolding that has been erected. There is a sharing of goals and mutual assistance in the process. The skills which the pupils acquire are also not the sole possession of the teacher as the one who assists the pupil (Williams, 1989, p. 109).

2.5. **INTERSUBJECTIVITY IN THE ZPD**.

The need for assistance by a competent other person means that learning is an *intersubjective* process. The nature of this intersubjectivity is such that it could be described as two subjects interacting with each other or as Gallimore & Tharp (1991, p. 187) suggest, it is typified by "two grasped hands". Rogoff (1990, p. 143) understands intersubjectivity as, "mutual engagement in the exploration of possibilities" in which the people involved are partners.

When teaching is understood as "assisting performance through the ZPD" (Tharp & Gallimore, 1988, p. 31) then it is also an intersubjective endeavour. It is not important as to by whom this assistance is given, what is important is the nature of the assistance being given and the quality of the learning that takes place within the interaction.

The giving of assistance does not mean that it is only the one who receives the assistance that learns anything; the one who gives assistance also learns while the assistance is being given. Learning is a mutual process. This is important to note because teachers in classroom contexts often give the impression that they

do not have anything to learn because they have already mastered the content being dealt with in the interaction.

In her discussion of the intersubjectivity of the Piagetian and Vygotskian approaches, Rogoff (1990, p. 140) makes an important distinction between the two. While it is accepted that the nature of the intersubjectivity is such that the people share points of view, Piaget's understanding of this intersubjectivity is that those sharing points of view are working in parallel with each other and independently of each other. Vygotsky, on the other hand, sees intersubjectivity as having an influence on people's perspectives because the ideas are being shared. As Rogoff (Ibid.) points out, Piaget sees individuals as having to fit new information into their previous ways of seeing things. For Vygotsky the individual is seen as an apprentice, learning from an expert who has previously been along the path (p. 140f).

Paulo Freire (Shor & Freire, 1987) approaches the concept from a different perspective, describing the intersubjective nature of teaching as "dialogical" teaching. This is both artistic and political to the extent that it is concerned with the rescuing of people from domination and giving them freedom. In the process the status quo of society and the myths of the curriculum are questioned (p. 97).

Dialogue, Freire argues, is not just a way of doing something in the classroom so that the pupils feel that teachers are on their side. It is rather a method through which teachers penetrate into the nature of the pupils as people (Ibid., p.98f). Dialogue begins with the interaction between two people as human beings. In any dialogue where this is true people examine the nature of their reality and in the interaction make adjustments to their understanding of that reality as they become aware of what they know and what they do not know. Growth in

knowledge is, therefore, the result of social events.

In this way knowledge is no longer seen as the sole possession of the ones who teach. It is the mutual possession of both teachers and pupils. The teachers, whose responsibility it is to introduce a topic, do not then stand back and watch the pupils learn. They learn as well. The interaction in which they participate is a dynamic process in which both people learn, one for the first time the other for the second or third time (Ibid., p. 100). In this way the teachers are prevented from presenting pre-determined truths as if they could never change.

This does not mean that the teachers deny that they *know*. They demonstrate their competency by the way in which they teach. Secondly, it also does not mean that teachers change their knowledge in every dialogue in which they participate, or in every course which they run. It means that in the intersubjectivity of dialogue teachers are prepared to change when new insights emerge. Thirdly, it does not mean that teachers can do what they want to do in a seminar or lecture; each activity has a purpose that is to be achieved otherwise it loses its character as a learning context. Fourthly, it does not mean that everyone in a dialogical setting has to say something; some participants may listen sometimes and speak at other times. "One has the right to be silent!" (Ibid., p. 102)

Teachers are artists and are concerned with the transformation of any dialogical context into a learning opportunity. They are concerned with turning lines or colours into a picture; with reshaping a piece of clay into something of artistic value. In the classroom we have a script which is in need of transformation. This script is often the result of the authoritarian structure under which the teachers have to work. The teachers now have the responsibility to *re-present* the material in such a way that the pupil is not isolated from reality but helped to understand it

(Ibid., p. 115f).

An example of this authoritarian script from the context of mathematics is the fairly rigid manner in which tables have been taught in the past. The teacher has to give the material new life through the manner in which it is presented. Another example is the structure which teachers give to their lessons through an input/output model which is concerned more with the content of the lesson than it is with the processes involved in the lesson. The new approach to Mathematics is one in which the pupils are given the opportunity to construct for themselves ways in which to find answers to mathematical problems (Pirie & Kieren, 1992, p. 506). This enables teachers to change from a passive model of teaching to one which emphasises the intersubjective nature of teaching. Within this model teachers and pupils are able to be "artistic" in their teaching and learning.

The re-writing of classroom scripts, which previously cast the teacher in a role which was reminiscent of a Shakespearean soliloquy, is essential. It involves a change in the classroom environment from one in which pupils do not need to show interest in what is happening because they are like stage furniture and not actors in the production, to one in which they are able to construct their own mathematical knowledge (Ibid., p. 506).

Mathematics has for too long been perceived by many pupils as a dull and context-bound course of study. The teacher now has the responsibility of artistically shaping it so that it becomes a part of the life of the pupils. They can only do this when they creatively respond to the situations in which they find themselves and enable the pupils to participate in the lesson in a fully dialogical way.

The prior knowledge of the pupils who come into a context in which

meaningful learning is to happen provides a point from which to begin. Through the interactive processes in which they participate, what they know is re-constituted and their naïve understandings are enhanced. Through dialogue with others who know more and who are willing to assist them, the pupils advance through their ZPDs. The dialogical relationship which is established enables pupils to affirm their level of ability in the context of the lesson and in it they are stretched towards their potential ability (Rogoff, 1990, p. 149)

An aspect of intersubjectivity, discussed by Rogoff (1990), which can present a problem for teachers, occurs when the pupils are expected to work in an intersubjective manner but prefer to do so as individuals. Rogoff suggests that the reason for the difficulty is the problem of communicating some ideas within the groups. This emphasises the lack of appropriate prior knowledge which brings about the inability of the pupils to understand each other and even to understand the teacher (p. 144). As an easy solution to the problematic situation the pupils involved turn to their own work and ignore other persons in the process. Rogoff (Ibid., p. 147ff) points towards a further difference between Piaget and Vygotsky in relation to this issue. For Piaget the meeting of two people involves a form of authority. When the interaction is between an adult and a child this authority is invested primarily in the adult. Although it need not be the cause of learning, the teacher needs to be aware of the consequence of the authority structure and its influence on learning and attempt to diminish its effect. For Vygotsky, however, the role of authority is not as important an issue because the people involved are unequal because of their skills and their understanding rather than their power. He is concerned with one of the parties in the interaction being "more capable" rather than more powerful. If this is taken into account then the intersubjective

relationships in the classroom can be productive without being demeaning. Prior knowledge in this context is not seen as giving one of the people in the interaction an advantage.

2.6 **INTERNALISATION IN THE ZPD**.

The result of the process of mediation in the social (intersubjective) context is the *internalisation* of the shared understandings that occur in the interaction. As Vygotsky argues, the process of development is concerned with the acquisition of socially accepted meanings. First these meanings are in the society, represented by the competent adult or peers in the interaction, and then they are internalised by the pupil. The process through which mental structures are formed is one which is dependent on social interaction (Vygotsky, 1978, p. 163; Williams, 1989, p. 113) and not merely on internal developmental processes which are individual and natural as is suggested by the constructivist school of thought associated with Piaget.

At one extreme of the constructivist approach to the formation of mental structures is the belief that learning is an individual responsibility and that it depends on the individual's response to situations created by the teacher. In the environments created by teachers who follow a child centred approach, it is believed that the best form of learning happens as a result of the discovery of new truths by the child. The tasks in these situations are designed in accordance with principles related to Piaget's stage theory of development, i.e. tasks involve types of thinking which match the assumed stage of development.

Pirie and Kieren (1992, p. 505) suggest that although teachers see the constructivist approach of building cognitive structures as being a helpful way for pupils to discover new truths, the way in which it is often used shows that teachers

have a misconception of it as an approach to teaching. One of the techniques used, as a result of the misunderstanding of this approach, is that in which children manipulate objects and as a result of that activity develop the required mental structures. In the second technique, which is also the result of a misunderstanding of the constructivist approach, the children are expected to develop their mental structures as a result of working in discussion groups. Pirie and Kieren (1992) argue that these types of activity assume that there are *specific types of behaviour* which need to be performed in order that mental structures are developed. They further suggest that for learning to happen "constructive environments" need to be created by teachers "with the knowledge that the understanding that students draw from their experiences within the environment is determined by their own structures and histories, by their individual ways of perceiving and acting and organising" (Ibid., p. 506). What is internalised is determined by the teacher's intentions *and* by the actions of the learners and not just as a result of the types of activities in which the child is involved. Pirie and Kieren (1992) suggest that there are four tenets of belief about a constructivist approach to teaching, each of which emphasise the role of the pupil as an individual (p. 507f). These are:

1. Although the teacher may have the intention to move students towards particular mathematics learning goals, she will be well aware that such progress may not be achieved at all by some of the students and may not be achieved by others according to the expectations of the teacher.
2. In creating an environment or providing opportunities for children to modify their mathematical understanding, the teacher will act upon the belief that there are different pathways to similar mathematical

understanding.

3. The teacher will be aware that different people will hold different mathematical understandings.
4. The teacher will know that for any topic there are different levels of understanding, but that these are never achieved 'once for all'.

The difficulty of this description, from the Vygotskian point of view, is that the mental structures which are developed are dependent on the learner's individual activity and do not adequately accommodate a process of internalisation which is the result of the mutuality of society, represented by the teachers or competent peers, and the individual.

In the constructive activity of the individual, whether it is done independently or in collaboration with peers, mental structures are formed inductively (Bruner, 1960) and it is expected that because the structures are the result of a process of discovery they will be better understood and remembered. Ausubel (1968) on the other hand argues that not all learning that is the result of processes of discovery is meaningful (e.g. learning by trial and error) and not all learning that is received is rote learning. Ausubel further argues that for learning to be meaningful it should be based on the prior learning of children through the use of "advance organisers" (Ausubel, 1968, p. 136ff) which operate in three ways to enable the meaningfulness of learning:

1. They "draw on and mobilize" concepts which have already been established and to which new information can be anchored and so become potentially meaningful.
2. They make possible "optimal anchorage" to those concepts which are specifically relevant to the learning which is to take place so that

there is less opportunity of forgetting what has been learnt.

3. They make most rote learning unnecessary because the material being learnt more readily becomes familiar through their use. The pupils do not have to first develop the cognitive categories to which new information is to be related.

2.7 THE SETTINGS WITHIN WHICH TEACHING TAKES PLACE.

The assistance given by teachers to pupils in their ZPDs and the intersubjectivity that accompanies this assistance rendered by a teacher cannot happen in a random manner. Who assists the pupils; what kind of assistance is given; when this assistance is given; where it is given; and why it is given needs to be considered.

Teaching as assistance within a ZPD, cannot be understood as happening only within the context of a classroom in a school which has set periods fixed by a school timetable and within the context of a pre-determined curriculum. These may be important but they are not the only answers to the questions of where and when assistance should happen. A situation in a classroom, for instance, in which teachers create a divide between themselves and their pupils, as if there were an imaginary line on the classroom floor, will not be favourable to the kind of assistance which is envisaged in the Vygotskian model. The transmission style of teaching in which the teacher passes knowledge on to the pupils precludes the possibility of interactive learning which takes into account the ZPDs of the pupils.

When a person works within a model of teaching which is defined as *assisting in the zone of proximal development* the teaching and learning which happens is a purposeful and joint activity (Tharp & Gallimore, 1988, p. 71). Whether this teaching and learning happens in the home, in the community or at

work, the contexts in which collaborative interaction, intersubjectivity and assisted performance occur are not random (Tharp & Gallimore, 1988. p. 73). They occur as a consequence of a need. Secondly, the people involved in the interaction are not there by accident. They are there because of the nature of the social context in which they live (Tharp & Gallimore, 1988, p. 74). Thirdly, these contexts do not occur randomly with respect to time. They occur at times which are optimal for the development of the people involved (Tharp & Gallimore, 1988. p. 73, 76). The contexts which are being referred to are called *activity settings*. The depth of meaning which is attached to these activity settings is as a result of their association with the ZPD's through which people proceed in their learning and with the social context in which this learning takes place and in which assistance of performance happens (Vygotsky, 1978, p. 29). The "activity" of an activity setting includes both cognitive and motoric processes involved in the event and the "setting" aspect of the concept includes the external, environmental and objective features of the event.

When teaching is understood as happening within the context of an activity setting as described above then questions of who, what, when, where and why of these settings needs to be taken into account if an adequate description of an activity setting is to be given. Tharp & Gallimore (1988, p. 73) insist that to separate these aspects of an activity setting is to diminish the value of the concept. They must be seen in relation to each other as "interlocking dimensions".

It is necessary that in the planning of a lesson the teacher specifically designs interactive contexts in which pupils can be assisted in their learning. To do this teachers need to be competent in the design of activity settings which take into account the five aspects listed above.

Pirie and Kieren (1992) argue the point regarding "constructivist teachers" that they can use two false methods. These are frequently used by teachers and are supposed to characterise "constructivist teaching". In the first of these methods pupils are seen manipulating objects or ideas so that they can arrive at new ideas for themselves. The second is evident when pupils are divided into discussion groups with a group task to perform. The mere use of these methods does not mean that constructivist teaching, in the sense meant by Piagetian theorists, is happening. There is a danger represented in these methods of associating *specific ways of doing things* with constructivism. They further argue that:

> teachers can and do create environments, based on the belief that all knowledge has to be constructed by the individual, in which students' mathematical knowledge-building and understanding is fostered (Ibid. p. 506).

To do this, instead of following specific methods (p. 27f), teachers should create *constructive environments* in which constructive learning can take place.

The emphasis in this type of learning is on individual pupils and what they are able to learn in the constructive environments that are set up by the teacher. Simon (1994) supported by the findings of the French researcher, Brousseau, affirms the position taken by Pirie and Kieren, arguing that it is the role of the teacher to "take non-contextualised mathematical ideas and embed them in a context for student investigation" (p. 75). This allows pupils to solve problems which are examples of the ideas to be learned in a meaningful context. Brousseau's term for this type of situation is a *situation a-didactique* which describes a situation in which pupils develop solutions to problems within the context of the problem through the use of their prior knowledge and not as a result

of the instruction which they have received.

The centrality of pupils' activity, which is independent of the teacher's input and does not make provision for assistance by the teacher, is the result of a model of teaching which is diametrically opposed to the Neo-Vygotskian model as described by Gallimore & Tharp (1991). When teaching is understood as assistance in the ZPD it is marked by an intersubjectivity in which teaching and assistance do not flow in one direction (p. 189) and in which pupils are not expected to learn on their own as a result of their prior knowledge. The difference between the two models is further emphasised when Simon (1994), again following Brousseau, says that mathematical learning which happens in the context of specific problems must be "decontextualised and depersonalised" (p.76). Teaching which happens in *activity settings* and which is considerate of both the activity and the setting **cannot** be an activity in which the teacher plays the part of a commentator who is not involved in the process (p. 73).

Pupils who are involved in activity settings are not dependent on the *authority* of the teacher at every step of the process. The teacher should be a mutual participant in at least one of the activities with the children but not in such a way as to inhibit the potential of the activity as a learning experience. This does not mean that the teacher stands back and allows the pupils to be active without interference. The teacher may influence the direction of the process without inhibiting its forward movement by insisting on the attainment of certain specified goals *which are not integral to the activity setting*. At the same time, as previously noted, activity settings do not occur randomly and do not include pupils at random. That they have purpose (p. 83) is supported by Cobb, et al. (1992) in their research into the teaching of mathematics. They conclude that teachers should maintain the

sense of purpose in their teaching by providing a "running commentary" on the constructive activities of their pupils from their position as acculturated members of the wider community. This commentary should be done in a way which is comprehensible to the pupils and in accordance with their "current ways of mathematical knowing". To prevent the development of misunderstandings the teacher acts as a constraint but only within a "communicative context that involves the explicit negotiation of mathematical meanings" (p.102). The difference here is, as in other constructivist approaches, that while the teachers interact with and assist the pupils in their learning, they are not mutually involved in the learning process. The teachers who provide *commentaries* on the work of the pupils under their care do so without the mutuality of assistance but as observers.

Through the asking of the five questions (Who? What? When? Where? Why?) regarding the nature of activity settings teachers are able to give substance to their teaching in their classrooms (p. 79). As situations of "joint productive activity" (p. 80), activity settings facilitate the monitoring of the progress of pupils through their ZPDs. They are also useful at a higher level in the chain of authority. Heads of departments may assist teachers and principals may assist their Heads of department by means of activity settings. Without activity settings one level of management may be left out of the chain of assistance and have little effect on the performance of others (p. 81).

2.8 **THE MEANS OF ASSISTANCE IN THE ZPD**.

Within the Vygotskian model, internalisation may be enabled through a number of different *means of assistance*. Tharp & Gallimore (1988, p. 48ff) and Gallimore & Tharp (1991, p. 177ff) discuss six different ways in which people may be assisted. The importance of their chosen list of the means of assistance is that

they while they originate within the context of Vygotsky's theory they reflect a variety of different schools of psychology. Thus demonstrating the power of Vygotsky's theory. Although Vygotsky primarily was concerned with linguistic means of assistance other (non-linguistic) means of assistance are included. Furthermore, their list is not intended to be exhaustive and there may be other means of assistance that may be identified at a later stage. Tharp & Gallimore (1988, p. 34) also argue that the kinds of assistance that are given to the child may differ in quality but are not to be regarded as hierarchical.

The means of assistance when used in an appropriate manner enable pupils to proceed from an actual developmental level through the use of their prior knowledge towards a potential level of development by providing appropriate "scaffolding" for this development (Greenfield, p. 118). While the concept of scaffolding may contain the sense of being rigid as part of its image, since scaffolding is a support system, this is not the nature of the means of assistance which retain a sense of flexibility in their use.

The means of assistance are not to be used in any given sequence, despite their difference in quality. They are "tools" which can be used singly or in combination depending on the activity setting in which they are being employed to enable progress through pupils' ZPD's (Tharp & Gallimore, 1988, p. 34ff).

2.8.1. MODELLING.

The first means of assistance discussed by Tharp & Gallimore (1988) is that of *Modelling* which is concerned with the way in which children are influenced either by a demonstration of a way of behaving so that they are consciously aware of what is required of them or by being unconsciously influenced through the observation of the behaviour of others. Modelling may occur in the context of the

family, for instance when children follow their parents around while they are going about their daily chores. In a traditional rural society, boys will learn how to care for the animals whereas girls will learn to cook and clean the house. As they mature so the assistance of the adults through modelling will happen more consciously as the tasks are demonstrated to the children and they are required to duplicate what they have observed in an imitative way.

Bandura (1977) identifies a three-fold means of influence on the child of personal factors, environmental factors and behavioural factors in the social learning process. These three influences operate in a reciprocal way on each other to produce a composite influence on the child. Through a process of observational learning the child develops forms of behaviour which are the result of all three of these influences (p.40). It is not the environment alone which produces the form of behaviour, but the interaction between all three factors.

During the process of modelling, children form mental images of what is required of them in different situations and are later able to use those mental images to guide their behaviour (Tharp & Gallimore, 1988, p. 48, Bandura, 1977, p. 40). This is particularly useful in the development of skills which are needed for competent performance. Children learn, for instance, how to dress correctly through modelling their parents' getting dressed.

The use of modelling can be very sophisticated as in the modelling of the patterns of construction involving written material. This is an indirect form of modelling which involves the pupil in a critical process which may or may not have been assisted by any specific person. So a person may be able to duplicate the iambic pentameter of a poem without being told that it is iambic. In the teaching of mathematics the use of this form of assistance is evident when the teacher does

some examples on the chalkboard and then asks the pupils, using the examples as models, to do an exercise in their textbooks.

2.8.2. CONTINGENCY MANAGEMENT.

In *Contingency Management,* which is in some ways comparable to "reinforcement" of the behaviourist school of thought, the focus is on positive ways to create environments which are conducive to learning. This type of assistance cannot bring about *new* behaviour, but when it occurs, desired behaviour is reinforced in order to encourage the pupils to continue that behaviour. Undesired behaviour is ignored or (rarely) punished. Through contingency management the teacher either reinforces desirable behaviour or extinguishes those forms of behaviour which are undesirable. Positive methods may include praise or commendation of required behaviour patterns, or the giving of material rewards like stars, marks or other such concrete things. The methods which are used to extinguish undesirable forms of behaviour may be used in a positive manner so that they are corrective without being destructive of the pupils' self-esteem.

2.8.3. FEEDING-BACK.

Feeding-back is used with such frequency in the classroom that it no longer is considered as a specific means of assistance which needs to be developed (Gallimore & Tharp, 1991). Its importance is such that without it little progress is possible. In the stage of self-regulation, feeding-back can, on its own, be of significant help in almost all types of problematic behaviour (Tharp & Gallimore, p. 54). It must not, however, become normative for a teacher to use it.

In feeding-back the teacher is providing more than information about the performance of the children in a class. To provide adequate feeding-back a standard must be applied by the teacher. This standard should be one which is

understood and agreed upon by the teacher and the pupils. Too often feeding-back which is given to pupils is done in a way which does not explain why the pupils have not achieved the correct standard (Tharp & Gallimore, 1988, p. 55).

The next three means of assistance are those in terms of which the research for this dissertation was done. They are all regarded as being *linguistic* means of assistance.

2.8.4. INSTRUCTING.

Instructing, as a means of assistance, does not stand on its own, unlike some of the other forms of assistance (Gallimore & Tharp, 1991, p. 181). Instructions are linked to forms of assistance like contingency management and feed-back and are experienced in every sphere of life. Doctors will instruct patients to open their mouths. While driving a car, traffic signs symbolically instruct the driver to stop at an intersection or to keep to the left of the road.

In the classroom instructing is concerned with two contexts (Gallimore & Tharp, 1991, p.181). The first is that which is specifically concerned with how the pupils behave, and the second with directing pupils to perform certain tasks. The children may be required to: "Sit up straight" or "Stand in a straight line", or they are required to do certain tasks in the classroom. The teacher may require the pupils to "Go back to page ... and read the passage again" or to "Open your classwork books and first do ... then do ....".

The purpose of instructing children is to enable them to bridge the gap between their present behaviour and their potential behaviour within their individual ZPDs. When pupils are being assisted in their ZPD it is not to be expected that they will be given an instruction and then allowed to proceed on their own in the execution of the instruction, although it is evident that this appears to be the

expectation of many teachers. For the assistance of the pupils to be effective, the teacher needs to practise instruction in conjunction with other means of assistance (Tharp & Gallimore, 1988, p. 56). When instructing is done in conjunction with feedback, for example, the pupils will then be able to know immediately whether they are achieving the goal of the exercise and progressing through their ZPD.

