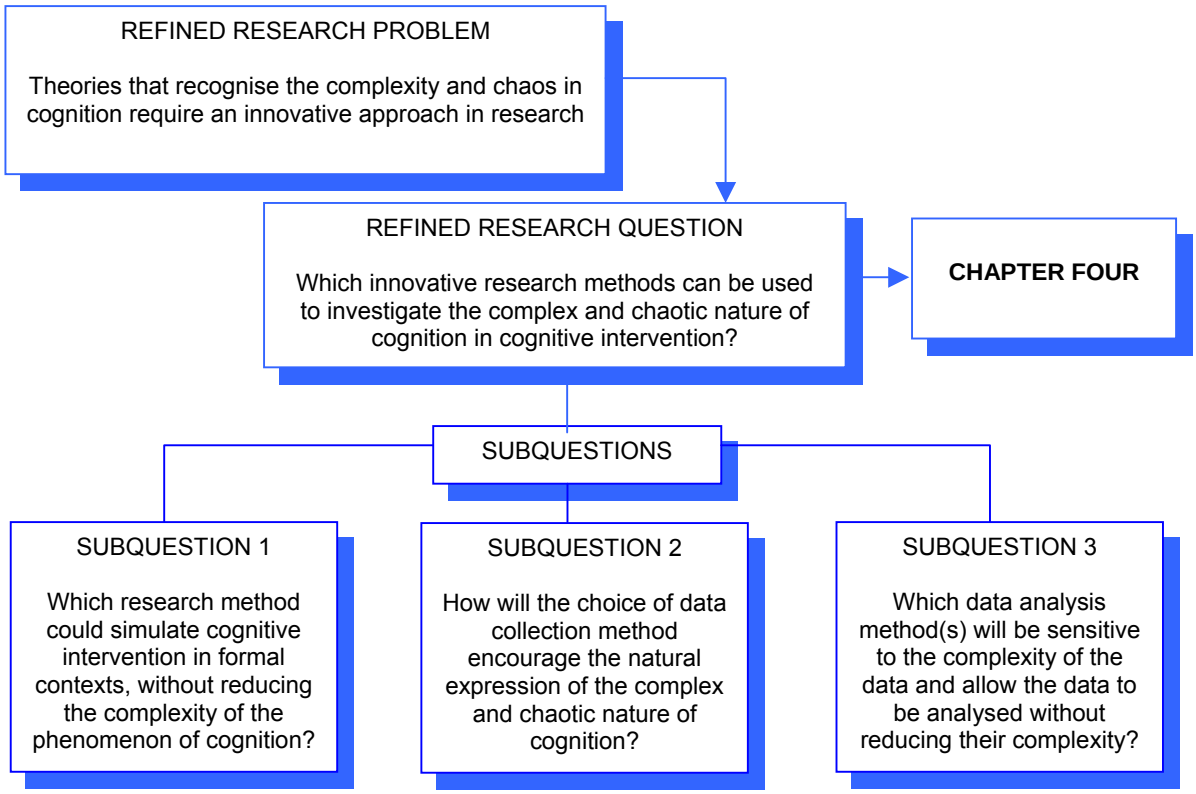
CHAPTER FOUR

Research design and preliminary data analysis

Doing research means forever having to find ways of getting your bearings.

John F. Schostak, *Understanding, designing and conducting qualitative research in education.*

META-NARRATIVE 4.1



4.1 THE ILLUSORY DISTINCTION BETWEEN QUALITATIVE AND QUANTITATIVE RESEARCH

McMillan and Schumacher (2001) describe the ultimate aim of science as "the generation and verification of theory" (p. 8) and elaborate by saying that scientific inquiry concerns the "search for knowledge by using recognized methods in data collection, analysis, and interpretation" (p. 9).

Traditionally, there has always been a sharp distinction between quantitative and qualitative approaches to research. Quantitative approaches to research are frequently associated with the positivist tradition (Denzin & Lincoln, 1998) which assumes that there is a singular reality that can be measured objectively, using a valid and reliable instrument. The researcher in quantitative research is sometimes described as "the aloof observer" (Denzin & Lincoln, 1998, p. 21), someone who is detached in order to gain objectivity (McMillan & Shumacher, 2001). By contrast, qualitative approaches to research are usually associated with an interpretivist tradition (McMillan & Shumacher, 2001) which emphasises multiple realities within particular social contexts. Through distinctions such as these, research in disciplines such as chemistry and physics has become associated with the quantitative approach which emphasises a singular reality, objectivity, and the discovery of the truth. Similarly, qualitative research methods that emphasise multiple realities, subjectivity and meaning, are more likely to be associated (although not exclusively) with social and educational research.

Yet, as was pointed out in Chapter Two, in the early part of the twentieth century it was shown by quantum physics through the very use of quantitative methods that the existence of a single, objective reality is an illusion brought about by the interaction between the observer and that which is being observed. Quantum physics challenged the illusion that the scientist is the independent knower of an objective knowledge, by illustrating that all human knowledge is subjective. The Many Worlds Interpretation of Schrödinger's wave theory further describes how reality consists of probabilities instead of actualities, making the likely existence of multiple realities a scientific fact arrived at by quantitative methods in the positivist sciences. Similarly, recent developments in chaos theory which describes the chaotic and complex nature of living systems was arrived at through quantitative methods that emphasise the study of complex systems in their natural settings. Yet, naturalistic research methods that emphasise "a complex, holistic picture" (McMillan & Schumacher, 2001) are generally regarded as the mainstay of qualitative research (Denzin & Lincoln, 1998).

It would appear, then, that the distinction between qualitative and quantitative approaches to research is largely based on a persistent belief that Western science never progressed beyond the nineteenth century Newtonian conception of science which was so prominently associated with the positivism of Auguste Comte. In fact, very few scholars seem to realise that it was the quantitative methods of the positivist sciences that provided the thrust and direction for the development of postpositivist, constructivist and critical studies that feature so centrally in qualitative approaches to research. Neither do qualitative researchers always appreciate the fact that the positive sciences are as much concerned with multiple realities, subjectivity, complexity and behaviour in natural settings as qualitative researchers are.

Bauer, Gaskell and Allum (2000) suggest that the debate between qualitative and quantitative approaches to research is unproductive and fruitless because the measurement of social facts hinges on the categorisation of the social world, and point out that numerical data do not speak for themselves, they have to be interpreted. Instead, Bauer *et al.* (2000) argue for a more holistic approach to research that would focus on commonalities. McMillan and Schumacher (2001) suggest that some commonalities in research would be objectivity, precision, verification, explanation, empiricism, logical reasoning and conditional conclusions. Earlier, Agar (1999) alleges that even within the narrower framework of qualitative research there is too much focus on distinctions between different qualitative approaches and too little reflection about the commonalities in qualitative research.

In terms of qualitative research, Agar (1999) suggests following a family resemblance approach to qualitative research using four prototypic characteristics that would enable one to define research as being “more” or “less” characteristic of qualitative research. The four prototypic characteristics discussed by Agar (1999) are *rich points* (problems that arise in the research, that require the researcher to interpret their meaning), *abductive logic* (plausible explanations are created in the context of the study and tested through experimentation), *multiple overdetermination of pattern* (or MOP, the explanation created must be proved beyond a reasonable doubt), and *complexity* (a representation of the research process and the research product as complex systems).

The present study follows a holistic approach to the investigation of the research problem by adhering to the commonalities as discussed by McMillan & Schumacher (2000) and Agar (1999). They form the criteria by which the quality of the research can be measured, and by which the nature of the research can be classified.

In the next section, each of these commonalities will be discussed in the context of the study.

4.2 CHARACTERISTICS OF THE RESEARCH

4.2.1 Objectivity

McMillan and Schumacher (2001) point out that "to the lay person, objectivity means unbiased, open-minded, not subjective" and they acknowledge that, as a procedure, "objectivity refers to data collection and analysis procedures from which a reasonable interpretation can be made. Objectivity refers to the quality of the data produced by procedures which either control for bias or take into account subjectivity" (p. 11). Objectivity then, is frequently viewed as the opposite of subjectivity and procedures that enhance objectivity are thought to reduce subjectivity. Traditionally, quantitative research has been viewed as more objective than qualitative research which, due to the participative role of the researcher, is viewed as subjective. The implications of the distinction between objective and subjective research, are that objective methods are less biased and therefore more valid, and that they reflect "true knowledge" better than subjective methods.

In the context of the present study, the concept of objectivity will be re-defined in order to clarify its relationship with concepts such as "validity," "reliability" and "truth". Firstly, the illusion of the objectivity-subjectivity dichotomy is not acknowledged in the context of the present study because it does not exist. Epistemologies which are positivist (at least in the disciplines of quantum physics) and constructivist alike acknowledge that knowledge cannot be anything but subjective. If an objective reality exists, there is no way of knowing it (Zukav, 1980, Von Glasersfeld, 1989, Barrow, 1999).

Regarding the role of quantitative concepts in science, Cairns-Smith (2000) acknowledges that "the mathematical constructs of physics are so beautiful and effective that it is a particular hazard of the trade to suppose that they *are* the reality" (p. 48, author's emphasis) and goes on to say about scientific theories that they are not the reality, but simply a [subjective] representation of what reality might be like. Similarly, the verbal labels that are used to refer to objects are not the objects themselves, just as the names of psychological constructs are not physical entities. In psychology, we speak of memory, cognitive structures, or the mind as though one might open up someone's head and expect to find some corresponding physical structure, yet we know that such an expectation is an illusion brought about by the Newtonian notion of one-to-one correspondence. In the final analysis, there is simply no way for us to step outside our "cognitive universe" (Saunders, 1992, p. 139).

The implication is that objectivity is no longer viewed as a means of obtaining a carbon copy of reality, but it is viewed as a subjective construction of what reality might be like. The shift in meaning from objective representation to subjective construction also requires a re-

definition of what we mean when we talk about “true knowledge” or the “truth of facts”. Whereas “truth” was previously thought of as positive knowledge of reality that was acquired by the scientific method (objective, valid, reliable), it is now apparent that such positive knowledge is not possible. Instead, “truth” now points to *viability.* Viability introduces a pragmatic dimension to the truth because it describes knowledge as something we construe to allow us to cope with the world around us (Von Glasersfeld, 1989). When our theories of what reality might be like show internal consistency, can explain and predict events with “acceptable” regularity, we are likely to support them because they enable us to cope with the world. Viability allows societies and cultures to develop and cope with different ways of knowing the world and themselves in the world.

Viability allows the concept of the truth to be viewed as a subjective construction which has gained wide-spread support within a particular context because it gives people a common experience and allows them to communicate with one another and to manage their world. In terms of scientific enquiry, concepts such as “objectivity” no longer point to a tool or measure that reduces subjectivity or “procedures from which only one meaning or interpretation can be made” (McMillan & Schumacher, 2001, p. 596), but to a procedure that enhances the likelihood that outsiders will reach consensus with the researcher on the interpretation of the research findings, however varied those interpretations may be. The concept of reliability is no longer used as a measure to reduce subjectivity, but as a way of ensuring precision and internal consistency in the knower’s subjective constructions of a phenomenon. The principal means by which qualitative researchers increase the viability of their constructions, is through the process of multiple overdetermination of patter (MOP). Agar (1999) describes MOP as a kind of legal reasoning and says that, in order to make a powerful case in favour of a particular explanation, the qualitative researcher is interested in showing how a particular explanation can be supported from many different sources.

It therefore remains a challenge to all researchers, irrespective of whether they are working from a predominantly quantitative or qualitative frame of reference, to conduct their research in such a way as to maximise the likelihood that an independent researcher will come to the same conclusions. When that happens, “objectivity” points to the viability – a kind of pragmatic truth – of the research findings.

In the present study, various measures were introduced to ensure the objectivity of the research. They will be described in some detail in Section 4.3.7 which deals with analysis of the data.

4.2.2 Precision, verification and explanation

McMillan and Schumacher (2000) say that precision in research requires the use of language that conveys exact meanings. Precision makes it possible for others to replicate and extend the current research.

If the object of research is to produce viable scientific knowledge, and if the viability of scientific knowledge hinges on widespread consensus and support of a particular construction of reality, then it is in the own interest of researchers to conduct and present their research in such a way that this becomes possible. The use of ambiguous language and arbitrary concepts can cloud the phenomenon that is being researched, and so particular attention should be paid to the clarity of theoretical and technical concepts that are used in the research.

In the present study, much of the actual data collection was indeed informed by an analysis of the theoretical concepts that surround the phenomenon being researched. A theoretical examination of the viability of the concept of cognition has been a crucial aspect of the first three chapters of the study since the way in which a construct is defined dictates the way it will be researched and practiced. As many social researchers will probably agree, disciplines such as education and psychology are characterised by low levels of agreement among theorists on various phenomena. Because of the complexity of most social constructs in education and psychology, one cannot expect uniformity in the way researchers define the theoretical constructs that inform their research problems. Careful analysis of the theoretical concepts of the research therefore functions as a method of enhancing the precision of the research.

Precision should also be a hallmark of data collection and data analysis and the researcher has to choose appropriate measures to improve the precision of analysis and interpretation of the data. In the present study, computer-assisted text analysis of verbatim transcriptions, as well as examination of coding consistencies were used to ensure that the findings and interpretation of the findings would be precise and consistent. These measures will be addressed in greater detail in Section 4.3.7.

Precision in research makes it possible to verify and extend the results of a particular study in order to develop a growing body of viable scientific knowledge. McMillan and Schumacher (2001) say that research is a social enterprise and that verification entails submitting the results to the professional community for public scrutiny. The public scrutiny of research findings serves as a good example of how scientific knowledge is socially constructed.

Research findings are considered viable scientific knowledge when the outcome of such scrutiny results in acceptance of the research results by the professional community and the research is published. Published research then sets the stage for gaining further support for a particular theory as the wider public also gains access to the "scientific knowledge".

The "scientific knowledge" that research generates should provide a theory which describes and explains the relationships among phenomena (McMillan & Schumacher, 2001). However, since scientific theories are merely subjective constructions of reality (Cairns-Smith, 2000), they can hardly be said to explain reality. The most that a scientific theory can do, is to *summarise* the way phenomena are viewed by the researcher (Babbie, 1998). In terms of the role of complexity in qualitative research, Agar (1999) proposes that, because complex systems can be explained but not predicted, qualitative research should in some way reflect the emerging research process, the complex worlds of the participants, as well as interactions between the researcher and the participants. The inclusion of meta-narratives at the beginning and end of each chapter was considered to be a particularly effective strategy in reflecting the research as emerging and complex.

Therefore, although McMillan and Schumacher (2001) believe that the ultimate aim of research is to reduce complex realities to simple explanations, the aim of the present study is not to reduce to simple explanations, but to summarise what was observed, however complex that may turn out to be, and to show how the researcher's construction of meaning emerged throughout the entire research process.

