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CHILDREN'S THINKING IN FORMAL CONTEXTS: ACCOMMODATING CHAOS AND COMPLEXITY IN COGNITIVE INTERVENTION

by

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Submitted in partial fulfilment of the requirements for the degree

Philosophiae Doctor
(Educational Psychology)

in the

Faculty of Education

at the

UNIVERSITY OF PRETORIA

Promotor

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South Africa 2003

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It is only when we have descended to the depths of sorrow that we can understand the complexity of being human.

- Pam Brown

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ACKNOWLEDGEMENTS

I wish to thank the following people who contributed to the completion of this study:

- Prof. A C Bouwer, who has helped me to transform my frequent moments of chaos into something that makes sense. Her expert mentorship has contributed in significant ways to the quality of the work in this study.
- My partner, Ruric, who had to listen to all my ideas as I constructed my narrative of cognition and who provided me with valuable and much appreciated feedback.
- Various friends and colleagues who, in the course of this study, showed interest and encouraged me to finish it.
- The teachers and children who participated in this study without whom this study would not have been possible.

The financial assistance of the Human Sciences Research Council (HSRC) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are those of the author and are not necessarily to be attributed to the HSRC.

University of Pretoria, etd - Human, S

SUMMARY

This study is about the conditions that may serve as prerequisites for the development of self-regulated learning (SRL). In the context of educational psychology, SRL is not only about the formal aspects of managing one's learning, but also the motivational and affective processes that drive learning, as well as the social and political arena which provide the context for learning. In this study, I will propose that personal, social and political factors can combine in complex ways to produce a learning situation which cannot be addressed adequately without addressing its inherent complexity.

I examine some current issues in cognition and cognitive intervention and begin by drawing attention to some problematic aspects concerning children's thinking from an educational and psychological point of view. I review the sociopolitical context in which the conceptualisation and implementation of outcomes based education (OBE) and Curriculum 2005 takes place in South Africa and I also discuss some issues pertaining to the study of cognition from a more psychological point of view. I also address issues of complexity by examining how the meaning of the word has changed in response to changing paradigms in science and psychology and suggest that complexity theory is a metaphor that best fits current knowledge about cognition and problem-solving.

Since this study is about the accommodation of complexity in cognitive intervention, an important feature of this study concerns a specific characteristic of complex systems, namely chaos. Chaos allows self-organisation in a complex system and is also the main reason why change in a chaotic system is non-linear and unpredictable. It is generally believed that complex systems need to be studied in an unrestricted context if one is to observe those features that lend the system its chaotic character. In the context of the present study, complexity and chaos are hypothesised to be necessary prerequisites for the development of children as self-regulated learners because they form the mechanisms by which cognitive change becomes possible.

The research was carried out in two phases. In Phase One of the research, classroom observations were made and the Mediational Behaviour Observation Scale (MBOS) was especially designed for this purpose. Phase Two of the research was carried out in an intervention context by means of a design experiment. Verbatim transcriptions were

made of the interaction between the researcher and the learners in nine group sessions which formed part of the design experiment. To enhance the reliability and validity of the data, re-coding and intra-coding consistencies were calculated before the data were analysed. The re-coding consistencies ensured that the subsequent analysis of patterns would enable reliable conclusions to be drawn, whereas the intra-coding consistencies helped to refine the MBOS by indicating which categories may have been flawed, poorly described or impure. As such, the examination of the intra-code consistencies could perhaps be likened to factor analysis which resulted in some codes being merged and others being rejected. These data were used to construct a revised and shortened version of the MBOS.

Some of the more important results of the data-analysis on the design experiment indicated that when complexity and chaos are encouraged in cognitive intervention, some of the mediator behaviours that are most likely to be observed are (i) guidance of the way in which learners execute tasks, (ii) attempts to engage learners in group discussions, (iii) modelling or requiring learners to explore tasks systematically, (iv) positive interactions such as acknowledging responses or praising learners, (v) modelling analytical thinking and (vi) probing of learners' responses.

KEYWORDS:

Cognition
Cognitive intervention
Complexity
Chaos
Qualitative research
Design experiment
ATLAS/ti

University of Pretoria, etd - Human, S

TABLE OF CONTENTS

CHAPTER ONE

Current issues concerning children's learning in formal contexts

CHAPTER TWO

The relationship between science, psychology and cognition

University of Pretoria, etd - Human, S

CHAPTER THREE

Accommodating principles of complexity and chaos in cognitive theory

University of Pretoria, etd - Human, S

University of Pretoria, etd - Human, S

CHAPTER FOUR

Research design and preliminary data-analysis

University of Pretoria, etd - Human, S

CHAPTER FIVE

Data Interpretation

University of Pretoria, etd - Human, S

CHAPTER SIX

Summary and future directions

University of Pretoria, etd - Human, S

LIST OF TABLES AND FIGURES

LIST OF META-NARRATIVES

LIST OF FIGURES

University of Pretoria, etd - Human, S

LIST OF TABLES

University of Pretoria, etd - Human, S

LIST OF DIALOGUES

University of Pretoria, etd - Human, S

PREFACE

> It is not easy being an educational psychologist these days. To our colleagues in psychology, we are too educational, a disparaging label reflecting our interest in studying educationally relevant problems rather than contrived laboratory tasks. To our colleagues in education, we are too psychological, a disparaging label reflecting our interest in basing educational practice on scientific research methods and theories rather than relying on popular opinion and doctrine. We disturb psychology by failing to accept contrived artificial laboratory research as the ending-point for psychological research. We disturb education by failing to accept good intentions, expert opinions, and doctrine-based claims as the rationale for educational practices (Mayer, 2001, p. 83).

The situation described above leads Mayer (2001) to ask a very basic, yet significant question, namely: *What good is educational psychology?* Mayer (2001) goes on to answer his own question by saying that both education and psychology have contributed significantly to this "match in heaven that has had a somewhat difficult history here on earth", firstly, through what Mayer (2001) terms the psychologies of subject matter and secondly, through the teaching of cognitive strategies for self-regulated learning (p. 84).

Self-regulated learning in educational and psychological contexts

In terms of the psychologies of subject matter, Mayer (2001) suggests that education saved psychology from becoming irrelevant by offering psychology the challenge of understanding how people learn in real school content areas. As far as cognitive strategy instruction goes, Mayer (2001) suggests that its main contribution to educational practice was that it helped to specify what knowledge and skills children need for various tasks. One particular area of research in cognitive strategies that has become an important area of research in educational psychology concerns self-regulated learning (SRL), which is described as children's ability and propensity to be active participants in their own learning (Patrick & Middleton, 2002).

This study is about the conditions that may serve as prerequisites for the development of SRL. In the context of educational psychology, it is recognised that SRL is not only about the formal aspects of managing one's learning, but it is also about the motivational and

University of Pretoria, etd - Human, S

affective processes that drive learning, as well as the social and political arena which provide the context for learning. In this study, I will propose that personal, social and political factors can combine in complex ways to produce a learning situation which cannot be addressed adequately without addressing its inherent complexity. Indeed, research on SRL in educational psychology has pointed to the importance of factors such as the nature of learning tasks, instructional contexts, and interaction and Patrick and Middleton (2002) suggest that qualitative research methods are particularly well-suited for the study of SRL because they involve rich, holistic descriptions, they emphasise the social settings in which phenomena are embedded and are oriented toward revealing complexity.

In an article in which they discuss 30 years' of research on SRL in educational psychology, Paris and Paris (2001) describe two models of SRL. The first is a "transmission" metaphor which emphasises the acquisition of strategies for SRL. The second metaphor focuses on "becoming" a self-regulated learner. The "transmission" metaphor of SRL is rather problematic because it cannot explain why all children do not become self-regulated learners once they have acquired the appropriate strategies through cognitive intervention. This is also the basic problem of the present study, namely that some factors inherent in the learning situation, whether they are connected to the participation of the learner or the teacher, or to the nature of the learning task (or more likely a mix of all of them), appear to be responsible for some children becoming self-regulated learners and others not.

Pulling all the themes together

In this preface I use SRL as a framework that provides relevant educational and psychological questions about children's thinking in formal contexts.

Using SRL as a framework to summarise the content of this study serves as a means of pulling together all the themes that influenced the direction of this study at one point or another. For example, when this study was conceptualised, the focus was less on an examination of children's thinking in formal contexts, and more on the development of materials for cognitive intervention. Even then, an important principle in the design of the cognitive intervention materials was that they should reflect the complexity of children's environments so that children could learn to adapt to such complexity. It was only approximately a year later upon reading Briggs and Peat's (1999) *Seven life lessons of chaos* that I was eloquently reminded by the authors of what I was trying to achieve. I was also reminded of an earlier article that described how a chaos model of the brain could be used to effect therapeutic change. The article in point was Gary Flint's (1994) *A chaos model of the brain applied to EMDR*[1].

In the article, Flint (1994) describes how a chaos model of the brain could explain why clinicians who use EMDR can neutralise patients' traumatic memories in a very short space of time. As Flint (1994) describes, EMDR requires the patient to recall a traumatic memory while watching a therapist's finger move back-and-forth at eye-level and Flint (1994) claims that repetitions of such a process "have been shown to eliminate quite rapidly the painful qualities associated with a traumatic picture or feeling"(p. 120). Chaos theory is then offered as a theoretical framework to describe how a traumatic memory is represented by a specific pattern of neuronal activation, also called a neural network, and how by stimulating the patient's perceptual system visually, additional neurological activity is elicited in the brain, causing the neural network of the traumatic memory to be altered and consequently to be neutralised. The point was that a small, seemingly insignicant event that was unrelated to the trauma had the potential to produce a significant change in the patient's experience of a traumatic memory.

Flint's (1994) article introduced me to chaos theory long before it occurred to me that chaos theory could provide a plausible framework for studying children's thinking with a view to improving the practice of cognitive intervention. However, it was only later when *Seven life lessons of chaos* also introduced me to complexity theory that I felt it had become a necessity to examine the relevance of complexity and chaos theory to children's cognition to see whether it could be used to improve cognitive intervention practice and to provide guidance about the kind of interaction teachers and children need to engage in to promote self-regulated learning. At this point, my research focus changed from concerning itself with the development of a cognitive intervention programme to focusing more on examining the complex and chaotic nature of children's thinking and considering ways in which those aspects could be accommodated in

[1] EMDR is an abbreviation for Eye Movement Desensitisation and Reprocessing.