When appropriate assistance is given, the instructing voice of the teacher will become the self-instructing voice of the learner as internalisation happens. Tharp & Gallimore (1991, p. 181) point out, however, the danger that the teacher may rely excessively on instruction and as a result it will become a hindrance to the childrens' progress through the ZPD because they are not allowed soon enough to move into the stage of self-instruction. In this situation instruction may become offensive to them rather than assist them.

2.8.5. QUESTIONING.

Questioning is ubiquitously used in the classroom, although the type of questions used are most often those which merely test the recall of facts by the pupils. It is important to distinguish between those questions which are merely asked for effect and those which are asked as a means of assisting pupils through their ZPD's. Tharp & Gallimore (1988, p. 58) point out that questions are too often "embedded in the recitation script" in that they ask pupils to repeat previously learnt cognitive structures and do not require discussion or another creative form of response.

They continue (following the work done by Ervin-Tripp, 1976, 1977) by comparing and contrasting questioning and instructing. First they consider the suggestion that questions may have the same effect as instructions. In a mathematical context a teacher may ask, "Will you multiply?" The teacher,

depending on the way in which the question is asked, is giving an instruction to the pupils to multiply some numbers together. The pupils could, in response to the question, answer, "Yes", and not do so. The form of the question is inappropriate and does not bring about the kind of assistance that is expected of questioning.

Another form of question, which may take a form similar to that of an instruction, is the following, "What kinds of operations are needed to answer the following problem?" The pupils are expected to answer by recalling the relevant facts which pertain to the question. The question, if not followed up by other questions, does not assist the children beyond their ability to recall information. Questions which merely ask for recall of factual information are not much more than instructions.

The second point regarding the difference between questions and instructions is that: "questions work on a level that lies below the surface" and that "questions call up the use of language and in this way assist thinking" (Tharp & Gallimore, 1988, p. 58f). They do not just test a person's ability to understand the words being used or the way in which the question is asked; they challenge the person's belief structures and demand a reasoned linguistic reply.

This does not mean that it is only questions that encourage thinking. As Tharp & Gallimore (Ibid.) continue, the processes that are characteristic of thinking are not immediately accessible to the teacher; they are invisible and silent and are present in the formulation of a response to instructions as well as to questions. In questioning, however, these subprocesses can be verbalised as the pupils explain what they are doing while formulating an answer to the question. While facilitating this explanation the teacher is practising an aspect of assistance in the ZPD through questioning. In the teaching of mathematics this is essential if the pupils

are to develop a correct understanding of mathematical problem solving.

In the response to instructions, however, the teacher would not usually be able to observe or know in any tangible way what is going on in the thinking of the pupils as they act in response to the instruction.

Two forms of questioning can now be identified. The first contains the group of questions which are used to assess the ability of the pupils to perform without the assistance of the teacher. This group of questions contains something of the nature of instructions because usually no opportunity is given for pupils to interact with the teacher in the formulation of the answer. The pupils' thinking remains hidden from the teacher and the teacher merely requires a considered answer.

In the teaching of mathematics it was previously required of the pupils that they explain in some form or another how they arrived at the answer. The present tendency is to look only for the answer. The method used by the pupils to arrive at the answer can be different from pupil to pupil.

Assessment questions are not, as a result, unhelpful because they do not reveal thought processes. Their value for assisting pupils in the ZPDs is that they may indicate where weakness in instruction has taken place. They may also assist the teacher in determining the actual developmental level of the pupils and the prior knowledge which they have as a starting point for the next level of development (Tharp & Gallimore, 1988, p. 60). In the light of the definition of teaching as assistance in the ZPD, however, they may not be described as teaching *per sé* but as preparation for teaching (Ibid. p. 60).

The second form of question is that which assists the pupils. These are identified by their ability to lead pupils through their ZPDs when the pupils "cannot or will not" formulate answers on their own (Ibid., p. 60). These "assisting

questions" motivate the pupil to carry out the mental operations that are required for the construction of an answer to the question which was interpolated by the teacher in the process of assisting the pupils. The teacher may, for example, require the pupils to link certain pieces of information which the pupils already have as part of the progression towards an answer (Ibid p. 61).

Although not working within a Vygotskian paradigm, Pressley, et al. (1992) and Wood, et al. (1994), in their discussion of *elaborative interrogation,* suggest that the use of "why" questions as a means of assisting children helps them to build knowledge structures which enable them better to remember information as a result of building on their prior knowledge. In the technique of elaborative interrogation, however, there is sufficient indication that it is a technique through which pupils are assisted in their learning. Whether it is used, in Vygotskian terms, in what may be called a ZPD or not, elaborative interrogation makes use of actual developmental levels, with understanding as an expected consequence. The use of "why" questions which assist pupils within their ZPDs do so because they provoke mental operations that are associated with the development of meaning. The purpose of the "why" questions in elaborative interrogation is to encourage the subjects to make meaningful inferences and elaborations and produce understanding in reaction to the questions which, for the purpose of the experiment, contained arbitrary content (Pressley, et al. 1988, p. 268).

To make these elaborations and draw the appropriate inferences the subjects had to access prior knowledge which was relevant to the content of the questions. As a result of their elaboration they were later able more effectively to recall the information. Two things in the study of Pressley, et al. (1988) are important in relation to the use of questions to assist pupils in the ZPD; the nature

and use of the techniques of elaboration which stimulate mental processes and the importance of prior knowledge in the process of the elaboration.

2.8.6. COGNITIVE STRUCTURING.

Of the three means of assistance examined in detail in this chapter, Cognitive Structuring is different in its effect from the other two. Instruction calls for a specific type of action specified in the instruction. Questioning calls for a verbal response which is created by the pupils. Cognitive structuring does not call for specific action or a response. There is no single sequence in which the means of assistance should be used, no one means of assistance is superior to another and no one means of assistance is to be preferred over the others. Cognitive Structuring is, however, a potentially powerful tool for the influencing of behaviour and perception, unlike the other two forms of assistance (Ibid., p. 66).

Cognitive structuring gives structure to both thought and action. As a means of assistance in the ZPD it is the most difficult to understand (Tharp & Gallimore, 1988, p. 63). The form that a cognitive structure may take differs depending on the context. For example, in a scientific context it takes the form of a theory; in games it takes the form of rules (Ibid. p. 63).

Through the use of cognitive structuring the teacher is able to assist the pupils by providing them with structures that will enable them to organise their understanding of what is being taught in a lesson and subsequently to justify a position which they might take regarding their beliefs. The teacher may do this through the way in which a lesson is taught. When the material is presented in a structured form it will not easily be forgotten and will be better understood, even if the structure is only intuitively accepted by the pupil (Ibid. p. 63). Cognitive structures are not always specific in their application. In mathematics, for example,

the four basic operations are not confined to arithmetic, they are equally applicable to algebra, geometry and trigonometry.

The universal nature of some cognitive structures, such as addition, is not gained through one context alone. It is possible to gain it through an environment which does not deal initially with abstract mathematical concepts. When cooking a speciality which has to have a variety of ingredients, the expert may not know exactly how much of any one ingredient is needed. It is done by taste. Yet the operation of addition is being used.

Cognitive structures may vary according to the culture within which they are developed and depending on the need for the Cognitive Structure in the functioning of the community. They may also be conscious in the sense that they can be verbalised or they may be unconsciously present in the structure of the knowledge or skills of a person. They may be automatic in the sense that attention does not have to be given to what is thought, said or done (Tharp & Gallimore, 1988, p.64). Some cultural groups might be concerned to make the cognitive structure of their beliefs known whereas others prefer to allow them to be automatically present in action. This point is simply illustrated in the difference of approach to teaching between communities. Those which follow a discursive approach encourage the conscious presence of Cognitive Structure whereas those which follow a "recitation script" are not concerned with the conscious structuring of knowledge. In Freire's discussion with Shor (Freire & Shor, 1987 p. 101f) they highlight the effect of authority in the classroom. In a non-democratic classroom the teacher says what the truth is and it is accepted in the form in which it is given. In a democratic classroom, in which the freedom of the individual is important, knowledge does not have a rigid structure; it is discovered through dialogue .

In a mathematical context the same issue is dealt with by Pirie & Kieren (1992) in their discussion of the creation of a constructivist environment in teaching:

> In doing so we are consciously using "environment" not in terms of the teacher creating a given external reality which will enable children to learn specific mathematics, but with the knowledge that the understanding that students draw from their experiences within the environment is determined by their own structures and histories, by their individual ways of perceiving and acting and organising. We intend the phrase "creating a constructivist environment" to point to the fact that it is the teacher's intentions, not any specific activities which are done or not done, which determine the constructivist nature of the teaching. The environment in that sense is the result of deliberate, active behaviors (sic) by the teacher in the full knowledge that constructivism pertains to the actions of the learners (p.506).

The importance of this position, from the constructivist point of view, is that the structure given to mathematical knowledge is not determined by the teacher alone, whether the structure is conscious or not. The teacher assists the pupils, through the environments which are created in the classroom, to develop Cognitive Structures which are meaningful for mathematics.

Tharp & Gallimore (1988) make a distinction between two types of cognitive structuring, both of which may be encouraged in the classroom. Type I is concerned with "structures of explanation" and Type II with "structures for cognitive activity". In Type I Cognitive Structures the teacher may explain how to solve a quadratic equation to a standard eight class. In this kind of assistance, pupils may,

for instance, learn how to sequence the steps involved in the solution of a mathematical problem. In Type II Cognitive Structures pupils may be helped through the giving of structures for memorising the content of a lesson. A mnemonic or a mind-map could be of assistance to them. They may also be given some rules to follow when accumulating information from a piece of written work such as a text book or article in a journal (p. 65). The nature of the type of assistance suggested by this form of cognitive structuring is such that it is concerned with strategies for processing information and could be called "metacognitive" structuring.

Research into cognitive structuring as a means of assistance looks promising, especially in comparing the research of Piaget and Vygotsky as two of the major influences on the understanding of the cognitive processes involved in teaching and learning. In a review of research by Geoffrey Saxe on Brazilian street children, published under the title: *Culture and cognitive development: studies in mathematical understanding*, Bidell (1992) draws together the constructivist model of Piaget and the socio-cultural approach of Vygotsky. He describes the constructivism of Piaget as "interpretative constructions and reconstructions based on reflective and transformative participation in the world" (p. 307) and Vygotsky's view of development as a "story of changing 'interfunctional relations' among the many personal and sociocultural processes participating together in psychological development" (p.308).

2.9 **CONCLUSION**.

The argument which has been pursued throughout this chapter is that there is a need to review the process of teaching as it is practised by the majority of teachers at present within the context of South Africa. There is also a need to

review initial teacher training (and in-service training). For too long the majority of student teachers, particularly in the traditionally "black" colleges, through the study of Teaching Science and subject didactics, have been given skills and trained in their use as if they were like garden tools which, if used in the correct way will produce success in the presentation of their lessons.

There *is* a need for student teachers to develop relevant skills but not in the way in which they are taught at present. They need to be taught in a manner which enables student teachers subsequently to assist their pupils in the identification of ZPDs and development within these ZPDs. Tharp & Gallimore's means of assistance, if used in a way that develops the students in *their* ZPDs, i.e. by building on their prior knowledge, have the power to make a substantial difference to the teaching and learning that takes place in South African classrooms.

Part of the reason for the failure of the present approach to produce meaningful learning in students and pupils is that there has been a separation in the college curriculum of what happens in teaching from what happens in learning. Methods of teaching, which are taught in Teaching Science and in didactics subjects, if used in a mechanistic way, can only bring about rote learning. Therefore, there is a need to produce a curriculum which integrates an understanding of teaching *and* learning. In the theory of teaching as assisted performance (Tharp & Gallimore, 1988) this integration is brought about. If student teachers themselves are assisted in their ZPDs in such a way that they become able to regulate their own learning, they will develop an understanding of the unity of teaching and learning. This can be achieved through a process which builds on the students' prior knowledge of what happens in the classroom.

In the process of their development student teachers will, from the method

modelled by college tutors, acquire insight into the use of the means of assisting pupils so that they do not simply become a new set of skills which can be used in a mechanical way but bring about effective learning. This insight into the importance of assisting pupils in their ZPDs will also assist student teachers in their understanding of their subject content.

It is possible that a "chain" effect might be achieved if the people involved in teacher training can influence the students being trained to make use of the means of assistance in their classrooms for the benefit of the pupils. The question which needs to be answered is "Who trains the people involved in teacher training?"

CHAPTER 3 - METHODOLOGICAL CONSIDERATIONS

3.1 INTRODUCTION.

The focus of this chapter is on the methodological issues which are related to the study of teacher behaviour in the classroom. Some of the different ways in which information can be gathered from the classroom are discussed. The method which was adopted for this research is examined in greater detail. A description of

the compilation and testing of an observation schedule is given together with an account of the problems encountered in the use of this observation schedule and the reasons for its being discarded.

3.2 THE PURPOSE OF CLASSROOM RESEARCH.

Montgomery & Hadfield (1989, p. 7f) argue that there are three main purposes for which observation may be done in the classroom. These are:

a) *To appraise the performance of teachers*. The formal appraisal of teachers is becoming increasingly important because of calls for accountability to their employers, to the teaching profession and, in particular, to colleagues and to pupils and their parents. This kind of appraisal means that the person carrying out the appraisal must be present as a non-participant observer in the classroom with the specific purpose of making a factual record of what happens during the lessons that the teacher delivers. It entails that value judgements be made about the behaviour of the teacher and that the observer is competent to make this assessment (Ibid., p. 80ff).

b) *The improvement of teacher competency*. Elliott (1991), in a discussion of the fundamental characteristics of action research, says that its purpose is to improve the practice of teachers in the classroom rather than to produce knowledge. The concern for the production of knowledge is secondary to this fundamental aim (p. 49).

c) *Understanding what happens in the classroom*. This form of observation is different to the appraisal of teachers in order to assess their accountability. Its focus is on the teaching and learning that happens in the classroom. It is concerned with the processes that occur during the lesson.

3.3 APPROACHES TO CLASSROOM RESEARCH.

Delamont & Hamilton (1976) suggest that there are two main approaches to the gathering of information in classrooms. The first may be called the "psychometric" approach, the second is what they call the "anthropological" approach.

The psychometric approach is closely associated with what Biddle & Anderson (1986) label as the "confirmatory perspective" in educational research. Within this perspective information is gathered with the intention of testing theories and with the generalization of conclusions drawn from a statistical analysis of data. It also lays stress on the design of the research so that reliable measurements can be made. The events and processes which occur within the classroom are not of immediate concern to the researcher because they are not easily examined through psychometric analysis. The focus is rather on the difference between the initial state of the pupil, before what happens in the classroom, and the final state after what has taken place in the classroom. Research of this kind, which is not directly related to the processes that take place in the classroom, is mainly concerned with "antecedents and consequents" of classroom events (Delamont & Hamilton, 1976, p. 5).

The second approach, the "anthropological" approach, is similar to the perspective which Biddle & Anderson (1986) describe as the "discovery perspective". Within this perspective, which is antipathetic to the confirmatory perspective, explanations are socially constructed and each event examined is unique. Researchers working from within this perspective are influenced in their judgements by their values and the conclusions which they draw from their observations are made complex because of the difference between the values of the people involved. Delamont & Hamilton (ibid., p.5) show a similar line of thought

when they argue that when educational processes are analyzed then there must be an appreciation and an understanding of what happens in the classroom from the point of view of the participants and *their* understanding of these processes.

The third perspective, the "integrative perspective", draws from the two previous perspectives. Biddle & Anderson (1986) describe this merging of the perspectives as one which formalises the way in which people think and act in normal life. It takes the rigour of the confirmatory perspective and the interpretative role of the discovery perspective and draws from each perspective. In the integrative approach people look at what is going on around them, develop ideas to represent these events, ponder ideas and develop notions about the events, decide on courses of action in response to these notions and then act. In could be regarded as a simple description of the approach known as "action research" which will be discussed below.

In a discussion of the work of the Institute for Research in Teaching in the United States, Porter (1990) asks for the development of a closer relationship between practice and research through the *collaboration of the researcher with the teacher in the classroom*. Through this collaboration, which shows similarities to the integrative approach, he suggests that a number of difficult issues can be considered. Issues such as:

- the differences in the goals which teachers have in the classroom.
- the responsibilities which teachers are prepared to accept for themselves in their classrooms.
- what achievements teachers believe are possible for pupils.
- how teachers interpret policy and practice in the classroom.
- the attention which teachers give to cultural and individual

differences between pupils.

- the knowledge which teachers have of their subjects and the way in which they should be taught.
- an understanding of the dilemmas of teachers and the complexity of teaching.

The merging of the confirmatory and the discovery perspectives provides a way forward in which the researcher can become fully aware of the kinds of issues outlined above and be able to take them into account in an approach to research which collaborates with teachers in their classrooms. The value of this integrated approach is that it allows for both the application of theory to the situation in which the research is being done and the discovery of meanings which are being developed by the teacher during the process of teaching.

Within the above three perspectives it is possible to make a further distinction in approaches to research. David Hopkins (1985) suggests that observation may be either unstructured or structured in its approach. Unstructured observation is *ad hoc* and dependent on the situation in which it occurs. In this approach, for example, teachers may observe other teachers during their routine lessons and co-operate with each other to improve the quality of their teaching. It is made possible because teachers will often more readily receive criticism from their peers rather than from an outsider. In this form of evaluation the observers are able to participate in the lesson and ask questions of the pupils without too much disruption of the lesson. It makes the analysis of the lesson easier, increases the objectivity of the data gathered and enables the teacher to become aware of things which happened and which might have been missed by the teacher.

In more structured approaches the teacher and the observer may co-

operate differently. Hopkins (Ibid., p. 88) outlines an approach which he calls *Clinical Supervision*. This form of observation has three phases to it:

- a *planning conference* in which the teacher and the researcher reflect together on the lesson and decide on the data to be collected.
- the *classroom observation* itself in which the data gathered is done in as objective a way as possible.
- the *feedback conference* in which the teacher and the researcher discuss the outcome of the observation, decide on possible remedial action and plan the lesson to follow.

The principles involved are important because it is on them that the success of the research depends. Hopkins (Ibid.) mentions the following principles:

- a non-threatening and helpful climate in which mutual trust exists.
- the focus is on the reinforcement of successful patterns of instruction and not on criticism or the changing of the teacher's personality.
- a dependence on objective data.
- the usefulness of the data gathered for the construction of hypotheses out of the inferences made.
- each cycle is part of an ongoing process and is not seen in isolation.
- through the mutual interaction of the teacher and the researcher there is an improvement in teaching and in observation skills.

Another structured approach to research in the classroom which is becoming more widely used and accepted as a tool which enables both the understanding of classroom behaviour and the improvement of ways of teaching, is that of action research. Kemmis (1988, p. 42) argues that action research "is a form of research carried out by practitioners into their own practices." He describes

action research as a form of enquiry, which is self-reflective and leads to an improvement in the rationality and the justice of educational practices.

The method of action research consists of four main steps which happen in a cyclic pattern. Starting with a planning step it continues through the other steps of acting, observing and reflecting. The next phase begins, after the necessary changes have been made, with further planning, acting, observing and reflecting. When used effectively, action research is a continuous activity, which leads to better performance on the part of the teacher. Unlike clinical observation, the teacher can do action research. If used as a method within teaching action research will improve with use.

An aspect of action research, which extends its value, is that it moves away from approaches, which are closely associated with the authority structures within a system of education. As Kemmis (1988) points out regarding the empirical-analytic approach:

> It views schooling as a delivery system whose effectiveness and efficiency can be improved by improvements in the technology of the system. Its form of reasoning is technical, instrumental (means-ends) reasoning. Its interest is in the technical control of education systems, and this technical rationality readily expresses itself in an interest in hierarchical bureaucratic control of the social relations between systems personnel and between teachers and students (p. 48).

Kemmis (1988, p. 48) continues by arguing that education as "lived experience" follows a pattern of practical reasoning through which the consciousness of teachers can be changed and this will bring about a change in what they do in the classroom. It assumes a relationship of mutual trust between

researchers and teachers which "leaves practitioners free to decide how to change their practices in the light of their own informed practical deliberation". In this way the gap between theory and practice can be diminished and even removed as it places the responsibility on those who are involved in the act of teaching.

In structured approaches there are two different methods for the gathering of information. The first is through the use of *observation schedules which have been previously created* and which may be used in different situations, the second through *observation schedules which are created by the observer for the purpose of the study being done*.

Previously constructed schedules for observation of classroom interaction have an important part to play in the assessment of what happens in the classroom. The advantages of this type of observation schedule are that they are relatively easy to learn how to use and a large amount of data can be readily gathered. They are also useful because the correspondence between two observers using the same schedule is usually high, especially if training is given in the use of the observation schedule.

The disadvantages associated with the use of previously constructed observation schedules are important. A schedule of this nature can miss some information which is of vital importance for the *interpretation* of what was happening during the lesson. For instance, in the recording of information given by pupils, the schedule does not allow for the distinction between answers which are correctly given and those which are incorrectly given.

An example of a previously designed schedule which may be used is that of Flanders (1970). In his scheme there are ten categories which briefly may be outlined as follows:

FLANDERS' INTERACTION ANALYSIS CATEGORIES	
Teacher talk	1. Accepts feelings
	2. Praise
	3. Accepts ideas
	4. Question
	5. Lecture
	6. Command
	7. Criticism
Pupil talk	8. Solicited
	9. Unsolicited
	10. Silence

(Source: Hopkins, 1985. p. 100)

The observer is required to write down on a data sheet every three seconds what verbal behaviour is happening in the classroom. When there are different episodes during the lesson these can be recorded separately from other episodes so as to distinguish them.

Delamont & Hamilton (1976, p. 9f) point out that, while these types of schedule may have the advantages of being simple, well tried, easy to learn, reliable and applicable to a wide range of situations, they tend to be normative. They also make a rigid distinction between the observer and the person being observed, ignore the response of the observed person to the observer, do not allow for comment on the cognitive aspects of the lesson because they are subjective. Finally, they can ignore the local aspects of the situation and are based

on assumptions which may be outdated.

Bloom's taxonomy of educational objectives (Bloom, 1956), is an example of the kind of work which is used to support a previously constructed schedule like that of Flanders. It makes a simple distinction between the kinds of objective in the cognitive domain which a teacher may be expected to achieve in a lesson. The kind of distinction made between the different kinds of objective as suggested by Bloom is no longer accepted without question by researchers because of the areas of activity which are not dealt with in the taxonomy but are important aspects of classroom life.

Delamont and Hamilton (1976, p. 6f) further argue that these types of schedule, which are used to give structure to the observation of classrooms, do not take into account the spacial and temporal factors of the classroom and are mainly concerned with observable behaviour. Nothing is said about the actual intentions of the teachers, the silent language of the pupils or the "hidden curriculum" of the school. To be concerned with what can fit into the categories of the schedule, without taking into account the undefined aspects of the classroom, distorts the qualitative aspects of the events and does not render a full picture of what is happening. Furthermore, when the description of the classroom is made in terms of the categories contained in the schedule, the result could end up in tautology; assuming the truth which is about to be explained. Finally, the schedule creates artificial boundaries because all observation is done in terms of fixed categories which are difficult to transcend and in the words of Delamont and Hamilton, "freeze reality" (Ibid., p. 9).