4.2.3 Empiricism, logical reasoning and conditional conclusions

Perhaps the most important aspect that distinguishes the interpretation of research findings from mere opinion is the fact that research follows a process of systematic and analytical inquiry as opposed to a random and intuitive approach to knowledge construction. Systematic inquiry not only refers to methods by which research data are collected and analysed, it also includes a rigorous examination of the research data and this follows the inductive and deductive rules of logical reasoning.

Although deductive reasoning is often associated with quantitative research and inductive reasoning is associated with qualitative research, McMillan and Schumacher (2001) believe that when both systems of logical reasoning are integrated into the research, it can make a single study more effective. Agar (1999) describes another kind of logic that is important in qualitative research, called abductive logic, where the researcher invents antecedent causes or explanations for an observed phenomenon. Abductive logic is not contingent upon pre-

defined premises, and so it allows the researcher a playful approach to making meaning of the data.

Bauer *et al.* (2000) state that the object of scientific inquiry is persuasion. The three elements of persuasion are *logos* (the logic of pure argument), *pathos* (appeals to the audience and referring to the social psychology of emotions) and *ethos* (referring to the status of the speaker). The elements of *logos*, *pathos* and *ethos* are similar to Habermas' conceptualisation of the empirical-analytical sciences (*logos)* where the imperative has been to gain control over the material conditions in which we live, the historical-hermeneutical sciences (*pathos)* which arose through a practical interest in the establishment of consensus and intersubjective understanding, and the critical sciences (*ethos*) which question the legitimacy of social hierarchies and believe that reason is emancipatory (Bauer *et al.,* 2000). The present study could be viewed as a study in the historical-hermeneutical tradition since constructs such as cognition and cognitive intervention are essentially social constructs which have been created in order to achieve consensus and intersubjective meaning.

However, whether the aim of science is to gain control over the material world, or to achieve understanding of a social world, or to question the legitimacy of social structures, the methods by which material and social phenomena are researched all result in subjective constructions which can only be accepted as viable through wide-spread consensus. Therefore, all research results (and this study is no exception) regardless of their quantitative or qualitative nature, yield findings and conclusions which are subject to further verification.

4.3 RESEARCH DESIGN

4.3.1 The research purpose

The purpose of the present study is to explore and describe principles of complexity and chaos in children's thinking in formal contexts and to analyse how complexity and chaos may be accommodated in cognitive intervention. The research design is in keeping with the view that research is multi-dimensional and therefore it contains a mix of quantitative and qualitative elements.

The multi-dimensional view of research followed in this study is also intended to reflect a view of reality that accommodates multiple perspectives. Schostak (2002) uses the example of the Gestalt drawings in which it is possible to perceive two or three different images depending on one's frame of reference, and explains that researchers may very well perceive reality either one way or another way and spend much time refining their research to prove their version of what they perceive. I wish to go one step further and suggest that

what we perceive when we view the world around us, resembles a hologram more than it does a two dimensional drawing. What one perceives, depends very much on where one stands in relation to that which is being perceived. One's position therefore also precludes one from seeing what would be visible if one were to take even a slightly different position. Research does not depend on viewing only one of two possibilities, but many different possibilities existing at the same time. Viewing all the possibilities require one to shift position, to change perspective and to keep in mind that some truths are still there even though our theoretical position precludes us from seeing them, or requires us to ignore them for the moment.

In this study, I try to shift position often. Although the theoretical framework of the study has a decidedly postmodern slant, the approach to data analysis is essentially postpositivist by nature, while the data interpretation could be more adequately described as qualitative. The entire study that is reported here reflects a process of constructing meaning about children's thinking in formal contexts, yet it would be erroneous to describe the research as constructivist. All knowledge, whether quantitative or qualitative, is constructed in the mind and so it is not really possible to talk about any research as being anything other than constructivist.

Thus far, the study has focused on a deconstruction of the nature of cognition. Part of that deconstruction involved an examination of chaos and complexity in the context of human thought. Although, from a theoretical point of view, it appears as if human cognition meets the criteria for being described as a complex system, its relevance to practice still remains to be examined. Thus, the second part of the study will focus on exploring, through the development and implementation of innovative research methods, ways in which the complex nature and chaotic moments of cognition could be accommodated in cognitive intervention.

4.3.2 Problem formulation

Authentic research is not a process in which problems and questions are rigidly pre-defined and adhered to throughout. Rather, it is an open and flexible process which responds to new and changing questions, and even constraints as they arise throughout the study. The meta-narratives in this study were considered to be an appropriate tool to demonstrate such openness and flexibility. Schostak (2002) compares the research process to a journey during which one must acquaint oneself with certain practices, choosing a path and seeing where it leads, and choosing when and where to stray from the pre-designed pathways.

Problem formulation is a complex process in which researchers attempt to make evident their thinking about the phenomena which are studied. As the research progresses, researchers often find themselves reconsidering the initial problem statement and/or research questions and it frequently happens that the research problem and/or research questions are re-formulated as new information comes to light through a review of the literature or through the data collection process. Such an emergent model of the research process meets Agar's (1999) fourth prototypic characteristic of qualitative research, namely that an adherence to the principles of complexity requires one not only to view one's field of study as a complex system, but also to reflect on the research process as complex and non-linear in its own right.

Viewing the research process as a complex system necessarily means approaching research in a playful manner and allowing the research problems and questions to be informed by new data and insights, even making room for new questions to emerge even though they might not be answered by a particular study. In the present study, I have attempted to show how the continual formulation and re-formulation of the research problem and the research questions have directed the study and how they have been guided by insights gained from literature. This emergent process will be continued through the remainder of the study where the research problem and questions will be refined even further in response to insights gained from the research data.

The flexibility with which the emergent research problems and questions have been handled is reflected in Figure 4.1.

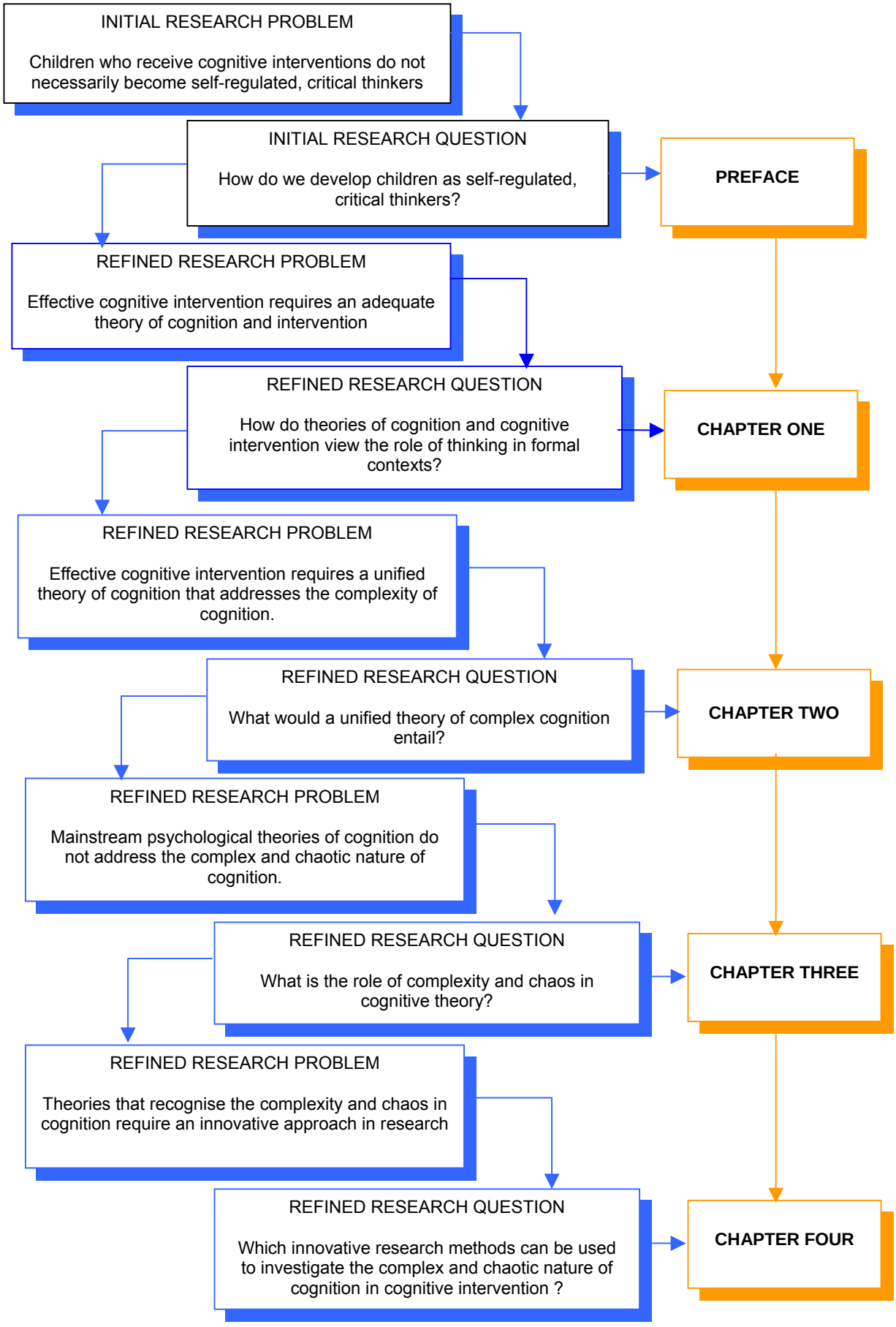


Figure 4.1 The flexibility of the complex research process

4.3.3 Research method

The present study used a design experiment approach as the main method of data elicitation. Design experiments allow the researcher to design a rich instructional environment in which the effects of particular kinds of instruction can be investigated and evaluated.

Design experiments are frequently used to create complex contexts for the research of context-based mathematical problem-solving where the goal is to transform learners into more active, strategic problem solvers (Verschaffel, De Corte, Lasure, Van Vaerenbergh, Bogaerts & Ratinckx, 1999). Initially, the use of design experiments derived from a cognitive-rationalist perspective as theorists attempted to isolate and describe cognitive components and processes inherent in a problem solving task. According to Verschaffel *et al.* (1999), however, design experiments that focus on the creation of powerful learning environments are currently better aligned with situated learning and social-constructivist theory because they emphasise the role that social interaction plays in knowledge construction.

Recognition of situated learning has given rise to cognitive apprenticeship models of learning that emphasise the integration of practical real-world knowledge with learning, the importance of acquiring cultural strategies for problem-solving and the role of the learner as an active agent (Hedegaard, 1998). Social-constructivist theory has arisen from an integration of the constructivist epistemology of Jean Piaget, and the sociocultural theory of Vygotsky, with the main distinction being that constructivism locates the mind in the head of the individual and sociocultural theories locate the mind in the social and cultural interactions of individuals (Cobb, 1994). Design experiments incorporate both the psychological and interactional dimensions of constructivism because a learning environment is designed in which social interaction forms the context within which perturbations in learners' conceptual structures can lead to self-organisation, which is an important aspect of learning in constructivist theory (Cobb, 1994) and complexity theory (Cilliers, 2000).

In the present study, the aim of the design experiment was to create a learning environment that would enable the study of cognitive intervention as a complex and chaotic phenomenon. This was achieved by designing stimulus materials that would enhance children's active participation in the form of unstructured discussion. It was decided that the stimulus material would be designed in the form of a colourful poster. Young children find posters appealing and their size make them big enough to facilitate discussions with children in groups of up to eight. Posters are generally selected to address topics that children find pleasant and are eager to talk about. For children who have had negative and/or repeated experiences of

failure in learning, posters can provide a non-threatening means of facilitating thinking and learning.

The poster that was used in the present study is an A2 size, full colour poster depicting a zoo theme. It is attached as Exhibit B. Young children generally have a natural affinity to animals and many young children in South African schools have visited the zoo at least once, so the theme of the poster should be familiar to many young learners. However, to accommodate learners who many never have visited a zoo, as will probably be the case with rurally situated and/or disadvantaged learners in South Africa, the illustrations were made as realistic as possible. This was done to allow such learners to begin to construct from the poster and from interactions with peers in group discussions, a personal understanding of what a zoo is like. The realistic illustrations also made it possible to discuss the characteristics of various animals in order to help learners understand principles of classification within a real-world context.

Figure 4.2 shows some of the animals that feature on the poster.

Figure 4.2 Vulture, flamingo and seahorse from the poster

The interactive nature of the poster was an important aspect of the research. The rationale for the design of the poster mostly centred around the princples of chaos and complexity theory. Seeing that the aim of the research was to study cognition as a complex, chaotic phenomenon, the poster was designed to enable the researcher to elicit complex themes in her interaction with the children.

Despite a pervasive assumption among most educators that illustrative material for young children should be simple and not too overwhelming, the theory described thus far in the present study suggests otherwise. The appearance of the poster was specifically founded on the following theoretical principles:

a) The present study addressed the development of self-regulated learning which encapsulates the notion of learning as a process of self-organisation. Self-organisation requires complexity and chaos and therefore the design of the poster was largely directed by the principles of chaos theory and complexity theory.

b) The learning environment was created around the principles of constructivism, chaos and complexity theory and facilitated the use of design experiments to overcome the theory-practice gap by focusing simultaneously on theory building and the innovation of practice (De Corte, 2001, Verschaffel *et al.,* 1999).

c) The design of the poster is consistent with the view that complex phenomena should be studied in their natural settings by methods that allow them to reveal their true complexity (Lorenz, 1993).

d) Using a poster in group discussions would allow cognition to be studied as an open system that is in dynamic interaction with its environment, that can modify and be modified by its environment (Cilliers, 1998).

e) A well-designed poster would create an ambiguous problem-space that creates the disequilibrium needed for self-organisation (Masterpasqua & Perna, 1997).

f) Using a poster was consistent with the view of the present study that knowledge is constructed through social interaction with others and that interaction in the context of problem-solving can help the facilitator to understand the learner's conceptual structures (Von Glasersfeld, 1989).

g) Social interaction would allow the use of language to mediate the internalisation and transformation of social interaction to higher mental functions (Vygotsky, 1978) and therefore make it possible to investigate the role of language in the development of cognition.

Supplementary materials were designed to be used in conjunction with the poster. The supplementary materials included the design of four sets of encapsulated A4 boards containing illustrations of animals in four categories, namely mammals, birds, fish and insects An example is attached as Exhibit C. The A4 boards were accompanied by four sets of

encapsulated cards (6 x 6 cm) containing illustrations of mammals, birds, fish, and insects (Exhibit D). The animals in each category (mammals, birds, fish, insects) were chosen in such a way that multiple groupings would be possible. For instance, the mammals can be divided into categories such as *warmblooded* vs *cold-blooded*, *diurnal* vs *nocturnal,* whether they are *herbivores, carnivores, omnivores*, *predators* or *non-predators*, and so on.