University of Pretoria, etd - Human, S

cognitive intervention. Cognitive intervention is about change – cognitive development – and chaos theory is concerned about how change takes place in complex systems.

Children with special education needs (SEN)

The participants in this study were all young children in the first three years of school whose home language differ from English, their language of learning and teaching (ELoLT). They can be considered children with special education needs (SEN) because their limited language proficiency in ELoLT constitutes a barrier which prevents them from participating fully in learning opportunities. Frederickson and Cline (2002) suggest that children may encounter difficulties in school when they have grown up with a different set of conventions from those that they encounter at school, including speaking a different language at home. If children cannot participate in learning opportunities because of limited language proficiency their cognitive development may suffer as a result and their difficulties will become compounded (Hart, 2000).

Cognitive intervention by means of verbal interaction is an important aspect of cognitive intervention with young children, especially children with SEN as a result of language factors, because children are still in the process of internalising and transforming social speech to mental functions (Vygotsky, 1978). Perhaps a large portion of learners in South Africa could be described as learners with SEN, because even though learners have the right to be educated in their home language, more often than not this is not happening. It is in the nature of current South African classrooms that they show a great deal of linguistic diversity and in most cases the most pragmatic solution is to implement ELoLT. In such cases, it should also be considered that linguistic diversity is rarely a communication problem only, because it affects the healthy development of children's identities as competent learners and problem-solvers, and their development as self-regulated learners. This study directly addresses some aspects of SEN as they relate to language and communication by including them as a natural aspect of cognitive intervention.

It was specifically decided to discuss all children's cognitions in a complex learning environment without addressing children with SEN separately or making any other classifications that could be viewed as exclusionary or discriminatory. All children learn

University of Pretoria, etd - Human, S

and all children should benefit from cognitive intervention. If cognitive intervention practices accommodate complexity and chaos, it follows that all children's needs can be accommodated without the need to make exclusionary exceptions for children with SEN. In this sense, the accommodation of complexity in cognitive intervention is perhaps the same as the accommodation of diversity in cognitive intervention since complexity and diversity both recognise the multi-dimensionality of human nature. In terms of inclusion, the accommodation of complexity and chaos in cognitive intervention could play an important part in providing meaningful learning experiences to all learners, including those with SEN.

The use of meta-narratives

Many questions (some educational and some psychological) emerged over the course of the research and their process of development is reflected in the form of meta-narratives at the beginning and end of each chapter.

On the one hand, the purpose of the meta-narratives was to represent clearly the core problems and questions that informed the study and to reflect the complexity and flexibility of the research. On the other hand, the meta-narratives were regarded as a suitable tool to reflect the postmodern situatedness of the research by presenting research as an emerging narrative rather than a finished product. As such, the use of meta-narratives supports Agar's (1999) description of the qualitative research process[2]. The emergence of the research questions was very much a meta-research process that evolved parallel to research activities. It was therefore important to me to report the research as an activity in which decisions were constantly shaped through a meta-level process as problems and questions arose in the course of the study.

The meta-narratives are intended to reflect the ongoing and open-ended nature of the entire research process. Research can never really be concluded, since new questions and concerns constantly arise. As one question is answered, the answer brings many new possibilities and avenues of investigation which the researcher must address. Inevitably, some questions are more pertinent to the original research question than others so that some questions have to be put aside momentarily. The research

University of Pretoria, etd - Human, S

questions that are generated in the course of this study are certainly not the only questions that may be asked, but they do represent the most pressing issues in the context of the main research question. True to its postmodern situatedness, the research narrative should therefore be regarded as only one of many viable narratives that could have evolved.

The meta-narrative is also a useful tool to reflect concerns that the researcher may have at a particular point and provides an innovative way of including the researcher's assumptions, beliefs and opinions so that the reader may decide to what extent the subjectivity of the researcher influenced the outcome of the results. As such, the inclusion of meta-narratives can significantly enhance the credibility of the research because a clear line can be drawn between the academic process of conducting scientific research and the reflective mental activity of the researcher.

Primary themes in the present study

In *Chapter One* I examine some current issues in cognitive intervention and draw attention to some problematic aspects concerning children's thinking from an educational and psychological point of view. I mention issues related to the conceptualisation and implementation of outcomes based education (OBE) and Curriculum 2005 in South Africa and I also discuss some issues pertaining to the study of cognition from a more psychological point of view.

Concerning the metaphor of the learner in the process of becoming a self-regulated learner, Paris and Paris (2001) have the following to say:

> In this view, self-regulation is a description of coherent behaviours exhibited by a person in a situation rather than a set of skills to be taught….Self-regulation in this view is not "acquired" as much as it is shaped and elaborated through participation in "zones of proximal development" according to tenets of sociocultural theories….In this view, SRL may be regarded not as the goal of students' learning but as the outcome of their pursuits to adapt to their unique environmental demands in a coherent manner (p. 96).

In the extract, Paris and Paris (2001) make several important points about SRL. Firstly, self-regulated behaviours are coherent, i.e. they are not a set of discrete skills that are

[2] See Chapter Four, p 97.

University of Pretoria, etd - Human, S

either purposefully or haphazardly chosen according to the learner's perception of the demands of the task at hand. Secondly, the behaviours that are associated with SRL are more likely to emerge as a result of dynamic interaction and adaptation between children and their environment rather than to be acquired as a result of direct instruction and thirdly, the dynamic interaction between the child and her environment must take place within a zone of proximal development. The features of SRL as discussed by Paris and Paris (2001) are addressed in the present study in accordance with two theories that are increasingly being used as metaphors to explain cognition, namely chaos theory and complexity theory.

In *Chapter Two* I address issues of complexity by examining how the meaning of the word has changed in response to changing paradigms in science and psychology and suggest that complexity theory is a metaphor that best fits current knowledge about cognition and problem-solving. Paris and Paris (2001) make a case for SRL as coherent behaviours that emerge through adaptation and complexity theory explains why this is plausible. However, instead of viewing adaptation as a passive reaction to information received from the environment, complexity theory views adaptation as active self-organisation in which the child is an open system not only influenced by the environment, but also capable of influencing her environment.

Chapter Three deals with a specific characteristic of complex systems, namely chaos. Chaos allows self-organisation in a complex system and is also the main reason why change in a chaotic system is non-linear and unpredictable. It is generally believed that complex systems need to be studied in an unrestricted context if one is to observe those features that lend the system its chaotic character. One of the more important reasons why complexity theory and chaos theory offer a promising framework to study the development of children's thinking in formal contexts as they become self-regulated learners, is studying cognition naturally. In the context of the present study, complexity and chaos are hypothesised to be necessary prerequisites for the development of children as self-regulated learners because they form the mechanisms by which cognitive change becomes possible. Chaos theory suggests that small, seemingly insignificant events (Butterfly effects) have the power to shape the development of an entire system in a fundamental way. Paris and Paris (2001) claim that an enduring research issue in SRL is the one of "hot cognitions and motivations" (p. 98) and the

University of Pretoria, etd - Human, S

specific reasons children may be motivated to develop SRL behaviours. Patrick and Middleton (2002) describe "hot" aspects of cognition as those associated with motivational and affective dimensions of learning, and "cold" aspects as the cognitive and metacognitive aspects of learning. Children not only construe meaning on a cognitive level, they also construe meaning on emotional and normative levels. The cognitive and emotional meanings that children construe as a result of their interaction with others in a learning environment may provide countless Butterfly effects as children develop the kind of identity that could help or hinder the development of SRL.

In a learning context, the events that can shape the meaning a child gives to her learning experiences are many and varied. These events can be connected to formal and social aspects of learning, to the social, cultural and political contexts in which learning takes place, factors within the child, the teacher as mediator or the dynamics of their relationship, and so on. For example, Paris and Paris (2001) suggest that SRL can involve a myriad of avoidance and approach behaviours that a child develops in order to preserve a healthy self-esteem. To examine which mediator behaviours may contribute towards the development of self-regulated learning in formal contexts, *Chapter Four* is devoted to an analysis of those behaviours by the mediator that may contribute to or constrain the development of SRL. To understand on a practical level how complexity and chaos may provide the conditions for the development of SRL, it was necessary to design a complex learning environment that would facilitate the emergence of complex cognition and *Chapter Four* describes how this was accomplished.

The coherence of children's behaviours, especially the behaviours that are associated with SRL, is particularly important within a theoretical framework that emphasises complexity and thus self-organisation, because it draws attention to the fact that children's behaviours are guided by the meaning they construe from their experiences. Paris and Paris (2001) point out that SRL is viewed as the integration of skill and will, and that children's identities play an important role in the emergence of SRL. Children's identities are formed by many different experiences over time in which children make judgements about their abilities and skills. Specifically, Paris and Paris (2002) suggest that "striving to enact identity, fueled by desires to be recognized and validated as a specific kind of self, provide coherence to a person's actions" (p. 97). In *Chapter Five* I offer some suggestions on how such coherency may be achieved as a result of

University of Pretoria, etd - Human, S
children's appraisals of formal and social aspects of a learning situation and I also suggest that these appraisals are guided by personality, cognitive preferences and emotional styles which have emerged through a dynamic interaction between genetic/hereditary aspects and the sociocultural environment. Chaos theory is essentially about processes of change. In the context of the present study, the focus is on cognitive change and how mediators could bring about such change through cognitive intervention. The accommodation of chaos in cognitive intervention is about creating the conditions necessary for children as complex human beings to change through self-organisation. One of the prerequisites for change in a complex system is sufficient complex interaction between different elements of the system. In the case of children's thinking, complex interaction between the child and her physical and social environment is required to ensure that cognitive change is an open and flexible process. Cognitive intervention must also accommodate interaction between the child's personality and her emotional and cognitive processes.