The kind of structured approach discussed above and exemplified by Flanders' Interaction Analysis and Bloom's Taxonomy is an attempt to give the

researcher the tools to enter the classroom and to record the events which occur in it. It does not, however, go far enough towards the goals of the anthropological approach which is not concerned with specific behaviours or with the narrowly focussed cognitive categories as suggested by Bloom (1956). The goal of the anthropological approach is to examine the classroom in the light of socio-cultural categories which are not previously constructed. In this approach the observer decides on what should be contained in the observation schedule as a result of experience in the classroom and constructs it for the circumstances in which the research is to take place.

This approach allows the observer the freedom to interact with the pupils and the teacher, to become immersed in the culture of the classroom (Delamont & Hamilton, 1976) and to change the categories when it is necessary to do so. As a result of this approach the future of classroom research will be different. Out of interaction in the classroom will develop a new way of describing what happens in the classroom. They argue for the development of a "mesa-language" which will enable "anthropological" explanations but not be rigid in its application. The argument of Biddle and Anderson (1986) is one which attempts to unite the two approaches in a meaningful way and provide a way forward.

3.4 **THE PURPOSE OF CLASSROOM OBSERVATION IN THIS STUDY** .

The alternative approaches to classroom observation discussed above gave the researcher a number of possible routes to follow in the process of assessing the way in which teachers use the prior knowledge of pupils in the lessons they teach. The decision to use classroom observation without participation, using an observation schedule which was designed for the situation,

seemed the wisest route to follow because it gave the opportunity for the development of a trusting relationship with the teachers involved and the adaption of the schedule to the situation as it developed.

The psychometric approach within the confirmatory perspective, with its concern for "inputs" and "outputs", had little relevance to the context because it did not give room for an understanding of the meanings that were created by the teacher and the pupils during the lessons. In assessing the teachers' use of the prior knowledge of children the emphasis was not, for instance, on how much instruction was being given or on how many questions were being asked. What *was* of concern was the *quality of the instruction*; the *way in which questions were used both by the teacher and the pupils*; the *cognitive structures which the pupils were being encouraged to develop*; and the *kind of assistance which was given* to the pupils by the teacher.

Delamont & Hamilton (Ibid., p. 14) pointed out the following cautionary issues which need to be noted when using a more unstructured approach in which the researcher had the opportunity to change the formulation of the categories being used in the observation schedule .

First, the classroom may become the sole determining factor in the construction of the categories. It was important at all times to keep in mind that each classroom was a part of the wider context of the school and even of society itself.

Secondly, while this approach may lend itself to the use of audio-visual media such as tape-recorders and video- recorders, it was important to explain what was happening in the classroom and not just to describe it. The amount of data which could be gathered through these means was such that they could

overwhelm the researcher and inhibit the kind of useful explanation needed.

Thirdly, because much research has focused on description rather than on explanation, the intentions of the person being observed are not taken into account. It was important to treat teachers as people who were trying to produce meaning in their classrooms and not as objects of study.

The fourth warning is that the researcher may become determined by a particular intellectual tradition and not be able to move outside of it in the research and make allowances for the teachers who have a different way of understanding what happens in the classroom. The researcher needed to be free to stand back and critically examine the positions from which the teachers being observed came.

Fifthly, researchers must be aware that in this approach there is no absolute truth in any explanation of what is happening in a classroom. There are different paradigms from within which teachers approach their work and what is observed must be interpreted and understood with those paradigms in mind.

3.5 **CONCLUSION**.

In the consideration above of the different perspectives on classroom research it was pointed out that there are two main options between which researchers can choose. On the one hand is the "psychometric" perspective which allows the researchers to maintain their objectivity and on the other hand is the "anthropological" perspective which allows researchers to become fully involved in the classroom. Within these perspectives a further distinction was made, that of structured and unstructured approaches to research in the classroom. It was also pointed out that there is a growing opinion amongst researchers that there should be a closer link between theory and practice. To facilitate this link it is important for the researcher and the teachers to co-operate more closely in the research being

done. One of the techniques which is being used to bring about closer co-operation between researcher and teacher is that of Action Research.

The choice of perspective and approach for this research was "anthropological" and "structured" but the observation schedule was designed for the context in which the research was done. The research design, including a discussion of the purpose-made observation schedule will be discussed in the following chapter.

CHAPTER 4 - THE RESEARCH DESIGN

4.1 INTRODUCTION.

The Theoretical Considerations in Chapter 2 and the Methodological Considerations of Chapter 3 provided the base on which to build the research design to be discussed in this chapter. During the preparation for the research, the

question which emerged as the central focus of the research (*Do teachers effectively use the prior knowledge of pupils in the lessons which they teach?*), provided the stimulus for the various categories included in the observation schedule.

The approach which was adopted for the research made it possible for changes to be made in the categories contained in the initial observation schedule. As it turned out, it was necessary to make some radical changes in the approach to the research during the initial stages of the research. The cautionary note, expressed by Delamont and Hamilton (1976, p. 14), which was noted at the end of the previous chapter, was of use when considering the changes that were made to the manner in which the information was gathered during the research.

4.2 **THE RESEARCH DESIGN**.

The three means of assistance on which this research hinged, *instruction, questioning and cognitive structuring*, all involved verbal responses by pupils and required that the researcher be present in the lessons in order to observe the interaction between the teacher and the pupils. In this way the best possible understanding of the interaction and the context within which it took place could be obtained and recorded.

Participant observation as a way of approaching a research project has a number of issues which need to be taken into account, the first being the level of participation by the researcher. Dane (1990) in his discussion of a continuum of involvement which progresses from total non-involvement to full involvement argues that if there is to be systematic observation then it is necessary for the researcher to be an observer *per sé* and not to become further involved in the process (p.158). Whether the pupils, as participants in the events, were aware or

not of the purpose behind the presence of the researcher was another dimension related to the level of participation by the researcher.

The second issue that needed to be controlled was the level of influence which the observer would have on the participants in the lesson. The mere presence in a classroom of a person other than the teachers, who are in the employ of the school and known by the pupils, would have an influence on the behaviour of the pupils. Inspectors, for example, are often seen as outsiders and as a result produce reactions from the pupils which are not characteristic of them. In this study this kind of reaction would not necessarily have been a hindrance to the process of observation because it was the way in which the teacher dealt with the prior knowledge of the pupils during the lessons that was of importance. Whether or not the teacher was dealing with a co-operative group was not an issue that needed to be taken into account because it would not have prevented the interaction between the teacher and the pupils although it might have changed the content of the interaction.

A further issue was an ethical one. The observer would be taking part in some lessons which could have produced some results which might, if taken out of context, have been damaging to the teacher both as a person and as a teacher. It would be essential to maintain the anonymity of the teachers both in the reporting and in the discussion of their lessons. No reference of any kind, therefore, would be made to the identities of the teachers involved in the research. In the end only the teachers would recognise themselves in the words of the dissertation. The researcher would also need to maintain his integrity as well as the integrity of the teachers in all discussions which might take place.

4.2.1 THE RESEARCH QUESTION.

For the last seven years the researcher has been responsible for the observation of student teachers as they participate in teaching practice which is an aspect of their training at the teachers' college where the researcher is employed. The question on which the research was based was gradually formulated during the years of observation of the lessons taught by the student teachers. Although the question arose in the context of student teaching practice, it was important also to consider it within the wider context of teaching. The question, therefore, became: *Do teachers effectively use the prior knowledge of pupils in the lessons which they teach?*

It was because of the wider context of teaching and because of the way in which teaching practice operates at the college, that it was decided to observe qualified teachers. Student teachers reading for the Senior Teachers' Diploma or the Senior Primary Teachers' Diploma are required in their teaching practice sessions to teach a lesson in each of their two specialist subjects. This means that they do not continually teach one subject but alternate between their two major subjects. Sometimes they are also required to teach their ancillary subject. This meant that observation of student teachers was not practicable because of the lack of continuity in the lessons. In the Junior Primary Teachers' Diploma student teachers are required to teach all of their subjects.

The concern which is expressed in the research question is associated with one of the requirements for the writing of lesson plans in accordance with the "objectives" model of teaching in which every lesson is expected to have a clearly stated starting point and an objective to be reached during the lesson. In the introduction to the lesson student teachers are expected to link the new content to be taught to the prior knowledge of the pupils in the class. This does not mean that

teachers should be expected only to use the prior knowledge of children at the beginning of the lesson; it should pervade the whole lesson. It was this pervasive use of the prior knowledge of the children that was being researched, not just its use in the introduction as is done by many student teachers.

Closely related to this question are some other questions regarding the use of prior knowledge such as: *Do teachers know how to ascertain what relevant prior knowledge the pupils may have? Do students fully understand the need to link the new content to be taught to the knowledge which the pupils already have?* and *In a context in which a "teacher-tell" or a transmission approach to teaching is followed, is the importance of prior knowledge fully grasped?*

When these questions were viewed from the context of the three selected *means of assistance* and their relationship with the prior knowledge of the pupils there were a number of variables which emerged. When these variables appeared as part of a lesson it would be possible to observe whether the teacher also made use of the prior knowledge of the pupils or not. The variables were chosen with the specific intention of examining how teachers made use of the prior knowledge of their pupils. It was recognised that the purpose of the means of assistance is wider than the process of using the prior knowledge of pupils.

The reason for the choice of instruction, questioning and cognitive structuring was that, although they are three linguistic means of assistance when the use of prior knowledge was stimulated by the teacher, the results would be observable and not just an internal process performed by the pupil.

4.2.2 THE VARIABLES TO BE CONSIDERED.

The following was the list of possible variables which was compiled from the literature (Tharp & Gallimore, 1988, Gallimore & Tharp, 1991, Pressley, et al,

1988, 1992, Pirie & Kieren, 1992, Freire & Shor, 1987) which formed the basis of the theoretical considerations in Chapter 2.

Instructing.

a) The teacher establishes the conditions for learning by:

- correcting behaviour
- directing the pupils to perform certain actions
- assigning classwork to be done

b) The teacher assists performance by:

- directing the pupils to link pieces of information
- telling pupils to internalise information (e.g. remember this)
- requiring pupils to complete a task

Questioning.

a) The teacher asks questions to assess pupil performance so that the pupil can be enabled to move forward by:

- testing their recall of information
- finding out their current level of performance

b) The teacher assists pupil performance by:

- interpolating questions during performance
- provoking thought, using questions
- encouraging pupils to construct answers on their own
- requiring pupils to verbally make connections between bits of information
- enabling pupils to develop comprehension
- asking pupils to verbalise their mental operations

Cognitive structuring.

a) The teacher provides a structure for the knowledge being taught by:
   - assisting the pupils in the organisation of their perceptions
   - structuring explanations through
     - the use of examples
     - the doing of exemplars
     - showing of patterns
     - demonstrating methods

b) The teacher encourages and assists independent cognitive activity by the pupils through:
   - indicating a process for solving problems
   - using rules for finding out things or doing things
   - the developing of patterns
   - the sequencing of information
   - the grouping of operations
   - the evaluation of answers
   - evaluating, grouping and sequencing perceptions, memory and action
   - developing insight into problems
   - the use of intuition by pupils
   - guided re-invention (re-organisation of material) during mutual participation

c) Assists in the recognition of metacognitive processes which are evident in:

- patterns for remembering information
- the choice of methods available for the solution of a problem
- ways to organise perceptions
- the strategies used for solving problems
- the pupils' own explanations
- the pupils' formation of their own patterns
- the way content is organised by pupils
- gaining of an overview of how problems are solved
- the giving of appropriate examples
- the way in which pupils communicate their ideas
- the questions asked to clarify patterns
- the way pupils test their patterns

4.2.3 THE SAMPLE TO BE STUDIED.

The selected school was a co-educational, parallel medium (English and Afrikaans) primary school in what could be called a traditionally white area. In 1994 when the lesson observation took place there were a number of pupils from other racial groups attending the school. In the school there are both English and Afrikaans medium classes. The staff of the school was all white with a roughly equal number of female and male teachers.

Three teachers were chosen for the observation on the advice of the vice-principal of the school. A fourth teacher was excluded from the research because of lack of experience. It was felt that, because of their experience, the three experienced teachers would be sufficiently confident in their teaching and that the presence of an outsider as an observer would not cause too much disruption to

their normal teaching.

None of the three teachers was told anything about the focus of the research so that they would not be influenced in any way by a knowledge of the issues being addressed, in case such knowledge caused them to behave differently from normal in their classrooms. The researcher also did not discuss with the teachers any of the theoretical positions on which the research was based, either prior to or during the sequence of observations. It was intended that at the end of the research the researcher would, at the request of the vice-principal, spend some time in the school explaining the process and introducing some of the theoretical foundations on which the research was based.

Teacher A was a male teacher with many years of experience in different classes. Teacher B was a female teacher who had taught at this school for many years and had recently been asked to take over the teaching of a Standard 5 class. She had more experience of teaching in the lower Standards and felt a bit insecure at this level. Teacher C was a younger male and experienced teacher. Teacher A was in the management team of the school, Teacher C was a senior teacher and Teacher B an assistant teacher.

The lessons were to be taught in three of the four Standard 5 classes. The fourth class was an Afrikaans medium class. Standard 5 was divided into a "top" stream of one class, a middle stream of two classes and a "bottom" class. One from each of the categories was observed.

4.2.4 THE LESSONS TO BE OBSERVED.

The number of lessons to be observed depended on the analysis of data gathered during the observation of the first lesson of each of the teachers. It was intended that at least three lessons of each teacher would be observed. In this way

it would be possible to observe each of the teachers at a different point in the syllabus with different topics for their lessons.

It was expected that the small number of lessons would not influence the result of the research because the teachers were all competent and it was assumed that their individual styles would not vary much from lesson to lesson.

The subject which was chosen for observation was mathematics. The reasons for this choice were first, because it is the subject with which the researcher is most familiar. Secondly, because it lends itself to frequent changes in technique such as questioning or instruction during the teaching of a lesson. Thirdly, it is a subject in which a number of different types of lesson are possible, ranging from "teacher-tell" or purely transmission lessons (both of which might make use of rote learning) to lessons involving a discovery learning approach.

4.2.5 THE OBSERVATION SCHEDULE.

The number of possible ways in which assistance in the ZPD can be given in the classroom are numerous and the list suggested above (4.2.2) is not necessarily exhaustive. The researcher believed, however, that they would give sufficient indication of the extent to which teachers used the prior knowledge of pupils in the classroom. The presence of the researcher in the classroom during the lessons would make it possible to evaluate the observation schedule and to modified it if necessary.

The development of the observation schedule was the result of the consideration of a wide range of comments on the work of Vygotsky (1978) and a variety of other authors which were seen to be compatible with his approach to teaching. The work of Paulo Freire (in Freire & Shor, 1987 and Freire & Faundez, 1989), for instance, has been an influence on the thinking of the researcher about

a relevant approach to teaching within the political context of South Africa during the last twenty-five years. The idea of teaching as assistance in the ZPD as developed by Tharp & Gallimore (1988) and Gallimore & Tharp (1991), provided the framework within which the variables mentioned above could logically be included. The following main headings give an indication of the extent of the categories used in the observation:

INSTRUCTION
- The teacher establishes the conditions for learning.
- The teacher assists performance.

QUESTIONING
- The teacher asks questions to assess pupil performance so that the pupil can progress forward.
- The teacher assists pupils performance.

COGNITIVE STRUCTURING
- The teacher provides a structure for the knowledge being taught.
- The teacher encourages independent cognitive activity.
- The pupils form their own patterns.
- Metacognitive processes are evident.

The observation schedule as it was designed is included as Appendix 1.

For reasons explained in the next section, the observation schedule failed to fulfil the researcher's expectations. Fortunately, this did not mean that all of the research would have to be replanned. The alternative, to which the teachers agreed, was to tape record the lessons. This provided a means by which the lessons could be transcribed and later analyzed. The tape recordings were supplemented by observation notes of the teachers actions, use of the overhead projector, chalkboard, whiteboard and other aids to their lessons.

4.2.6 THE METHOD OF RECORDING THE DATA

In the first instance the data for the research was gathered through the medium of the observation schedule. It was intended that when one of the categories was observed to have occurred a mark would be made in the appropriate space alongside the category. In this way the tally of the occasions when that variable was observed would give a profile of the occasions in which the teacher used the prior knowledge of the child under one of the headings on the observation schedule.

When first used, the observation schedule turned out to be too complicated and could not be followed during the lesson being observed. The categories divided the behaviour of the teacher into parts which were not easy to separate from one another. Sometimes the interactions between the teacher and the pupils included more than one of the categories and it was difficult to separate them for the purpose of the observation schedule without losing contact with what was happening in the lesson. The researcher had to resort to making general observations about what happened during the lesson. This was an important experience for the researcher because it led to some interesting conclusions regarding the teachers' use of the prior knowledge of the pupils in their lessons. For instance, the prior knowledge of the pupils was sometimes not immediately retrievable by them and they had to be reminded of the required knowledge before being able to use it in the answering of a question.

The failure of the observation schedule as a tool meant that other methods had to be substituted as follows:

1. The only data manually recorded was with regard to the movement of the teachers in the classroom and their use of the chalkboard (or

whiteboard) and the overhead projector.

2. Comments were recorded in the observer's field notes during the informal conversations which took place between the teacher and the researcher. These conversations were not set up with the intention of clarifying what was happening in the lessons. To do so might give the teacher some insight into the questions around which the research was designed. The purpose in these conversations was to maintain a relationship with the teachers and to let the teachers volunteer information about what they were trying to achieve in their lessons.

3. A tape-recorder was used and transcripts of the lessons were made from the recordings. The researcher took notes during the lessons to supplement the recordings. These were later able to be indexed with the recordings which were made. The reasons for changes in the tone of voice of the teacher were also noted. It was not intended that the tape recorder should become a substitute for the observation schedule or for the presence of the researcher within the reality of the lesson. The recordings made possible later analysis in terms of the categories contained in the observation schedule.

After a lesson of Teacher B and Teacher C had been recorded, the data gathered was analyzed using the three sources of data; the observation schedule, tape-recording and field notes, to see if the alternative approach adopted was effective or not. The initial analysis indicated that the teacher-pupil interaction was sufficiently varied to give the researcher insight into the ways in which the teacher used the prior knowledge of the pupils.

Through this approach, using the three means of gathering information it

was expected that there would be sufficient data gathered in order to throw light on the main question being asked and that this could lead to some insights which could later lead to an improvement in the approach to teacher training.

4.2.7 THE POST-LESSON CONVERSATIONS WITH THE TEACHERS.

The conversations which took place between the researcher and the three teachers after the lessons were informal and took place during the mid-morning break or between lessons. These were the only times in the teachers' schedules and the schedule of the researcher when these could be organised. In the school where the research was done, most of the teachers, other than the specialist teachers who taught art, woodwork and physical education, were class teachers. During these discussions it was necessary to avoid a discussion of the question being asked in the research. The data gathered was recorded after the conversation. One of the comments made by Teacher C during one of these conversations that he had changed the lesson which he was going to teach, put the researcher on his guard about the direction taken in the conversations. The teachers appeared to have pre-conceptions of what they should do in the lesson because they were being observed. Occasionally, during a lesson, a teacher voluntarily made a comment to the researcher about the progress of the lesson and what was being attempted in the lesson.

4.3 **CONCLUSION**.

In the design of this research task there were two levels at which the researcher needed to operate. The first was a general level, which involved a consideration of the theoretical positions concerning classroom observation and the use of observation schedules. The second level was that on which the researcher determined the specific process by which data was to be gathered. It

was through the influence of the general level on the specific level that the final process was arrived at. What became clear to the researcher, in the interaction between general theory and specific theory, was that in this research task the circumstances in the classroom (including both the activity of the teacher and the pupils), the nature of the observation schedule and the taking of field notes needed to be carefully integrated if meaningful data was to be gathered. The later, unplanned, introduction of the tape-recorder, because of the difficulty in using the observation schedule, became essential. This served to emphasise the importance of flexibility in research of this kind.

In any research, which involves the observation of a number of classrooms, there is a need to be able to spend a longer period of time in the classrooms than was possible in this research. Being able to spend more time in the classrooms would not only produce a greater amount of data but would also make possible a programme of intervention as a follow-up to the findings which would emerge from the analysis of the data which was gathered. The intention of the researcher in this research was less ambitious and involved gathering data only concerning the use which teachers made of the prior knowledge of pupils during their lessons.

For classroom research to succeed the issues raised in this brief discussion of some of the theory regarding the different approaches are most important and need to be carefully considered. Furthermore, the decision which was made between the use of a previously constructed observation schedule or one which is flexible was also important for the success of the research.

It is hoped that as a result of the approach adopted in this study that the realities of what is taught in schools will become clearer. The insights gained will assist in the improvement of the approach to teacher training and enable the

transformation of the approach of those teachers who neglect to take into account the prior knowledge of their pupils. If this is to happen then some basic assumptions about the method should be taken note of:

a) Teachers roles may appear to be similar but the roles of the pupils may vary significantly and produce very different kinds of interaction.

b) The classroom is not a context within which only one person talks at a time. To observe only the teacher is to miss much of what goes on in the classroom.

c) The kind of language used in the classroom is not unambiguous and needs to be seen in its variety as used by both teacher and pupil (Walker & Adelman, 1976. p. 136f). The language used by the pupils, because it is developed in a social context, contains the meanings, as prior knowledge, on which the teachers can build their lessons.

The importance of these assumptions is that they point to the complexity of classroom observation. The use of the tape-recorder, although not originally included in the approach meant that the interaction between the teacher and the pupils could more effectively be analyzed.

CHAPTER 5 - ANALYSIS AND INTERPRETATION OF THE LESSONS OBSERVED

5.1 INTRODUCTION

In this chapter the intention is to analyze and interpret the data concerning the use of the three means of assistance by the teachers in the classroom and to report on the success of the techniques used in the research, including the observation schedule and the use of the tape recorder as a means of gathering information during the observation of the lessons. The data was gathered during the observation of the teachers and transcripts were made of the tape-recordings made in the classroom.

5.2 THE GATHERING OF THE DATA.

5.2.1 THE TYPES OF LESSONS AND CLASSES OBSERVED

As previously described, the lessons that were observed were mathematics lessons given to three Standard 5 classes with different ability ranges. From the observations made, it was clear that the pupils in the "express" class had a wide range of abilities. This was evident from the different responses, which were shown by the pupils to the tasks given to them. On one occasion, while constructing the different "nets" of a cube in an introductory lesson on cubes, a particular girl responded with a variety of nets, which were different to those that were developed by the rest of the class. She spent the available time constructively developing her nets; continuing even after the teacher had moved on to the next step in the lesson.