A set of five encapsulated discs with the word *Go* and the digits 2 – 4 written on them is attached as Exhibit E. A collection of blue and red beans and cards with illustrations of cameras completed the set of research materials which was used during fieldwork.

4.3.4 Constructing the learning environment

4.3.4.1 Careful selection of open problems

Vosniadou, Ioannides, Dimitrakopoulou and Papademetriou (2001) state that there is considerable general agreement that learning environments should be designed to promote active learning and guide learners towards self-regulated learning. This, Vosniadou *et al.* (2001) argue, can be done by requiring learners to participate in projects, solve complex problems, and to think about their and others' ideas. Verschaffel *et al.* (1999) describe three pillars upon which they design a powerful learning environment. The first pillar involves the design of carefully selected and open problems, the second pillar involves the implementation of powerful instructional techniques and the third pillar is represented by the establishment of a classroom culture.

The poster that was used in the present study was designed to elicit the use of cognitive skills in a realistic, complex environment. The interaction between the researcher and the participants was not structured around pre-defined problems, although several cognitive skills were formulated from the outset and were implicitly present in the researcher's frame of reference. They are the following:

- Knowledge-acquisition skills
  - Analytical skills (selective attention, comparing, contrasting, classifying patterns and rules)
  - Reasoning skills (inductive, deductive and analogical reasoning)
  - Application and transfer of analytical and reasoning skills to learning areas

- Metacognitive skills
  - Focusing (selective attention, impulse control)
  - Planning (setting goals, identifying steps)

- Controlling (monitoring, assessing progress)
- Checking (end-evaluation, self-questioning)

🕮 Critical thinking skills

- Formulating personal opinions and beliefs about events and situations
- Giving reasons for personal opinions and beliefs
- Distinguishing between fact and opinion
- Distinguishing between true and false statements
- Examining a variety of viewpoints and alternatives

In order to decide which cognitive skills to address, I leaned heavily on Sternberg's (1984a) triarchic theory of intelligence, and Beyers' (1989) guidelines on the development of cognitive skills programmes.

Knowledge acquisition and metacognitive processes are central to Sternberg's triarchic theory, and even though Sternberg does not include critical thinking skills in his theory, it was added because critical thinking skills are generally recognised as an important aspect of good thinking (Pithers, 2000) and even a political necessity (Selikow, 1999). In fact, Beyers (1989) argues that the development of a disposition towards critical thinking should be an essential part of any cognitive intervention. In addition, Beyers (1989) also makes a case for the staggered introduction of a limited number of cognitive skills over a longer period of time in order to combat skills overload, which is why three cognitive skill areas were considered sufficient for Foundation Phase learners.

The purpose of the supplementary materials was to facilitate and extend the social interaction among learners on the posters, and to facilitate the internalisation and transformation of social interaction to inner speech. The rationale for the supplementary materials is based on Vygotsky's (1930/1978) distinction between elementary (biological) forms of behaviour and higher (cultural) forms of behaviour, and on Vygotsky's premise that external functions are internalised and transformed to higher psychological functions through the use of psychological signs that mediate the process of internalisation and transformation. Young children who are in the process of developing attention and memory, and who have to learn how to regulate their behaviour, can use supplementary materials as mediators (Vygotsky, 1930/1978). The supplementary materials in the present study were designed to mediate elementary attention and memory processes, and self-regulatory, metacognitive behaviours such as a systematic approach to tasks, and checking and controlling.

4.3.4.2 Instructional techniques

The instructional techniques that were used during the teaching experiment were strongly influenced by theories of mediation in cognitive intervention literature (Vygotsky, 1978; Feuerstein *et al.,* 1980; Feuerstein *et al.,* 1991; Kozulin & Presseisen, 1995).

The mediational interaction of the researcher was conceptualised around three core areas, namely mediation of knowledge structures (domain/declarative knowledge), cognitive skills (procedural knowledge), and disposition for critical thinking (conditional knowledge). As Boekaertz (1997) points out, domain, procedural and conditional knowledge are important aspects in the development of self-regulated learning as these types of knowledge underpin metacognition. Later, Mason (2000) also makes a strong case for the importance of the mediation of what he calls propositional (declarative), procedural and dispositional knowledge by teachers in outcomes-based education.

In the context of the present study, the distinction that Mason (2000) makes between *facilitation* and *mediation* is very important. Viewing the teacher as a facilitator of knowledge does not sufficiently address the interpretive function that the teacher plays when she takes on the role of mediator, "where the teacher is actively getting involved in getting her hands dirty with the messiness and unfinished business of pragmatic knowledge" (Mason, 2000, p. 346).

These broad types of knowledge (domain/declarative, procedural, conditional) were translated and operationalised in the Mediational Behaviour Observation Scale (MBOS) in three broad areas, namely knowledge structures, cognitive skills and disposition. As such, the MBOS categories may be viewed as high-inference descriptors which allow much freedom for subjective interpretation of mediator behaviour. The MBOS was designed as a framework for judging the nature and structure of a mediator's interaction with his/her learners. To this end, the MBOS was tested during the third day of classroom observation, and was later used to examine the researcher's mediation on the design experiments.

The MBOS underwent significant changes during the course of the study. For example, the MBOS was initially designed to judge a mediator's behaviour on a scale from one to four. After some consultation with colleagues, it was decided rather to adopt a frequency scale, where observed behaviours would be ticked everytime they were observed, giving an indication of the number of times a particular interaction took place. A frequency scale is a low-inference form of observation that avoids the high degree of subjective interpretation

required to award a scale value to observed teacher behaviour. Figure 4.3 shows an example of the MBOS as it was used for classroom observation.

School:		Grade:		Date:		Time:	
Researcher behaviours that promote understanding of learners' knowledge structures					Researcher behaviours that impede understanding of learners' knowledge structures		
KS1+: The researcher interacts with learners by asking their opinions about what they are learning					**KS1-:** The researcher interacts with learners by giving orders and without engaging learners' involvement		
KS2+: The researcher asks open questions that require an extended verbal response from learners					**KS2-:** The researcher asks mainly closed questions which require one-word responses		
KS3+: The researcher encourages learners to respond verbally, and in full sentences to questions					**KS3-:** The researcher accepts non-verbal responses from learners (head shaking, pointing)		
KS4+: The researcher does not accept a learner's correct response without investigating the thinking behind it					**KS4-:** The researcher accepts learners' correct responses without further inquiry		
KS5+: The researcher probes the thnking behind incorrect learner responses and uses them as a basis for further thinking and interaction					**KS5-:** The researcher rejects incorrect responses without further inquiry		
KS6+: The researcher requests learners to provide evidence for their statements					**KS6-:** The researcher accepts statements from learners without requiring evidence		
KS7+: The researcher encourages learners to give clear, analytical reasons for their statements					**KS7-:** The researcher accepts vague, global or intuitive reasons from learners		
Researcher behaviours that promote the use of cognitive skills in learning					Researcher behaviours that impede the use of cognitive skills in learning		
CS1+: The researcher encourages learners to explore tasks systematically					**CS1-:** The researcher allows learners to approach tasks in a disorganised fashion		
CS2+: The researcher models the execution of tasks to her learners					**CS2-:** The researcher requires learners to do tasks without modelling their execution		
CS3+: The researcher guides learners in their thinking and task executions without showing them the correct way immediately					**CS3-:** The researchers immediately supplies learners with the correct answer or method when they encounter difficulty		
CS4+: The researcher points out to learners unhelpful behaviours that lead to incorrect responses.					**CS4-:** The researcher criticises learners for incorrect responses without clarifying their mistakes		
CS5+: The researcher gives clues and hints after incorrect responses to help learners correct their errors in thinking					**CS5-:** The researcher rejects incorrect responses and does not attempt to correct a learner's thinking errors		
CS6+: The researcher points out helpful behaviours that lead to correct responses					**CS6-:** The researcher accepts correct responses without any further analysis		
Researcher behaviours that promote a positive learning disposition					Researcher behaviours that promote a negative learning disposition		
LD1+: The researcher engages in positive interactions with learners					**LD1-:** The researcher engages in negative interactions with learners		
LD2+: The researcher engages learners in classroom discussions					**LD2-:** The researcher discourages discussions with learners in the classroom		
LD3+: The researcher provides positive feedback in response to a correct answer					**LD3-:** The researcher provides negative feedback in response to an incorrect answer		
LD4+: The researcher recognises partially correct answers and provides positive feedback					**LD4-:** The researcher rejects partially correct responses and dismisses the learner's response as incorrect		
LD5+: The researcher attributes success in learning to intrinsic factors (e.g. the efforts of the learner)					**LD5-:** The researcher attitributes success in learning to extrinsic factors (e.g. luck, easy work)		

Figure 4.3 Mediational Behaviour Observation Scale (MBOS)

Behaviours on the left (positive side) were considered as evidence of a mediational interactional style, whereas behaviours on the right (negative side) were considered to be those that bear evidence of a non-mediatory style of interaction. A disadvantage of the MBOS as it was used during the third day of classroom observation is that it contains 36 categories of behaviours (18 enhancing behaviours and 18 impeding behaviours), which increases the chances that some behaviours may be allocated incorrectly or missed

altogether in a busy classroom. The MBOS is therefore perhaps better suited to judging recorded interactions than live ones.

4.3.4.3 Culture of learning

Because the design experiments were carried out by the researcher, the researcher's efforts were more focused on the establishment of a culture of learning associated with positive learning dispositions in the group than the establishment of a classroom culture. As reflected in the MBOS, behaviours such as providing learners with positive feedback, recognising partially correct responses and promoting the notion of self-responsibility by encouraging the formation of an internal locus of control formed an important aspect of the development of learning dispositions.

Beyers (1989) has noted that critical thinking is often driven by dispositions such as having a passion for clarity, and a willingness to question socially sanctioned views. Selikow (1999, p. 8) notes that "thinking critically involves exposing yourself, your ideas and views and knowing they are open to discussion and disagreement. Hence the importance of setting up a climate of mutual trust." Selikow (1999) therefore advises that the development of learning materials should make room for dialogue and the shared creation of knowledge as well as encourage argument, self-evaluation and reflection. Recently, Pithers (2000) also stated that critical thinking is often associated with broad dispositions such as being open-minded and a tendency towards weighing the credibility of evidence. Addressing the development of a positive learning disposition as the driving force behind the development of critical thinking skills was an important goal in the researcher's interaction with learners. Critical thinking, more so than knowledge acquisition skills and metacognitive skills, is not about the development of domain, procedural and conditional knowledge only. Personality and emotional factors play an important role in mediating children's tendency to become critical thinkers because critical thinking often involves a departure from mainstream norms and values and requires children to view things differently. If children are not sufficiently rewarded for questioning behaviour, or if they feel that they will be criticised for doing so, it does not provide a safe psychological space for the development of critical thinking. For example, Beaman and Wheldall (2000) mention studies that report significant positive correlations between teacher approval and on-task behaviour, which suggests that children's learning behaviour can be significantly shaped by teacher behaviours. Since critical thinking involves debate and argument, it is reasonable to expect that teachers' approval/disapproval in class may help or hinder the development of critical thinking skills.

Creating a safe psychological space requires the mediator to "connect" with her learners on a personal, social and cultural level. It requires the mediator to show solidarity with her learners (Callendar, 1997) and to create positive experiences that help learners to feel that their experiences are valued. Here, the role of language is very important since language acts as a powerful symbol of cultural identity (Callendar, 1997). It is frequently the case in South African schools that children in multilingual classrooms learn through the medium of English even though their English language skills may be lacking. Ignoring for the moment the adverse effects that such a scenario holds for cognitive development, it poses an even more serious threat to the development of healthy cultural identies because children are not encouraged to communicate their cultural and social experiences in their own language.

In constructing the learning environment, the researcher wanted to create an emotional climate that would encourage learners to participate and take risks. Approaching the group session with a curiosity for learners' experiences, and a basic respect for what they know, helps to create a learning environment in which learners feel they also have something to offer.

4.3.5 Role of the researcher

During the first phase of the research, the researcher contacted the principal of an inner-city school in order to gain access. After initial interviews with the principal during which the researcher described the aim of the research, the researcher contacted the Foundation Phase coordinator of the school. The Foundation Phase coordinator made arrangements for the researcher to liaise with a Foundation Phase teacher who would assume responsibility for coordinating the participation of three Foundation Phase classes in the research.

The researcher assumed different roles during the course of the research project. The researcher had two informal conversational interviews with the responsible teacher to explain the aim of the research and to gain some understanding of the school dynamics before entering into the field. In informal conversational interviews, "questions emerge from the immediate context and are asked in the natural course of events" (McMillan & Schumacher, 2001, p. 443).

The first phase of the research comprised classroom observation of the Grade 1, 2 and 3 classes that were participating in the study. The role of peripheral participant-observer was established when permission for classroom observation was given. The researcher was positioned in the back of the class and was making fieldnotes as unobtrusively as possible. McMillan and Schumacher (2001) describe participant observation as "an interactive

technique of 'participating' to some degree in naturally occurring situations" and emphasise that "the researcher does not collect data to answer a specific hypothesis; rather the explanations are inductively derived from the fieldnotes" (p. 41).

Although the researcher did not participate actively in any activities during classroom observation, the participative nature of the observation is acknowledged insofar as it is acknowledged that the presence of an observer changes the situation being observed. Therefore, by virtue of his/her presence alone, the observer is always participating to some degree in the situation being observed. The researcher did not interact with the teachers or learners during the course of the lessons. However, it did occur once or twice in the Grade 2 class that the teacher addressed the researcher and that learners came to show their work to the researcher. On those occasions, the researcher acknowledged the initiative of the teacher/learners, but did not pursue the interaction.