Specific attention is also paid to the themes that can arise in complex learning environments that do not focus on the instruction of specific skills, but that emphasise a natural process in which children become self-regulated learners. Perhaps one of the main points that I want to make clear in *Chapter Five* is that learning environments that accommodate chaos and complexity in cognitive intervention do not have to imply directionless, unfocused activity in which the teacher and her learners have a good conversation but little or no learning is accomplished. Through well-considered questioning and mediation on the part of the teacher, a wide variety of issues can be accommodated that are very relevant to the development of healthy identities and the kind of "hot cognitions" that Paris and Paris (2001) believe to be important in SRL.

Another area of research that Paris and Paris (2001) suggest requires more research, is the question of exactly how children become self-regulated learners. They suggest that SRL can develop through a combination of direct induction (from experience), direct instruction and elicited actions (through participation in tasks that require SRL), but exactly how this is thought to happen is still unclear. Paris and Paris (2001) further suggest that SRL can be promoted through "directed reflection", "metacognitive discussions", "reflective analyses" and so on. Yet, what remains elusive is exactly how such practices are supposed to be managed by the teacher, how they should be

University of Pretoria, etd - Human, S

structured, for what purposes, and how they should be conducted. For example, reflective analyses of a learning task can involve anything from an analysis of the participation of the learner, her demonstrated abilities and skills, personal experiences [or lack thereof] with similar tasks, other children's contributions, transcendental aspects such as the importance of a particular task, its meaning within a broader context, and so on.

The themes which are addressed in *Chapter Five* begin to answer some of these questions by examining how metacognitive discussion and reflective analysis are used specifically to address (i) learning as self-organisation by enhancing psychological and cognitive flexibility, (ii) mediation of self-organisation through the use of concrete materials and cultural signs, (iii) mediation of language as a means of promoting cognitive development, (iv) self-regulatory behaviour, (v) group participation and (vi) self-esteem. *Chapter Five* also offers a detailed description of the characteristics of the mediator and the learner when different levels of mediation is provided. These characteristics can be of significant practical relevance because, instead of providing vague and abstract descriptions, they describe to teachers the kinds of practical behaviours they need to engage in in their efforts to promote SRL.

Chapter Six contains a summary of the main themes in the study. Some issues that remain problematic in the study of children's thinking within a context of complexity and chaos are discussed. Practical suggestions about the accommodation of chaos and complexity in classroom settings are offered. Directions for future research are also addressed.

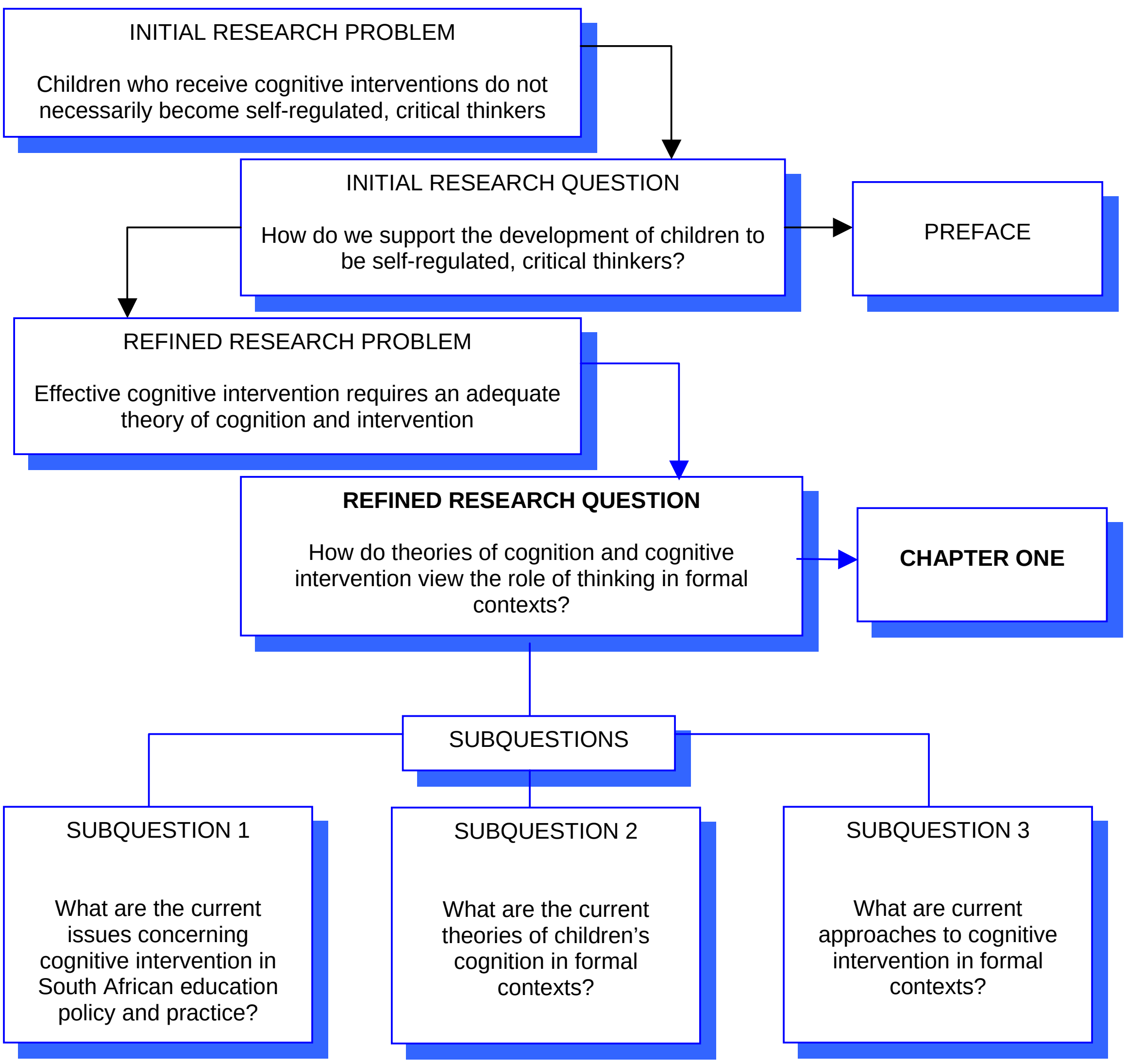
CHAPTER ONE

Current issues concerning children's learning in formal contexts

Weighing the pig doesn't fatten it.

Black and William (1998 in Long, 2000)

META-NARRATIVE 1.1



University of Pretoria, etd - Human, S

1.1 THE SOCIOPOLITICAL CONTEXT OF COGNITIVE INTERVENTION

In the first decade since the introduction of outcomes based education (OBE) and Curriculum 2005 in South Africa, there have been continuous large scale and small scale attempts, both formal and informal, to assess the effectiveness of the new educational system. Long (2000) notes that assessment is a major part of the educational process because teaching could become unfocused without it. However, Long (2000) also notes that not all assessment activities are necessarily justified, especially if assessments are unable to contribute to the improvement of educational practice.

The implementation of a new education system in South Africa has led to widespread concern that particular standards in education are not being achieved and that South Africa's position in relation to other countries' should be carefully monitored as part of a global concern about standards in education. Hence our participation in studies such as the Third International Mathematics and Science Study (TIMSS) and the UNESCO-sponsored Monitoring Learning Achievement (MLA) project. However, educational issues in South Africa still extend far beyond merely setting and achieving minimum educational standards. Prof. Kader Asmal, Minister of Education (Asmal, 1999) acknowledged in an address to the Cape Town Press Club:

> We have not succeeded in ameliorating the devastating impact of *apartheid* in the education and training of the majority of our people. Many weaknesses and shortcomings have survived – indeed thrived – in the first five years of democratic government. Large parts of the system are dysfunctional (p.2)."

Minister Asmal (1999) reiterated that (in terms of education and training) "we have a national emergency on our hands (p. 3)." The emergency in South African education can be felt on institutional level, as well as in the classroom. In that sense, the greater African educational experience which Samoff (2001) describes reflects another dimension of some of South Africa's most pressing educational problems:

> The sense of excitement, hope, and anticipation in African education has been replaced by widespread dismay, disappointment, and discouragement…After a period of rapid growth and dramatic progress, education in Africa, at all levels and in all forms, is in dire straits, we are told. With few exceptions, both schools and learning have deteriorated, and the situation is continuing to worsen. Roofs leak and wind blows through paneless windows. There are too few teachers to sustain expanded access, too many teachers have had little preparation, and very few teachers have opportunities to improve their skills (p. 6).

University of Pretoria, etd - Human, S

Samoff (2001) notes that the “absence of a visible, energetic, and purposive leadership” (p. 25) may well have contributed towards the despondency, but that the limited success with which the responsibility for education was decentralised, coupled with the inclination to seek external funds, also played a role. The reliance on international donor funds may well have led to a situation where African countries’ educational reform was being determined by external roleplayers with their own interests. Samoff (2001) concludes by saying that:

> *Africa [must] run faster as it tries to catch up with those who are ahead….Scrambling to catch up always leaves those presumed to be in front to determine where they, and thus everyone else, are going* (p. 27).

The educational crisis is by no means an African phenomenon only, so it is not always clear who is “in front”, or even if anyone is really in front. If TIMSS, the largest international comparative study of educational achievement to date, is anything to go by, then countries such as Singapore, the Czech Republic and Japan find themselves in front, and countries such as South Africa, Colombia and Cyprus find themselves at the back of the race (Plomp, 1999). It would admittedly be very simplistic to make such judgements on the basis of one study alone. A study that ranks the science and mathematics achievement of countries’ learners in certain grades can hardly reveal the complex ways in which social, political, economical and educational factors interact to determine the health of a country’s education system. For example, the United States of America (USA) is politically and economically one of the most powerful countries in the world, yet Lambert and McCombs (2000) report that its education system is in crisis, and Everson (1999) points out that education standards are at the centre of widespread education reform for the purpose of improving academic achievement in USA schools. Despite approximately 10 years of educational reforms, the USA finds itself being outscored in the TIMSS by at least 10 other countries (Plomp, 1999). If a country such as South Africa wants to transform its education system, I believe we need to look inward, identify the unique obstacles we face, find solutions that work for our society.