The other two classes were different to the express class and to each other. Although they were also streamed, the difference in mathematical ability was not noticeable. One of the teachers pointed out during a conversation that class C, for whom Teacher C was responsible, was not as competent in English as class B

which was the responsibility of Teacher B. A feature that did distinguish the two classes was the kind of banter that occurred between and Teacher C and his pupils. Frequently, during the lessons observed, the pupils in the class made comments to the teacher, some of which were comical. There was also some banter between the pupils themselves in classes B and C but this did not often happen in class A.

The choice of the Standard 5 classes was because this school was in the process of introducing what was called by the vice-principal (Teacher A) a "new approach" to mathematics teaching in which the children were encouraged to find answers to problems in ways which *they* thought were best. The arrival at the correct answer was more important than the methods which were followed, even if they had been taught by the teacher. There was not much evidence of this happening other than when the pupils were involved in group work. To a large extent the pupils continued to operate in the traditional manner, doing problems out of a text book and checking to see if they had the right answer. They were seldom asked about the method which they had used to find the answer.

5.2.2 THE USE OF THE TAPE-RECORDER

In the tape recordings, which were made of the lessons it, was important to record the words of the teacher and as best as possible the words of the pupils. The teacher's voice often came across clearly but the pupils spoke too softly at times and it was not possible to hear what they said. However, the tone of the teacher's voice was often of assistance in the interpretation of many of the statements made by the pupils.

5.2.3 THE TEACHER AND NOT THE PUPILS WERE BEING OBSERVED.

It was important to make this clear at the outset because the tape

recordings which were made, at times, did not clearly record the voices of the pupils. This was not regarded as a major obstacle because the study was concerned with the teachers' words and actions in their use of the prior knowledge of the pupils. During the lesson itself the teacher was able to hear and respond appropriately to what the pupils said and did. Therefore, the words of the teacher were of greater importance than those of the pupils although both *were* needed for the purpose of the analysis of the lessons. That some of the words of the pupils were not recorded did not detract from the value of what was recorded of the teachers' spoken words.

5.2.4 DIFFICULTIES EXPERIENCED IN THE ANALYSIS OF THE TAPES.

1. Significant difficulty was found during the making of the transcripts because of the type of recorder which was used. Stopping, re-starting and many re-runs had to be made in order to determine the exact words which were used.
2. It was difficult to punctuate both the words spoken by the teacher and by the pupils. This was because of the way in which the teachers spoke to the pupils. They often did not speak in whole sentences and they often repeated what the pupils had said as if the class needed to be quite clear about what was said. It occurred in a way that seemed almost habitual.
3. The dialogue between the teacher and the pupils contained many hesitations and changes of direction in mid-sentence. It was very difficult to follow some of the things said by Teacher C at times because of the type of interaction which happened between him and

the pupils. Often he would go to a group and turn his back on the tape recorder or bend down to help a pupil. The equipment which was used was not able to pick up the dialogue in these conversations. The use of the notes taken during the lessons was an invaluable aid.

5.3 **THE METHOD OF ANALYSIS**.

The analysis of the lessons which were transcribed was done using a process which involved dividing the lesson into progressively smaller units which could be examined in greater detail.

In the theoretical considerations reference was made to activity settings in which the teacher and the pupils interacted with each other in joint productive activity during the lessons. Being able to identify these activities was important because it was in this kind of mutuality that the teacher was able to assist the pupils in their development (Tharp & Gallimore, 1988, p. 72). The observation schedule originally was designed in order to assist in the identification of these settings and to record what happened in them because it was in them that the teachers would enable their pupils' development through the use of their prior knowledge.

It was important to note that not all the activity that was observed in the classrooms showed the goal-directedness of activity settings (Tharp & Gallimore, 1988, p. 73). There were times, for instance, when the pupils talked together without any specific purpose.

There were three different types of activity setting. In the first type the teacher interacted with the whole class in a mutually constructive manner. The

second was when the teacher interactively was involved with a small group of pupils or with one or two pupils during group activities or when problems had arisen. The third was when the pupils co-operatively were involved with each other in a group activity. This latter form of activity was often seen to lose direction. The nature of the interaction in each case varied according to the type of activity.

The activity settings in the lesson provided the units which could be identified and examined in closer detail. The following diagram (Fig. 2), related to the lesson on the 10.8.94 taught by Teacher A, can be used as an example of the process through which the activity settings were identified:

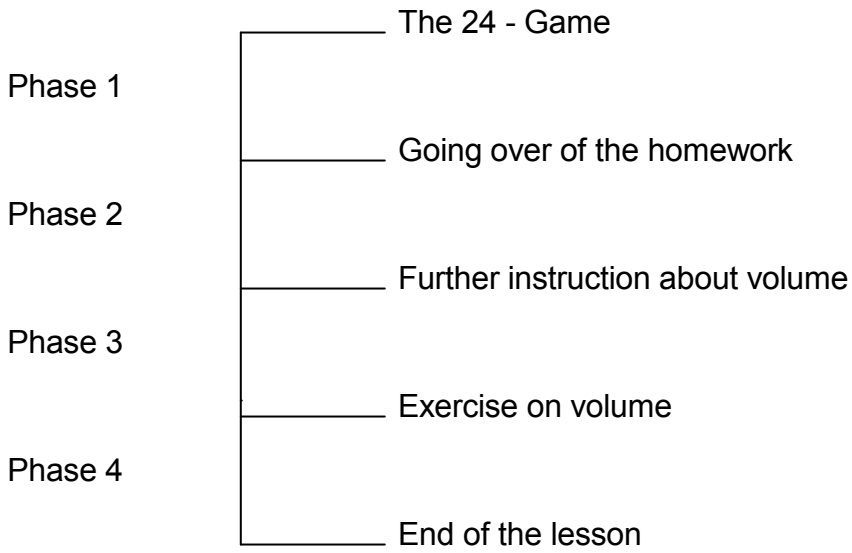

Figure 2

5.3.1 THE PHASES OF THE LESSON.

The lesson began in Phase 1 with an activity setting in which the task was one of choosing a team of four people who would go to a 24-Game competition. The 24-Game is a game in which the four basic operations of addition, subtraction, multiplication and division are used to produce an answer of 24. A set of cards is

used, each of which contains the numbers to be used to make a total of 24 using the four operations. Each of the cards could be associated with an activity setting. This took up the first 18 minutes of the lesson. Phase 2, the checking of the homework given in the previous lesson, represents the next activity setting. This phase continued until the teacher gave the instruction for the pupils to put down their pens, pencils and anything else that they had in their hands so that they could pay attention. Phase 3 began when the teacher did some further instruction on Volume, leading them further in their understanding of it. In Phase 4 the class was assigned an exercise to do. This consisted of both group and individual activity. The lesson ended with the teacher assigning the exercise which was to be done by the class as homework. Each of these phases was then able to be divided into smaller units.

5.3.2 THE USE OF LESSON PLANS.

It was not apparent at any time that any of the teachers had a written lesson plan. The lesson seemed to flow because of their experience and their subject knowledge. That does not mean that they had not given some thought to the lesson. In one of the lessons of Teacher C, it was clearly evident that he had done a significant amount of preparation for the lesson in the construction of the exercise, which the pupils were given to complete. The structure of the lesson was not written down in the form of a lesson plan, yet it was clear that the teacher had a strategy for the lesson, evident in the overhead transparency on which the problem which the pupils were to tackle was written. The teacher was able to be flexible in the lesson with this visual aid as the main focus.

What was apparent was that, as in the example mentioned above, there were a number of focal points around which the three teachers constructed their

lessons and which gave rise to the activity settings in the lessons. These focal points were, for example:

1. The previous night's homework.
2. The input needed to move the lesson forward.
3. Some form of activity by the pupils, whether it was discovery of information, a test, or classwork from the textbook.

Various combinations of these were used to maintain the flow of the lesson.

5.4 A DETAILED CONSIDERATION OF THE LESSONS OBSERVED IN TERMS OF THE CHOSEN THREE MEANS OF ASSISTANCE.

5.4.1 GENERAL OBSERVATIONS.

The following general observations were regarded as important but not central to the research.

The aims and objectives of the lessons.

In each lesson which was observed the teacher did not make clear to the pupils *what they were going to achieve* in the lesson i.e. neither the aim nor the objectives of the lesson were communicated to the pupils other than to say, "Today we are going to ....". In the activity settings in which the children were involved the pupils were told *what* the activity was to be, sometimes they were told *where* they were going to do it (in the case of the measurement of the shapes of various parts of the school premises) and at other times they were told *who* was going to do it (when they were to work in groups). The *why* of the activities was not always specified. Whether the teacher had in mind an objective to be achieved could only be inferred from the instructions which were given by the teacher. In the first lesson of Teacher C, as he came into the classroom, the class was asked to take out their books and do a test. The test consisted of a number of problems, types of which

had previously been done. Nothing was said as to why these tests were given and nothing was done about those pupils whose answers were incorrect. The function of the test, therefore, seemed to be just to get the attention of the pupils to reinforce previous learning and to help them to focus on the work for the day.

What emerged from this type of analysis of the lessons observed was that the teachers all used a number of key activity settings around which they built their lessons.

Classroom noise.

In all of the classes in which lessons were observed the level of activity of the pupils was accompanied by a fair amount of noise which occurred in waves during the lesson. Each teacher had a particular way of dealing with the situation. "*Right, settle down*" was one of the frequently-used instructions given by Teacher A. Another of the comments, of Teacher B, was that they should "*use their hands and not their tongues*" to do their work. On yet another occasion the pupils were told to "*mind their manners*". The noise, however, began to crescendo not long after the instruction had been given. The pupils seemed to be reluctant or unable to work quietly. The maintenance of discipline, however, did not seem to be a problem for any of the three teachers although they approached the situations in very different ways. Teacher A was able to keep the level of noise down without too much trouble because of his authoritative approach. Teacher C used a variety of techniques to get the pupils to work quietly. On one occasion he told them that in the exercise which they were doing, involving calculating of the cheapest solution to a problem, they would have money added on to their total if they did not settle down. Teacher B was concerned to maintain control during the lesson by standing in front of the class in a central position and maintaining control at all

times. In this way the imaginary line drawn between the teacher and the pupils was clearly defined.

Group work.

In some of the classrooms the activity settings were structured in such a way that group work naturally became a part of the lesson. In a conversation with Teacher A before the observations took place it was made clear that the objective in mathematics was to get the pupils to find their own ways to solve problems and that this should happen in groups as far as possible. On one occasion the pupils in one of the classes were unwilling to discuss the problem with each other until the teacher encouraged them to do so. Whether this reluctance was because of the authority of the teacher and their previous experience of it was not clear.

Teaching aids.

When it was appropriate, use was made of teaching aids. For the lessons on area and volume it was through the means of small wooden cubes of 2 centimetre side, which the pupils used to build certain shapes in order to see how cubes could be increased in size from using only one to using eight for the next biggest cube. The overhead projector was used by Teacher C on a couple of occasions but only in order to project the test questions on to the screen. The whiteboard or the chalkboard was the most frequently used aid in the lessons which were observed.

On one occasion a couple of boxes which happened to be in the classroom were used in an *ad hoc* way in a demonstration of how the construction of cubes progressed from one to eight and on to sixty four.

5.4.2 SPECIFIC OBSERVATIONS.

The specific analysis of the lessons was in terms of the way in which the

teacher used the prior knowledge of the pupils through the three linguistic means of assistance (Gallimore & Tharp, 1991, p. 177) chosen for this research. These was dealt with in the following order:

Instructing

Questioning.

Knowledge structuring.

The observation schedule was used as a framework for all of the lessons which were observed. The categories which were chosen were included because they are all verbal means of assistance. The three categories mentioned above are not exclusive and when it was useful the other three categories of assistance, modelling, contingency management, and feedback, are referred to in the following discussion. The analysis of the lessons in terms of these variables was supported by the tape recordings which were made during the lessons. Transcripts of these lessons are included as Appendix 2. The analysis was also supported by the notes that were taken during the lessons as they were observed. This was necessary because of the nature of the mathematics teaching which frequently involved the use of the chalkboard and the overhead projector.

(For ease of reading the following convention is followed in the discussion, which follows. The major headings are indicated in underlined, bold lowercase letters, the minor headings are underlined lowercase letters and the minor sub-headings are italicised lowercase letters.)

Instructing.

This means of assistance occurs within the context of other means of assistance when teachers accept responsibility for assisting the pupils in the performance of the next specific act instead of expecting the pupils to take the

initiative for their own learning (Tharp & Gallimore, 1988, p. 57). For ease of discussion four types of instruction have been isolated: establishing the conditions for learning, linking of information, giving directions towards task completion and telling pupils how to internalise information.

Establishing the conditions for learning.

Each of the teachers in the study used a different method to establish the conditions for learning. Teacher A on each occasion used the technique of walking into the classroom with something to do with the class as a preliminary task. On the first day of observation the instruction took the form of an introduction of the pupils to a stock exchange game which the pupils were going to play. Although the teacher referred to this game in a subsequent discussion with the researcher in which he explained that the pupils had become very involved in the game he did not refer back to it during the lesson in which it was introduced. It was possible, therefore, that the game was introduced merely because the lesson was being observed.

At no point did the game appear to have any connection to the lesson which was to follow. It was an activity which was given to the express class as a task which would involve them in a creative activity on their own. Whether all the children were to be involved or not was not specified and whether they had the required prior knowledge for what was to be done was not clear.

All three teachers on occasion changed direction in their lessons and moved into a different activity setting by using instructions such as: "*Right people let's get out our maths books*" and, "*Right, OK, now I want to see if you can use all your information which you have discovered today to do some mathematical*

examples." These, and other similar instructions, were used to provide a context within which the children could do classwork.

Instructions were sometimes in the form of reprimands to correct behaviour because there was too much noise in the classroom or because of some other form of behaviour which was not acceptable to the teacher. As Teacher A said on one occasion, " *right people, its going very nicely but there is far too much noise. Discuss it, I don't mind that."* (As a result of this interjection the volume of noise in the classroom was reduced for a short time.) Whether what was being done by the pupils was relevant to the task at hand or not was not taken into account.

<u>The linking of pieces of information</u>.

Another of the ways in which instruction is used is in the way in which the teacher directed the pupils to link pieces of information. In the following interaction, between Teacher A and his pupils (10.8.94), the opportunity to make these links is present but not fully used.

T: Let's have a look at (b), 4(b) It [the problem in the text book] is just asking you actually to read it correctly. People, its nothing more than that. Let's have a look at that, its just the wording that they are actually giving you, there is no calculation as such to do. So we are going to have a look at that. "Complete the following; volume of a stack", whatever, they actually ask you, "equals, area of base" - now area of base you have been working with for a long time, that is length, times breadth, times height ..... so what are we short of?

P: Height.

T: Height. So all we need to fill in there is ... they are actually asking you, they are actually asking, do you know the formula for volume?

> And instead of saying length times breadth, they are actually saying area. [Writes the formula for area on the chalkboard] Can you all see that? So that is area times the height. Um. Right we carry on with number 5 please.

The question in the textbook asked for the pupils to complete a sentence which began "The volume of a stack equals area of base times ...? " This kind of situation is a typical example of an opportunity in which the teacher could have assisted the pupils, through the use of their prior knowledge, to make the links between this previous knowledge and what was new to them. It is an opportunity for them to be extended through the mediation of the teacher.

There are some other points that can be noted in this interchange between Teacher A and the pupils. The first concerns the apparent assumption by the teacher that the pupils do have the knowledge, which is required for an answer to the question but that it is the *wording of the question* which appears to the teacher to be the source of the problem which the pupils have. It is a situation that involves linguistic understanding in which the teacher explains the problem without using the opportunity to test the understanding of the pupils.

What this highlights is that during a lesson the teacher is always aware of the dynamics of the lesson and the types of assistance that can be introduced into each activity setting. It emphasises the need for the teacher to have a strategy, which is informed by an understanding of the use of activity settings at every stage of the lesson.

The second point is that the pupils are not involved in any higher order thinking because it is the teacher who provides the way to the answer of the question. In this regard, Tharp & Gallimore (1988, p. 29) argue that, "The child is

not merely a passive recipient of adult guidance and assistance; in instructional programs, the active involvement of the child is crucial". In the above interaction the child is receiving instruction without being given the opportunity to interact with the teacher in the process.

The same can be said of teachers who are aware of the Piagetian stages of development and do not always work in accordance with the principles of assimilation and accommodation in the development of childrens' understanding of concepts; that for growth in their understanding there needs to be a change within their present structures. The constructivist approach to teaching is a step in this direction because it emphasises the need on the part of the teacher to be aware of the processes of cognitive growth. Pirie and Kieren (1992, p. 506) make the point that "teachers can and do create environments, based on the belief that all knowledge has to be constructed by the individual, in which students' mathematical knowledge-building and understanding is fostered."

From the Vygotskian perspective, when the teacher is assisting a pupil in a ZPD, the movement from everyday concepts to schooled concepts can be facilitated through episodes such as the one discussed above. The teacher needs to consider the pupils' actual developmental level and assist them towards being able to regulate their own learning. Instead of this approach we see in this vignette the pupils being asked to supply the words needed to complete sentences. Whether there **was** any understanding on the part of the pupils is not ascertained by the teacher who appears to have made the assumption that the pupils will, at a later stage, understand what was done as a result of their own endeavour.

Instructions to complete a task.

In each of the lessons observed the teachers arrived at a point where the

children were given a task to complete. This was either an exercise from a book or, as in the case of Teacher C (8.8.94), it was a specially prepared exercise used by him to meet the needs of the lesson:

> T: Right settle down ... Let's look at our task. I'm only going to go through this once and you must listen carefully ... right, your assignment ... you have four tasks. Task one ...

The teacher then went on to give a detailed set of instructions about what the pupils were required to do. The task was to be done in groups so that they could share the load of the number of calculations involved in the task. Teachers A and B usually used the text book for their tasks other than when the pupils were expected to do some practical manipulations, such as tessellations.

Gallimore and Tharp (1991) in pointing to the essence of instruction in the ZPD argue that, while instruction can assist the pupils in their movement through a stage in their development, to continue with the task beyond the point at which the pupils are able to work on their own is not helpful. More often than not, the instructions of the teachers being observed were concerned with assigning a task which would *reinforce* the knowledge which had just been covered in the lesson. This could be regarded as part of the pupils' progress through a ZPD. However, it did not always happen that when the reinforcement was complete the task was regarded as complete or changed. This was noticed in one of the tasks assigned by teacher B. The pupils were given a worksheet and they were instructed to find and colour in the geometrical shapes which they had been discussing in the lesson. The pupils were able to identify and colour in the various different shapes after having done one or two of each of them and the reinforcement of the concepts was soon completed. Similarly, a task which Teacher C assigned the

pupils, to use their prior knowledge to calculate percentages, profit and loss, continued beyond the point where the concepts had been reinforced.

Telling pupils to internalise information.

There is a sense in which the above examples and other similar ones reflect a fourth type of instructing, that of *requiring pupils to internalise information*:

> the instructing voice of the teacher becomes the self-instructing voice of the learner in the transition from apprentice to self-regulated performer. The non-instructing teacher may be denying the learner the most valuable residue of the teaching interaction: that heard, regulating voice, that gradually internalised voice, which then becomes the pupil's self-regulating 'still, small' instructor.
>
> (Gallimore & Tharp, 1991, p. 181)

The pupils in their own activity will remember the words of the teacher which they have just been discussing, internalise it and then use it to solve the problems in the assigned exercise.

This self-regulatory process will enable the formation of concepts in a formal environment through the conscious choice and application of the pupils to the task at hand (Panofsky, et al., 1991, p. 252). Teacher B on one occasion (8.8.94) assigned a task for the pupils in this way:

> T: Right, OK, now I want to see if you can use all your information which you have discovered today to do some mathematical examples.

She was expecting that the pupils would now be able to link their previous knowledge about area (including that which they had just gained in the lesson) and use it to calculate the answers to the mathematical problem in the assigned

exercise. In the process they would demonstrate that they had internalised the information.

Questioning.

Questioning was ubiquitous in all of the lessons that were observed. The forms that the questioning took varied from simple questions requiring factual answers, to complex questions demanding deeper thought. There were also a number of rhetorical questions like "*Can you all see that*?", "*Are you all happy with that one*?" and "*Can you see what he saw*?". These questions had the function of checking understanding but did not require a response, it appeared, because none was forthcoming and there was not enough time given for a response.

As well as the questions which were essentially rhetorical there were other questions which were asked and which also did not require a response from the pupils. An example is found in one of the lessons of Teacher C (8.8.94):

T: When they want to put up a fence. OK, there's your house (draws a house on the chalkboard). This is the end of your garden, it's got a funny shape and the guy says OK, that's fine, I will put up a concrete fence but how long should it be? Then you have to work out the perimeter. And what do you have to do? You've got to measure all the way round the outside of this so that you have got the perimeter. OK, we are measuring the perimeter and it is in metres - it will just be straightforward metres hey?

None of the questions seemed to expect or give opportunity for an answer from the pupils. They were reflective of the teacher's thinking aloud. This may be a form of modelling used by the teacher and is one of the other forms of assistance in the ZPD. The use of the picture which the teacher draws on the chalkboard

effectively assists this modelling of the thought processes involved in the solving of a mathematical problem. The forms of assistance are often isolated in theory but operate together in practice (Tharp & Gallimore, 1988, p. 47ff).

Two types of questioning.

There were two aspects of questioning as suggested by Gallimore & Tharp (1991) that were taken into account during the observation of the teachers. The intention was to discover whether the teachers made a distinction between these two types of question. The first type included questions that were used to assess the level of ability of the pupils and the second type of question were those which were used to assist the pupils in their performance.

Questions that assess performance.

Questions of this type are intended to determine the developmental level of the pupils. Their function is to *assess* rather than to assist the level of performance of the pupils.

The simplest level of testing ability was through the use of recall questions. The following extract is from a lesson taught by Teacher C (8.8.94). It gives some insight into the use of this form of questioning:

T: Right, you had a little task this weekend. You had to look at area, volume and perimeter. Let's see if you did that. How do you work out area?

P: Length times breadth.

T: Length times breadth. Why would you want to work out area, or what do we do with area? Richard?

P: In case you wanted to tile a room or put a carpet in.

T: In case we wanted to tile a place or put a carpet in. How would we

work out volume? Catherine?

P: Volume! (Thinking ...)

T: Help, Michelle.

P: We want to see how much there goes inside.

T: We want to see how much there goes inside. Remember I drew that little box last week and we said that we wanted to work out what the volume of such a thing was.

P: Yes, sir.

P: Length times breadth times height.

T: Let's go back to area quickly. What is the measurement for area? Say for instance that we were measuring in metres. The answer would be in?

P: Metres and a little two.

T: Metres and a little two. Square metres, hey? Carlo said if we measure volume we must go length times breadth times height. What would that give us?

P: Cubicles.

T: Cubes!

P: Cubes.

T: Meaning that we are going to fill it up with little cubes. We played with those little blocks and we made one little cube, and the next cube, and the next cube, and the next cube and after a while we said that we needed 64 little cubes to make this one. OK, that gives us the volume.