During the second phase of the research, the role of the researcher changed from that of a peripheral participant-observer to that of an active participant-researcher. The second phase entailed the use of a design experiment format (described in Section 4.3.3) in which the researcher constructed a learning environment conducive to the mediation of complex reasoning. The researcher's involvement with participants during the study is illustrated in Figure 4.4:

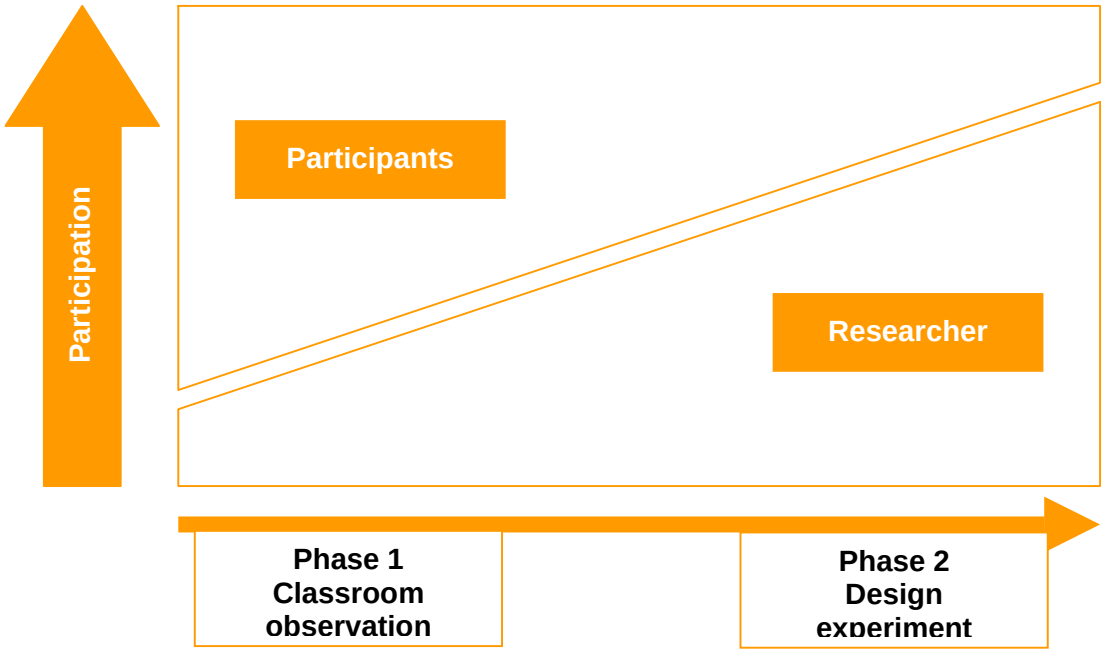


Figure 4.4 The researcher's involvement with participants during the course of the study

4.3.6 Data collection

Data were collected through classroom observation in the first phase and by recording, transcribing and analysing the interactions between the researcher and the participants in the nine group sessions that formed part of the design experiment during Phase 2 of the research. During Phase 1, the researcher visited a Grade 1, 2 and 3 class for a period of 40 minutes each day for three days. During Phase Two, the researcher conducted three 40 minute group sessions a day with three groups of children selected from the same Grade 1, 2 and 3 classes that had been observed. The children who participated in the group sessions were newly selected each day and no child attended a group session more than once. Table 4.1 indicates the number of hours during which data were formally collected.

Table 4.1 Data collection time in hours

	Observation			Design experiment		
	Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3
Frequency	3	3	3	3	3	3
Total hours	2	2	2	2	2	2

Structured, low inference observations were made during the first two days of classroom observation where the researcher merely recorded the teaching-learning activities as they happened without selecting particular behaviours over others or making any interpretations (Exhibit F). Low-inference observations were considered preferable since the researcher did not have the benefit of a second observer who would be able to verify the validity of high-inference observations.

McMillan and Schumacher (2001) note that the advantages of low inference observations are that one does not have to be as concerned about self-report bias and social desirability as in the case of high-inference observational methods. A disadvantage however, is that the observer generally affects the behaviour of the subjects in the study. However, it is an accepted assumption that any act of observation changes that which is being observed, which makes it rather impossible to strive for data collection methods that will record behaviour without contaminating it. This was certainly the case in the present study when the researcher was introduced to the Grade 2 class and the teacher mentioned to learners that the researcher was there to see whether they were “good” learners. During another period of observation, the Grade 2 teacher publicly showed the work of a learner in her class to the researcher as she was reprimanding him and criticising his work.

Despite the unfortunate incident, the children who participated in the study were generally responsive to the researcher and eager once they had begun participating in the group sessions on the design experiment. For example, during break on the second day some of the Grade 2 learners voluntarily sought out the presence of the researcher in order to continue some of the storytelling that they had been engaged in with the researcher on the previous day. On the same day, the Grade 2 teacher informed the researcher after break that no learners would probably want to partipate that day because they were working on a project in class that they were all very enthusiastic about and would want to finish. Yet, when a group of six learners were asked to line up in order to accompany the researcher, all the learners who had by then not yet participated fought to be included in that day's group session.

Table 4.2 shows the number of learners (from each grade and in total) who participated in the group cognitive intervention sessions.

Table 4.2 Design experiment participants (n = 51)

Group	Day 1	Day 2	Day 3	Total (Grade)
Grade One	4	5	5	14
Grade Two	6	8	6	20
Grade Three	4	6	7	17
Total (learners)	14	19	18	51

All the group sessions were audio-recorded and subsequently transcribed. The verbatim transcriptions of the interaction during the group sessions on the design experiment generated nine discrete data subsets which, together, formed the main data source for the study. The data subsets are summarised in Table 4.3.

Table 4.3 Data subsets (DS)

Grades	Day One	Day Two	Day Three
Grade 1	DS1 (n=4)	DS4 (n=5)	DS7 (n=5)
Grade 2	DS2 (n=6)	DS5 (n=8)	DS8 (n=6)
Grade 3	DS3 (n=4)	DS6 (n=6)	DS9 (n=7)

All nine data subsets are attached in Exhibit G – O.

4.3.7 Reliability and validity

The reliability and the validity of the present study were enhanced in various ways. Examining the reliability and validity of the data was considered important because it would contribute towards the precision, accuracy and consistency of the researcher's interpretations, which would again contribute to the viability of the research findings.

Audio-recorded data and verbatim transcriptions of the researcher and participants' interaction on the design experiments ensured precision and accuracy in data collection. The transcriptions were analysed with *ATLAS/ti*, " a powerful workbench for the qualitative analysis of large bodies of textual, graphical and audio data" (Muhr, 1997). *ATLAS/ti* is a software programme designed to accommodate various tasks associated with the analysis of data which cannot be analysed by quantitative measures. *ATLAS/ti* was designed according to the VISE principle: *visualisation* (supporting the way humans think and plan and enabling them to visualise complex relationships that emerge from the data), *integration* (providing tools to integrate data to prevent the researcher from getting lost in the detail), *serendipity* (finding relationships in the data without having searched for them) and *exploration* (incorporating an exploratory, discovery-oriented approach) (Muhr, 1997).

When analysing a document that contains qualitative data by means of *ATLAS/ti,* the document is opened as part of a hermeneutic unit, and it is called a primary document. The primary document is analysed by selecting quotations (segments of text which are considered important) and coding them. In *ATLAS/ti,* codes capture some meaning in the data and they are used as "handles" to find specific occurrences in the data (Muhr, 1997, p. 11). Codes capture the rich points in qualitative data (Agar, 1999). The MBOS categories (as they appear in Figure 4.3, e.g. KS1+, CS1+, LD1+ and so on) and their descriptions were created as codes on *ATLAS/ti*, and they were used in interpreting the researcher's utterances. Codes were therefore not generated from the data in the course of analysis, but were pre-defined and fitted to the data by means of open coding, axial coding and selective coding as discussed by Smith (2002). Open coding was done by coding utterances rather than words, lines or paragraphs. Axial and selective coding was used to make connections between the codes and to build theory, or as a tool for the multiple overdetermination of pattern (MOP) as discussed by Agar (1999).

As a further measure to increase reliability, the categories on the negative end of the MBOS (e.g. KS1-, CS1-, LD1- and so on) were also created as codes and they were used to facilitate the active search for negative cases, which McMillan and Schumacher (2001) describe as "discrepant data that contradict the emerging pattern of meanings" (p. 410). The

ATLAS/ti codings analyser revealed no redundant codes on any of the nine data subsets. Redundant codes arise when overlapping quotations have been coded with the same code, indicating the existence of inconsistent or unnecessary codes.

Despite the absence of redundant codes, it was decided that the consistency with which text was coded should be examined by re-coding a sample from each of the nine data subsets on a second occasion (between 2 – 4 days later). Although the interactions within each group were unique on a micro-level, patterns of interaction did emerge on a macro-level. For example, each of the nine group sessions started with the learners saying their names, guessing what might be on the poster, discussing the poster and then using some of the supplementary materials for special tasks. Selecting different sections of text from each data subset for re-coding ensured that the sample reflected the variation in the interaction between the researcher and the learners.

Table 4.4 shows how the nine data subsets were divided into sections of text according to the number of lines in the document. Except DS1, all the data subsets were divided into four sections, and the samples for recoding either came from the first and third section, or the second and fourth section. The subsets were arbitrarily divided by counting the total number of lines in the text and dividing them into sections that were roughly equally long in terms of lines of text.

The shaded blocks in Table 4.4 indicate that the second and fourth sections of DS4 – DS7 were selected for re-coding, the first and third sections of text were selected in the case of DS2, DS3, DS8 and DS9, while the first, third and fifth section of text were selected from DS1. So, for example, the sections of DS1 that were chosen to be coded a second time included the first section which comprised lines 5 – 99. Lines 100 – 199 were omitted and lines 200 to 294, as were 401 – 499, were selected for a second coding. Lines 295 – 400, as well as lines 500 to 573 were not coded a second time.

Table 4.4 Sample for re-coding of researcher utterances in the design experiment

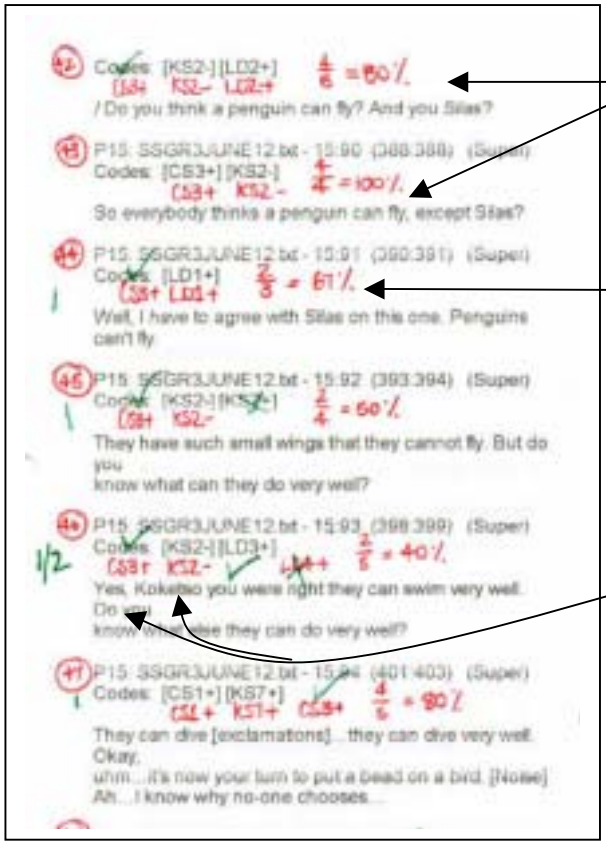
Day	Data source	Lines of text in Section 1	Lines of text in Section 2	Lines of text in Section 3	Lines of text in Section 4	Lines of text in Section 5	Total number of lines in DS
1	DS1	5 - 99[1]	100 - 199	200 - 294	295 - 400	401 - 499	5 - 573[21]
	DS2	9 - 153	154 - 300	301 - 463	464 - 606		9 - 606
	DS3	6 - 160	161 - 378	379 - 540	541 - 742		6 - 742
2	DS4	9 - 147	148 - 308	309 - 450	451 - 584		9 - 589
	DS5	8 - 149	150 - 303	304 - 450	451 - 628		8 - 628
	DS6	8 - 180	181 - 362	363 - 521	522 - 680		8 - 684
3	DS7	11 - 149	150 - 304	305 - 449	450 - 578		11 - 590
	DS8	6 - 128	129 - 259	260 - 390	391 - 550		6 - 550
	DS9	6 - 186	187 - 369	370 - 556	557 - 746		6 - 746

[1] Lines of text

Comparisons between the coding and re-coding were made by calculating the consistency with which *utterances* were coded on both occasions (re-coding consistency), and by calculating the consistency with which *codes* were allocated to all utterances on both occasions (intra-code consistency). The re-coding example depicted in Figure 4.5 shows the difference between re-coding consistency and intra-code consistency.

In utterance 42 (*Do you think a penguin can fly? And you Silas?* DS9*)*, the typed text shows that KS2- and LD2+ had been coded for that particular utterance on the first occasion. On the second occasion, the red text shows that utterance 42 was coded with CS3+, KS2-, LD2+. Of the five codes with which utterance 42 had been coded on two occasions, four were similar, therefore showing a re-coding consistency rate of 80%.

[21] Lines of text do not begin at 1 because the first few lines were taken up by details such as the name of the file.



The consistency of utterance number 42 was 80%.

For researcher utterance number 44 the *coding consistency* of LD1+ was 100%, while CS3+ was only 50% consistent.

After re-coding, each utterance was scrutinised in order to determine whether the coding error had been made during coding (black) or re-coding (red). In researcher utterance number 46, errors were made on both occasions and codes were adjusted in order to achieve a 100% consistency rate.

In this case, CS3+ was added to the data subset, LD3+ was added to the section which had been re-coded, and LD4+ was omitted in the data subset and also in the section which was re-coded.

Figure 4.5 Sample from data subset (DS9) that shows the re-coding process

To determine the intra-code consistency rate, attention was given to the consistency that one particular code achieved on two occasions. Taking utterance 46 as an example, we see that the re-coding consistency rate was 40%, i.e. only two of the five codes that were allocated in total on two coding occasions (CS3+, KS2- [twice], LD3+, LD4+) showed 100% agreement. In terms of intra-code consistency, we only examine the agreement within a code and see that the intra-code consistency for KS2- is 100%, because KS2- was coded on both occasions. For CS3+, LD3+ and LD4+ the intra-code consistency is 50%, because these codes were coded once out of a possible two times.

The rationale for calculating both a re-coding consistency and an intra-code consistency is as follows: It was pointed out at the beginning of this chapter than objectivity is an important consideration in research, also in qualitative research. The re-coding consistencies are primarily viewed as a methodological means by which the objectivity of the research can be enhanced. Objectivity in this study is used as a means of increasing the likelihood that outsiders to the research will reach the same conclusions and not as a means of reducing subjectivity. In a sense then, a high re-coding consistency points to a measure of consistent subjectivity.

The intra-code consistencies are primarily used as a means of enhancing the validity of subsequent interpretations of the data, as well as the study itself. The primary argument is that codes which were used consistently, i.e. the code is applied in the same way on different occasions, would increase the accuracy of subsequent interpretations and ensure that the resulting theory is not based on haphazard observations that may very well vary over time.

Once the re-coding and intra-code consistency rates had been calculated, the data subsets and the sections that had been re-coded were scrutinised to determine where the coding errors had arisen. Each utterance that had been subjected to re-coding was scrutinised individually and a judgement was then made to alter either the coding on the section that had been re-coded (leaving the original data subset intact), or the original data subset (leaving the section that was selected for re-coding intact) or both, so that a 100% consistency rate was achieved.

Again, using Figure 4.5 as an example, the green markings show how codes had been adjusted as a result of the scrutinisation process. Utterance 45 shows that changes were mainly made to the original data subset by adding CS3+ and deleting KS7+, which means that the coding errors were judged to have been made in the original coding and not during the re-coding process. Utterance 46 shows changes to both the original data subset (adding CS3+) as well as the section selected for re-coding (adding LD3+ and deleting LD4+ without adding it to the original data subset).