Most of the so-called developing countries are faced with problems ranging from the formulation and implementation of educational policies and education reform strategies to more pragmatic issues such as setting educational standards, assessment, achievement and equity. Ravela’s (1999) reminder that educational underachievement in a developing country such as Uruguay appears to result mainly from poverty, is hardly a revelation. Yet, there appears to be significant educational problems even in developed countries such as the United Kingdom where educational problems frequently centre around the inability of the education system to meet the needs of ethnic minority groups. For example, Gipps (1999) reports that African Carribean, Pakistani and Bangladeshi learners in the United Kingdom frequently achieve less well than their White counterparts, while Indian learners achieve better than White learners in some urban areas.

In the Education for All (EFA) Assessment, which forms part of the joint international UNESCO-UNICEF Monitoring Learning Achievement (MLA) project, it is reported by Chinapah, H'ddigui, Kanjee, Falafayo, Fomba, Hamissou, Rafalimanana and Byamugisha (1999) that none of the 11 participating African countries[1] met the minimum learning achievement targets[2] in Numeracy that were set at the World Conference on Education for All in Jomtien, Thailand in 1990. Only two African countries (Morocco and Tunisia) met the Literacy target, and three (Madagascar, Malawi and Tunisia) met the Life Skills targets.

In a separate report on the same EFA 2000 assessment, Strauss and Burger (2000) report that South Africa was among the three lowest scoring countries in respect of achievement in Numeracy and Life Skills, where South African Grade 4 learners achieved a mean performance of 30% and 47.1% respectively. In respect of Literacy, South African learners achieved a mean performance of 48.1% and were outperformed by eight other African countries[3]. Importantly, Chinapah *et al.* (1999) acknowledge as a serious limitation the fact that the MLA project was primarily quantitative and thus unable to provide in-depth qualitative information about teacher-learner interactions, and stress the need to "understand the dynamics in teaching and learning [in order to] establish what must be taught and how each learner must be better prepared to optimise his/her learning potential and attributes" (p. 70). In addition, Brooks and Brooks (1999) say that educational improvement can only be "achieved through attention to the complicated, idiosyncratic, often paradoxical, and difficult to measure nature of learning" (p. 20). Therefore, although large scale studies may be able to compare how various countries fare in respect of global achievement on certain outcomes, by no means do they provide sufficiently detailed information about more specific factors, particularly those that influence teacher-learner interactions in the classroom, that create barriers to learning.

[1] They are Botswana, Madagascar, Malawi, Mali, Morocco, Mauritius, Niger, Senegal, Tunisia, Uganda and Zambia (Chinapah, *et al.* (1999, p. vi).
[2] Minimum learning targets required at least 80% of the participants to score at least 50%.
[3] They were Madagascar, Mali, Morocco, Mauritius, Senegal, Tunisia, Uganda and Zambia.

University of Pretoria, etd - Human, S

The practical implementation of OBE and Curriculum 2005 in South Africa is one specific factor that has created many barriers to learning that are not necessarily visible upon inspection of large scale educational assessment results. Mason (1999) says the following about the implementation of OBE in South Africa:

> Responsible and committed teaching and administration are sorely missing in many instances. Many teachers and administrators are severely under-prepared on a daily basis, under the influence of alcohol at work or absent altogether. The reasons for this are complex, not least among them the sheer exhaustion and demoralisation consequent on years of teaching in apartheid's desperately under-resourced schools. (p. 138)

The complexity of Curriculum 2005 methodology and terminology, its revolutionary and radical nature, inadequate delivery of in-service teacher training and lack of financial resources to ensure sustainable implementation of the new curriculum are a but a few of the complex reasons that have been cited as the main reasons for the disappointing implementation of Curriculum 2005 (Chrisholm, 2000; Jansen, 1998; Van der Walt, 2000).

The outcomes based philosophy embodied in Curriculum 2005 represented a shift away from rote learning practices and a general model of learning that views the teacher as the expert "transmitting" knowledge to her learners. Instead, the outcomes based philosophy was conceived around social constructivist principles which emphasised the social nature of knowledge and the recognition that knowledge does not exist independently of the knower, because it is construed by the knower. OBE emphasises the active role of the child in learning and views the role of the teacher as that of mediator, a role which acknowledges the fact that all people create their own meaning and that the teacher is meant to mediate the social construction of meaning. Against this background, the development of self-regulated learning should play a central role in cognitive intervention in the context of OBE. Self-regulated learning contributes to lifelong learning, which is one of the primary goals of OBE in South Africa.

Unfortunately, the emphasis on constructivist learning principles led to teaching strategies that were supposed to promote active participation through groupwork, "discovery" learning, and restraint on the part of teachers because they were not allowed to "lecture" or "tell" their students anything. With regard to children's thinking, teachers began viewing their role as one of facilitation rather than teaching. As Mason (2000) points out, a facilitative approach to teaching encourages the teacher to stand back and passively look on as children "discover" knowledge instead of actively and critically mediating knowledge construction by helping children to

University of Pretoria, etd - Human, S

deconstruct and reconstruct their understanding of problems. In addition, the notion that knowledge can be discovered further reinforces the notion that perfect knowledge exists independently of the knower, a notion that works against the assumption that knowledge is construed through social and cultural interactions rather than discovered. Such a "discovery oriented" perspective reflects little else than a transmission model of learning which assumes that information "enters" the mind of the learner in a perfect state and is "stored" there without undergoing any kind of deconstruction or transformation. In terms of the development of self-regulated learning, a transmission model of learning does little to encourage children to participate actively and to take responsibility for their learning. However, simply requiring children to participate actively does not necessarily lead to the development of self-regulated learning either and it is this question that the present study investigates: what conditions are necessary for children to become self-regulated learners?

The distinction between facilitation and mediation, as the distinction between discovery and construction, may appear to some to be inconsequential, but they reflect fundamental philosophical differences in the way that people view the world. Such philosophical differences impact fundamentally on teachers' classroom practice. For example, Curriculum 2005 places a premium on the instruction of processes of knowledge construction such as higher-order thinking and problem-solving. Teachers, who for the most part were not trained formally in OBE-related philosophy, are expected to teach[4] complex problem solving skills and at least one study has shown that, despite teachers' best efforts, this is not happening (Taylor, 1999).

There may be a host of reasons for teachers' lack of skill in teaching complex problem-solving. These may include lack of knowledge about what complex problem-solving entails, their own exposure and experience with complex problem-solving, how to teach complex problem-solving in academic contexts, and so on. However, teachers may also fail to teach complex problem-solving simply because we, as psychologists and educators fail to grasp its complexity! In essence, this study is about examining how the complexity of children's thinking contributes to the development of self-regulated learning.

[4] I use this term to indicate the traditional notion of teaching as "telling", "instructing" and "informing" and to distinguish it from "facilitation" and "mediation".

University of Pretoria, etd - Human, S

1.2 A THEORETICAL PERSPECTIVE ON CHILDREN'S THINKING IN FORMAL CONTEXTS

1.2.1 Phases in the development of cognitive and learning theory

Children's thinking has been extensively studied across a range of formal and informal contexts. Research which investigates children's thinking in informal contexts often focuses on the nature of the home environment (Sternberg, 2000) and the quality of the interaction between the child and caregiver as a predictor of eventual cognitive functioning (Klein, 2000; Gauvain, 2001; Hubbs-Tait, Culp, Culp, & Miller, 2002). The present study focuses on children's thinking in formal contexts where children are expected to develop their knowledge, skills and values in collaboration with a teacher through structured activities.

Research on children's thinking in formal contexts deals with a wide variety of different problems associated with formal learning, but less often includes a systematic investigation of the nature and quality of the entire context of thinking and learning. For example, in a recent volume on learner-centered education, Mayer (2000) relates how the study of learning has moved through phases of being associated with response acquisition, knowledge acquisition, and knowledge construction. In the response acquisition phase, mechanistic, behaviourist theories of cognition informed instructional practice, while the knowledge acquisition phase was characterised by a shift towards an information processing approach to cognition and a corresponding curriculum-centered approach to instruction. Mayer (2000) notes that it was only in the 1970s and 1980s that the knowledge construction phase of cognition led to instructional practices which recognised the learner as an active participant, rather than a passive recipient. The three phases in learning theory that Mayer (2000) describes emphasise children's thinking in formal contexts as the result of the environment acting on the child (behaviourist), the mastery of information (information processing) and the nature of knowledge construction (constructivist).

The influence of behaviourist approaches to cognition is rather restricted in current learning theory. Based on classical and operant conditioning principles, Long (2000) suggests that behaviourist approaches can appear simplistic and encourage an approach based on rote learning. While behaviourist approaches may have some merit in simple problem-solving tasks that require routine solutions, they are generally problematic when complex thinking skills and behaviours are called for. Moreover, Long (2000) notes that it is becoming increasingly evident that the behaviours that follow a stimulus are not just the consequence of automatic association between stimulus and response, but the outcome of a more cognitive task that allows a person to predict what will follow stimuli and develop expectations as a result thereof. Thus the stimulus-response model of learning will not be considered in the discussions in 1.2.2 to 1.2.5.

In addition to the three major themes in learning theory that Mayer (2000) identifies, another theme which has significantly influenced the study of children's thinking in formal contexts will be discussed in the following sections, namely the contextual approach to cognition. The contextual approach to cognition favours a social constructivist framework that emphasises social interaction and collaboration. The contextual (social constructivist) approach should be distinguished from the cognitive constructivist approach descended from Piaget that emphasises the cognitive construction of meaning without giving explicit attention to the importance of social interaction.

1.2.2 Information processing approaches to cognition

Mayer (2000) suggests that the information processing approach to cognition can be traced back to the cognitive revolution of the 1950s and 1960s which provided educators with a knowledge acquisition metaphor for learning. Groome (1999) explains that the information processing approach, together with computer modelling approaches and cognitive neuropsychology, all represent the field of cognitive psychology.