(The discussion continues to look at the formula for perimeter and why it is

useful for a person to know how to calculate perimeter.)

In the interaction the teacher was assessing the pupils' ability to remember the formulae for perimeter, area and volume and to be able to say what the units were for these measurements. The questions were phrased in such a way that it appeared as if the teacher was expecting the pupils to give an answer which would be in the form of an explanation. This was not the case. For example, "How do you work out area?" did not produce an explanation but was apparently only asking for the recall of the formula for area. The same was true of "How would we work out volume?" and "What is perimeter, John?" In this form of questioning the expected level of cognitive activity that was involved in the answering the questions was relatively low. It could have been at a higher level than recall and involve explanation, showing that the pupils understood the concepts involved.

One of the questions in the extract above is of interest:

T: Let's go back to area quickly. What is the measurement for area? Say for instance that we are measuring in metres. The answer would be in _____?

While not wanting to be critical of the grammar of the question for its own sake, the fact that the teacher did not ask for the "units" of measurement for area did not prevent the pupils from getting the correct answer. The sense of the question was carried in the request, "The answer would be in?" It is important that the questions asked in a lesson should be grammatically correct and that the *sense* of the question must be able to be understood by the pupils. A question which is asked in a manner, which makes sense to the pupils, will more readily link to the prior knowledge of the pupils and enable them correctly to interpret the question and to provide the answer.

Questions that assist performance.

The second general type of question is used to *assist* the pupils' performance. These questions are designed to help pupils in their progress through a ZPD. Gallimore & Tharp (1991) point out that questions which are used to assist the pupils "produce a mental operation that the pupils cannot or would not produce alone" (p. 182) and do so by stimulating a higher level of mental operation than recall. It is sometimes difficult to clearly distinguish between questions, which are purely recall, and those that demand a response from a position of understanding. In the observation of the lessons there were six specific ways in which these questions could have been used in the classroom. The construction of responses to these questions might:

- involve the interpolation of information.
- provoke thought.
- involve the construction of answers.
- assist pupils verbally to make connections.
- assist pupils to verbalise their operations.
- develop comprehension.

Teachers, in the process of being trained, are often criticised for using questions which only require reproduction of information and for not asking questions which are "why" questions or "productive" questions. Some questions have the appearance of *productive* questions, which requires a clearly thought out answer, but are only superficially so and do not give the pupils the opportunity to respond in a productive way. The apparent ambiguity of the questions shows either that the teachers do not expect a productive answer or else they are unaware of the potential of the questions. For example a teacher may ask pupils, "How do we

distinguish between perimeter and area?" and expect an answer which gives the formulae for the calculation of the two measurements. This points to the need for teachers to develop a way of thinking about questioning so that they are always on the alert for opportunities to deepen the cognitive level of pupil response.

In most of the responses of the pupils it was seldom required that the pupils go beyond a sentence or two in reply to a question. Most often the level of response required was short and consisted of only one sentence and often only one word. An examination of the transcripts made of four of the lessons of the three different teachers revealed that on only two occasions did a pupil use more than one sentence in answer to a question and even then used only two sentences.

The research of Pressley, et al. (1992) into *Elaborative Interrogation* highlights the importance of more involved questioning techniques if learners are effectively to remember the information which is being taught. Elaborative interrogation involves the use of "why" questions. The teachers observed in this study did not make much use of these types of questions to extrapolate on the content of the questions. Willoughby, et al. (1993, p. 37) suggest that the importance of elaborative interrogation in learning may be because "students put greater effort into answering the "why" questions because they *self-generate* answers". The importance of self-generation of answers points towards the use of prior knowledge. Pupils are not able to generate answers for themselves if they do not have a base from which to work. This base is their actual developmental level or prior knowledge. An example of assisting questions is the following from a lesson by Teacher A (10.8.94):

T:.... How many cubes will I be able to stack in the bottom of my box?

People, I've got a box here [fetches a box] there it is, it is two centimetres. Down at the bottom I'm going to stack cubes from one side, from one end to the other and each little cube is half a centimetre in length. How many will I be able to stack across? Lyn?

P: Four.

T: Four. And that cube that way, Lorette?

P: Four.

T: Four, and the height?

P: Four.

T: Four. So how many cubes will I get in that box?

P: Sixty four.

T: Thank you...

Opportunities for this type of questioning need to be created in all lessons, including mathematics lessons. The level of the assisting question may vary.

The teacher's lesson preparation is not complete unless adequate thought has been given to the types of questions which might stimulate the pupils to generate answers to questions on their own.

Questions that involve interpolation of information.

An example of the first type is found in a simple form in the following interaction between Teacher C and his pupils (8.8.94) :

T: OK, some people seem to be confused. Just listen here quickly. All these other tiles are per square metre. So that if you buy these tiles they'll give you so much. [Draws a square to represent a 1 metre by 1 metre tile] What happens if you get here and they say that each tile is 25 centimetres by 25 centimetres?

P: You times by four!

T: Then that happens, hey? [Draws in the four tiles in the square] For each tile you must buy 1,2,3,4 tiles.

P: Told you. Yes, sir.

T: You say four times the price of the tile for each square metre. These tiles are even smaller, they are 10 centimetre by 10 centimetre. How many tiles will fit into a square metre?

Note: The teacher is here accepting an incorrect response. There were sixteen 25 centimetre by 25 centimetre tiles in one square metre.

The teacher was able to get the pupils to move forward in their understanding through the use of questions to extrapolate on the problem at hand. These questions are often used in lessons to interpolate necessary information in situations where there are gaps in the knowledge of the pupils. They enable the link between prior knowledge and new knowledge effectively to be made.

Questions that provoke thought.

The second form of question which assists are those designed to provoke thought. As was mentioned earlier the frequency of this type of question was low. In the following extract Teacher A (10.8.94) was attempting to get the pupils to do some thinking according to the instruction which was given.

T: Right, people, put down your pens and pencils. I'm drawing a cube quickly [draws on the whiteboard] ... and I want some information from you people. That is a cube; the length 1 centimetre. I want some information. What can you tell me about that cube? Anything, any information. Any information. Yes Brian.

P: The breadth is 1 centimetre and the height is 1 centimetre.

T: Good information. You said that is a centimetre sir, and thank you Brian, that is a centimetre. [fills in the measurements on the drawing] Other people could not see that. It's a cube and he actually told me, you know sir, a cube, the length is 1 centimetre and the breadth is 1 centimetre. So Brett, what else can you tell me?

P: It has six sides, sir.

T: Six sides, six faces, OK, if I make a dice out of that I could throw either a 1, or a 2, or a 3, 4, 5 or 6. Lovely, a cube has got six faces. What else? Let's see, ... [The teacher looks for another pupil to say something]

P: The volume is 1 centimetre cubed.

T: The volume is 1 centimetre cubed. Lovely! What else?

P: All the angles are right angles.

T: All the angles are right angles. Lovely! What else?

P: There are 8 angles.

T: It's got 8 angles, we call them edges. How many edges? Raymond.

P: It's got 12 edges, sir.

T: 12 edges, lovely! It's got 12 edges.

The teacher followed this line of questioning until he got to where he wanted to be. The idea of the pupils giving information about the cube drawn on the whiteboard was, at face value, a task which demanded some thought on their part. The answers, which they gave, did not, however, show any forward movement from what they already knew. The teacher's request for knowledge did not assist the pupils in their ZPD, it rooted them in the position in which they had been for a few days. That they were saying relevant things about the cube did not mean that

they were learning anything new or that they were being extended in any way. They were doing nothing more than revision using recall.

If the teacher is to assist the pupils then the knowledge which they have, as prior knowledge, must be used through appropriate questioning as the foundation for further development. For this to happen the teacher must see the setting as one in which assistance through questioning is possible. This involves an understanding of the nature of questions as a means of assistance as well as the role that the teacher plays in the interaction between them and the pupils: that of mediator and not just a receiver of answers. The mediatory function of the teacher is like that of a telephonist who is continually directing calls to different extensions and not like a telephone answering machine which simply records messages for use at some later stage.

Questions that encourage the construction of answers.

This aspect of the use of questions was evident in the groupwork in which the pupils were involved. Each of the teachers set the pupils tasks which they were to do in groups or on their own. During this group interaction opportunity was given for the pupils to collaboratively or individually produce answers to the problems set out for them in the tasks.

Unfortunately it was not possible to record the conversation of the children in their group activities but the teachers did give tasks which enabled a collaborative response to the teacher's questions.

Concepts which may have been closer to everyday types of concept were developed into schooled concepts as a result of this type of activity. An example is found in the following interaction between Teacher A and his class (10.8.94).

T: Right, I am going to give you a problem! How do you have your

medicine? In a so many centimetres cubed ...? In a teaspoon? From a bottle? ... How do you have your medicine, Lyn?

P: We measure it in 5 millilitre spoons.

T: We measure it with a 5-millilitre spoon. We normally ... the pharmacist, or the doctor will write on the prescription, "Take 5ml every two hours" or whatever the case may be. Right we are looking at that. Now we are going to convert and really get an idea of what 5 millilitres really is. I want you to see and imagine a little cube there in front of you. 1 centimetre by 1 centimetre by 1 centimetre.

The mediation of the teacher in this situation was important because of the use of everyday concepts to mediate the possibility of a schooled understanding of volume. Lyn, for instance, knew about medicine measures and could make the transfer from her everyday knowledge to the knowledge needed for an understanding of volume.

Questions that assist pupils verbally to make connections.

The importance of prior knowledge in this aspect of questioning cannot be overemphasised. The pupils need an organising principle and then to verbalise the connection. The questions of the teacher can fulfil this function because the teacher is an experienced person who has previously made the connections.

In a lesson on area and perimeter Teacher B (11.8.94), in one of the activity settings, spent some time with her pupils asking them what they thought the use of perimeter might be:

T: OK, now I want to see if you can tell when you think you might be able to use perimeter ... When do you think in normal life, in everyday life, at home or at school or when you are doing something,

a hobby or something that you might have to work out the perimeter of something? Louise?

P: If you are building and you want to build a house, you've got to measure the outside of the yard.

T: Right! If you want to know the distance all the way round something. OK. Yes, Jason.

P: If you are going to measure a carpet.

T: Does a carpet go round the edge of your room? No, so that is not a very good example is it? The carpet isn't just going to ... you are not just going to put a path of carpet around the edge of your room. So we won't use perimeter to find a carpet.

P: You want to fence in your garden.

T: Right! If you want to fence in your garden.

This small cameo of the discussion showed how the teacher skilfully led the pupils to point out examples of how they would use perimeter. As they did this they were verbalising the connections, which they had made regarding perimeter. For some the examples indicated understanding, for others, like Jason, they still had to fully understand the nature of perimeter. Their previous knowledge of perimeter was poised for further development. The teacher could have used this interaction with Jason to correct his understanding of perimeter but did not. Later in the lesson Jason gave an example in response to another question which demonstrated that he had gained understanding. This development was the result of the continued interaction between the teacher and the pupils and not just through Jason's own thinking. It demonstrates the Vygotskian model of learning in which peer group interaction leads to the development of understanding.

The next step of the process, that of assisting pupils to gain comprehension and the development of a "schooled" concept, is also illustrated in this interaction. Jason's naïve concept of perimeter was developed through the interaction which he showed in the later example, the frame of a picture. The teacher gave him time to work out the nature of perimeter and express it in an example which was appropriate. It was the development from a naïve, or even incorrect, concept to a schooled concept.

Questions that assist the pupils to verbalise their operations.

This aspect of assistance was not present other than in the small group activities in which the teachers were sometimes of assistance. Most of the verbalisation in relation to operations that had been performed was in the giving of the answers to problems, which had been done either in the classroom or for homework. Teachers did not see it necessary for them to encourage pupils to say how they had got their answers; even when they had done the problems incorrectly. More attention needs to be given to this possibility as an aspect of the means of assistance.

Questions which develop comprehension.

Throughout the process of asking questions in the lessons the teachers were concerned with the development of comprehension although, as was seen above, at times the questions asked were purely at the level of recall. The importance of prior knowledge in the development of comprehension cannot be overemphasised.

Cognitive structuring.

When teachers assist pupils in their building of cognitive structures they are concerned with the development of a framework or scaffolding for thinking and

acting (Gallimore & Tharp, 1991, p. 182. Greenfield, 1984, p. 117). In mathematics these frameworks may take a number of different forms such as formulae for working out areas or methods for solving geometric problems. The lessons which were observed covered a range of subject areas, including fractions, percentages, geometric shapes, perimeter, area and volume. In each of these topics the opportunity to build cognitive structures was available to the teacher.

Cognitive structuring is an aspect of assistance in the ZPD which cannot happen without the teacher accessing the prior knowledge of the pupils. Without a foundation there can be no structure.

<u>The teacher provides a structure for the pupils</u>.

In one of the lessons taught by Teacher C (8.8.94) there was an attempt to provide a structure within which the pupils could do a particular problem. The discussion had been about perimeter and the teacher wanted an example of this but instead a pupil gave an example that involved area.

T: OK. That has got to do with area.

P: Or perhaps when they want to put up a fence.

T: When they want to put up a fence. OK. There's your house. [Draws a house on the chalkboard] This is the end of your garden ... its got a funny shape and the guy says OK that's fine, I will put up a concrete fence but how long must it be? Then you will have to work out the perimeter. And what do you have to do? You've got to measure all the way round the outside of this so that you have got the perimeter.

Through the use of the diagram and the prior knowledge of the pupils the teacher developed a structure within which the pupils were able to understand the way in which perimeter could be used. This was followed up in an exercise which

was later given to the class.

The teacher organises the pupils' perceptions.

In the lesson on perimeter and area given by Teacher B (11.8.94) we saw this type of structuring happen. The teacher had begun the lesson by sending the pupils out of the classroom to measure a number of different shapes: the netball field, the swimming pool, the cricket pitch and a paved courtyard. These concrete experiences presented some problems which the pupils had to overcome, such as the irregular shape of the courtyard.

T: [Asks the group which was set the task of measuring the perimeter of the netball field to explain what they had done.]

P: We measured the length of the field and timesed it by two and measured the breadth and timesed it by two and got ninety-two metres.

T: So you measured the length and timesed by two...

P: Measured the breadth...

T: Breadth...

P: And timesed by two.

T: OK. And what did you get?

P: Ninety-two metres.

T: Ninety-two metres around the whole field? You did the whole netball field ... Or half of it?

P: The whole one.

T: So you went around the whole one, Tim? OK. The cricket pitch. OK, Louise.

P: OK! We measured the width, it was 2 metres 50 centimetres,

timesed that by two and got 5 metres. We measured the length we got 24 metres 20 centimetres, we timesed that by two and got 48 metres 40 centimetres. Then we timesed the width and length and got 53 metres 40 centimetres. [The girl reporting this does so without hesitation or interruption and gains comments from the rest of the class.]

T: Gee, Louise, that's complicated.

T: OK, right, well done.

The teacher gave the pupils the opportunity to report back on their measuring of the shapes that they had been assigned. While they did this the teacher was preparing them for the next step which was to look for a pattern which would emerge from the results of the pupils' activity. During the report back it was evident that the pupils had recognised that there were sides of the shapes that were equal in length and that not each side needed to be measured. Through the kinds of comments the teacher made she began to organise the perceptions of the pupils in such a way that they could be led from what they knew to what she wanted them to know: the formula for perimeter and later the formula for area.

This is an example of what Vygotsky is concerned to see done in a ZPD: pupils are taken from the position in which they can perform some activity on their own (measuring the designated areas) to one in which they can perform at a potentially more complex level with the help of the teacher (to find a formula and to use it in calculating the perimeter of some abstract shapes).

The teacher was aware of the actual development level of the pupils, their prior knowledge, and the likelihood that the learning process would follow a pattern parallel to that suggested by Vygotsky. This happened as the result of a well-

planned activity setting. The teacher, from experience, was aware of how the process would develop. Whether it was purely the result of experience and a tacit theoretical framework or supported by a theoretical model of how children learn from experience was not confirmed because of the researcher's purpose which was to observe without influencing the teacher in any way. This kind of awareness shown by the teacher could be enhanced by specific training in the use of the means of assistance and the theoretical framework within which they can effectively be used. With knowledge of the means of assistance in the ZPD the teacher could have dealt differently with the interaction in the above example.

Discovery learning as used in this lesson also follows the pattern suggested by Pirie and Kieren (1992, p. 506) in which the pupils are asked to perform certain behaviours so that they can come to a conclusion. This is shown in Louise's report on what they had done. Her group performed all the right behaviours, using terms which reflected the influence of earlier teaching, i.e. using "timesed" instead of "multiplied".

The teachers' explanations are structured.

In the following, rather lengthy, extract, again from a lesson by teacher B (11.8.94), we see the teacher using the information which the pupils have discovered in their task. The structure of the teacher-pupil interaction was one in which the teacher used the responses of the pupils to move them forward in the lesson. She did not just give them the formula but, through the use of questions, assisted the pupils first to find a formula which applied to rectangles and then one which applied to squares.

The teacher not only assisted the pupils in the derivation of the formula for the perimeter of a rectangle and a square but went on to look at the ways in which

the length of a side could be found, given the perimeter of a rectangle or a square.

T: Have you seen a common pattern? Let's talk about the rectangles first.

P: Timesed the length by two and the breadth by two.

T: And did it work for every single one? Who said no? Jason, just trying to be clever? Right we took the length and timesed by two and took the breadth and we timesed by two and then we added them together and it worked every single time. There was a long way, I was hoping someone was going to do it but you were all cleverer than I thought, I was hoping one group might have measured all four sides and then added them together but you are already thinking like I want you to think so you can be congratulated on that, you are finding shorter methods. All right? Do you think we can work out a formula that's going to work for when we find the perimeter of a rectangle? Do you think if we do the same thing with all rectangles we're going to get the right answer? (No answers) ... Did it work five times? Well it is going to work every single time. OK, now what can we say our formula is for the rectangle? Barry?

P: Times the breadth by two and the length by two.

T: Right! We can say twice (writes on the chalkboard) length plus breadth, and I've got them in brackets, why have I got them in brackets? What does brackets mean? ... Barry?

P: They come first.

T: Right, so I find the length, I add it to the breadth, I multiply the answer by two and I will know the perimeter of any rectangle. What

about the square now, we only did one square and that wasn't even a complete square.

P: We times the length by four.

T: Right! Good girl, if we times the length, we just have to measure the length of one side, and we are going to multiply it by four. So that's the rectangle and that was a square [indicates the formulae written on the chalkboard]. Now I want to see who is going to be really clever. If I have got the perimeter of a shape and I want to work out the length, how am I going to do that? I've got the perimeter. Let me give you an example, right here's my rectangle, the perimeter equals 60, let's say centimetres and I know that this side here is equal to 10 centimetres. Right, so the perimeter is 60 centimetres and that side is 10 centimetres, can anybody think of a way how we can work out what the length of this side is? Michelle.

P: I think you take 60 minus 10 minus 10 and you get forty, divide it by two and you get 20.

T: Do you agree with her that it is 20? Right! So she thinks she took 60 minus 10, minus 10 again, right, she did that first so we put it in brackets and than she divided that by two. Kerry-Anne?

P: She could have divided 60 centimetres by two and then minused 10.

T: OK. Good girl, why did you divide it by two?

P: Because then you have the length of the one side. T:OK, so she took sixty and divided it by two OK, which is going to give her 30 which is two sides then she minused the one side which was 10 and she got 20 as her answer. Good girl that was another way of doing it.

Right ! What about a square? I have a square and the perimeter is 40 centimetres and I know that this side is 10 centimetres. Yes, Michelle.

P: 40 divided by four minus 10. [Some discussion]

T: Right! Michelle.

P: 40 divided by four.

In this part of the activity setting, which was shaped around the discovery of the formulae for the perimeter of a rectangle and a square, the teacher *used examples, showed patterns* and in a subtle way was *demonstrating methods*. All of these are aspects, which indicate cognitive structuring.

Although the teacher did not do examples using the formulae that had just been derived, it did not detract from the effectiveness of the process she used. Often this type of approach will lead to a teacher's working of examples to show how the formula may be used, thus modelling for the pupils the use of a formula. The adopted approach did, however, prepare the way for the next section of the lesson in which the teacher went on to ask the pupils where perimeter might be used.

<u>The teacher encourages independent cognitive activity</u>.

Although identified by the researcher as a potential use of "Cognitive Structuring" difficulties were experienced in gathering adequate data. Other than the responses to the questions asked by the teacher it was not possible to record the individual activity.

In every lesson observed the teachers gave the pupils some activity as reinforcement of what had been learnt. This was either in the form of an exercise from the textbook or in the form of a task which was prepared by the teacher. In

these activities the pupils interacted with each other and on occasion corrected each other's understanding. This was in accordance with the theory that learning in a ZPD can be effected by either an adult or a peer who has greater understanding. The group activity of the pupils was not the central focus of the research and could be used as a focus for some further research.

The pupils form their own patterns.

In the extract from the lesson by teacher B referred to above (p. 132ff) it was clear from a comment by the teacher that the pupils had begun to form their own patterns regarding the nature of perimeter. Whether they had prior knowledge of it or not is not certain (a teacher often does not know what content is remembered from lessons in previous years). The pupils did, in this lesson, form patterns without the assistance of the teacher. This is evident in the way in which they were ready to give an answer to the teacher's request for a pattern concerning perimeter ("Timesed the length by two and the breadth by two").

The pupils discovered patterns for themselves, organised the content of their discovery activity, clearly had an overview of what was happening, could give relevant examples of what perimeter was about, could meaningfully communicate their findings and, later, test their patterns in the exercise that they were given to do. All of these abilities indicated a fairly well-developed amount of prior knowledge. The teacher did not, however, exploit it to the full.

Evidence of metacognitive processes.

As a person progresses within a ZPD from naïve to schooled concepts, so the possibility exists for the parallel development of metacognitive processes. For learners to be able to regulate their own learning, they must develop strategies, which are of a metacognitive nature, to do so. Why in the extract on p. 132ff, for

instance, did the pupils develop an understanding of the nature of the formula for perimeter? It may have been because of their previous knowledge of formulae and the way in which formulae function. When the pupils said that it was not necessary to measure all four sides of the rectangular shapes they were demonstrating their use of metacognitive processes. Whether they were consciously aware of these metacognitive processes or not was not determined by the teacher. For instance the pupils could have been asked to explain how they arrived at some of their conclusions.

In the playing of the 24-Game, as used by Teacher A and discussed earlier, the pupils who were good at the game had developed executive strategies. The speed at which the answers were given, suggested that they had a well-developed strategy by which they were able to find a correct answer. Whether this strategy was consciously known to the pupils or not is not certain. On one occasion teacher A did not understand how a pupil had arrived at the answer and asked the pupil to explain to him how he had obtained the answer. The pupil's explanation was in terms of the steps he had followed in getting the answer and not in terms of a strategy used.