Codes with low intra-code consistency rates (60% and lower) were identified and all the researcher utterances on all the data subsets which had been coded with those codes, but which had not formed part of the sections that had been chosen for re-coding, were scrutinised again and adjusted if judged necessary. Table 4.5 summarises the re-coding consistency rates attained on DS1 – DS9 after the initial data subsets had been compared with the re-coded sections. The consistency rate with which utterances had been coded ranged from 64.64% (DS6) to 74.46% (DS2). The overall mean re-coding consistency for all the transcriptions was 70.23%, which was regarded as acceptable because the data were not going to be used to predict future behaviour or performance, but would merely be analysed to examine possible evidence of complexity and chaos in learning.

Moreover, considering that there was a total of 1402 researcher utterances across all nine data subsets of which 645 were recoded, and considering that each utterance was unique in its wording, and had to be judged without taking the context into consideration, an mean consistency of 70.23% can be regarded as satisfactory. Also, an utterance could be coded

with any combination of the 13 MBOS codes, so that achieving a consistency of 70.23% can be regarded as adequate.

Table 4.5 Re-coding consistency rates for DS1 – DS9 ($\bar{x}$ =70.23%)

	Day 1			Day 2			Day 3		
	DS1	DS2	DS3	DS4	DS5	DS6	DS7	DS8	DS9
Nr of utterances in DS	162	113	184	168	159	168	132	132	184
Nr of utterances re-coded	79	56	62	78	83	73	69	63	82
Utterances re-coded (%)	48.76	49.55	33.69	46.42	52.20	43.45	52.27	47.72	44.56
Consistency (%)	71.51	74.46	70.40	67.13	74.44	64.64	74.42	66.47	68.68

In contrast to the re-coding consistency of *researcher utterances*, the intra-code consistencies across all utterances varied greatly. The frequencies with which codes were allocated, as well as their consistency rates are provided in Exhibit P.

Tables 4.6 to 4.8 summarise the code consistencies in intervals of 20% for each code. Since the frequencies with which codes were allocated varied greatly, the data in Tables 4.6 – 4.8 should be read together with the frequencies contained in Exhibit O, since the percentages on their own can be misleading. For example, a code may achieve a 100% consistency rate, but may only have been allocated on one utterance in the entire data subset, whereas other codes may have been allocated more frequently, making it more likely that inconsistencies in judgement would arise. To take this fact into consideration, I not only examined the intra-coding consistency rates that were achieved on a particular data subset, but I also considered intra-coding consistency trends across all the data subsets.

Each code can attain one of three arbitrarily determined consistency rates (fair to high, intermediate and low to inconsistent) on any given day (one for each data subset). If a code achieved a particular consistency rate across **three** data subsets on a particular day, that code is indicated in **red**. If a code achieved a particular consistency rate on **two** data subsets only, that is indicated in **green**, whereas codes that achieved a particular consistency rate on only **one** data subset is indicated in **blue**.

Given the fact that many codes were allocated across all three data sets, it is conceivable that a particular code (e.g. CS5+ in Table 4.6) could achieve an intermediate consistency rate on two data subsets (DS1 and DS2) and be reported in green, while the third consistency rate is the only one in the fair to high consistency range (on DS3), and is therefore reported in blue. So the same code appearing in different categories need not be the same colour, as long as they appear only once (for **blue**), twice (for **green**) or thrice (for

red). It is also possible for a code to appear in blue three times, e.g. KS7+ in DS1 (intermediate consistency), DS2 (high consistency) and DS3 (inconsistent).

Table 4.6 Intra-code consistency rates on DS1 – DS3: Day One

Day One - Consistencies (%)					
	CATEGORY 1		**CATEGORY 2**	**CATEGORY 3**	
Data subset	0 – 19 Inconsistent	20 – 39 Low	40 – 59 Intermediate	60 – 79 Fair	80 – 100 High
DS1	KS3+	-	CS5+	CS1+	KS1+
	KS3-		KS5+	CS3+	KS2+
	KS4-		KS5-	CS6+	KS2-
			KS7+	KS1-	KS4+
				LD2+	LD1+
				LD3+	LD5+
				LD4+	LD6+
DS2	KS1-	LD6+	CS5+	CS2+	CS1+
	KS3-			CS3+	KS1+
	KS4+			KS2-	KS2+
	KS5+			KS6+	KS3+
	KS5-			LD1+	KS7+
				LD4+	LD2+
					LD3+
					LD5+
DS3	CS2+	-	KS1+	CS1+	CS5+
	CS4+		KS1-	CS3+	KS2-
	CS6+		KS6+	KS2+	KS3+
	KS4-			KS5+	KS4+
	KS6-			LD2+	LD1+
	KS7+				LD3+
	LD4+				LD6+
	LD5+				

Blue Code appears in category 1,2 or 3 only once **Green** Code appears in category 1, 2 or 3 twice

Red Code appears in category 1, 2 or 3 thrice

Table 4.6 shows that most of the codes for DS1, DS2 and DS3 transcriptions on Day One were clustered in the fair to high consistency range. Certain codes, most notably CS1+, CS3+, KS2+, KS2-, LD1+, LD2+, and LD3+ steadily[22] show fair to high levels of intra-coding consistency. The majority of the codes that showed fair to high consistency rates were achieved on at least two of the three data subsets.

[22] This means a code achieved a particular consistency on all three data subsets on a particular day.

There were seven codes (CS2+, CS5+, CS6+ KS1-, KS5+, KS6+ and KS7+) that achieved fair to high intra-coding consistency rates on one data subset only. The absence of red codes in the total to low intra-coding consistency range is a good sign because it shows that there were not any codes that were allocated inconsistently on all three data subsets.

The codes which were allocated in all three data subsets on Day One are presented visually in Figure 4.6. For each code, the lowest and highest values together with the mean for each code are indicated. The codes which show the most variance in respect of intra-coding consistency have longer lines, whereas the codes with shorter lines show less variance. Generally, codes with long lines are regarded as codes that have been allocated inconsistently, irrespective of their mean value.

Codes that had been allocated with great consistency show a high mean and little variance (shorter lines), while codes that had been allocated with some consistency show a high mean and more variance (longer lines). Codes that had been allocated with some inconsistency show a low mean and great variance, whereas codes that had been allocated with great inconsistency would show a low mean and little variance (shorter lines).

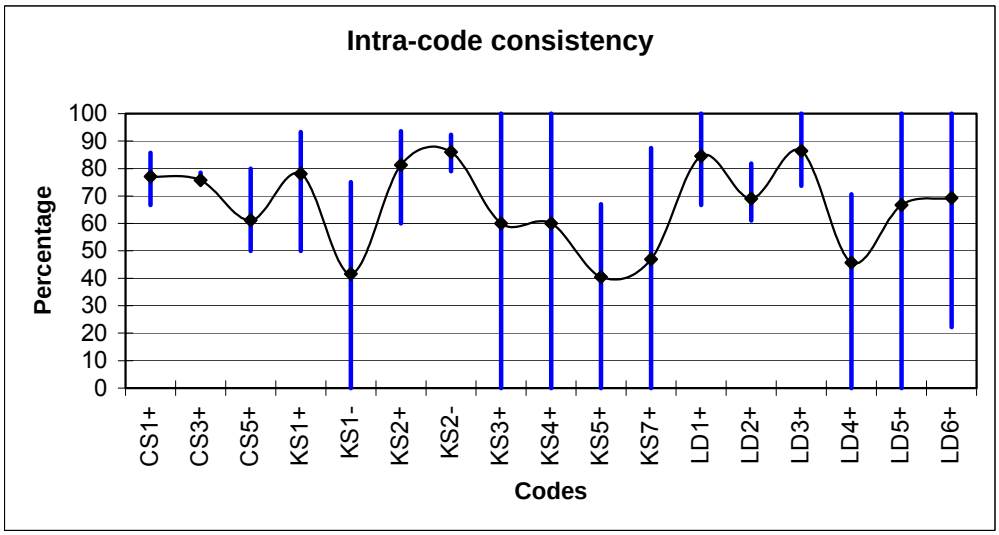


Figure 4.6 Day One: Intra-code consistencies for selected codes

Seven of the codes (41%) showed inconsistent allocation (0%) on at least one of the data subsets (KS1-, KS3+, KS4+, KS5+, KS7+, LD4+ and LD5+), while 6 codes (35%) were highly consistent (100%) on at least one data subset (KS3+, KS4+, LD1+, LD3+, LD5+ and LD6+). Despite the variance with which codes were re-coded across the three data subsets, none of the means of consistency was < 40%.

From the data in Figure 4.6 it appears that the codes allocated most consistently were CS1+, CS3+, KS2-, KS2+, LD1+, LD2+ and LD3+. These codes all show little variance and have lowest intra-coding consistency values > 60% and averages of consistency ≥ 70%.

The codes which were allocated inconsistently were KS5+ and LD4+. These codes show greater variance in consistency with their highest intra-coding consistency values close to 70% and average intra-coding consistency of between 40% and 50%.

The intra-code consistencies for the three grade groups on DS4 – DS6 on Day Two are presented in Table 4.7.

Table 4.7 Day Two: Intra-code consistency rates for DS4 – DS6.

	Day Two – Consistency rates (%)				
Data subset	0 – 19 Inconsistent	20 – 39 Low	40 – 59 Average	60 – 79 Fair	80 – 100 High
DS4	CS1+ CS4+ KS1+ KS4- LD6+	KS5+	CS5+ CS6+ KS1- KS4+ KS7+ LD4+	CS3+ KS2+ KS6+ LD1+ LD2+	KS2- KS3+ LD3+ LD5+
DS5	CS2+ CS3- CS5- KS3- KS4+ KS4- LD1+ LD2-	-	CS5+ KS1- KS5+ LD2+	CS3+ KS1+ KS2+ KS5- KS6+ KS7+ LD4+	CS1+ CS4+ KS2- KS3+ LD3+ LD5+ LD6+
DS6	CS3- CS4+ KS4-	KS4+	CS2+ CS3+ CS5+ KS1- KS3+ LD2+ LD4+	KS1+ KS2+ KS2- KS5+ KS5- KS7+	CS1+ KS6+ LD1+ LD3+

Table 4.7 shows that most of the red codes (KS2+, KS2-, KS6+, LD3+) appear in the fair to high range of intra-coding consistency, while two codes (KS1-, CS5+) appear in the average range of intra-coding consistency. Only one code (KS4-) shows total inconsistency across three data subsets. Considering that KS4- showed total inconsistency on at least two data subsets (DS1 and DS3) on Day One, it is likely that this code could be problematic in terms of its formulation and/or content, and should therefore be flagged for further inspection.

Another code that should possibly be flagged for further inspection, is CS4+, which was coded inconsistently on two data subsets (DS4 and DS6), but coded highly consistently on one data subset (DS5). Upon examination of Day One's data subsets(DS1 – DS3), it is evident that CS4+ was coded inconsistently on at least one additional data subset (DS3). Some codes that appear to be highly consistent across data subsets, are KS2+, KS2- and LD3+, which were allocated with high consistency on all data subsets thus far.

Figure 4.7 shows the lowest and highest intra-coding consistency values and their means on three data subsets that were allocated on DS4 – DS6 on Day Two.

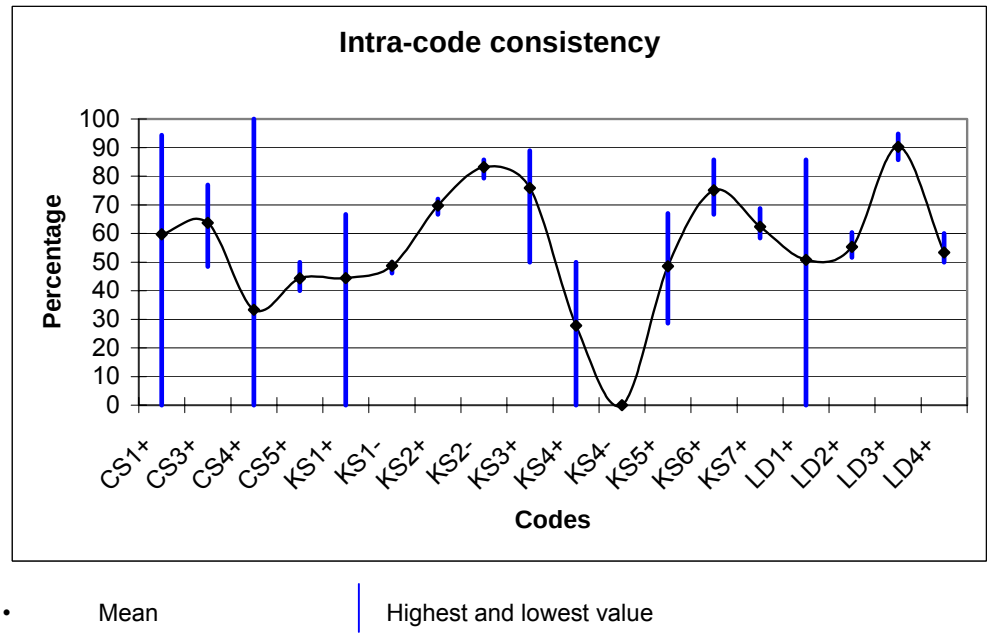


Figure 4.7 Day Two: Intra-code consistency for selected codes.

At least 6 codes (33%) showed inconsistent allocation on one of the three data subsets on Day Two (CS1+, CS4+, KS1+, KS4+, KS4-, LD1+), while only one code (6%) showed high consistency on at least one data subset (CS4+).

The codes that were allocated most consistently across the three data sources on Day Two are KS2- and LD3+. Both codes show little variance and their mean intra-coding consistency

is > 80%. Other codes which were allocated with acceptable intra-coding consistency rates include KS2+ with little variance and a mean of 70%, and also KS6+ with a mean of > 70% but somewhat more variance.

Codes which were allocated inconsistently across the three data subsets on Day Two were KS4- with zero intra-coding consistency, KS4+ (mean consistency = 28%), and CS4+ (mean consistency = 33% and a lowest intra-coding consistency value of 0% on two of the three data subsets. It should be noted that KS4+ achieved a fair mean of consistency on Day One but with great variance (0% on DS2 and 100% on DS3), which suggests that KS4+ should be flagged for further inspection.

Table 4.8 shows the intra-code consistency rates for DS7 – DS9 on Day Three.

Table 4.8 Day three: Intra-code consistency rates for DS7 – DS9.