Long (2000) describes the information-processing approach as the most recent and productive approach in the context of educational psychology and claims that it applies to virtually every topic of educational study. Yet, the information processing approach to cognition has been much criticised for its mechanistic, reductionist approach to human cognition and the fact that humans are viewed as *limited-capacity processors* (Groome, 1999, p. 8) whose thinking processes are compared to the workings of a telephone exchange. Mayer (2000) explains it like this:

> Within this new cognitive metaphor, the learner becomes a processor of information and the teacher becomes a dispenser of information. As the acquisition of knowledge becomes the focus of psychologists, the curriculum becomes the focus of instruction…According to this view of learning, the goal of instruction is to increase the amount of knowledge in the learner's repertoire so that learning outcomes can be evaluated by measuring the amount of knowledge acquired (p. 359).

So the emphasis that the information processing approach places on information processing in the brain of the learner largely ignores the social, cultural and other dimensions of cognition (Bowers, 1999), and leads to instructional practices that focus on knowledge acquisition instead of problem solving. As such, the information processing approach promotes a process-oriented approach to cognition in the sense that complex problem solving is viewed as a series of cognitive processes which the learner engages in as she attempts to solve a problem. Nell (2000) contrasts the information processing approach to cognition with the psychometric approach to cognition by saying that the psychometric approach is essentially a structuralist approach, whereas the information processing approach emphasises process rather than structure. Both the information processing and psychometric traditions have for a century strongly influenced the assessment of human intelligence.

It should be noted at this point that intelligence and cognitive functioning are not synonymous. Intelligence refers (coarsely) to the *facility* with which individuals can engage in a task (cognitive, social or otherwise) with the express purpose of solving a problem inherent to the task at hand. Psychometric theories of intelligence (being primarily concerned with the structure of the intellect) are interested in the *outcomes* of complex problem solving. Information processing theories of intelligence are interested in the *process* of complex problem solving, but they are by no means developmental theories of cognitive functioning. Cognitive functioning is a broader construct which entails a study of the *nature* of human thought, knowledge and learning as the individual develops in a particular context over time.

Theories of intelligence are often based on theories of cognitive functioning. A good example is the incorporation of an information processing approach to cognition in the development of the Wechsler Adult Intelligence Scale – III (WAIS-III) and the Wechsler Memory Scales – III (WMS-III) with the addition of a Perceptual Organisation Index, Processing Speed Index, and Working Memory Index (Nell, 2000). Another example is Robert Sternberg's (1984a) triarchic theory of intelligence. Sternberg's triarchic theory of intelligence is largely a response to contextual theories of cognitive functioning by constructing a theory of intelligence that incorporates componential, experiential, and contextual theories of cognitive functioning (Sternberg, Forsythe, Hedlund, Horvath, Wagner, Williams, Snook & Grigorenko, 2000).

The legacy of information processing theory continues to contribute to our understanding of thinking and learning. For example, Sternberg *et al.* (2000) recently highlighted the importance of tacit knowledge in practical intelligence and explained how practical knowledge is psychologicallly and statistically distinct from academic intelligence, personality and styles of thought. Tacit knowledge, which is defined by Sternberg *et al.* (2000) as procedural if-then

University of Pretoria, etd - Human, S
statements, is thought to be a central concept in practical intelligence, which is thought to predict certain aspects of school functioning better than does academic intelligence.

In addition, research on connectionism,[5] neural networks (Phaf, 1994) and cognitive neuroscience, which add a biological aspect to information processing (Mazzoni & Nelson, 1998; Posner, 1998) has gained momentum in the last two decades, although the complicated nature of these studies have prevented them from being fully embraced by the majority of psychologists as a plausible metatheory of human cognition, and even less so by educators as a learning theory that could inform educational practice. Nor are they intended to become super-theories of human cognition. Groome (1999) admits that a mutually advantageous, symbiotic relationship exists between the normal and clinical fields of neuropsychology, and that this collaboration is necessary to advance our understanding of the brain and how it functions.

However, as Mayer (2001) points out, cognitive psychology was about to die of its own irrelevance by the 1970s simply because it could not account for thinking in realistic situations. The same cannot be said of constructivist and contextual approaches to cognition which are very much concerned with thinking in realistic situations.

1.2.3 Constructivist approaches to cognition

Mayer (2000) suggests that cognitive theory matured in the 1970s and 1980s as the metaphor for learning shifted from a view of the learner as a passive recipient of knowledge to an active constructor of knowledge. Although the roots of constructivism go back to the eighteenth century (Von Glasersfeld, 1989), constructivist approaches to cognition were only recently "rediscovered" in the cognitive development theory of Jean Piaget, specifically his concept of the adaptive function of knowledge (Von Glasersfeld, 1989).

Constructivist theory, as Von Glasersfeld (1989) has pointed out, is essentially a theory of knowledge, and how people represent their knowledge. Cobb (1994) describes constructivism as an approach that analyses cognitive processes located in the individual and so makes a distinction between constructivism and sociocultural theory which, he says, refers to a process of enculturation. Consequently, many constructivists find their epistemological roots in the theory of

[5] Connectionism assumes that information is processed on an asymbolic level as opposed to classical information processing theory which assumes information is represented in the brain by symbols.

Piaget while socioculturalists (or social constructivists) are more associated with Vygotsky (Cobb, 1994).

Von Glasersfeld (1995) argues that constructivism should be viewed within a postmodernist (postepistemological) framework and says that it arose mainly out of a dissatisfaction with Western theories of knowledge. The consequence of such a postepistemological way of thinking, Von Glasersfeld (1995) suggests, is that the concept of **truth** as the correct representation of states of the external world must be replaced with the notion of viability. Viability is a relative concept and, unlike the concept of truth, means that knowledge is viable only if it allows one to cope within a given context. Such a statement is consistent with postmodern thought which questions the existence of a “grand narrative” because grand narratives are based on static views of reality (Higgs & Smith, 2002). Postmodern constructivist thought therefore emphasises the local and specific nature of knowledge rather than elevating it to the status of singular truth.

Constructivist theory is an epistemological theory, and not a pedagogical theory. Constructivist theory itself does not prescribe how teachers should interact with children in order to facilitate thinking. Nevertheless, Brooks and Brooks (1999) suggest that ‘constructivist’ teachers display particular behaviours in the classroom which distinguish them from non-constructivist teachers. Some of the most important characteristics of ‘constructivist’ teachers, are that constructivist teachers (i) seek and value learners’ points of view, (ii) structure lessons to challenge learners’ suppositions, (iii) structure lessons around big ideas and not small bits of information, (iv) recognise that learners must attach relevance to the curriculum, and (v) assess learning in the context of daily classroom investigations, and not as separate events (Brooks & Brooks, 1999, p. 21).

Regarding the relevance of constructivism to teaching, Von Glasersfeld (1989) suggests that constructivist theory changes the concept of knowledge merely by introducing a distinction between what is regarded as **training** (the acquisition of skills which are described as patterns of action) and **learning** (which is equated with the active construction of viable conceptual networks, i.e. understanding), and this distinction forces teachers to re-evaluate their instructional goals and to adjust their teaching to accommodate the active role of the learner. To do this, Von Glasersfeld (1995) suggests that the teacher must be concerned with what goes on inside the learner’s head, listen and interpret what the learner says and so try to build a model of the learner’s conceptual structures. In the context of the present study, I believe the purpose of

University of Pretoria, etd - Human, S
cognitive interventions that focus on the acquisition of specific or localised skills, especially when they are domain-specific, is to train children rather than to expect them to learn. Cognitive interventions for the purpose of learning require the active construction of conceptual networks that depends on the creation of a state of disequilibrium so that the learner may adapt and reorganise her knowledge. Interventions that focus on the acquisition of skills do not necessarily require states of disequilibrium, and therefore adaptation and reorganisation of current conceptual structures do not occur and learning does not take place.

Constructivist theory has been criticised for the fact that it is overly permissive and lacks rigor (Brooks & Brooks, 1999), and that it ignores the historicity of the learner and does not account for the failure of the politically and socially disadvantaged groups to achieve at the same levels as privileged groups (Magadla, 1996). However, Cobb (1994) argues that a forced choice between constructivist and sociocultural theories is unwarranted, because “the sociocultural perspective informs theories of the conditions for the possibility of learning, whereas theories developed from the constructivist perspective focus on what students learn and the processes by which they do so” (p. 13).

The point is that constructivist theory, while it represents a significant shift beyond behaviourist and information processing theories, in itself does not address all aspects of children’s thinking in formal contexts, and perhaps does not intend to do so either. Apart from constructing meaning through mental adaptation to the environment, we also know learning to be a social process, which makes it important to consider contextual (social constructivist) theories of learning if one is to understand children’s thinking in formal contexts more fully.

1.2.4 Contextual approaches to cognition

Research concerning contextual theories of cognition has proliferated in the past three decades. As an alternative to mainstream cognitive psychology, the contextual approach to cognition is represented by a collection of theories which focus on thinking and learning as social processes influenced by the learner’s historical, cultural, and political experiences. The theories in this paradigm are rather diverse, and may focus on aspects of cognition such as *community inquiry* methods in learning (Brown & Campione, 2000), the role of *mediation* (Feuerstein, Klein & Tannenbaum, 1991; Kozulin & Presseisen, 1995; Burgess, 2000) and *classroom discussion* in cognitive development (Conteh, 2000; Larson, 2000), *cooperative learning* (Mercer, 1996) and *learner-centered* education (Lambert & McCombs, 2000).

University of Pretoria, etd - Human, S

The ascension of contextual theories on cognitive development in the 1970s and 1980s occurred partly in response to greater social and political awareness of the plight of marginalised ethnic groups. In America, the 1960s were characterised by political activism and a fight for human rights, particularly those of minority groups. Martin Luther King focused the attention of the world on the plight of African Americans. Some time later, in South Africa, the Soweto uprising of 1976 marked the beginning of political instability as Black South Africans fought for equal rights, particularly in education. The last four decades of the twentieth century were characterised by a heightened awareness of the plight of minority and disadvantaged groups around the world, and researchers and theorists of human cognition came under increasing pressure to re-evaluate their theories of human cognition, as well as the role of cognition in education and psychology if these were to have any relevance in diverse societies.