5.5 **CONCLUDING COMMENTS**.

The use of the three means of assistance in the ZPD as a framework for the analysis of the observed lessons gave the researcher some insight into the processes in the classroom. However, since the means of assistance were not discussed with the teachers, it was not possible to derive the intentions of the teachers. The conclusions to be drawn, therefore, are the result of inferences made from the observations and informal talks with the teachers.

The importance of activity settings as a unit in which the means of assistance can be effectively employed became clear during the observations in all of the lessons attended. With increased insight into the use of the means of assistance within the context of the many interactions which occurred, the teachers could have been able to extend the children beyond the level at which they seemed to be used to working. Further research needs to be done in order to demonstrate the value of an approach of this nature.

CHAPTER 6 - CONCLUSION

6.1 THE USE OF PRIOR KNOWLEDGE IN THE LESSON.

In the theoretical underpinning of this research (Chapter 2) a parallel was drawn between the actual developmental level of pupils in a ZPD as understood by Vygotsky (1978. p. 86) and the prior knowledge of the pupils. It was further pointed out that if a teacher was to assist pupils in their progress through a ZPD, then the

point at which this assistance should commence must be the identification of their prior knowledge or actual developmental level.

What was observed in the lessons which were attended was that teachers did make some use of the previous knowledge and skills of the pupils although only to a limited extent. When the teachers did make use of the pupils' prior knowledge it was during the questioning done by the teachers and in the problem solving activities, which were assigned to the pupils as classwork.

The use which teachers made of the pupils' prior knowledge, however, appeared to be accidental rather than intentional. It was not possible within the parameters of the research to confirm whether the teachers did intentionally use the prior knowledge of their children or not. This was because of the concern of the researcher not to influence the teachers in any way by discussing their intentionality with them. What *was* observed, regarding the intentions of the teachers who were observed, was that their central task in their lessons appeared to be to cover the content of the lesson and to ensure that the pupils understood each aspect of the lesson.

The teachers showed what might be called a *tacit understanding* of the importance of giving assistance to their pupils in their learning (which could be described as assistance in the ZPD) but they did not begin the process by identifying the actual developmental level of the pupils and they did not complete the process. The rationale for this conclusion is that on no occasion did any of the teachers pursue a line of questioning once they had received the required answer. They did not *build* on the prior knowledge of the pupils by continuing with their line of questioning until the pupils clearly indicated by their answers that they fully understand the content related to the question being asked.

The implication of this conclusion is that a knowledge of teaching as assistance through a ZPD would enable each of the teachers, in the delivery of their lessons, to bring about greater understanding on the part of the pupils and to use effectively the prior knowledge of the pupils.

6.2 THE USE OF MATHEMATICS AS THE CONTEXT FOR THE RESEARCH.

Little was said in the analysis of the lessons about methods which may specifically be used in the teaching of mathematics in the primary school. This is because the *subject* itself was not the main concern of the research. Any school subject could have been chosen. Mathematics was chosen for four main reasons:

1. The researcher has an interest in Mathematics as a subject in the school curriculum.
2. The availability of Mathematics teachers and classes in which observation could be performed.
3. The structure of Mathematics as a discipline often required building on prior knowledge.
4. Primary mathematics provides ample opportunity for the teachers to use instruction, questioning and cognitive structuring.

The teachers who were observed varied significantly in their approach to the teaching of Mathematics but this did not mean that the observation was not productive. The analysis of the data which was gathered indicated that much can be learned from the teaching of it as a subject. With regard to the question being researched, if mathematics is to be taught effectively then the use of the prior knowledge of the children is essential.

6.3 THE DEVELOPMENT OF AN INTERSUBJECTIVE CONTEXT IN A LESSON.

In an intersubjective relationship with their teachers, pupils are able to

reveal their prior knowledge and provide a starting point on which the teacher can build the pupils' subsequent understanding. The teachers who were observed, however, maintained a position of authority and emphasised the subordinate position of the pupils through the kinds of instructions they gave the pupils. This relationship, which was maintained by each of the teachers with varying degrees of success, did not allow for pupils adequately to express themselves and clarify their difficulties. This resulted in an atmosphere in which the pupils were not assisted through their ZPDs and they remained at the actual developmental level which obtained at the beginning of the lesson.

The teachers, as a result could not fully make use of the opportunities for them to develop their ability to assist pupils in the use of their prior knowledge. The lessons appeared to be seen as a means to an end, which was the transmission of knowledge (Gallimore & Tharp, 1991, p. 189).

6.4 **THE SKILL OF QUESTIONING**.

The skill of questioning, through which joint activity could have been developed, was used to assess pupils understanding but did not always assist them in their ZPDs. If the teachers had been orientated towards the use of the pupils' prior knowledge they would have been unable to avoid questions which assisted pupils.

As has been pointed out in the analysis above, the questions which were asked by the teachers did not encourage answers which were more than one or two sentences. There was no occasion on which any of the teachers used a series of questions to develop a form of dialogue which would have assisted the pupils in their learning. Had this been done, the understanding of the topic by the pupils would have had a greater chance of being enhanced. The result was that pupils

were initiated into an approach which followed the recitation script in which they needed only to give the correct answer to the questions which were asked. There was no building of a structure on the knowledge which the pupils had already acquired with appropriate scaffolding (Greenfield, 1984, p. 118) offered by the teacher.

Pupils, on the other hand, seldom made use of questioning in order to clarify their misunderstandings. Occasionally, during their group activities, a pupil may have asked a question, but it was usually for clarification and not for explanation. The reason for this may be that pupils were not used to asking questions as part of the lessons, or else it meant that they understood everything that was being taught. As a corollary it might also be true that, because of their inability to ask questions, pupils may also be unable adequately to frame answers to questions.

The implication of this is that if teachers do not ask questions which are designed to assist in the development of understanding then they are not modelling the type of questioning which pupils should be able to ask in order to acquire understanding. It also emphasises the need for an intersubjective approach to teaching as discussed in the previous section.

6.5 **THE SKILL OF INSTRUCTING**.

Teachers were able to give instructions about how pupils should behave in the classroom but they appeared to find it difficult to give instructions which assisted pupils in their learning. Here, too, the identification of the prior knowledge of the pupils would have been a guide to the kinds of instruction, which would have assisted the pupils such as the linking, and internalising of information and the completion of a task. The most frequently given instruction was for the pupils to

perform a specific task such as doing some set exercises from their textbooks, doing some practical work such as the construction of the nets of solids as required by Teacher A (in the lesson on 10.8.94) or the colouring in of geometric shapes as Teacher B instructed her pupils to do (in the lesson on 8.8.94).

The instruction by the teachers for the pupils to do their tasks in a specific way did not assist them in their understanding of the content of the lesson. Those pupils who were able to consolidate their work and use their knowledge succeeded because they had formed their own cognitive structures and had integrated their prior knowledge and the new knowledge contained in the lesson.

What appeared to be the expectation of the teachers was that the mere doing of the classwork and the practical work would be sufficient to produce the required understanding of the pupils. The testing of this understanding would, according to the approach of Teacher C, happen in the next test.

The implication of these conclusions regarding instruction is that teachers tend towards the assigning of tasks as reinforcement within their lessons. They do not see instruction as a means of assistance in which pupils are helped to progress through a ZPD. The linking and the internalising of information in relation to progression from an actual developmental level (prior knowledge) to a level of potential development is not envisaged.

6.6 **THE SKILL OF BUILDING COGNITIVE STRUCTURE**.

The teachers were not seen to consciously concern themselves with this aspect of assistance other than on one occasion when Teacher B led the children to the discovery of the formulae for perimeter and area after their measurement of the different shapes in the school grounds. This exercise in itself did not indicate

cognitive structuring as such but a rounding off of an inductive process of discovery.

There were many opportunities for the three teachers to use this means of assistance in an appropriate way. The making of the nets of the shapes as required by Teacher A (10.8.94) was an example of a lost opportunity. Teacher A could have demonstrated the development of cognitive structure in the making of the nets by associating the net with the formulae for area and volume.

That does not mean that the pupils did not form cognitive structures as a result of what they were doing. It is just that the teachers did not assist the pupils in this process. It happened incidently. The teachers did not know, therefore, whether the cognitive structures that were developed by the pupils were as complete as they might have been had appropriate assistance been provided by the teacher.

The discovery method is associated with the danger that the cognitive structures developed by the pupils may be incomplete and may never become complete unless the teacher assists in the formation of these structures. The teacher needs to develop the skills to be able to do this (Tharp & Gallimore, 1988, p.67, Gallimore & Tharp, 1991, p. 182f).

6.7 **THE DESIGN AND USE OF ACTIVITY SETTINGS**.

An observation, which the researcher believes is an important pointer towards the success of many lessons and which was noted in the analysis of the lessons was the use of "focal points" in the lessons observed. Each of the teachers appeared to build their lessons around a number of specific focal points. Whether it was an exercise involving discovery or a complex problem which involved a series of calculations to reinforce a number of skills or even the 24-Game, the activity was a focal point of the lesson.

Earlier, in Chapter 2 (Section 2.7, p. 33f.) "activity settings", which is a technical term used by writers working in a Vygotskian paradigm, were described as the "contexts in which collaborative interaction, intersubjectivity, and assisted performance occur - in which *teaching* occurs" (Tharp & Gallimore, 1988, p. 72).

In the light of this discussion of activity settings, an approach which uses a number of focal points appears to have a coherence which has the potential to produce the kind of result which teachers would like to achieve in their lessons. The value of these lessons would be further enhanced if the focal points become the planned and spontaneous activity settings in the lesson. The concept of a "focal point" as used in relation to the lessons which were observed refers to a unit in the lesson which is much broader than the unit to which the concept of an "activity setting" refers. When teachers understand the use of activity settings then they will better be able to assist the pupils in their learning. They will not overlook the smaller interactions which are vitally important in the assistance given to pupils in their ZPDs.

In their consideration of the importance of activity settings, Tharp & Gallimore (1988, p. 162) argue that to give pupils the opportunity to work collaboratively in peer groups is not always the most valuable method to use. While they may enjoy the activity, pupils often do not achieve as much as they could if they had continued to be assisted by the teacher. Pupils themselves do not necessarily know how to use their prior knowledge to assist others in a collaborative context.

In the lessons of Teacher C, who frequently used small group activity to complete a task, it was observed that these groups after a short time began to get noisy and tended to lose their direction. This seemed to indicate that they did not

know how to keep themselves busy with the problem before them in a creative way. They did have a degree of prior knowledge which they had accumulated in previous lessons and which provided a base from which to work.

The implication which is contained in this discussion is two-fold. The first aspect is that teachers themselves need to develop an understanding of the nature and use of activity settings so that they will not miss opportunities for assisting pupils. There were frequent examples in the lessons observed when the teacher missed an opportunity to assist a pupil. (The interaction which was possible between Teacher B and Jason in the lesson on perimeter and area is a case in point.) The second aspect is that teachers need to assist pupils to develop strategies for assisting their peers in their peer group activities in the classroom so that learning becomes effective.

6.8 **IMPLICATIONS FOR THE TRAINING OF TEACHERS**.

Conclusions drawn from the analysis of classroom observations suggest a number of pointers towards ways in which teacher training could be improved.

An important issue that needs urgent attention is that the present type of classroom activity is too dependent on the teacher as an authority figure. If the prior knowledge of children is effectively to be built on as a matter of course, in every lesson, then the teachers need to develop the relevant skills to be able to assist pupils in their progress through their zones of proximal development. The pupils in turn need to be able to develop the necessary structures in their knowledge which will enable them to regulate their own learning (Gallimore & Tharp, 1991, p. 198f).

The implication for the training of teachers is that there needs to be a change in the curriculum of the Colleges of Education. In the methodology used

the change will be from a method of teaching which is still caught up in a form of fundamental pedagogics, in which knowledge is taken as a "given" which must be transferred to students and pupils, to a method which involves an understanding of teaching as assistance of pupil in their ZPDs (Gallimore and Tharp, 1991, p.177).

For too long emphasis has been placed on the psychology of learning and not enough attention given to the psychology of teaching. Teachers have been given theories concerning child development and learning but not of teaching as such. The understanding of teaching which many teachers in the past have developed has been as a result of a series of painful experiences as they have struggled to find a way to cope in difficult circumstances. It has not been as a result of their training.

The approach to teacher training, which needs to be developed, is one which does not leave the new teacher to discover in an accidental way or through an experimental process, what happens in the classroom. It must be an intentional and interactive process in which student teachers are assisted from their actual developmental level to a level of potential development from which they will be able to assist others (Gallimore & Tharp, 1991, p. 198f).

To return to the argument of Perkins (1992), discussed in Chapter 2, regarding the characteristics of an effective educational process, he concludes that "if we face up to what we really want students [pupils] to learn, we then know a good deal about how to approach it: à la Theory One, provide information capturing the performance in question, provide needed background knowledge, offer thoughtful practice, generate informative feedback, and build motivation" (p. 72). This kind of approach can successfully be achieved within the framework of what has been examined during this research project. The importance of prior

knowledge within the approach of Perkins' Theory One is evident in each of the first three phases. Background knowledge consists of the prior knowledge of the pupil; this prior knowledge will be used in thoughtful practice and will be the focus of informative feedback. When pupils are treated in this educationally effective manner then they will be motivated to regulate their own learning.

6.9 LIMITATIONS OF THE RESEARCH PROJECT AND SUGGESTIONS FOR FURTHER RESEARCH.

A major limitation in this research project was that the question being asked did not take into account the possibility of making an intervention into the approach used by the three teachers who were observed. A new question of the form: *To what extent can the means of assistance (Tharp & Gallimore, 1988) be used to develop the understanding of pupils in Standard 5 within the context of the teaching of mathematics?* would provide for a more in-depth examination of the effectiveness of the means of assistance and would involve the use of prior knowledge as teachers identify the ZPDs of their pupils.

To research the above question will involve a long term programme of classroom observation and a number of committed fieldworkers. In this research the researcher had a limited amount of time within which to do the research. If the teachers involved in the research could have been trained in the techniques of action research then the effectiveness of the research could have been enhanced. This does not mean that this research did not produce any significant results. Within the time available for this research a significant amount of information was gathered. Further interpretation of this information, with different criteria could be done.

To facilitate the development of research into classroom practice, using the

means of assistance within a Vygotskian paradigm, a research centre could be established. The comprehensiveness of the description by Vygotsky, of teaching as "assistance in the Zone of Proximal Development", is such that it warrants further research.

REFERENCES

Adelman, C.; Cooper, D.; Ebbutt, D.; Elliott, J.; Hurlin, T. and Sitte, K. (c. 1975) *The stranger in the classroom*. Mimeograph. Cambridge Institute of Education.

Ausubel, D.P. 1968. *Educational Psychology: a cognitive view.* New York: Holt, Rinehart & Winston.

Bandura, A. 1986. *Social foundations of thought and action: a social cognitive theory.* New Jersey: Prentice-Hall.

Biddle, B.J. & Anderson, D.S. 1986. Theory, methods, knowledge, and research in teaching. In Wittrock, M.C. (ed) *Handbook of research on teaching.* Third Edition, New York: Macmillan.

Bidell, Thomas R. 1992. Beyond interactionism in contextualist models of development. *Human development,* vol. 35, p. 306-315.

Bloom, B.S. (ed) 1956. *Taxonomy of educational objectives: the classification of educational goals*. London: Longmans.

Brause, Rita S. & Mayher, John S. (eds) 1991. *Search and re-search: what the inquiring teacher needs to know.* New York: Falmer Press.

Cobb, P.; Yackel, E. & Wood, T. 1992. Interaction and learning in mathematics classroom situations. *Educational studies in mathematics,* vol 23, p. 99-122.

Croll, Paul. 1986. *Systematic classroom observation.* London: Falmer Press.

Dane, Francis C. 1990. *Research methods.* Pacific Grove: Brooks/Cole.

Delamont, Sara. 1992. *Fieldwork in educational settings: methods, pitfalls and*

perspectives. London: Falmer Press.

Derry, S.J. 1990. Learning strategies for acquiring useful knowledge. In Jones, B.F. & Idol, L., *Dimensions of thinking and cognitive instruction*, New Jersey: Lawrence Erlbaum.

Duminy, P.A & Söhnge, W.F. 1980. *Didactics: theory and practice*. Cape Town: Maskew Miller Longman.

Elliott, John. (c. 1975) *Developing hypotheses about classrooms from teachers practical constructs.* Mimeograph. Cambridge Institute of Education.

Elliott, John. 1991. *Action research for educational change.* Milton Keynes: Open University Press.

Fosnot, Catherine Twomey. 1989. *Enquiring teachers, enquiring learners*. New York: Teachers College Press.

Freire, Paulo. & Faundez, Antonio. 1989. *Learning to question: A pedagogy of liberation.* New York: Continuum.

Freire, Paulo. & Shor, Ira. 1987. *A pedagogy for liberation: dialogues on transforming education.* Bassingstoke: Macmillan.

Gallimore, R. & Tharp, R. 1991. Teaching mind in society: Teaching, schooling, and literate discourse. In Moll, L.C. (Ed), *Vygotsky and education: Instructional implications of socio-historical psychology.* Cambridge, Mass: Cambridge University Press

Goodson, Ivor F. & Walker, Rob. (eds) 1991 *Biography, identity and schooling: Episodes in educational research.* London: Falmer Press.

Greenfield, P.M. 1984. A theory of the teacher in the learning activities in everyday life. In B. Rogoff & J. Lave (Eds), *Everyday cognition: its development in social context*. Cambridge, Mass: Harvard University Press.

Hopkins, David. 1985. *A teacher's guide to classroom research.* Milton Keynes: Oxford University Press.

Howard, Robert W. 1987. *Concepts and schemata: an introduction*. London: Cassell.

King, Alison. 1992. Facilitating elaborative learning through guided student-generated questioning. *Educational psychologist,* vol. 27, no. 1, p. 111-126.

Moll, L.C. (ed). 1991. *Vygotsky and education: instructional implications and applications of socio-historical psychology*. Cambridge, Mass: Cambridge University Press.

Montgomery, D. & Hadfield, N. 1989. *Practical teacher appraisal.* London: Kogan Page.

Mouton, J. & Marais, H.C. 1988. *Basic concepts in the methodology of the social sciences.* Pretoria: HSRC.

Perkins, D. (1992). *Smart schools: from training of memories to educating minds.* New York: Free Press:

Pirie, Susan. & Kieren, Thomas. 1992. Creating constructivist environments and constructing creative mathematics. *Educational studies in mathematics,* vol. 23, p. 505-528.

Porter, A.C. 1990. Collaborating with teachers on research. In Olson, Mary W. (ed) *Opening the door to classroom research.* Newark: International reading association.

Pressley, M.; Symons, S.; McDaniel, M.A.; Snyder, B.L. & Turnure, J.E. 1988. Elaborative interrogation facilitates acquisition of confusing facts. *Journal of educational psychology,* vol 80, no. 3, p. 268-278.

Pressley, M.; Wood, E.; Woloshyn, V.E.; Martin, V.; King, V. & Menke, D. 1992. Encouraging the mindful use of prior knowledge: attempting to construct explanatory answers facilitates learning. *Educational psychologist,* vol. 27, no. 1, p. 91-109.

Shor, Ira. *Critical teaching and everyday life.* Chicago: University of Chicago press.

Simon, M. A. 1994. Learning mathematics and learning to teach: learning cycles in mathematics teacher education. *Educational studies in mathematics,* vol. 26, p. 71-94.

Tharp, R. & Gallimore, R. 1988. *Rousing minds to life: Teaching, learning, and schooling in social context*. Cambridge, Mass: Cambridge University Press.

Van Maanen, John. (ed) 1983. *Qualitative methodology.* Newbury Park: Sage.

Vygotsky, L. S. 1978. *Mind in society: the development of higher psychological processes.* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds. and Trans.). Cambridge, MA: Harvard University Press.

Walker, Rob. & Adelman, Clem. 1975. *A guide to classroom observation.* London: Longman.

Williams, M. 1989. Vygotsky's social theory of mind. *Harvard educational review,* vol 59, no. 1, p. 108-126.

Willoughby, T.; Waller, G.T.; Wood, E, & MacKinnon, G.E. 1993. The effect of prior knowledge on immediate and delayed associative learning task following elaborative interrogation. *Contemporary educational psychology.* vol. 18, p. 36-46.

Wajnryb, R. 1992. *Classroom observation tasks.* Cambridge: Cambridge University Press.

Woloshyn V.E.; Wood, E. & Willoughby, T. 1994 Considering prior knowledge when using elaborative interrogation. *Applied cognitive psychology,* vol 8, no. 1, p. 25-36.

APPENDIX 1

1. **OBSERVATION SCHEDULE USING THE CHOSEN THREE MEANS OF ASSISTING**.

A. INSTRUCTION

1. The teacher establishes the conditions for learning by:

a) Correcting behaviour

b) Focusing the attention of the pupils

c) Directing the pupils to perform certain actions

d) Assigning classwork to be done

2. The teacher assists performance by:

a) Directing the pupils to link pieces of information

b) Telling pupils to/how to internalise information

c) Requiring pupils to complete a task

B. QUESTIONING

1. The teacher asks questions to assess pupil performance so that the pupil can progress forward by:
a) Testing the recall of information

b) Finding out the level of current performance

2. The teacher assists pupil performance by:
a) Enabling interpolation through the use of questions

b) Provoking thought using questions

c) Encouraging pupils to construct their own answers

d) Helping pupils to verbally make connections

e) Moving pupils from being naïve to showing comprehension

f) Getting pupils to verbalise their mental operations

C. COGNITIVE STRUCTURING
1. The teacher provides a structure for the knowledge being taught by:
a) Organising the pupil's perceptions

b) Structuring explanations by:
i) Using examples to illustrate

ii) Doing model problems

iii) Indicating patterns

iv) Demonstrating methods

2. The teacher encourages independent cognitive activity by:
a) Indicating a process for solving problems

b) Developing rules for finding out things or doing things

c) Encouraging the formation of patterns

d) Sequencing information

e) Grouping operations

f) Evaluating answers

g) Enabling evaluation, grouping or sequencing of perceptions, memory, actions.

h) Enabling insight into problems

i) Encouraging pupils to use intuition

j) Guiding re-invention through mutual participation

3. The pupils form their own patterns by:
a) Discovering patterns for themselves

b) Organising content

c) Gaining overviews of how problems are solved

d) Giving appropriate examples

e) Communicating their ideas with meaning

f) Asking relevant questions to clarify patterns

g) Testing their patterns

4. Metacognitive process are evident in:
a) Patterns for remembering information

b) The choice of available methods

c) Ways for organising perceptions

d) The use of strategies

e) The development of explanations

APPENDIX 2

TRANSCRIPTS OF OBSERVED LESSONS

2.1 TRANSCRIPT OF THE LESSON TAUGHT BY TEACHER A ON 10.8.94

The lesson was given to a Standard 5 class.

This is a follow up lesson on area and volume.It followed on the introduction which was to choose a team of pupils in a 24 Game competition.