	Day Three - Consistencies (%)				
Data subset	0 – 19 Inconsistent	20 – 39 Low	40 – 59 Average	60 – 79 Fair	80 – 100 High
DS7	CS2+ KS4+ KS4-		CS5+ KS5+ LD4+	CS1+ KS1+ KS1- KS3- KS5- KS7+ LD2+	CS3+ CS5+ KS2+ KS2- KS3+ KS6+ LD1+ LD3+ LD5+ LD6+
DS8	KS1+ KS4+ KS4- KS5- KS6+	KS5+	KS3- LD1+ LD2+	CS1+ CS3+ CS5+ KS1- KS2+ KS7+	CS6+ KS2- KS3+ LD3+ LD4+ LD6+

	CS6+	KS1+	CS1+	CS5+
DS9	KS4+	KS1-	CS3+	KS2+
			KS3+	KS2-
			KS5+	LD3+
			KS5-	LD6+
			KS7+	
			LD1+	
			LD2+	
			LD4+	

Table 4.8 shows that most of the scores for DS7 – DS9 on Day Three were clustered in the average to high intra-code consistency range. Codes that were allocated with fair to high consistency across all three data subsets were CS1+, CS3+, CS5+, KS2+, KS2-, KS3+, KS7+, LD3+ and LD6.

KS4+ was coded inconsistently across all three data sources on Day Three. Bearing in mind that KS4+ also showed varying levels of intra-coding consistency on DS1 – DS6, the observation from DS7 – DS9 appears to confirm that KS4+ should definitely be flagged for further inspection. Another code which shows inconsistent allocation on two data subsets (DS7 and DS8) is KS4-. Examining the data from DS1 – DS6, it is apparent that KS4- was allocated inconsistently on all data subsets except DS2, where it was not coded at all. It appears that the KS4 category *per se* may be flawed.

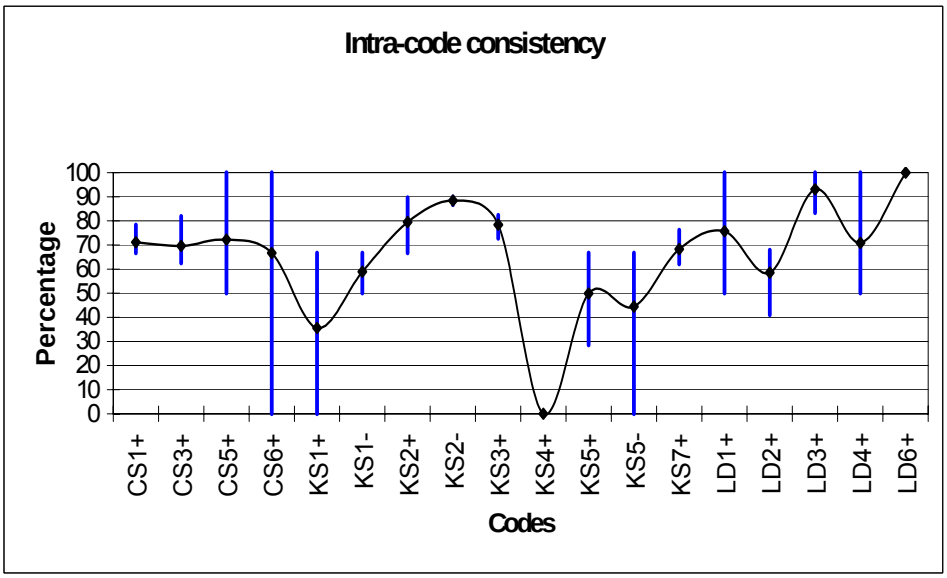


Figure 4.8 Day Three: Intra-code consistency for selected codes

Figure 4.8 summarises the highest and lowest intra-coding consistency values and their means for those codes that were allocated across all three data subsets on Day Three.

From Figure 4.8 it is evident that three codes (17%) showed complete inconsistency on at least one of the data subsets on Day Three (CS6+, KS1+, KS5-), while five codes (28%) showed complete consistency on at least one data subset (CS5+, CS6+, LD1+, LD3+, LD4+). One code (KS4+) was allocated inconsistently on all three data subsets.

Codes that have been allocated across DS7 – DS9 with the highest consistency appear to be KS2+, KS2-, KS3+, LD3+ and LD6+. CS1+ and CS3+ were also allocated with high consistency (mean > 70% and lowest intra-coding consistency values > 60%). The two codes that show the most inconsistent allocation, KS1+ and KS5-, have means < 50% and they also show considerable variance. On Day Two, KS1+ also showed a mean intra-coding consistency of < 50% with its highest intra-coding consistency value < 50%. This trend was a reverse from Day One, where KS1+ achieved a mean intra-coding consistency of just < 80% and a lowest intra-coding consistency value of 50%. Even though the trend appears to show that KS1+ tends to be allocated inconsistently more often, it was decided not to flag KS1+ for further inspection. The primary reason is that the frequency with which KS1+ was coded, amounted to a total of 56 times on DS1 – DS3, but only 10 times on DS4 – DS6, and 16 times on DS7 – DS9. It is therefore likely that the lower intra-coding consistency rates on DS4 – DS9 are not as reliable as those on DS1 – DS3, which are based on higher frequencies.

To summarise, codes that were allocated inconsistently and/or with great variance on at least one data subset were CS4+, CS5+, KS3+ KS4+, KS4-, KS5+, KS5-, KS7+, LD1+. Low intra-coding consistency rates, as well as great variance, were taken as evidence that the code could be problematic in terms of the clarity of its formulation, or in terms of the construct it addresses. The flagged codes were inspected and compared with other codes on the MBOS. As a result, various codes were merged because there was overlap between codes in the construct being addressed. Figure 4.9 shows how the codes were merged.

Original code	Merged code	Reason
CS4+: The researcher points out to learners unhelpful behaviours that lead to incorrect responses. CS6+: The researcher points out helpful behaviours that lead to correct responses	CS4+: The researcher points out general learner behaviours that enhance or impede problem-solving.	Both CS4+ and CS6+ were coded with low frequencies (< 4), and they show great variance. Overlap of the constructs also occur.

KS4+: The researcher does not accept a learner's correct response without investigating the thinking behind it. KS5+: The researcher probes the thinking behind incorrect learner responses and uses the responses as a basis for further thinking and interaction. CS5+: The researcher gives clues and hints to help learners correct their errors in thinking.	KS3+: The researcher probes the thinking behind learners' responses and uses the responses as a basis for further thinking and interaction.	KS4+ was flagged for inspection as a result of low inter-coding consistency rates, while KS5+ showed great variance on Day One. CS5+ showed acceptable inter-coding consistency and was merged with KS4+ and KS5+ because all three codes address the same core construct, namely the probing for the purpose of mediation. Also, the formulation of KS4+ and KS5+ was ambiguous.
KS6+: The researcher requests learners to provide evidence for their statements. KS7+: The researcher encourages learners to give clear, analytical reasons for their statements.	KS4+: The researcher models clear, analytical thinking by requesting learners to provide evidence for their statements.	KS7+ showed great variance on Day One. It was merged with KS6+ because of overlap in their constructs.
LD1+: The researcher engages in positive interactions with learners. LD3+: The researcher provides positive feedback in response to a correct answer.	LD1+: The researcher engages in positive interactions with learners, makes empathic statements to acknowledge a learner's opinion and/or conveys a personal interest in the learner.	Merged mainly because of vague and ambiguous formulation. LD1+ showed great variance on Day Two and Three. LD3+ was generally coded more often and more consistently than LD1+.
LD2+: The researcher engages learners in classroom discussion. KS3+: The researcher encourages learners to respond verbally.	LD2+: The researcher engages learners in discussions where verbal interaction is encouraged.	Construct overlap and variance in inter-coding consistency on Day One for KS3+.

Figure 4.9 Merged codes on the MBOS

Because the codes on the positive end of the MBOS were merged, their counterparts on the negative end of the MBOS were necessarily subjected to the same treatment. This resulted in a slightly shorter, revised version of the MBOS shown in Figure 4.10. The merged codes will be used to analyse the researcher's interaction with the learners in each of the nine design experiments in Chapter 5.

School:		Grade:		Date:		Time:	
Researcher behaviours that promote understanding of learners' knowledge structures				Researcher behaviours that impede understanding of learners' knowledge structures			
KS1+: The researcher interacts with learners by asking their opinions about what they are learning. Also includes statements which request personal background knowledge and experiences				**KS1-:** The researcher interacts with learners by giving instructions which learners must follow.			

KS2+: The researcher asks open questions that require participation from learners in the form of an extended verbal response.				**KS2-:** The researcher asks mainly closed questions which require one-word responses
KS3+: The researcher probes the thinking behind learners' responses and uses them as a basis for further inquiry.				**KS3-:** The researcher accepts learners' responses without any further inquiry.
KS4+: The researcher models clear, analytical thinking, or requests learners to provide evidence for their statements.				**KS4-:** The researcher accepts vague, ambiguous statements from learners without requiring evidence for statements.
Researcher behaviours that promote the use of cognitive skills in learning				Researcher behaviours that impede the use of cognitive skills in learning
CS1+: The researcher encourages learners to explore tasks systematically, asks learners to think before they act, or wait while someone else is busy.				**CS1-:** The researcher allows learners to approach tasks in a disorganised fashion
CS2+: The researcher models the execution of tasks to her learners				**CS2-:** The researcher requires learners to do tasks without modelling their execution
CS3+: The researcher guides learners in their thinking and task execution without showing them the correct way immediately				**CS3-:** The researcher immediately supplies learners with the correct answer or method when they encounter difficulty
CS4+: The researcher points out behaviours that enhance or impede problem solving.				**CS4-:** The researcher does not provide information on behaviours that can enhance or impede problem solving.
Researcher behaviours that promote a positive learning disposition				Researcher behaviours that promote a negative learning disposition
LD1+: The researcher engages in positive interactions with learners, makes empathic statements to acknowledge and confirm learner's opinion and conveys a personal interest in the learner.				**LD1-:** The researcher engages in negative interactions with learners, does not acknowledge learner's contributions and shows no personal interest in the learners.
LD2+: The researcher engages learners in discussions and encourages learners to respond verbally.				**LD2-:** The researcher discourages discussions with learners in the classroom and accepts pre-verbal responses such as pointing, headshaking.
LD3+: The researcher accepts partially correct responses and provides positive feedback.				**LD3-:** The researcher rejects responses that are partially correct and dismisses/rejects them as incorrect.
LD4+: The researcher attributes success in learning to intrinsic factors (e.g. the efforts of the learner, hard work)				**LD4-:** The researcher attitributes success in learning to extrinsic factors (e.g. luck, easy work)
LD5+: The researcher encourages risk-taking and invites learners to take chances, encourages learners to use their home language.				**LD5-:** The researcher discourages risk-taking, prevents learners from taking chances, discourages learners from using their home language.

Figure 4.10 The revised version of the MBOS

It should be noted that LD5+/- (risk-taking) did not exist in the original MBOS and was only created during the coding of the data subsets because there were enough utterances that required the formation of such a category. During the coding risk-taking behaviour was originally coded as LD6+, but since LD1+ and LD3+ were merged in the revised version of the MBOS, the risk taking category became LD5+.

The revised version of the MBOS was used to analyse the researcher's interaction with learners in the nine group sessions of the design experiment presented in Section 4.3.8.2.

4.3.8 Data analysis

4.3.8.1 Phase One : Classroom observation

The first three days of classroom observation were intended to provide the researcher with a preliminary understanding of the learners' everyday learning environment, and the role of the teacher in constructing that learning environment. Observing the teachers whose learners

would be participating in the design experiment assisted a great deal in understanding the kind of learning environment they are exposed to.

The participating Grade 1 class consisted of 29 learners, Grade 2 had 32 learners and Grade 3 had 40 learners. The desks of the Grade 1 and 2 classes were placed to facilitate group discussion and collaborative learning, yet discussion and collaborative learning appeared to be discouraged by the teacher, such as when saying *"Own work! No talking about it, you do your own work!"* (**CO1-2, 33**), *"I want your own thoughts, you're not going to talk with anyone!"* (**CO1-3, 19**) and *"I'm going to see if you can think for yourself a bit."* (**CO2-3, 30**). The desks of the Grade 3 learners were placed in the conventional manner, facing the front of the classroom, with the teacher's desk at the front of the class.

In both Grade 1 and 2 classes, some learners who were perceived to be "problematic", were isolated from the rest of the class. These isolated learners sat alone at their desks and were not part of a group. In the Grade 2 class particularly, one group of learners frequently attracted negative remarks from the teacher, and appeared to receive little attention. From their workbooks, it was evident that some of them experienced difficulty with phonic skills. After the teacher had criticised their work in front of the teacher, they became quiet and appeared to withdraw somewhat. The Grade 3 teacher did not have any learners isolated at a table, but did mention to the researcher that the learners in her class had a slow work tempo and although they could express themselves reasonably well, had some difficulty understanding the teacher, as well as with reading and writing skills.

All three Grades implemented a reward system to encourage conforming behaviour. The Grade 1 teacher primarily used a merit system to encourage learners to work quietly *"Who would like a smiley face? A merit? Then show me!"* (**CO1-1, 43**). The Grade 2 teacher used verbal praise *"Lovely, good girl! I see there's some angels in my class, I'm so glad!"* (**CO1-2, 9**), while the Grade 3 teacher had appointed managers who had the responsibility to help the teacher maintain order in the classroom *"Are my managers helping me, or are they the ones talking?"* (**CO1-3, 21**). However, children's efforts were not always acknowledged and/or appreciated, as in the following example when learners misunderstood the task:

> "Why are you turning over, what is this nonsense? Sit properly! Can you see the letters in that word? Tell me what they are! You're also doing the same nonsense! Excuse me! What did the metacog[23] say? Now they are writing anything they want!" (**CO1-2, 35-38**).

[23] A kind of brain map which was used as a tool to prepare for creative writing.

Sometimes learners' initiatives were rejected, e.g. when a Grade 2 learner wanted to show the teacher her book, the teacher responded by saying *"I don't want to read it, go on"* (**CO1-2, 53-54**), or when a Grade 3 learner had difficulty expressing herself in English (the teacher was explaining what nouns and adjectives were and learners had to give examples of adjectives - **CO2-3, 13-16**):

Learner	A medium cow.
Teacher	What is a medium cow?
Learner	It's when its fat but not that fat! (Demonstrates)
Teacher	I've never heard of a medium cow. Crocodile, what about a crocodile?
Learner	A scary one.

In each of the participating classes there was evidence of a "hidden curriculum" or implicit rules of behaviour that the teachers enforced. Learners were generally expected to work fast - *"Go on! You've got four minutes to finish!"* (**CO2-2, 12**) – and be quiet. Some teachers did not appreciate being questioned by learners, as the following teacher's response shows after a Grade 2 learner disagreed about the colours of a picture that the teacher was describing (**CO2-2, 38-40**):

Learner	I don't think that is red, it is brown.
Teacher	Shall I stop showing you? And then you can do your own and then we'll see what happens!

Personal hygiene was strongly encouraged *"What's the matter with your nose? Take tissues to blow your nose!"* (**CO1-1, 2-3**), *"How did I teach you to blow your nose? You didn't do anything good!"* (**CO2-2, 18**).