Political pressure helped to provide the thrust for the development of approaches to cognition that viewed intellectual development as not only a hereditary function, but also as a function of the environment. Awareness of the position of minority groups certainly provided the thrust for Feuerstein's theory of cognitive modifiability, which was inspired by his work with culturally different immigrant children from North Africa and the Yemen at a time when Israel was in turmoil (Burgess, 2000). Feuerstein realised that minority groups were generally not mediated into the culture of the dominant group, and this posed major problems for minority groups who had to cope within an essentially unfamiliar culture with unfamiliar cognitive, behavioural and social patterns. In South Africa, the situation is not much different. Political and educational transformation has created a need for cognitive psychology to become cross-culturally relevant (Nell, 2000), as well as pointing to the need for cognitive education among learners and teachers alike (Cilliers, Park & Thiart, 1999:37).

Contextual theories of cognition have special significance within the South African context because they highlight the importance of non-cognitive dimensions in children's thinking and learning. For example, it appears as if African culture has traditionally attached greater value to *collective responsibility, empathy* (Goduka, 1999), and *social association* (Onyewadume, 2000) in learning. Several other authors (Meyer, Moore & Viljoen, 1997; Van Vlaenderen, 1999) also distinguish between an *African worldview* which is often equated with a field-dependent style of learning (Goduka, 1999) characterised by intuition, emotion and extrinsic motivation, and a *Western worldview* which favours a field-independent style of learning, characterised by intrinsic motivation and self-regulated learning. For example, Callendar (1997) describes the African cultural ethos as spiritual, emotional and social, with an emphasis on the value of genuine personal expression.

The philosophy of *Ubuntu*[6] is considered by some (e.g. Goduka, 1999) to be an important philosophical and theoretical foundation in education that could serve as a framework to affirm and validate unity in diversity. Because of the African tradition of *menschlichkeit*[7], Goduka (1999) suggests that educational models must *inter alia* nurture learners' construction of cultural identity and cultural voice, and promote empathic interaction among members of diverse cultures. Yet at the same time, African-Western classifications of learning could create more problems than they provide solutions. For example, an African-Western dichotomy most often rests on a simplified racial non-white/white distinction between societies and may trivialise the experiences of black South Africans living in an urban westernised context. It creates a dichotomy of white South Africans as predominantly Western, rational and logical and black South Africans as predominantly non-Western, irrational and emotional. Such classifications may point to broad patterns in societies, but they should be regarded cautiously since they tend to ignore completely the very diverse contexts in which South Africans live, whether they be advantaged/disadvantaged, urban/rural, city/informal settlement, rich/poor, conservative/progressive communities, and so on. For example, viewing the majority of African learners as primarily emotional and/or social learners could preclude them from being exposed to learning opportunities that favour rational and analytical learning simply because it is thought that they "do not learn that way". Such practices could serve to perpetuate a situation in which black South African learners are taught differently than white South African learners because they are perceived as being incapable of logical and rational thought. Such practices are discriminatory and do not afford all learners equal learning opportunities.

Nevertheless, the concept of *menschlichkeit* has been formalised on various levels in South African education. The Constitution (Act 108 of 1996) founded a democratic South Africa on the values of dignity, equality and the advancement of human rights. The National Education Policy Act (NEPA) (No. 27 of 1996) determined that education must "contribute to the full personal development of each student, and to the moral, social, cultural, political and economic development of the nation at large…" (RSAb, 1996). The Education White Paper 6 on Special Needs Education was conceived in an effort to offer quality education to all children and to build

[6] The term *Ubuntu* is defined by Goduka (1999: 39) as a philosophy of humaneness that emphasises communality and collectivity. It is characterised by the expression *Umntu ngumntungabantu* which means *I am because we are, we are because I am.*
[7] Humanity, humaneness.

University of Pretoria, etd - Human, S

a caring society that accommodates the needs of all learners (RSA, 2001). The Education Labour Relations Council (Resolution No. 8 of 1998) reminds educators that they have the responsibility to establish a classroom environment that stimulates learning, and to consider and utilise learners' own experiences as a valuable resource. The Norms and Standards for Educators which were determined in terms of section 3(4) of the NEPA (Act No. 27 of 1996), state that one of the key roles of educators is to provide a supportive and empowering environment which shows an appreciation for people of different cultures. The South African Qualifications Authority (SAQA) further endorses this view by recommending that learning programmes must make learners aware of the importance of their participation as responsible citizens in the life of local and global communities, as well as being culturally sensitive across a range of social contexts while reflecting on and exploring a variety of strategies to learn more effectively (SAQA, s.a). Finally, the critical cross-field outcomes[8] adopted by SAQA through the formulation of the National Qualifications Framework (NQF) not only advocate that learners must be able to use science and technology effectively and critically, but they should also be able to work effectively with others as members of a team, group, organisation and community (SAQA, s.a.).

Despite the proliferation of constructivist and contextual approaches to cognitive and learning theory and an implicit acknowledgement that learning is more than a mental operation, the majority of cognitive theories that inform on children's thinking in formal contexts focus selectively in a reductionist fashion on two themes that Mayer (2000) identifies as (i) a focus on learning and cognition within subject matter domains, and (ii) a focus on the detailed assessment of individual learning strategies and outcomes, a situation which Mayer (2001) suggests a reflection of primarily educational and psychological approaches to the study of cognition and instruction.

Despite wide recognition that cultural, motivational and affective aspects of learning are interdependent with cognitive development (Ceci & Nightingale, 1990; Markus & Kitayama, 1991; Weinstein, 2000), cognitive studies for the most part do not integrate cultural, affective and motivational dimensions with cognitive dimensions in their studies, at least not to the point where it is recognised that the dynamics of society, culture, emotion and motivation has a fundamental influence over thinking and learning. Indeed, in a detailed discussion about individual differences in academic achievement, Long (2000) report on a series of studies that show for example, that

[8] Critical cross-field outcomes are broad goals that underpin the specific learning outcomes of learning programmes in SA.

University of Pretoria, etd - Human, S

birth order can account for up to 86% of the variance in children's formal examination results 17 years later, **parent behaviours** (quality of verbal interaction) can account for up to 59% of children's cognitive accomplishments at three years of age, and **socio-economic status** can account for up to 29% of the variance in intelligence scores. Moreover, up to 20% of the variance in academic achievements can be accounted for by personality factors (Long, 2000).

In a recent study by Hubbs-Tait *et al.* (2002) that investigated the relationship between children's cognitive abilities and maternal cognitive stimulation, they report significant relationships between emotional support from caregivers and later cognitive functioning. In addition to other measures of emotional support, positive feedback explained significant variance found in children's perceptual scores. Furthermore, statistically significant relationships were found between children's vocabulary and verbal reasoning scores and their parents' levels of emotional support and intrusive behaviour. (Hubbs-Tait *et al.,* 2002). From studies such as these, one can conclude that cognition is not a monolithic concept consisting of logic only, but is multi-faceted and intimately interlinked with our personalities, emotions and social functioning.

The study by Hubbs-Tait *et al.* (2002) primarily involved the interactions between preschool children and their caregivers, not school-going children and their teachers. Nevertheless, results such as those reported by Hubbs-Tait *et al.* (2002) do point to the importance of studying cognition more broadly by including other aspects such as emotional and social relationships, traditionally regarded as non-cognitive, in studies of cognition.

1.3 COGNITIVE INTERVENTION IN FORMAL CONTEXTS

1.3.1 A definition of cognitive intervention

Cognitive intervention is broadly defined in this study as a concerted effort on the part of the teacher to mediate the emergence of knowledge, skills and values in the learner by providing focused and structured learning opportunities to improve a learner's (i) capacity to learn and (ii) capacity to benefit from instruction.

Children's *capacity to learn* is understood to be directly related to the facility with which they are able to use cognitive processes to choose, adapt and apply cognitive skills and strategies in order to solve complex, real-life problems through active construction of conceptual structures. The capacity to learn is distinguished from the learner's *capacity to benefit from instruction*,

University of Pretoria, etd - Human, S

which refers to the learner's inclination (or disposition) to engage in learning, which is determined (beyond cognitive factors) by personal, social, emotional, and cultural factors.

In the context of this study, cognitive intervention is not considered to be a way of training intelligence (Sternberg, 1984b). The difference between cognitive intervention and training intelligence, is that the former takes place within a holistic framework that incorporates the personal development of the learner within a social and cultural context, and utilising principles of disequilibrium, adaptation and re-organisation of knowledge. The latter is defined as an approach that focuses on the provision of specific learning tasks with a view to teaching the learner specific skills and procedures in order to improve the learner's performance on a particular problem-solving task.

Whereas intelligence training is considered within the context of this study as an exclusively cognitive approach that focuses on micro-skills for solving the problem at hand by means of certain skills, the goals of cognitive intervention transcend the task to include other domains of human functioning such as emotional, social, linguistic and academic development.

1.3.2 Formally structured cognitive intervention programmes

Traditionally, cognitive intervention has been associated with formally structured curricula that target the development of specific thinking skills, often outside the classroom. Some of the well-known programmes in South Africa include Reuven Feuerstein's (1980) *Instrumental Enrichment,* Katherine Greenberg's (1990) *Cognet,* Haywood, Brooks and Burn's (1992) *Bright Start,* Edward De Bono's (1976) *CoRT (Cognitive Research Trust),* and Matthew Lipman's (1991) *Philosophy for Children*.

Thinking skills curricula, such as the afore-mentioned programmes, are generally constructed around particular principles that are associated with a particular theoretical approach to cognition. For example, *Instrumental Enrichment (IE)*, *Cognet and Bright Start* are all organised around Feuerstein's principles of mediated learning experience, whereas *CoRT* emphasises a heuristic approach to creative thinking, and *Philosophy for Children* emphasises philosophical inquiry.

Although it is generally agreed that cognitive intervention can help children to improve their thinking skills and learning achievements (Johnson & Gardner, 1999), cognitive intervention

University of Pretoria, etd - Human, S
programmes do not always lead to long term gains. For example, a South African study that investigated the use of Feuerstein's *IE* with 10 pre-adolescent children over a period of three months showed that the program did not lead to any significant changes in children's group IQ scores or scholastic achievement (Lomofsky and Green, 1990). In addition, Long (2000) reports on a study in the United Kingdom by Blagg in 1991 that showed that *IE* did not have any measurable effects on children's academic progress although children did appear more active in their learning and more aware of the various strategies available to them. These results point to a commonly acknowledged difficulty in cognitive intervention concerning the transfer of knowledge and skills not only regarding the *IE* programme (Skuy, 2002), but in general (Alexander & Murphy, 1999).