T: Right! People let's get out our maths books.
[Noisy preparation]

T: Right! We are going to exercise 13.4a ... right! 13.4a ... Michelle am I right? ... [Discussion about it] ... we'll come back to those. Just exercise 13.4a at the moment please people, I've got to carry on with that today. What's wrong Mavis?

P: Nothing, sir.

T: 13.4a. If there is anything that you would like to ask, ask me to explain, we'll do that afterwards. OK, no. 2. Let's start with this group here, Bridget, you start for us please.

P: 28 metres cubed.

T: Again.

P: 28 metres cubed.

T: 28 metres cubed. Yes, Mark?

P: 50 centimetres cubed.

P: 400 centimetres cubed.

T: No 3? Let's just have a look at no. 3. It's cubed, ja.
No. 3? ... 50 centimetres cubed, that's correct.

P: 400 centimetres cubed.

T: Lovely.

P: [Inaudible]

T: Let's have a look at b, 4b. Its just asking you actually to read it correctly. People, its nothing more than that. Let's have a look at that, its just the wording that they are actually giving you. There is no calculation as such to do. So we are going to have a look at that. Complete the following: Volume

of a stack, whatever, they actually ask you, equals, area of base, now area of base you have been working with for a long time, that is length times breadth times .... so what are we short of?

P: Height

T: Height. So all we need to fill in there is .... they are actually asking you, do you know the formula for volume? And, instead of saying length times breadth, they are saying area. [Writes on the chalkboard] Can you all see that? So that is area times the height. Um. Right we carry on with number five please.

P: 2000 centimetres cubed.

T Yes. Next.

P: 55 millimetres squared.

T: Yes. Next.

P: [Inaudible]

T: Correct.

P: [Inaudible]

T: I think that you are going to disagree with him there aren't you?
[Pupils seem to be in general agreement!]

T: Are you all happy with that one? People let's have a look at that one quickly, number d. *No, we are talking far too much.* Are you happy with the answer there, we have got the base of 300 centimetres and that will be 15 centimetres, the height, so we have 300 times 15 and that will give us 4500 and .... , if we work in that, what will that give us? Centimetres cubed. What did you get as the answer? Michael, who gave that answer? What did you get John?...[inaudible statement] Sorry that's correct, my mistake. Quite correct. And now the last one.

P: 27 metres cubed.

T: 27 metres cubed. Right number six. A lovely one. I think we did work through that one as well. The first one, yes please! I think we disagreed on this one, was it this class? Somebody...no it was my class, sorry. Uh, where are we? Sam, we're at the back there.

P: Eight sir.

T: It is eight. Look at that, it is very nice. How many cubes, how many one centimetre cubes, in figure 3, can be fitted into the space in the box? ... Some people, if you have any trouble in seeing that ... who disagrees with the answer? Are you all happy with that, that is fine that's super. Now we go the next one, how many half centimetre cubes, how many half centimetre cubes, people I want you to have a *very* good look at this one ... will we be able to fit into that, [draws on the board] into that box? How many half centimetre cubes? Saartjie what do you get?

P: Sixteen.

T: Saartjie gets sixteen. Who agrees with her? Who agrees? I want you to give us the answer. I'm going to write them down. Who agrees with sixteen?

One, two, three, [counts the number of pupils who say sixteen]... we've got ten people. OK. Mark?

P: Thirty two.

T: You get thirty two. Who gets thirty two? [counts again] Four [writes it on the chalkboard] OK. Who gets a different answer? Ettienne?

P: Sixty four.

T: Who gets sixty four? Put up the hands [counts again] seven people. Who gets a different answer to that? Sam, you got?

P: Twenty four.

T: You get twenty four. Who is going to support Sam on twenty four? [laughter] Sam you're the lone outlaw there hey? Who else? One more, we can't only have thirty two answers. Yes Seetal.

P: Forty eight.

T: Seetal has forty eight. Seetal are you going to be all by your lonesome there? Right people let's have a look at that. I want to be able to *discover*, to see what the solution is. *No we have got too much talking in between*. Now we have got a box measuring two centimetres and down in the bottom of the box I'm going to stack some of my cubes, remember how we did it, how we played around with the cubes and those little cubes of mine will be half a centimetres. Isn't that what they said? Half a centimetre cubes. They will be half a centimetre by half a centimetre by half a centimetre. So how many cubes will I be able to stack in the bottom of my box? [Draws a box on the board] How many cubes will I stack in the bottom of my box? People I've got a box here [fetches a box] there it is, it is two centimetres. Down at the bottom I'm going to stack cubes from the one side from one end to the other and each little cube is half a centimetre in length. How many will I be able to stack across? Lyn? [approx. 10.00 mins]

P: Four.

T: Four. And that cube that way, Lorette?

P: Four.

T: Four, and in the height?

P: Four.

T: Four. So how many cubes will I get in that box?

P: Sixty four.

T: Thank you ... you see what happened ... you see what happened. You people just *doubled* up. Remember cubes, cubes not doubling; not squared, but cubed. Length times breadth times height. I can see where some people got sixteen from. I can see that. They just doubled eight. It is twice the length plus twice the breadth plus twice the height. Have a look at that. You got caught on that one. Right then what is the volume in cubic centimetres of the box? Cubic centimetres. Right Eloise?

P: Eight centimetres cubed.

T: Eight centimetres cubed. Eight centimetres cubed. Right we go up to

number 7 quickly. Lyn, have you all had your turn in that group? Right Clint.

P: 24 cubes

T: Right, 24 cubes. Correct. b?

P: 24 centimetres cubed.

T: 24 centimetres cubed.

P: And they are equal.

T: And they are equal. They are equal. Lovely. Look at that. Totally different shape. Both cuboids but the volume is equal. OK then, that is what we got there. And then number e, they ask you in which unit and we are working in. Right! People put down you pens, pencils, anything. Let's have quick look. I'm drawing a cube quickly [draws on the chalkboard] and I want some information from you people. That is a cube, the length 1 centimetre. I want some information. What can you tell me about that cube? Anything, any information. Any information. Yes Brian.

P: The breadth is 1 centimetre and the height is 1 centimetre.

T: Good information. You said that is a centimetre, sir, and, thank you Brian, that is a centimetre. Other people could not see that. Its a cube and he actually told me, you know sir, a cube, the length is 1 centimetre and the breadth is 1 centimetre. So Brett, what else can you tell me?

P: It has six sides. Sir

T: Six sides, six faces OK. If I make dice out of that I could throw either a one or a two or a three, four, five or six. Lovely, a cube has got six faces. What else?

P: The volume is 1 centimetre cubed.

T: The volume is 1 centimetre cubed. Lovely! What else?

P: All the angles are right angles.

T: All the angles are right angles. Lovely, what else? Cuan.

P: There are eight angles.

T: Its got eight angles, we call them edges. How many edges? Raymond?

P: It's got 12 edges sir.

T: 12 edges, lovely? It's got 12 edges.

P: Sir, the volume of the cube is 1000 millimetres squared, cubed.

T: Oh! Now he is getting somewhere. He says, sir, we could always, also convert the volume of that cube to millimetres. He said, sir, if you want to work that in millimetres you can convert that to millimetres. Lovely, Mark, that is what we did. That [pointing to the diagram] won't be one centimetre that will be 10 millimetres, and that one? So what will the volume be in cubes? Not in centimetres, in millimetre cubes, *pay attention*, what will the volume be then? Senelle.

P: 1000 millimetres cubed.

T: Right. Lovely. Mark I am pleased with that answer. 1 centimetre cubed can also be [writes & draws on the board]? Brian?

P: 0,000001 metres cubed.

T: You can also give it to me in metres cubed. We are not going to use that quite often but we can. So I can go and convert that to metres cubed. Right, I am going to give you a problem. How do you have your medicine? In a so many centimetres cubed. In a teaspoon? From a bottle. How do we have our medicine? Lyn?

P: We measure it in 5 millilitre spoons.

T: We measure it with a 5 millilitre spoon. We normally ... the pharmacist, or the Dr. will write on the prescription there "Take 5 ml every two hours" or whatever the case may be. Right, we are looking at that now we are going to convert and really get an idea of what 5 millilitres really is. What 5 millilitres is. So we're going to look at this and I want you to see and imagine a little cube there in front of you. 1 centimetre by 1 centimetre by 1 centimetre. You have all seen a cube of ice like that. Now imagine that being hollow, imagine that being hollow and I can pour some liquid in there, I can pour a little bit of water, a little bit of milk in there. Now that little cube being hollow it's only got a certain volume I can fill it up to the top and it will only hold a certain amount of water. And that amount of water will come down to 1 millilitre. So for every centimetre cubed I've got 1 millilitre. Now I wonder if I say to you people I've got a cube and it's 8 centimetres cubed, how much water will that little cube hold? Here's a cube [shows a box] it's 2 by 2 by 2. Volume 8 centimetres cubed. I fill it with water, its hollow, how much water will that hold? Seetah? [20.00 mins]

P: It will hold 8 millilitres.

T: It will hold 8 millilitres of water. I'm going to quiz you now. I'm going to leave my cube there and I'm going to give you this. [Draws a cube of side 3 centimetres on the chalkboard] I am going to say that's a cube. Have a look at that. And the only information that I am going to give you is that. That's a cube and I want to know in millilitres how much water that cube will hold. Lovely, now we're working! Now we're working! That's my cube, I need some information here to be able to answer that. Kirk, what do you say? Thank you Clint, that's good thinking, that's 27 millilitres. Now we have got to work out how did he get to that. How did he get to that? How did Clint get to 27 millilitres? There must be a reason for it.

P: 3 times 3 is 9, times 3 is 27 that will give the volume and to convert it into ...

T: So you went there and said sir, I have got to calculate that volume that is length times breadth times height, thank you very much, and that is 27 centimetres cubed, and you've got your answer. Is that clear to everybody, you all understand. Now something else happens here. You know that the bigger the container the more water it holds but somewhere along the line, somewhere along the line, I'm going to find this [draws another cube on the chalkboard, this time side 10 centimetres] who can give me that answer? Who can give me that answer. Michael?

P: You fill it ...

T: You fill it ... you are a little bit ahead of me, you are a little bit ahead of me but that's smart thinking, my boy, that's good thinking. You can explain that to the class just now. I am just waiting for this little answer first. That's good thinking. Sam?

[Inaudible response]

T: No ... no not yet, don't ...

P: 1000 centimetres cubed.

T: That's right. I didn't give you this, I gave you that ... and I worked back to this. Michael, now I want you to come ... come to the front here please. You saw this immediately. Fill that cube please. Can you see what he saw? So he said if I've got a cube this size times that size times that size ... you people have met this, we've met this haven't we and I've used the box from the chalk that we use, can you remember that? And I said to you people ..... think now ... thank you Warren. So if I've got a little ... holder, 10 centimetres, people, it looks unbelievable, you'll argue about it, you'll say never, it won't take half a litre ... 10 centimetres times 10 centimetres times 10 centimetres, I can fill that with a litre of Coke, it will not spill. The volume of that container is one litre. So it becomes clear. Lets look at page 307, no. 8, 9 and no. 10. Neatly, date down please people, I want those done now.

[The pupils become actively involved with the exercise, discussing it with each other. The teacher moves around the class. Some pupils ask questions of the teacher.]

T: [Aware that there is a growing amount of noise, intervenes] *Right people it's going very nicely but there is far too much noise. Discuss it, I don't mind that*.

[Activity continues more quietly]

T: Right! [claps his hands] Everybody sit down. I would like to explain that, right, I want everybody to look at the board there, right hand corner, right hand corner, here at the bottom. You are going to come to 9c and all of a sudden, OK, now you are going to have to explain to us about kilometres and maybe that, it might be so in cubic metres but there is nothing, you've got all the information here, you have got all the knowledge actually, just to go one step further, now look at this, just look at this. I have made a cube there and I've made it 1 metre, by 1 metre, by 1 metre; 100 centimetres, 100 centimetres, 100 centimetres, so I've actually discovered for myself that if I take one metre cubed it comes to the same as 1 000 000 centimetres cubed. Having a look at that further I've discovered that 1 000 000 centimetres cubed will give me 1000 litres. A 1000 litres equals one metre cubed. So that's the way you go about it. And once you get to that you can work in kilometres, so you can get to the answer. People, please, for homework up to and including no. 10 please. Good morning standard five.

P: Good morning sir. [34.30 mins]

The lesson ended at this point.

2.2 TRANSCRIPT OF THE LESSON OF TEACHER B ON 8.8.94

The lesson was given to a Standard 5 class.
The lesson begins with a discussion of the parts of a triangle. The pupils are referred to a page in the textbook.

T: What do we call this part of the triangle? Its called a vertex. Can you all see it on your triangle? So, wherever two sides join, that's the vertex. What do we call, I don't want to say the word, that .. from the vertex to another vertex? Yes what do we call that line?
[Pupil answers are inaudible on the recording but their guesses are not correct]
No...no...height? It could be in another shape but let's look at our triangle. It's just the side. All right the side. When we talk about these shapes and that line, we talk about the sides. The side of a square or the side of a rectangle. Side of a triangle, OK. The vertex and the sides. Those are two names that you are going to have to remember.
Then we go on to our four sided figure, here we have got a quadrilateral. Not symmetrical, right, a quadrilateral doesn't have to be symmetrical, it can be symmetrical. There are some special quadrilaterals, what are those? Four sided figures that are symmetrical? Ayanda
P: Square.
T: All right, a square is one, a rectangle, Tyrone you mentioned it earlier on.
P: A diamond.
T: What do we call the proper name for the diamond?
P: Kite.
T: Kite, OK. All right so those are all special quadrilaterals.
P: [Inaudible]
T: That's not a quad. A quadrilateral has only got four sides. Right, then we look at our pentagon, that's got five sides. When you do TD when you get to

high school you'll come across that, you don't really use it that much in maths. The hexagon, heptagon, and octagon. Right, so those are our main geometrical shapes that we are going to use. They are all two dimensional. We have only talked about 2-D shapes. What I am going to do now is I am going to give you another worksheet and I want you to see how many of those shapes you can find on here and colour in. All right, so all those shapes we have talked about, I'm giving you a time limit, seven minutes. We'll see who's found the most in seven minutes.

P: What happens if they overlap?

T: They can overlap. Colour them in as you find them then you will remember where they are.

P: Can you only start the time when we are ready?

T: OK Jason if you're going to get technical.
[Arguments amongst the pupils]

T: [Sarcastically] Don't start because you might have 30 seconds more than Jason.

T: All ready? Right, ready, steady, GO.

P: I've gone already.

P: I can't find one.

T: Right do it on your own with your with your hand not your tongue.
[Pupils' activity begins in earnest, with noise.]

T: Any of those shapes that we've talked about. They are all on the board.
[Inaudible question]

T: Well you must decide, by knowing about those shapes.

P: How are you meant to show where it is?

T: Just colour in your shape

P: Can you go over a line?

T: Yes you can overlap.

P: I was going to anyway.
[Laughter]

T: Sorry?

P: I've coloured the whole thing.

T: Luke, your hand not your tongue.

P: Can we colour in as many of the same shape?

T: No! Try and find different ones first.
[Pupils are quietly active]

T: Four minutes left!

P: No ways!

T: Right, once you have found one of each then go back and see if you have found others. So at the end we can say how many circles, how many rectangles and so on.

P: Where are the circles?

T: You might have to use your compass to help you find the circle.

P: Isn't it time?
P: Must it be a perfect circle?
T: It will be once you use your compass.
[Quiet activity, some concern that they cannot find the circle which does not appear in the tessellation]
T: Don't worry too much about the circle.
[Interaction amongst the pupils continues - they ask each other about their shapes]
T: One minute left.
[Some concern is expressed about the making of the circle]
T: OK time's up. Right, let's start, the only way in which you would have got a circle is how? Nicky, did you get a circle? Who managed to work out how you would get a circle? What did you do? [Pupil's response is not audible] Found a circle on their paper without drawing a line?
P: I drew one. [10 mins]
T: OK so what did you draw your line around? A hexagon, you took a hexagon and you found the mid-point of the hexagon, and if you got your radius right then you would have been able to construct your circle around there. OK. So who got a circle? Only you?
P: I got a circle.
T: All right, OK, count them as we are going along. So on the side write "circle", if you got one or two write it down, if you got nought then write 0.
P: But I can't count them all.
T: What did you do in that time? Right, a square, who found a square?
P: Me. Me.
T: Right, pretty easy, lots of squares. OK. Rectangles?
P: Me.
T: Right lots of rectangles, each one of these little ones itself was a rectangle. Quads?
P: Me! I found four.
T: Jason's got a nice example here, a blue one. Right, anyone find a kite?
P: Me!
T: OK, a pentagon? Five sides. Who got a pentagon? Good! OK, hexagon?
P: Me!
T: Good!
P: I got a pentagon.
T: Heptagon? Seven sides? Anyone find that? Where Luke?
[Luke suggests he has one.]
T: No! You've got to show us, you're just putting your hand up.
T: No one find a heptagon? ..... and, an octagon? Anyone find an octagon? No? We forgot one, a triangle! There were lots of triangles. Right add up how many you have got altogether. I only want to know the ones that you coloured in, those were your instructions. Did anyone get more than

twenty?

P: 21

T: 19? 18? You got 29! Good! Well done. So Kim is the winner, give her a clap.

[All clap for Kim]

[Arguments begin about the number of figures obtained. The teacher explains that they have to be coloured in.]

T: OK lets wait for Jason. He is desperate to win.

P: [Jason counts to 45] 45!

T: 45. OK, new winner, Jason. Give him a clap.

P: I've found a new pentagon.

T: Right you can take those home and try and find your shapes that you didn't find, the seven sided one, and the eight sided one. [14 mins]

P: I've found a huge pentagon.

T: All right put those down now please. So far we have only been talking about two dimensional shapes. *I'm waiting for you to all stop fidgeting!* We are going to go on to talk about three dimensional shapes, or shapes we call 3-D. Who can tell me what three dimensional shapes are? Kerry-Anne? They've got?

P: Depth.

T: They've got form or they have got depth. So it is something that we can actually pick up and that we can see its not just a flat surface on a piece of paper. Right look on your desks and see what three dimensional shapes you can find there.

[Activity focussed on the objects on their desks.]

T: Right, OK, Michelle?

P: Spacecase!

T: Right now what shape is that?

P: Triangle.

P: A rectangle!

T: It's not a rectangle. What do we call it when its 3-D? Its not called a rectangle any more. This little part, this one **face**, we call these faces, all right, this face here would be a rectangle or this face here, or this face here but when it's in three dimensions what do we call it? Anybody know? Right we call it a cuboid.

P: Cue! boid!

T: Right. So this shape is called a cuboid. OK, who can find me another three dimensional shape on their desk, not a cuboid, another example. Jason?

P: Pencil.

T: OK your pencil, what shape is that?

P: [Thinking] A stick.

T: Right a stick, but it has a special mathematical name. JP?

P: Cylindrical.
T: Cylinder, right! That's a cylinder. Cylinder or cylindrical shape. A pencil, well that wouldn't really be, because yours has got, like, ridges around. Right, I want geometrical shapes.
P: What about a pencil case?
T: That would be a cuboid.
P: Oh!
T: Right, something else? No one has got another shape?
P: What about the top of your desk?
T: No. That's two dimensional shape. We want a three dimensional shape.
[Various options are mentioned]
T: Right let me hold one up. What do we call this?
P: Cuboid.
P: Cube.
P: Block.
[Other suggestions made are inaudible]
T: Some one said a block, someone said a square. Not right yet! [Correct answer was not heard]
P: A cube.
T: A cube, right this is called a cube.
P: A cuboid.
T: No. A cuboid is not the same. Right, that is a cube, this is a cuboid.
P: What is the difference between that and what you have just told us?
T: What is the difference? OK, who can tell me? What is the difference?
[Shouting of answers.]
T: Don't shout at me! ... Michelle.
P: How can that long one be a cuboid when that ...
T: OK, how can that be? You answer that question.
P: That is different.
T: It's different in some ways and its the same in other ways. Right count the sides on your spacecase, or the faces.
[Pupils count the faces]
T: OK and how many here?
P: [Some say four and some say six.]
T: Right, so a cuboid in other words has six faces. What can you tell me about this face?
P: It's long.
T: And this face?
P: It's long.
P: They're both exactly the same.
T: They're exactly the same and they are both rectangles. Right, and this one and this one, also exactly the same and they are?
P: Rectangles.

T: These two?
P: Rectangles.
T: Exactly the same, and these happen to be squares but they needn't be squares, like on your spacecase they are not squares. Good, this one? How is this different? Good boy, Jason say that nice and loudly.
P: All the same.
T: All the faces are the same size. So is this the same, Jason? (20 mins)
P: In a way.
T: So how is it different?
P: By the length of the sides.
T: Right, all these sides are ... ?
P: The same.
T: OK, so they are the same shape. Right, we haven't got very far, what about if you were in ancient Egypt and you were walking along in the desert you would see some huge big shapes, that are geometric shapes.
P: Pyramids.
T: Right, pyramids, that is another geometrical shape. Pyramids.
P: Did you know that pyramids were ...
T: I'm sorry, excuse me there are some very rude girls here.
P: Did you know that the pyramids are blocks that are perfect all round.
T: Yes.
P: Do you know how they cut them like that?
T: The ancient Egyptians?
P: Yes
T: Do you?
P: No.
[Laughter]
T: Right. When you are doing your history project you can study up about that. It took thousands of slaves. Many years to cut them like that. Right, we have got one more shape, that we come into contact quite a lot with, that you haven't told me about. At break you would use it.
P: A ball.
P: I know, a lunch box.
P: [Inaudible]
T: That's 2-D. Now we want a 3-D.
P: A sphere.
T: A sphere, good boy! Right, a sphere. Those are the main shapes that we are going to be dealing with in geometry this year. Our cuboid .. oops, wrong one, a cuboid, a cube, a cylinder, right, and if I had a tennis ball here?
P: A sphere.
T: A spheroid.

P: And a pyramid.
T: And we haven't got a pyramid in the classroom. There you are, Michelle has got a sphere.
P: There's one.
T: OK, please take out your *Maths at Work* now and open to page 216.
[Noisy opening of desks and so on. Silence descends.]
T: Right, when your books are open I want all eyes on me again please ... All right, you are going to need to know this for the work that you are going to do. I have told you, lets just revise it, what do we call this?
P: A face.
T: A face. Right, what do we call this?
P: A vertex.
T: And this?
P: An edge. [24 mins]
T: And this, an edge or the side. But now you have been given a table here on page 216 and it is F, V, and E on the top meaning Face, Vertex and Edge. It says here: "A collection of three dimensional objects is shown, all their faces are flat. If F is the number of faces, V is the number of vertices, and E is the number of edges, complete the following table." All right. You've got to think about all those shapes and you have got to count up, in a cuboid for example, how many faces are there? How many edges are there? How many vertices are there? Right, and then you are going to do the table in your little geometry books. Please leave three pages first of all to stick in those notes that you've got, we'll stick them in later, and then on page four, draw your table and then I want you to fill your table in. You may work in pairs. And if you would like a shape you can come and get one from the box.
[Noisy preparation for the task]
T: There are not all that many cuboids, so please will you share and remember that working in pairs is a privilege. Just do it in pairs.
P: Do we have to work in pairs?
T: If you would like to work on your own that's fine.
[Pupils get down to work]
T: Anyone stuck?
P: Yes.
[Teacher goes over to help]
T: I think its a good idea to draw your table first. Before you start working.
[Working continues]
T: If you haven't got a cuboid just use your spacecase.
[Working continues quietly, Teacher answers questions.] [30 mins]
T: One more minute's enough? Whose finished?