Learners were expected to conform to certain standards of neatness, e.g. *"Look at how you page your book!"* (**CO1-2, 7**), and performance, e.g. *"Bernhard, what did I tell you if you go there? Rather go and do me some perfect work."* (**CO1-2, 55-56**). Children were encouraged to share with one another, e.g. *"Who do [sic] not have food? Who will share with Tshepang and John?*" (**CO2-1, 18-19**).

On the third day of classroom observation, the researcher used the MBOS to make high-inference observations. Each time the teacher interacted with her learners, the researcher made a tick in the appropriate category of the MBOS scale. The researcher also briefly noted the kinds of activities the teacher and learners were engaged in because that would later provide contextual data. Observations were made in four 10-minute intervals. Exhibit F provides a detailed description of the classroom activities and the frequencies of teacher

behaviours that were observed during the third day for each Grade. Table 4.10 summarises the five teacher behaviours most frequently recorded for each Grade in a forty minute observational period.

Table 4.9 Most frequently recorded teacher behaviours for each Grade

Grade	Frequency	Observed behaviour	Context
1	10	Closed questions (**KS2-**)	Main activity consists of going out on playground and collecting leaves. Fifteen minutes after class began teacher receives a note, rolls her eyes and leaves after requesting learners to whisper. They mainly draw, then teacher produces a flashcard that says "winter" – some learners read "water". Learners write "fun, sun, run, gun" on their boards. They sound out words, teacher lets them relax and asks them to calm down.
	9	Gives instructions without inviting participation (**KS1-**)	
	8	Positive teacher-learner interactions (**LD1+**)	
	4	Engages learners in discussion (**LD2+**)	
	3	Systematic exploration of tasks (**CS1+**) Negative teacher-learner interactions (**LD1-**) Open questions (**KS2+**)	
2	14	Positive teacher-learner interactions (**LD1+**)	Children do individual work, teacher hugs children, singing "You are my sunshine." Marks their stories. Teacher reads one learner's story to the class. A visitor arrives and learners show me their stories. I ask them to read to me. While teacher is marking, others come and show me their work. No formal teaching.
	7	Closed questions (**KS2-**)	
	6	Open questions (**KS2+**)	
	4	Negative teacher-learner reactions (**LD1-**)	
	3	Systematic exploration of tasks (**CS1+**)	
3	15	Immediately supplies correct answers (**CS3-**)	Learners complete a worksheet where they have to measure the length of various lines. They are encouraged to work with a partner and whisper. Teacher demonstrates, gives answers and asks learners to check their work. Angry when learners do not do the right thing. Class ends 5 minutes early.
	11	Negative teacher-learner interactions (**LD1-**)	
	8	Gives instructions without inviting participation (**KS1-**)	
	7	Closed questions (**KS2-**)	
	4	Positive teacher-learner interactions (**LD1+**)	

The summary of observed teacher behaviours on the third day shows that the Grade 2 teacher appears to have engaged in positive interactions with learners more than on the

previous two days of observation. It is difficult to provide a reason with any certainty, but it may have something to do with the fact that the third day of observation did not include any formal teaching as the teacher spent the time marking learner's stories individually. Interestingly, Beaman and Wheldall (2000) note in a meta-analysis of studies examining the occurrence of teacher approval and disaproval, that there is a clear trend over the past 25 years that teachers are becoming more approving of children's behaviour, but that they are much more likely to be approving of academic behaviour than social behaviour in class.

Even though "systematic exploration of tasks" (CS1+) appears as one of the five most frequently coded teacher behaviours, the frequency with which it was observed is low (3 times in a 40 minute period). Given the fact that the Grade 3 teacher tended to supply learners with a correct answer (15 times in a 40 minute period), it is perhaps not surprising that systematic exploration of tasks was not observed with much regularity. Encouraging learners to explore tasks systematically is of great importance in the mediation of problem solving (procedural knowledge). For example, Verschaffel *et al.* (1999) have noted that children often do not spend enough time exploring a mathematical problem, representing the problem in terms of their real-world experiences and selecting appropriate problem-solving strategies. This is important because it is through systematic exploration that children construe the problem in their minds, and so it stands to reason that systematic exploration may be critical to self-organisation, without which learning cannot occur.

META-NARRATIVE 4.2

On a personal level, the three days of classroom observation had a very significant impact on me. On the one hand, I was deeply touched by the eagerness of the children who participated and their apparent willingness to accept me into their lives. On the other hand, I was greatly disturbed by what I perceived to be an insecure and disempowering learning environment. I thought that it was very evident how some children's voices were "absent" in the class because they lacked the skill to express themselves in English, or because they had been subjected to experiences that threatened their feelings of personal self-worth. During the time I conducted research at the school, I felt myself being torn between my role as the detached outsider-researcher and an overwhelming need to intervene as children were being subjected to treatment that threatened their human rights. Looking back on the personal turmoil that I experienced during my time at the school, I can see now that those experiences have produced their own butterfly effects in my research, since they helped me to realise what a powerful effect seemingly insignificant non-cognitive factors can have on the cognitions of children.

4.3.8.2 Phase Two : Design experiment

For the design experiment, the teachers of the same three classes observed during Phase One were asked to divide learners into groups. The teacher was requested to select learners in such a way that each group would include learners with varying levels of ability and performance. The rationale behind such a selection procedure was that the learners in the group should reflect the same diversity in terms of ability as one would perhaps encounter in classrooms.

When one is interested in studying complex systems (and the learning that takes place in an ordinary classroom would certainly qualify as one), applying rigid criteria (such as structuring groups to represent even levels of performance) would eliminate much of the system's inherent complexity, thereby automatically rendering the experiment invalid.

Groups were pulled out of their classroom for a period of 40 minutes during which they participated with the researcher in the design experiment with the poster. Each group of learners participated only once. The sessions were audiotaped and transcribed. The revised MBOS was used to analyse the mediational behaviour of the researcher. As was indicated in Figure 4.4 (p. 101), the participation of the researcher increased considerably in the design experiment phase. The participation of the researcher and the learners is shown in Table 4.10. In each case, the total number of utterances is provided, followed by a percentage which indicates the portion of the total number of utterances belonging to the researcher and the learners.

Table 4.10 Participation of researcher and learners on the design experiment

	Day One		**Day Two**		**Day Three**	
	R	**L**	**R**	**L**	**R**	**L**
Grade 1	193 / 39.5%	295 / 60.5%	188 / 42.9%	250 / 57.1%	181 / 43.3	237 / 56.9%
Grade 2	145 / 37.2%	245 / 62.8%	189 / 39.8%	285 / 60.2%	157 / 42.7%	211 / 57.3%
Grade 3	215 / 34.4%	410 / 65.6%	210 / 41.7%	294 / 58.3%	207 / 43.2	272 / 56.8%

Because the main purpose of the design experiments was to examine the feasibility of a chaos model of cognition as a theoretical basis for cognitive intervention, the individual characteristics and personal demographics of the participants were not of critical importance and so the use of audio-recordings for this purpose was considered acceptable. As the research progressed, it became more and more evident that, in the context of the emerging research problem, studying individual learners' cognitions was not as relevant as studying

how the dynamics of chaos and complexity could potentially inform the theory and practice of cognitive intervention in the context of formal learning. To this end, the nature of the mediation and the dynamics of the interaction between the learners and the researcher were considered to be of primary importance. Table 4.11 shows the frequencies with which the researcher's utterances were coded across nine data subsets in the design experiment. Codes which were allocated less than 10 times on all the data subsets are highlighted.

Table 4.11 Frequencies of revised MBOS codes across all data subsets

Code	Shortened description	DS 1	DS 2	DS 3	DS 4	DS 5	DS 6	DS 7	DS 8	DS 9	Tot
CS1+	Systematic exploration of tasks	30	36	51	10	38	30	29	31	44	299
CS1-	Allows disorganised approach	0	0	0	0	0	0	0	0	0	0
CS2+	Modelling task execution	0	5	1	0	0	3	2	0	1	12
CS2-	Absence of modelling execution	0	0	0	0	0	0	0	0	0	0
CS3+	Guidance in task execution	84	55	76	72	91	62	86	75	112	713
CS3-	Immediately supplies correct answer	0	0	0	2	3	2	1	0	0	8
CS4+	Enhancing/Impeding behaviours	3	0	7	2	4	1	1	3	6	27
CS4-	Absence of enhancing/impeding	0	0	0	0	0	0	0	0	0	0
KS1+	Opinion/prior knowledge/experiences	15	7	24	10	6	20	3	4	8	97
KS1-	Gives instructions only	7	10	12	12	13	13	9	9	7	92
KS2-	Closed questions	95	49	78	112	83	75	51	59	88	690
KS2+	Open questions	31	22	23	26	22	29	40	20	37	250
KS3+	Probing learners' responses	48	7	15	25	15	17	24	19	23	193
KS3-	Accepts responses without inquiry	7	2	10	7	10	7	7	5	11	66
KS4+	Models analytical thinking	32	8	15	26	16	17	33	26	21	194
KS4-	Vague/ambiguous statement	0	0	8	0	0	0	0	1	0	9
LD1+	Positive interactions	27	24	41	27	30	24	26	28	27	254
LD1-	Negative interactions	0	0	0	0	0	0	0	0	2	2
LD2+	Engaging learners in discussion	64	47	66	90	47	40	60	53	53	520
LD2-	Discouraging discussions	0	2	0	0	2	0	6	6	1	17
LD3+	Accepts partially correct responses	9	10	11	7	14	14	7	3	9	84
LD3-	Rejects patially correct responses	0	0	0	0	0	0	0	0	0	0
LD4+	Intrinsic factors in success	2	5	1	2	3	0	2	0	1	16
LD4-	Extrinsic factors in success	0	1	0	0	0	0	0	0	0	1
LD5+	Encourages risk-taking	4	3	8	3	11	4	2	4	3	42
LD5-	Discourages risk-taking	0	0	0	0	0	0	0	0	1	1

Table 4.11 shows that the codes that were allocated the most are **CS3+** (Guidance in task execution, 713 times), followed by **KS2-** (Closed questions, 690 times) and **LD2+** (Engaging learners in discussion, 520 times). Considering the complexity of the learning environment that was constructed and the importance of mediation as the primary instructional strategy, the high frequency of **CS3+** and **LD2+** is certainly to be expected. What is somewhat surprising, is the high frequency of closed questions (**KS2-**, 690) in relation to a much lower frequency of open questions (**KS2+**, 250).

In terms of the complexity of the learning environment, one might expect that closed questions would serve the purpose of reducing complexity since they generally do not promote extended answers and discussion. One would also expect that closed questions would reduce chaos in a complex learning system, thereby limiting the potential for self-organisation. On the other hand, it is reasonable to expect that closed questions might be used more often with young children who are still learning to organise their learning behaviour. To further examine the allocation of codes further, the association of codes with other codes was made by observing the number of times that codes occur together. Table 4.12 shows the association of positive and negative codes on the nine data subsets. The upper red half of the table shows the association among negative codes and the lower blue half shows the association among positive codes (Some of the positive-negative code associations will be looked at further on).

Table 4.12 Association of positive and negative codes

	CS1-	CS2-	CS3-	CS4-	KS1-	KS2-	KS3-	KS4-	LD1-	LD2-	LD3-	LD4-	LD5-	
CS1+	-	0	0	0	0	0	0	0	0	0	0	0	0	CS1-
CS2+	12	-	0	0	0	0	0	0	0	0	0	0	0	CS2-
CS3+	241	12	-	0	0	4	0	0	0	0	0	0	0	CS3-
CS4+	17	0	24	-	0	0	0	0	0	0	0	0	0	CS4-
KS1+	6	1	39	0	-	13	3	1	0	2	0	0	0	KS1-
KS2+	40	1	147	4	56	-	21	2	1	9	0	1	1	KS2-
KS3+	21	0	165	4	13	62	-	3	0	4	0	0	0	KS3-
KS4+	17	0	149	0	13	72	86	-	0	1	0	0	0	KS4-
LD1+	45	2	89	8	6	24	17	28	-	0	0	0	0	LD1-
LD2+	69	1	284	4	70	203	95	96	58	-	0	0	0	LD2-
LD3+	9	1	52	1	14	26	19	14	7	31	-	0	0	LD3-
LD4+	5	0	7	1	0	5	1	1	11	5	0	-	0	LD4-
LD5+	7	0	8	0	2	3	1	0	11	26	0	0	-	LD5-
	CS1+	CS2+	CS3+	CS4+	KS1+	KS2+	KS3+	KS4+	LD1+	LD2+	LD3+	LD4+	LD5+	

Blue section : Association among positive codes

Red section : Association among negative codes

Positive codes which were strongly associated with one another include CS3+ and LD2+ (284 allocations), CS1+ and CS3+ (241 allocations), KS2+ and LD2+ (203 allocations), CS3+ and KS3+ (165 allocations) CS3+ and KS4+ (149 allocations) and CS3+ and KS2+ (147 allocations). In five of the six cases, the combinations were formed with CS3+, suggesting that CS3+ might share some characteristics with the other codes, and is therefore possibly not a pure construct.

Noting that CS3+ was the code allocated most frequently, one might assume that CS3+ could be a general construct which will probably have been coded along with other codes in most utterances. It would certainly explain the 284 times that CS3+ was associated with LD2+, another rather general construct. Also, each time that CS2+ was coded, CS3+ was also coded. Of the 27 times that CS4+ was coded, it was associated with CS3+ in 24 instances, and of the 299 times that CS1+ was coded, it was associated with CS3+ in 241 instances.

However, inspecting the associations between CS3+ and CS1+ (241 instances) for example, reveals that they were often geared toward developing children's conditional and procedural metacognitive awareness, i.e. knowing when to employ certain metacognitive procedures (Boekaertz, 1997). Examples include *Okay, how can we check and make sure that it is six?* (DS1, 388:390[24]) or *Listen to what I am asking you. How did we count the ants? What did we do?* (DS1, 401:402) and *Can you see that when we do things all at once that we don't get anything right. Okay? What would be a better way to do this?* (DS5, 463:465).

It is not surprising that the negative codes show very few associations among themselves, since it is evident from Table 4.12 that most of the negative codes were allocated less than 50 times on all data subsets. The exceptions are KS2- (690 allocations), KS1- (92 allocations), and KS3- (66 allocations). Table 4.13 shows the association of these three codes with the positive codes.

Table 4.13 Association of KS1-, KS2-, KS3- with positive codes

	CS1 +	CS2 +	CS3 +	CS4 +	KS1 +	KS2 +	KS3 +	KS4 +	LD1 +	LD2 +	LD3 +	LD4 +	LD5 +
KS1-	38	2	44	3	1	3	0	2	12	15	2	0	3
KS2-	103	3	338	15	40	14	98	64	99	261	28	16	31
KS3-	0	0	6	1	0	5	0	4	18	14	0	1	0

[24] This quote occurs in data subset 1, lines 388 to 390 (Exhibit G). All subsequent quotes will be referenced in the same manner.