In a Canadian study based on a sample of 21 grade 5/6 learners which investigated the combined use of *IE* with a computer thinking program, Maxcy (1990) reports encouraging results that point to the usefulness of *IE* as an adjunct to computer training. However, the small sample size makes it impossible to generalise results, and the author does not report any levels of significance in terms of the observed differences between the experimental and control group, making it difficult to rule out chance effects as a possible cause for the differences in scores.

Skuy (2002) reports that intervention programmes based on mediated learning experience (MLE) can be used effectively to promote cross-cultural co-existence and integration and so contribute to the transformation of the South African education system. One study that Skuy (2002) reports on concerns the use of *IE* with a group of disadvantaged black learners in a gifted child programme. Participants were divided into an experimental group receiving *IE* and academic enrichment, a second experimental group who received a combination of *IE, CASE (*a creativity and socioemotional development programme extending the principles of *IE* to emotional development and creativity enhancement) and extra tuition in school subjects, and a control group which received no intervention[P1]. The programme showed learners who received *IE* to be significantly superior to the control group in terms of the degree of metacognition and bridging skills demonstrated, while a test of verbal reasoning significantly differentiated both experimental groups from the control group. Skuy (2002) also reports on a study which combined *IE* with a model of multicultural education and suggests that a combination of MLE and a programme for multicultural awareness may offer a good framework for promoting awareness and cross-cultural integration in South African schools.

University of Pretoria, etd - Human, S

A programme which appears to produce long-term gains, is the Head Start programme in the United States of America, which was initiated in the 1960s as a way of improving preschoolers' intellectual abilities. Sternberg (2000) claims that long-term follow-ups have indicated that children who participated in the program, were more than a grade ahead of matched controls by the time they reached adolescence. They also scored higher on a variety of tests of scholastic achievement, were less likely to receive remedial treatment, and had fewer behavioural problems. Long (2000) also mentions that longterm gains in the Head Start programme were more likely when the intervention was long term, intensive and involved changes in the children's home backgrounds.

In the United Kingdom, Long (2000) reports that the Cognitive Acceleration through Science Education (CASE)[9] programme which is based on Vygotskian principles and focuses on metacognition, appears to be highly effective in raising the overall level of children's academic achievements in the long term as shown by their GCSE performance three years later. In the CASE programme complex, real-life situations are used and children are encouraged to reflect on their own thinking and to discuss their approach to problems with other children. Moreover, Long (2000) reports on studies that indicate that CASE has a generalised effect on thinking in a range of curriculum subjects and that the effects continue to be strong and positive even when implemented by workers other than the original team.

1.3.3 Context-dependent approaches to cognitive intervention

Apart from formally constructed cognitive intervention programmes, there are also a fair number of instructional approaches that aim to deal with the improvement of children's thinking in the classroom within the context of subject-matter. Ceci and Nightingale (1990) established earlier that context is important in the assessment of cognitive functioning because context acts to elicit certain strategies and resources over others. For example, Ceci and Liker (1986 in Ceci & Nightingale, 1990) found that expert gamblers' ability to do mental arithmetic on the WAIS was unrelated to their ability to do it at the race track. Ceci and Nightingale (1990) also reported on a study by Bronfenbrenner and Ceci that demonstrated how 10-year olds' ability to perform a distance estimation task increased when performed in an embedded context as opposed to a disembedded context.

[9] This programme is not the same as the one reported on in Skuy (2002), also named CASE (Creativity and socioemotional development).

In context-dependent approaches to cognitive intervention the onus rests on the teacher to teach thinking and it is generally done by teaching thinking skills and strategies while studying learning content. In this respect, Sternberg and Martin (1988) point out that virtually all teachers believe they teach for thinking, yet most teachers are uncertain whether their learners are actually learning to think. There are many reasons why teachers may think they teach for thinking while they do not, or why teachers very well do teach thinking, but the learners fail to benefit from these opportunities.

Sternberg and Martin (1988) believe that teaching style may be one reason why teachers think they teach thinking when in fact, they do not. Sternberg and Martin (1988) distinguish between a *didactic* (transmission) teaching style which is geared towards presenting new information, a *fact-based* (information-processing) teaching style suitable for recall of information, and a *dialogic* (sociocultural) teaching style which is geared toward the encouragement of critical thinking and discussion. Only the latter is really suitable for cognitive intervention, and yet many teachers find themselves primarily using either of the first two styles. Perhaps, as Sternberg and Martin (1988) suggest, this is because the dialogic style requires much more effort (which is not always forthcoming) on the part of the learners, and it is generally easier for teachers to expect less from their learners.

In addition to teaching style, there may be several other peripheral factors which limit the effectiveness with which teachers teach thinking. Firstly, teachers' knowledge of their subject and the skills which they use to convey that knowledge play an important role in the success of their learners. In a report on the President's Education Initiative (PEI) Trust (Taylor, 1999), some of the findings indicate that teachers who participated in the study have a poor understanding of the subjects they are teaching, that teachers only have a superficial procedural grasp of what they are doing, and that the teachers in the study generally showed an inability to relate different parts of a discipline to one another and to teach higher order cognitive skills.

In addition to their training, the monetary, psychological and social rewards (or perceived lack thereof) associated with teaching contribute greatly to teacher morale in general, which in turn influences teachers' motivation and their attitudes toward their learners. Long (2000) reports on a study by Borg *et al.* in 1991 that reveals that about one third of teachers experience moderate or severe levels of stress associated with learners' misbehaviour and time/resource difficulties. In Africa there is also an acknowledged shortage of teachers with appropriate training and teaching skills (Samoff, 2001).

University of Pretoria, etd - Human, S

While it is acknowledged that weaknesses such as those pointed out in the PEI project are partially due to inadequate training received by teachers teaching in historically black schools (Fleisch & Potenza, 1999), it appears that some of the bewilderment also stems from uncertainties and misconceptions surrounding the adoption of outcomes-based education (OBE) and the implementation of Curriculum 2005 (C2005) (Kok, Myburgh & Van Loggerenberg, 1999), and that teacher development workshops aimed at 're-training' teachers in the principles of OBE and C2005 are not succeeding very well (Pithouse, 2001).

Recently, Gersten, Vaughn, Deshler and Schiller (1997) pointed out that there may be a variety of reasons why research-based practices are not being adopted by teachers. Although their review primarily addresses teachers' adoption of research-based instructional practices, they make some valuable points that might be equally relevant to the degree to which teachers would consider adopting research-based cognitive interventions. Cognitive interventions invariably require teachers to change their instructional practice, and so there is much to be gained from paying attention to the way in which educational research in general translates to educational practice.

For example, Gersten *et al.* (1997) point out that researchers often underestimate the fact that teachers do not know how to implement material presented in research because it is based on fairly abstract theories. In addition, researchers often treat teachers as subjects who have to implement their research plans as opposed to professionals with extensive theoretical and practical knowledge bases. The failure of research-based interventions to deal with classroom realities, the lack of integration with current teaching practices and ambitious or ill-defined interventions that expect too much too soon are only some of the many factors that Gersten *et al.* (1997) say will impact negatively on the adoption of intervention practices by teachers.

Despite the numerous problems associated with teachers' adoption and/or implementation of cognitive interventions in the classroom, some studies have nevertheless shown that context-dependent approaches to cognitive intervention could be successful. In a study by Leshowitz, Jenkens, Heaton and Bough (1993) that aimed to improve the thinking skills of Grade 7 – 12 learners with learning disabilities, significant improvements were found in learning disabled students' ability to identify main ideas, critically evaluate claims made in newspaper articles and graph data. Leshowitz *et al.* (1993) developed an instructional unit focusing on teaching the principles of scientific reasoning and used student-teacher dialogues to engage the students in

University of Pretoria, etd - Human, S
an active process of critical inquiry. They found that, after working through the instructional unit, the special education students' performance exceeded that of a control group composed of regular education students who had not received instruction in critical thinking.

McNeil and Alibali (2000) report that children who were given externally imposed learning and performance goals in procedural instruction during a Mathematics lesson outperformed children who were not given learning and performance goals, and children who were not given learning and performance goals were more likely to apply their initial mental set in problem solving than children who were given goals. Vauras, Rauhanummi, Kinnunen and Lepola (1999) conducted a study to examine the effects of strategy training on at-risk learners' reading comprehension and Mathematics performance. They found that, although the children generally showed significant qualitative cognitive change, some students who were resistant to treatment efforts did not improve as much. From the results of this study, Vauras *et al.* (1999) report that the two factors that contributed to the success of strategy training, were early metacognitive and motivational readiness factors. Vauras *et al.* (1999) explain that higher psychological and motivational vulnerability leads to resistance in some children, making it more dificult for them to benefit from cognitive intervention.

An important aspect of the Vauras *et al.* (1999) study, like that of Hubbs-Tait *et al.* (2002), is that the study maps the relationship between cognitive and affective variables in order to explain why some children fail to develop critical thinking skills despite adequate instruction, and why cognitive interventions do not always lead to gains in academic performance. These studies also show that it may be important to pay closer attention to the development of learning inclination (disposition) as an aspect of cognition that is relevant to children's attitudes toward problem-solving. Even though children may develop (through cognitive intervention) in terms of their declarative and procedural awareness and knowledge of thinking skills, attention to the emotional dimension of thinking may shed light on the development of children's conditional awareness of thinking skills, that is, the extent to which they know when to use the thinking skills that they have acquired in cognitive intervention programmes.

1.3.4 The current status of cognitive intervention

The field of cognitive intervention is well-researched. Some of the most popular areas of investigation include research on interventions that target the development of *perceptual skills* (De Bono, 1976, 1991), *cognitive deficiencies* (Feuerstein, 1980), *critical thinking skills*

University of Pretoria, etd - Human, S
(Leshowits *et al.,* 1993), *higher order thinking skills* (Lombardi & Savage, 1994), *self-regulatory skills* (Boekaerts, 1997), *general skills of thinking and reasoning* (Marzano, 1998), and *classroom discussion* (Larson, 2000). Research has also been carried out in various academic contexts, ranging from *communicative language teaching* (Swartz, 1991), and *reading* (Das, Parilla & Papadopoulos, 2000), to *science* (Shepardson, 1999), *mathematics* (McNeil & Alibali, 2000), and even *counselling* (Falik, 2000).