[Pupil asks a question.]

T: No, just do the table.

[Working continues but it gets louder as time goes on. Some pupils count in the air with their pencils.]

T: OK, let's go over the answers. Right, stop playing with your blocks now. All of you! OK the first figure, our cube, how many faces?

P: Six.

T: All right, how many vertices?

P: Eight.

T: Eight, good and how many edges?

P: Twelve.

T: Twelve, good girl. Right. Our next shape is the cuboid. You do that one Brendon.

P: Faces, I got six. Vertices, I got eight. Edges, I got twelve.

T: Good! Right, then our pyramid? Craig?

P: Faces, four, vertices I got four, edges I got six.

T: Good, right. The next one. Michelle?

P: For faces, I got five.

T: No.

P: [In unison] Yes!

T: Oh, sorry, yes, yes, I beg your pardon. Five, yes. Vertices?

P: For vertices, I got six and edges I got five.

T: Right, good. The next one, Tyrone?

P: For faces, I got five. For vertices, I got five. For edges, I got eight.

T: Good. OK, and the last one? Who hasn't added anything, Rochelle?

P: For faces, I got eight. Vertices, I got five and for edges, I got ten. [The rest, in unison] Eighteen.

T: Right. OK well done, you did well on that exercise. The last two minutes you can use to stick in your worksheets. Please bring my blocks back.

The lesson ended at this point.

2.3 **TRANSCRIPT OF THE LESSON GIVEN BY TEACHER B ON 11.8.94**

The lesson was given to a Standard 5 class.
This lesson began with the children being sent to various parts of the school to measure the perimeter of different shapes. The transcript begins with their return and some of the pupils' discoveries.

T: [Asks the group which was set the task of measuring the perimeter of the netball field to explain what they had done.]
P: We measured the length of the field and timesed it by two and measured the breadth and timesed it by two and got ninety two metres.
T: So you measured the length and timesed by two ...
P: Measured the breadth ...
T: Breadth ...
P: And timesed by two.
T: OK, and what did you get?
P: Ninety two metres.
T: Ninety two metres around the whole field? You did the whole netball field .. Or half of it?
P: The whole one.

T: So you went around the whole one, Tim? OK. The cricket pitch. OK, Louise.
P: OK, it was ... we measured the width, it was 2 metres 50 centimetres, timesed that by two and got 5 metres. We measured the length we got 24 metres 20 centimetres, we timesed that by two and got 48 metres 40 centimetres. Then we timesed the width and length and got 53 metres 40 centimetres. [Says this without interruption and gains comments from the rest of the class.]
T: Gee, Louise, that's complicated.
T: OK, right, well done. The paving under the tree. Jason?
P: It was square, well not a complete square, one corner has like a curve that was 99 centimetres.
T: What was 99 centimetres?
P: The curve of the corner.
T: How did you measure that?
P: Each brick was 11 centimetres so we counted them and added them all up.
T: Right, so you measured your curve first.
P: [The reply was confusing and at times inaudible]
T: Right does anybody think that they could have done it a better way? ..... [The conversation is of no relevance because of the confusion over the first reply] OK, who did the basement, Cary? Let's hear.

[The pupil's answer is inaudible]
T: Have you seen a common pattern. Let's talk about the rectangles first.
P: Timesed the length by two and the breadth by two.
T: And did it work for every single one? Who said no? Jason, just trying to be clever? Right we took the length and timesed by two. Took the breadth, we timesed by two and we added them together and it worked every single time. There was a long way, I was hoping someone was going to do it but you were all cleverer than I thought. I was hoping one group might have added all four, had measured all four sides and then added them together. But you are already thinking like I want you to think so you can be congratulated on that, you are finding shorter methods. All right? Do you think we can work out a formula that's going to work for when we find the perimeter of a rectangle? Do you think if we do the same thing with all rectangles we're going to get the right answer? [No answers] .... Did it work five times? Well it is going to work every single time. OK, now what can we say our formula is for the rectangle? Barry?
P: Times the breadth by two and the length by two.
T: Right, we can say twice [writes on the chalkboard] length plus breadth and I've got them in brackets. Why have I got them in brackets? What does brackets mean? Barry?
P: They come first.
T: Right, so I find the length, I add it to the breadth, I multiply the answer by

two and I will know the formula for the perimeter of any rectangle. What about the square now? We only did one square and that wasn't even a complete square.

P: We times the length by four.

T: Right, good girl, if we times the length by four. We just have to measure the length of one side and we multiply it by four. So that's the rectangle and that was a square [Points to the formulae written on the chalkboard]. Now I want to see who is going to be really clever. If I have got the perimeter of a shape and I want to work out the length, how am I going to do that? I've got the perimeter. Let me give you an example, right here's my rectangle [draws a rectangle on the chalkboard], the perimeter equals 60, let's say centimetres and I know that this side here is equal to 10 centimetres. Right, so the perimeter is 60 centimetres and that side is 10 centimetres, can anybody think of a way in which we can work out what the length of this side is? Michelle.

P: I think you take 60 minus 10 minus 10 and you get forty, divide it by two and you get 20.

T: Do you agree with her that it is 20? Right so she thinks she took 60 minus 10, minus 10 again. Right, she did that first so we put it in brackets [writes on the chalkboard] and than she divided that by two. Kerry-Anne?

P: She could have divided 60 cm by two and then minused 10.

T: OK, good girl, why did you divide it by two?

P: Because then you have the length of the one side ....

T: OK, so she took sixty and divided it by two which is going to give her 30 which is two sides then she minused the one side which was 10 and she got 20 as her answer. Good girl that was another way of doing it. Right what about a square? I have a square and the perimeter is 40 cm and I know that this side is 10 cm. Yes, Michelle.

P: 40 divided by four minus 10.

T: Right, Michelle.

P: 40 divided by four.

T: OK, now I want to see if you can tell me when you think you might be able to use perimeter? When do you think you can use it in normal life, in everyday life, at home or at school or when you are doing something, a hobby or something that you might have to work out the perimeter of something. Louise?

P: If you are building and you want to build a house, you've got to measure the outside of the yard.

T: Right if you want to know the distance all the way around something OK. Yes Jason.

P: [Partly inaudible, but has to do with the measurement of a carpet in a room.]

T: Does a carpet just go round the edge of your room? No. So, that's not a very good example is it? A carpet isn't just going to, you are not just going to

put a path of carpet around the edge of your room. So we won't use perimeter to find a carpet.

P: You want to fence in your garden.

T: Right. If you want to fence in your garden. At home. Right, and your dad needs to go and buy the wire for the fence. He wants to know how much to buy, because he doesn't want to buy too much, and he doesn't want to buy too little. He can find the perimeter of your plot and then he can go and buy the correct amount of wire.

P: Isn't there an easier way to do it? If your garden is in the shape of a square, you stand on one side of the square and then you see where the half-way line is and then you measure half of one side of the square.

T: But how are you going to know that your garden is a square unless you measure it? Very few gardens are an absolute square and you'd have to measure it to be sure anyway. Right, any other examples of where you think you might use perimeter?

P: If you want to cover a patio and you want to put that canvas on the top. Like you want to ...

T: Does the canvas just go around the edge? Jason? The canvas just goes around the edge and there is nothing in the middle?

P: No there's ....

T: Then you are not going to use perimeter are you?
[Pupils make comments but nothing clear is said.]

T: Yes, Tyrone.

P: A swimming pool.

T: A swimming pool, what are you going to do with a swimming pool?

P: Measure the perimeter.

T: There is also water inside the pool isn't there, so that is not going to give you perimeter. Dean?

P: Those boards. [Points to the boards in the classroom]

T: OK, if he wants to put edging around the board, so when else do you put edgings round things?

P: When you put ribbon on the edge ....

T: Right, good girl, you make something that you want to put a piece of ribbon round the edge or you are making a table cloth and you want to put lace all around.

P: A verandah.

T: What about a verandah?

P: Perimeter.

T: What do you want to do with it?

P: Put up a fence, a railing.

T: OK, a railing round a verandah, good. Yes.

T: Come on, the teacher does it in the art room.

P: Makes picture frames.

T: Right the frame of a picture, good. Jason?
P: To fence an area to keep your dog in.
T: OK, also fencing a section of your garden. Yes, Rochelle.
P: If you are putting a ceiling in and you put those little boards on it.
T: If you are putting a ceiling in and you have to these ... cornicing I think it is called. Yes, Craig.
P: I don't know what they're called but you put them along the side of a room.
T: Good, right, a skirting board. So you see there are quite a lot of things that we need to know perimeter for. Can anybody think of anything else?
[Other suggestions were made like guttering, bricks around a garden]
T: Right, OK, now I want to see if you can use all your information which you've discovered today to do some mathematical examples.
P: [Groans.]
T: So please take out *Just Maths*, page 204. Use your geometry books. p 204. Right, exercise 116. Try and use the formulae that are on the board, these two here at the beginning of your sums.
P: Which exercise must we do?
T: Exercise 116. Nos 1 to 4, the whole exercise in other words.
[Activity begins]
T: You know the rule about the answer.
P: In this exercise do you have to write the whole thing out or just write the answer?
T: Craig you know the rules.
[Further activity]
T :What's this calculator doing out here?
P: To work out the ....
T: What's wrong with your brains?
P: They've gone on strike.
T: All right you may use your calculators.
P: [Cheers]
[More quiet activity]
T: Date? The 11th.
[Activity continued in silence]
The lesson concluded with the assigning of homework.

2.4 TRANSCRIPT OF THE LESSON GIVEN BY TEACHER C ON 8.8.94

The lesson was in a Standard 5 class.
The teacher sets the scene for the lesson by focusing attention on the task at hand.

T: Right you had a little task this weekend. You had to look at area, volume and perimeter. Lets see if you did that. .... how do you work out area?
P: Length times breadth
T: Length times breadth. Why would we want to work out area or what do we do with area? Richard?
P: In case we wanted to tile a room or put a carpet in.
T: In case we wanted to tile a place or put a carpet in. How would we work out volume? Catherine?
P: Volume! [Thinking]
T: Help, Michelle.
P: We want to see how much there goes inside.
T: We want to see how much there goes inside. Remember I drew that little box last week and we said that we wanted to work out the volume of such a thing was.

P: Yes sir.
P: Length times breadth times height.
T: Let's go back to area quickly. What is the measurement for area? Say for instance that we are measuring in metres. The answer would be in?
P: Metres and a little two.
T: Metres and a little two. Square metres hey?
T: Carlo said if we measure volume we must go length times breadth times height. What would that give us?
P: Cubicles!
T: Cubes!
P: Cubes.
T: Meaning that we are going to fill it up with little cubes. We played with those little blocks and we made one little cube, we made the next cube and the next cube and the next cube and after a while we said we needed 64 little cubes to make this one. OK that gives us the volume. What is perimeter, John?
P: Uh, the length of the ...
T: [Draws a square on the chalkboard] how would you calculate the perimeter of that square?
P: Sir, you say six times four.
T: Say six times four. We drew that little man and we said perimeter ... this little guy would have to walk all the way round. When we get to work our perimeter think of an example maybe at home. Your mom or dad ... will they ever need to work out the perimeter of something?
P: Yes, of their garden.
T: Of their garden, why?
P: Sir when they buy a plot of land they do it by the square metre.
T: OK. That has got to do with area.
P: Or perhaps they want to put up a fence.
T: When they want to put up a fence. OK, there's your house. This is the end of your garden ... its got a funny shape and the guy says OK, that's fine, I will put up concrete fencing but how long should it be? Then you have to work out the perimeter. And what do you have to do? You've got to measure all the way round the outside of this so that you have got the perimeter. OK, we are measuring perimeter and it's in metres - it will just be a straight forward metres hey? OK, going back last week, we also did percentages. Profit, loss and so on. Today, as I told you last week, we are going to combine ... I'm going to give you a task to do. You are going to work with percentage, fractions, decimals, you are going to work it out. In other words you are going to have to buy something first, or after you've calculated the areas and that ... I'm going to give you a place that you should tile, to brick, to pave, to carpet, the works. In your little groups you are going to work together and the winner today is the group that can do all

the jobs that I am going to give you, spending the least amount of money. OK you must look at all the bargains that there are to buy and then choose the one that will cost the least amount of money. Right let's look at our task quickly. [Sets up the OHP] You just need to take out your jotters so that you can write in them.

[Pupils take out their jotters.]

T: Right, settle down.... Lets look at our task. I'm only going to go through this once and you must listen carefully. Right, your assignment: you have four tasks. Task one. You must pave area one here, I have the floor plan of the house, I've got all the measurements, from there to there is 10, this top section here, that says three, three and nine means that from there to there is three metres, from there to there is three metres, from here to there is nine. It's not drawn 100% according to scale but you should get the idea from that. OK, so number one says pave area 1, so that block there, that rectangle needs to be paved. Number two, tile area two and three, here, there we are going to put in italian tiles or whatever tiles you prefer, quarry tiles. Task number three is carpet areas four and five, that big area there and the small one needs to be carpeted. OK those are wall-to-wall carpets. Number four, a farmer needs to build a shed in order to stock up with a 1000 bales of hay for the winter. What will it cost, if the cost of building adds up to R100.50 per square metre? OK, you must work out an area big enough to stock a 1000 hay bales and then you must build it, we are not going to add up what one brick costs and what cement costs or sand costs, the total amount for building for 1 square metre is R100.50. OK, so you must build a building where you can stack up all those hay bales. Then, I have got it here, one hay bale is 1 metre by 0.5 metre by 0.5 metre. If you look at a hay bale it is a metre long it a half a metre wide and half a metre high. Now you have the four tasks. Now let us look at the places where you can do your shopping. You are going to do those one by one. [Puts up a chalkboard on which the problem is written] I did not have time to go to the shops so I had to go to all the teachers and Mr Holder, he's selling boulders this morning [Pupils laugh] Each guy has got his own quote. Mr Botha has his own tiles. Mr Dudley has duds - don't tell him - Mrs Fourie has discount tiles and Mr Louw has his own brick factory. Abbreviations, here we have bricks tiles and carpets [B, T, C] If we are going to buy from Mr Holder you are going to pay R15.20 per square metre for bricks, R40.10 per square metre for tiles and R12.60 per square metre for carpets. There is no discount, that is the price you pay. Mr Botha was a bit more generous, his prices are slightly higher, though with all his prices you can have 10 percent discount that needs to be deducted. Mr Dudley, seeing that he has duds you must be very careful when you buy them they might be cheaper but when you buy them some of the things are also broken. His bricks are only R10, his tiles are R27 and his carpets are R12.99. He hasn't added VAT so

you must add 14 percent for VAT. If you are going to buy bricks then you must say R10 per square metre plus 14 percent VAT for each square metre. What will happen if you buy 60 square metres of bricks? Are you going to say R10 plus 14 percent VAT or are you going to look at the whole total and then add 14 percent VAT?

P: The whole total. It will be easier to do that.

T: Does it make a difference?

P: Yes it does.

T: Maybe we should look at that later. Just for today add up the whole thing first, the amount of money and then add 14 percent. Right, you must add VAT. Fourie's Discount Tiles, R11.00 per square metre for bricks, that stays the same. Look at her tiles, they cost R3.30 per tile. At the bottom here I said that each tile is 25 square centimetres. Her carpets come in little blocks like they've got in the AV room, you know those little block carpets, they are only R3.00 each and the size of the carpet block is 50 square centimetres. OK, Mr Louw's bricks are 90 cents each, his tiles are R2.00 each, his carpets are R1.00 each. And the I've got the size of his bricks, for his bricks you need 50 bricks to make one square metre. His tiles are 10 square centimetres and his carpets are 20 centimetres. Also because we know Mr Louw he is going to give us all a discount of 15 percent for every thing we buy. OK here's your assignment, you must do that, there are the possible shops from which you can buy, the group that ends up with doing everything they had to do, properly and spends the least amount of money you win. [Approx. 10 mins]

T: Keep it down.

P: Are we allowed to use our calculators sir?

T: The bad news today we are not allowed using our calculators.

P: Oooh.

P: Oh, oh.

P: Sir!

T: What I would suggest to help you save some time, you have a group leader, each group leader must make someone investigate something. Let not six guys sit and work out what Mr Holder's bricks are going to cost if there are four other, five other places which we can go to. Investigate all five ....

[Pupils arguing with each other as to how to go about it. Teacher interacts with some of the pupils then intervenes]

T: OK, let's have a look at this quickly. This thing is a rectangle and so are all the other shapes on the inside. So, for instance, Warren just said how far is it from the edge to there. Somewhere on this little picture you have the same length and that is from there to there which is four metres so this thing is three by four it does not look like it but it is suppose to be. OK this one is

nine and how far is this?

P: Six.

T: Six, OK, so you must times ... OK, what I would do in the groups now is the group leader must for instance say task one is to pave area number one. Are we going to pave it with tiles or bricks, you are going to go with bricks, the group leader should say to someone in the group you look at Holder's bricks, the next guy at Botha's, the next guy at Dudley's, the next guy at Fourie's, next guy at Louw's and find out which bricks are the cheapest per square metre and once you got the bricks that are the cheapest per square metre you work out how big that thing is, the area. Which is the formula to work out area, Blake?

P: Umm, breadth times length

T: Length times breadth, OK, see how many square metres we need and then we can do that, then we can go on to task two. Carry on like that.
[Activity continues with the teacher helping the pupils to work out the problem. Most conversation is inaudible]

T: You have thirty five minutes left to do your shopping. Put your hand up if you want me to come and help you. As soon as you have worked out which bricks you are going to use and as soon as you have paved area one and worked out how much it is, put up your hand, I would like to come and see what you are doing.
[Noise level increases]

T: Right. Settle down a bit!
[Noise level increases even more]

T: Who's finished with task one? Who's finished with task one? John?
[Pupils argue with each other but continue with the task.]

T: If you are writing down your answer for, say for instance, task one, pave area one, I don't want to know what Holder's bricks cost and what Botha's brick are. I want to know what it cost to pave that section one, it must be the cheapest price. Everybody's worked out a price and you must decide which is the cheapest and your answer is: Task one, so much.
[Activity continues, with similar arguments]

T: Right, boys and girls let's settle down. The next guy who talks too loudly, I'm going to add R50 to your quote.
[Quieter for a while]

T: OK, who of you are buying from Mr Dudley? Nobody? Let me tell you that each batch of a hundred that you buy from Mr Dudley 10 of them are broken.

P: How are we supposed to know that?

T: OK, time's up for area number one you should be working on area number two.
[Activity and noise continues]

T: Warren your whole group is going to lose R50!
P: Jeez!
T: OK, some people seem to be confused. Just listen here quickly. All these other tiles are per square metre. So that if you buy these tiles they'll give you so much. [Draws on the chalkboard a square 1 metre by 1 metre] What happens if you get here and they say that each tile is 25 square metres? [Approx. 30 mins]
P: You times by four!
T: Then that happens, hey? [Draws four small squares in the large square] For each metre block you must buy 1,2,3,4 tiles
P: Told you. Yes sir.
T: You say four times the price of the tile for each square metre.
T: These tiles are even smaller, they are 10 square centimetres. How many tiles will fit into a 1 square metre block?
[Group activity continues]
T: Right, let's help Janet. How many tiles of 10 square centimetres will fit into a 1 square metre block? [Calls the whole group to attention and asks the question.] How many tiles of 10 square centimetres will fit into the 1 square metre block?
P: Ten
T: Ten
P: No uh, no uh uh ... yes sir.
T: Are you only packing tiles on one side of the meter block?
P: 100
[Teacher leaves them to continue with their work.]
T: Right, who's finished with area no 3?
[Inaudible response]
T: If you don't do group work then you are never going to get the answers.
[More activity]

T: You have 8 mins left. There will be a R50 fine for each minute you are late in building.
[Frantic cries]
[Some groups at this stage seemed to have given up the task and were just talking. Some were still arguing as to what they should do. Noise level is the highest during the lesson.] [35 mins]
[Teacher awards another R50 fine to someone.]
T: Who's finished task three? [45 mins]
T: OK you should be going on to task 4, the last one, building the shed.
[The activity continues]
T: Right let's stop for a while. Let's try and solve problem no. 1. What no. 1

asks is that you pave that certain area. Let's work out the area quickly. How do we work out area, Zama? [About 48 mins]

P: Length times breadth

T: OK, length times breadth. Area no. 1, what is the length?

P: Uh ... 10 metres.

T: And the breadth?

P: 3 metres.

T: 10 times 3?

P: 30

T: So what's the area of surface no.1?

P: 30 square metres.

T: 30 square metres.

T: OK, let's look at the prices quickly. Mr Holder says per square metre of bricks is R15.20 with no discount, so that is the price we pay. Mr Botha is R16.50 but all of it minus 10 percent so we take R16.50 we should minus 10 percent. How do we work it out without a calculator? We should know how to work out 10 percent by just looking at something but let's calculate it quickly. 10 percent of R16.50 is 10 over 100 times that. I can simplify which gives me 16.50 over 10. I then divide by 10. What did we say happens to the comma when we divide by ten?

P: You move it back.

T: OK, it makes the number smaller because we are dividing. We move it one place. So, R1.65, that is our discount. So, Mr. Botha's bricks will cost R14.85 per square metre. Mr Dudley's bricks they are a bit cheaper, they cost R10.00 per square but we must still pay VAT so, that's plus 14 percent which will give us R1.40 so the total of the bricks will be R11.40. Then Mrs. Fourie's can't change. She just gives us a straightforward price of R11.00, and Mr Louw's bricks cost 90 cents each but to make 1 square metre you need 50 bricks, so, if we calculate that it's going to cost us R45.00 per square metre so we don't even want to talk to Mr Louw any more. So, which one is the cheapest out of the lot?

P: Fourie's.

T: 15.20, 14.85, 11.40 or 11.00?

P: R11.00. Fourie's!

T: R11.00. So, we should go for R11.00. What is the total area? 30 square metres; so each square metre costs R11.00 should be 30 times R11.00. What is 30 times 11?

P: R330.00

T: 11 times 30? R330.

P: Yeah! I got it right!

T: Right, who paved the first area for R330?

[Teacher checks with the pupils as to the builder from whom they bought

their bricks]

The lesson ended at this point. [52 mins]

APPENDIX 3

3.1 A PROFORMA FOR THE EVALUATION OF LESSONS FROM A COLLEGE OF EDUCATION.