KS1- showed substantial association with CS1+ (38 instances) and CS3+ (44 instances). When KS1- was associated with CS1+, it was because the researcher was giving children instructions designed to support them in the systematic exploration or execution of tasks, e.g. *No, do it like this so you can see it* (DS4:157), or *Okay, you must now hand all your cards to the other learners* (DS6:156), or *Yes, listen to what Pindi says, don't grab* (DS9:28). When KS1- was associated with CS3+ when the researcher guided learners in their task execution by giving them certain instructions, e.g. *Okay, do you have the number two? Let's change cards. Green goes to two, two goes to three, three goes to four,and four puts down* (DS2:44), or *Okay, I'm going to take your beads and I'm going to make a new pattern. I want you to look at the pattern and tell me…how to finish it* (DS2:105).

KS3- showed substantial association with LD1+ (18), as when the researcher accepted children's responses without further enquiry and provided positive feedback, e.g. *Yes, you're right.You listened…it's a crab* (DS1:74) or *Good, there's the frog. Show me where the snake is* (DS7:46). KS3- was associated with LD2+ (14) especially when the researcher accepted children's responses without further enquiry and subsequently asked a question to engage them in further discussion, e.g. *Monkey. Okay, and there?* (DS4:85) or *It's big! What is this?* (DS4:76).

KS2- showed a number of substantial associations with other codes, which is not surprising since, after CS3+ (713 instances), KS2- is the code that was most often allocated (690 instances). In fact, KS2- and CS3+ are associated with one another in 338 instances, while KS2- is also associated with LD2+ in 261 instances. To examine the use of open and closed questions as a possible mediational strategy in a complex learning environment, I have scrutinised the association of KS2+ and KS2- responses with other positive codes in order to learn something about the function of these questions.

Harris (1999) suggests that effective questioning can be used to encourage thinking, to promote understanding, to check children's understanding, to gain attention and to teach through the answers. In the present study, coding a question as an open (KS2+) or closed (KS2-) question is the most basic description of the *nature* of the question. However, describing the *function* of the question entails an analysis of the other codes with which a question is associated.

Table 4.14 shows open and closed questions in combination with at least one other code:

Table 4.14 Open (KS2+) and closed (KS2-) questions associated with at least one other code

Associated codes	KS2+ (n)	KS2- (n)
CS1+	40	103
CS2+	1	3
CS3+	147	338
CS4+	4	15
KS1+	56	40
KS1-	3	13
KS2+	-	14
KS2-	14	-
KS3+	62	98
KS3-	5	21
KS4+	72	64
LD1+	24	99
LD2+	203	261
LD2-	1	9
LD3+	26	28
LD4+	5	16
LD5+	3	31

From Table 4.14 it appears that the three basic functions of most closed questions (KS2-) were to guide children in their thinking and task execution (CS3+, 338 instances), engage children in discussions (LD2+, 261 instances), and to encourage systematic exploration of tasks (CS1+, 103 instances). The three basic functions of open questions (KS2+) were to engage children in discussions (LD2+, 203 instances), guide children in their thinking and task execution (CS3+, 147 instances) and to focus on analytical thinking by requesting learners to provide evidence for their statements (KS4+, 72 instances).

Approximately two-thirds of the researcher's questions consisted of closed questions that required a simple yes/no response from the child (Table 4.15).

Table 4.15 Distribution of open and closed questions across the data subsets

Code	DS1	DS2	DS3	DS4	DS5	DS6	DS7	DS8	DS9	Total
KS2+ Open	31	22	23	26	22	29	40	20	37	250
KS2- Closed	95	49	78	112	83	75	51	59	88	690
Total	126	71	101	138	105	104	91	79	125	940

Generally, one would not expect closed questions to be so well-represented in a cognitive intervention session since closed questions usually inhibit rather than stimulate discussion. Over the years, several authors have noted that the development of higher order thinking skills requires mediators to encourage children to express their opinions and defend their

answers (Lombardi & Savage, 1994) and is dependent on encouraging children to speak in a variety of contexts (Costello, 2000). The question that arises from the data in this study is whether closed questions necessarily constrain efforts to teach thinking skills.

An ATLAS/*ti* analysis of the researcher's questioning during the cognitive intervention sessions suggests that open and closed questions were used equally effectively in probing the thinking behind learners' responses and challenging their thinking.

Figure 4.11 reflects some examples of open and closed questions that were used to probe children's thinking.

KS2+: Open questions			KS2- : Closed questions		
Data source	Line reference	Quote	Data source	Line reference	Quote
DS1	153:154	Is it a leopard? How do we know it's a leopard?	DS1	115:115	Do you think an ostrich is purple, Sizwe?
DS3	533:533	Why does Pretoria Zoo make sense?	DS3	139:139	Yes, do you know what kind of buck?
DS4	26:28	What makes it look like it's at the zoo, Tumi? What is a zoo? What do we find at a zoo?	DS4	198:198	Are they different in their size?
DS5	383:383	Why is it not a bird?	DS5	210:210	Ah, do you know what a vulture is?
DS6	483:483	What's the difference between a tiger and a leopard?	DS6	361:361	But a gemsbuck that can kill a giraffe? Do you really believe that?
DS7	74:77	Why not? Who knows why not? Why don't they have dogs at the zoo?	DS7	177:178	And the shapes on their bodies? Is that the same?
DS8	337:339	Yes, how do you know if something is an insect?	DS8	305:306	It's a turtle! Okay, do you know what the difference between a turtle and a tortoise is?
DS9	555:556	Eight? Tell me how you worked that out? Tell me how all of you worked that out?	DS9	489:490	Okay, do you think we can solve this problem by voting?

Figure 4.11 Open and closed questions aimed at probing children's thinking

For a mediator to give children differential support that falls within their ZPD, she must have an understanding of how their knowledge is organised. This is necessary to ensure that mediation leads to learning and understanding, rather than mere training of skills. Generally, the assumption is that open questions are better suited for that purpose, but Figure 4.11 indicates that closed questions may be equally well suited to help the mediator understand how the child organises her knowledge.

Perhaps the primary use of closed questions can also be understood within a developmental and social context as we consider that the learners who participated in the study were young learners in the first three years of school and all of them were learning in a language other than their home language. Frederickson and Cline (2002) point out that children who are expected to master a language in school that is different to their home language, may develop special education needs (SEN) because the language of learning prevents them from accessing learning opportunities. Some learners in the study certainly found it difficult to express their thoughts verbally, and in an exclusive reliance on open questions that require extended verbal responses this would even more be the case. Furthermore, the dynamic adaptation that is necessary for self-organisation to occur is dependent on a sensitive balance between chaos and order, and for the learners in the present study, closed questions appeared to effectively provide the structure the children needed to organise their experiences.

Closed questions are an effective means of introducing discrepancies in a controlled manner by limiting the amount of information that the young child has to attend to at a time. Closed questions challenge children's knowledge organisation, but they generally do so by focusing the child's attention on the salient feature that needs to be adjusted. In the examples used above, the researcher focused attention on the aspect that the children needed to use to investigate the viability of their knowledge structures: what *kind* of buck, the *shapes* on their bodies, what the *difference* between the turtle and tortoise is, and whether a problem can be solved by *voting.* In these cases, closed questions also encouraged analytical thinking by either requiring learners to provide evidence for their statements (E.g. *Okay, are ALL gorillas bigger than monkeys?* DS4, 212:212), to clarify their thinking (E.g. *Do you know why the vulture's beak is round and sharp like that?* DS5, 235:236), or to provide information (E.g. *But, does a leopard have a little black line on its face there on its eyes? Does a leopard have a line like that?* DS4, 148:150). When used as in the aforementioned examples, closed questions are a form of high-level mediation that offers considerable support to the child.

By contrast, open questions introduce a greater deal of ambiguity and offer children very little structure to question the viability of their knowledge. Open questions generally offer the least support as the mediator tries to establish what nature and level of support is necessary to create the dynamic balance necessary for self-organisation. As in the closed questions, the open questions focused on analytical thinking by requiring learners to provide reasons for their answers (E.g. *She's cross. Why do you think she is cross?* DS1, 266:266), eliciting comparative information (E.g. *What's the difference between a tiger and a leopard?* DS6, 483:483) and clarifying personal problem-solving strategies (E.g. *Four? Yes…put four down.*

Why are you putting four down? How did you work that one out? How did you know there must be four? DS7, 561:563).

By striking a dynamic balance between the use of open and closed questions, and by adjusting the type of question to the level of support that various learners in the groups needed, it was possible to create a dynamic learning situation in which the children were inclined to participate and respond to the researcher's mediation. What is also interesting, is that closed questions were used more often than open questions to probe children's thinking as a means of using their responses as a basis for further enquiry (KS3+).

Figure 4.12 compares the use of open and closed questions to probe the thinking behind children's responses.

Codes	Quote in transcription	DS:Line nr
[KS2-][KS3+]	*Does the snake eat scary people?*	DS1:62
	Do you think maybe he could be stealing her bag and that's why she is cross?	DS1:278-279
	Are you seeing the whole picture or is some parts of the picture not visible?	DS3:272-274
	Leopard, does a leopard have a big or a small head?	DS4:253
	And the shapes on their bodies? Is that the same?	DS7:177-178
[KS2+][KS3+]	*She's cross. Why do you think she is cross?*	DS1:266
	Why does Pretoria Zoo make sense?	DS3:533
	What's the difference between a tiger and a lion?	DS4:490
	An owl. What does an owl hunt?	DS6:304
	Why did you think the giraffe is a zebra?	DS7:170

Figure 4.12 Selected KS2- and KS2+ questions in association with KS3+

It is evident that, when using closed questions as a basis for further enquiry, the support offered by the researcher was much more structured and specific and generally provided a clear clue as to the answer that was required from the child. In contrast, when open questions were used for further enquiry, it was very unstructured and not as focused on providing support as it was on eliciting information. Very much the same trend was evident for open and closed questions that were associated with CS3+, mainly because this category is not conceptually pure and tended to be coded together with other categories.

Figure 4.13 shows examples of open and closed questions that were coded with CS3+.

Codes	Quote in transcription	DS:Line nr
[KS2-][CS3+]	*No…does a snake have hair?*	DS7:420
	It's a turtle! Okay, do you know what the difference between a turtle and a tortoise is?	DS8:305-306
	No…does a duck have long legs like that and a long beak like that?	DS9:321-322
[KS2+][CS3+]	*What makes it look like it's at the zoo? What is a zoo, what do we find at a zoo?*	DS1:26-28
	Yes, okay…It's got a beak, and how do birds get their babies?	DS5:302-303
	Why not? Who knows why not? Why don't they have dogs at the zoo?	DS7:54-55

Figure 4.13 Selected KS2- and KS2+ questions in association with CS3+

An interesting feature of the open questions that were associated with CS3+, is that they were often the type of questions that were designed to extend children's responses or to expand on the topic. They did not necessarily require them to justify their answers as in the cases where KS3+ was coded, but simply required them to elaborate on what they knew. However, a fair amount of open questions were coded with both KS3+ and CS3+, once again indicating that CS3+ could be more of an umbrella construct than a pure construct.

Another interesting feature of the open and closed questions as they were used in the above examples, concerns the role of context in children's memories. Research on memory structure in modern cognitive neuropsychological research generally distinguishes between two forms of context – intrinsic and extrinsic. *Intrinsic context* refers to features that form an inherent part of the stimulus, whereas *extrinsic context* refers to features that are merely incidentally associated with a stimulus and generally includes time-aspects and surroundings (Parkin, 2001). In terms of the questions above, both the closed and open questions focused on what is called *declarative memory*[25]*,* and generally employed implicit context more than explicit context. In other words, many questions required children to talk about their specific knowledge of the animals on the poster by requiring them to analyse features inherent to the animals themselves (implicit context). Questions that required children to talk about their personal encounters with animals or the zoo and what they remember of them (explicit context) were generally used less, but with a view to invite participation and create a positive learning experience.

What might be learned from this observation, is that cognitive interventions that employ questioning as a mediational strategy would probably focus much more on questions that

[25] Any memory that is consciously accessible (Parkin, 2001).

dwell on implicit context since these are the questions that will require the child to analyse, compare and reason. In contrast, questions that focus on the explicit context may be used fruitfully to create a safe psychological environment in which children feel that their experiences are valued and that their contributions are welcomed. Conteh (2000) points out that the relationship between teachers and children can make or mar interaction, especially in multilingual classrooms, and so questioning that focuses on explicit context can be a valuable tool in promoting children's cultural experiences in relation to cognitive intervention.

On the other hand, effective use of questions in cognitive intervention can simply be regarded as effective teaching. In an analysis of teaching and learning in effective schools, Harris (1999) points out that effective teaching behaviours include clarity about teaching goals, knowledge of content and strategies, teaching metacognitive strategies, addressing higher cognitive skills and thoughtfully reflecting about one's teaching practice.

Harris (1999) states that effective questioning entails encouraging thinking, as well as promoting and checking understanding. The analysis of questions in the present study has shed some light on how that might be accomplished. Considering that many teachers in South Africa (Taylor, 1999) and other countries (Sternberg & Martin, 1988) are under the impression that they are teaching thinking when they are not, the research in the present study hopes to contribute towards the body of knowledge in cognitive intervention by describing in detail which behaviours teachers should be engaging in if they wish to teach thinking.

4.3.9 Design limitations

The present study suffers from a number of shortcomings. Firstly, an exploratory research design was used to explore how the principles of complexity and chaos theory might be accommodated in a study of children's thinking in formal contexts. The exploratory nature of the research prevents any conclusions from being drawn about the longterm effectiveness of cognitive intervention approaches that utilise chaos and complexity, while the merit of using posters to mediate children's thinking in formal contexts needs to be corroborated by data gained in other settings, especially in regular classrooms.

The design experiments also consisted of small groups of learners where it was fairly easy to influence emerging patterns of participation among the children. Implementing a cognitive intervention approach that promotes the principles of chaos and complexity would necessarily require a fair amount of adaptation and adjustment in regular classrooms. For example, Frederickson and Cline (2002) note that everyday classroom language is often

dominated by the classroom teacher and takes the form of a stylised exchange of questions and answers which tend to reduce the average length of children's utterances by as much as two thirds. In order to expect teachers to encourage chaos and complexity through conversation would probably entail teachers having to give up their right to begin and end conversational encounters, to ask all the questions, to allocate turns at speaking which they do not claim themselves and to control the framework of the conversation (Frederickson & Cline, 2002). Many teachers may not be ready to give up their power of determining what happens in the classroom.

A further shortcoming of the research concerns the ecological validity of the study. The design experiments were conceptualised and implemented by the researcher and not teachers. Since teachers ultimately remain responsible for cognitive intervention in formal contexts such as classrooms, it goes without saying that the conclusions that can be drawn from this study cannot be anything but tentative until data are available that point to the viability of these methods in regular classroom settings.

META-NARRATIVE 4.3