In a review of some of the most current and promising approaches to cognitive intervention, Newsome (2000) points out that the study and practice of cognitive intervention is beset by problems such as researchers' and theorists' inability to identify and understand the psychological and cognitive mechanisms that underlie thinking skills, the absence of systematic and extensive research on the nature of thinking and its development, and lack of consensus about the meaning of terms such as 'critical thinking', 'problem solving' and how complex reasoning skills are related to one another.

Newsome (2000) concludes that it may be time to re-assess the direction in which research in cognition and cognitive intervention is moving and suggests:

> At this point in theory development there seems to be a need to reassess the major models and theories of thinking skills in a sympathetic yet critical manner…It may be desirable to seek a more comprehensive framework or paradigm for understanding thinking skills than those now in use. Such a framework could encompass the models and theories now in use and help to foster newer ones as well. Within a newer framework or paradigm, the principles of cognitive psychology, neuropsychology, cognitive science, developmental psychology, and theories of human intelligence might be more easily integrated (p. 200).

However, apart from reviewing some major models and theories of cognition that have been offered by psychologists and philosophers, Newsome (2000) unfortunately fails to offer any suggestions as to how such a comprehensive framework of cognition might be constructed, or what it might entail. Whether a comprehensive framework of cognitive functioning is at all an attainable goal, is a question well worth asking. What does seem clear though, is that approaches to cognitive intervention appear doomed to be nothing more than fragmentary, incoherent attempts at developing cognition as long as the cognitive theories they are based on continue to reflect the theoretical confusion characteristic of research in cognition.

To underscore this point, I wish to draw an analogy between two different but related fields that both address problem-solving in different contexts. The first is **cognitive intervention** which deals with problem-solving in academic and educational contexts, and the second is **psychotherapy** which deals with problem-solving in predominantly intra- and interpersonal contexts. As with theories of cognition and approaches to cognitive intervention, the field of psychotherapy is characterised by many different psychological theories and treatment models, each claiming to be unique and superior in terms of treatment outcomes (Miller, Duncan & Hubble, 1997).

Despite the preponderance of research data that show that all psychotherapeutic treatment models work about equally well, psychotherapists curiously continue to believe that certain treatments work better for particular problems than others. I believe that much the same situation exists in the field of cognitive intervention. A host of cognitive intervention programmes are used in schools and organisations and most rely on research evidence that point to the superiority of their approach to teaching thinking. Yet, while it is acknowledged that some cognitive intervention is better than no intervention at all, it remains unlikely that any current approach to cognitive intervention can assert superiority over other approaches.

The question that arises is this: Why is it important to have unique cognitive intervention programmes or psychotherapeutic tools if hardly any evidence exists for the usefulness of such a situation? Miller *et al.* (1997) provides the following insight:

> Obviously, the emphasis on difference must be about something other than concern for increasing the effectiveness of therapy[10]. What that something might be is, of course, a matter of conjecture. One possibility, however, is that model developers are trying to influence and impress their primary consumers – not clients, but *other therapists*[11]*.* Therapists are the ones most likely to be interested in one theory or the other, to use the various models to conceptualize and organize their clinical work, and to buy professional books and attend training workshops….To succeed in the "therapy model marketplace,"[12] the proponents of a particular brand of treatment must somehow manage to make their model stand out from the competition….One way to distinguish a treatment model from others without validating data is to develop a special language or way of talking about the theory and techniques that is exclusive to that model….In essence, models are made to *seem* different because they *sound different.* (p. 9-11).

However cynical this may seem, one has to acknowledge that the developers of various commercial cognitive intervention programmes do gain considerably from the extent to which their consumers (teachers, psychologists, schools and organisations) believe in their claims of

[10] Read *cognitive intervention.*
[11] Read *teachers/psychologists/schools/organisations.*
[12] Read *cognitive intervention marketplace.*

uniqueness and superiority. And while it is clear that many cognitive intervention programmes do produce positive outcomes, it cannot be automatically assumed that those effects are due to the unique approach of the programme. As current data on the effectiveness of psychotherapeutic models show, positive outcomes may very well be associated with a set of factors common to all treatment models. Similarly, positive results across cognitive intervention programmes are perhaps more indicative of their commonalities rather than their distinctiveness.

For example, Miller *et al.* (1997) point out that the common factors that contribute most to successful therapy are (i) extratherapeutic factors (clients and their environment) which are estimated to account for about 40% of all improvement, followed by (ii) therapy relationship factors which are estimated to account for about 30% of the improvement, and then (iii) model and technique factors, and (iv) expectancy, hope and placebo factors, each of which account for approximately 15% of improvement in therapy. Is it not possible that the gains often reported with various cognitive interventions may also be attributable rather to a set of elements common to all cognitive interventions rather than their unique approach or method? For example, Skuy (2002) states that the effectiveness of *IE* is heavily dependent on the quality of the mediator and suggests that a focus on interpersonal interaction can have a positive influence on cognitive functioning, pointing to the importance of relationship factors as discussed by Miller *et al.* (1997). Furthermore, Skuy (2002) reports in a separate study that students who are task-oriented, flexible and adaptable tended to perform significantly better on certain cognitive intervention and transfer tasks, pointing to Miller *et al.'s* (1997) client factors as the most important variable to influence the success of therapeutic (and therefore cognitive) intervention. This may help to explain why learners simply do not benefit equally from cognitive intervention.

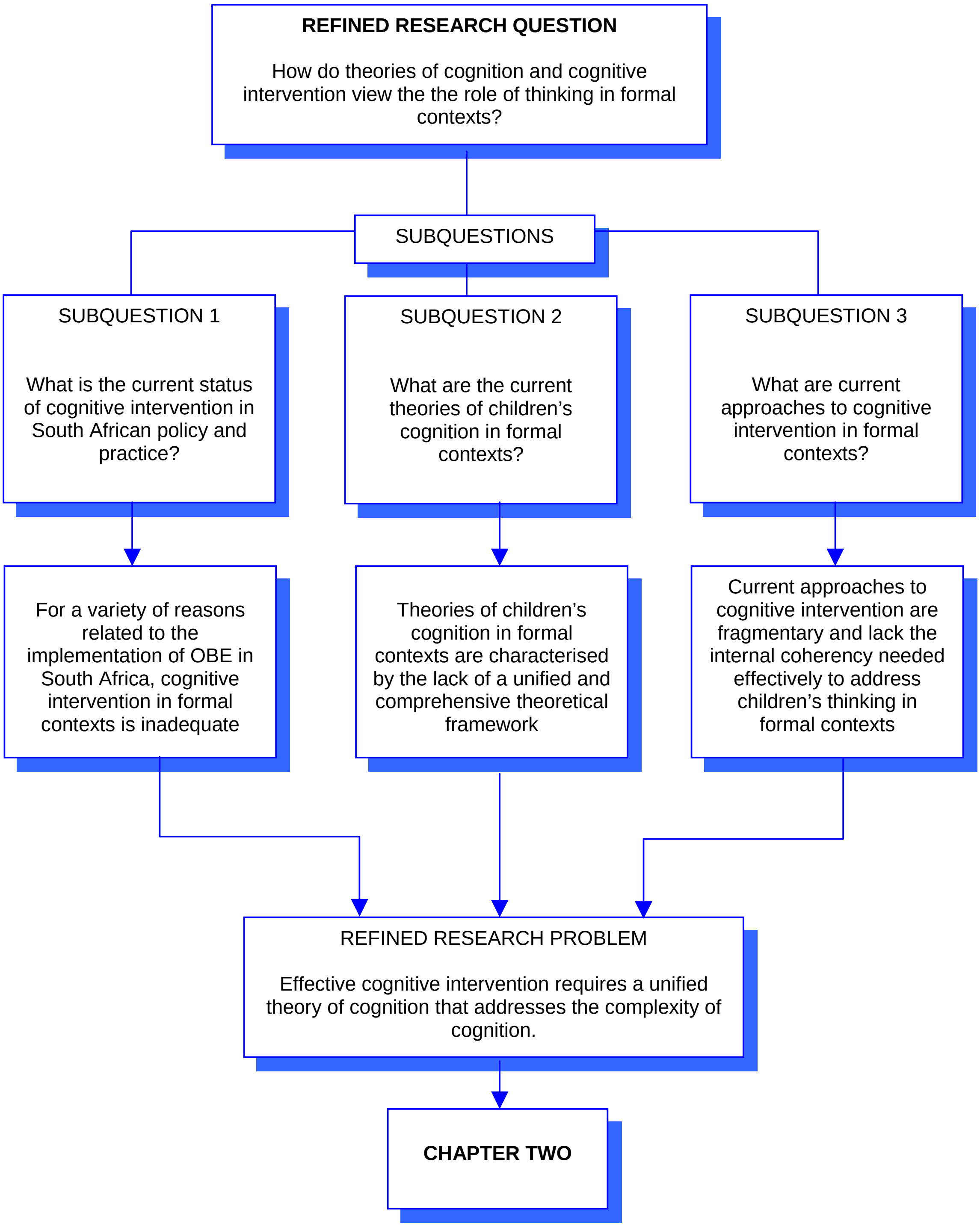
Long (2000) reports on numerous studies that investigated the effects teachers have on the academic achievement of their learners and show that teacher effects are rather limited and mostly not more 10%. Long (2000) argues that the main reasons may be that teachers' effectiveness is largely constrained by learners' abilities (client factors), and that teachers nowadays appear to do more supervision than teaching and they are normally able to have only very limited and superficial interactions with individual children (relationship factors). Studies that investigate the effectiveness of various approaches to cognitive intervention usually do so over a period of time during which special time is allocated and dedicated to a particular type of cognitive intervention. Therefore, it may very well be that the gains reported in such studies could as much be attributed to the more intense, focused and meaningful interaction between the instructor and the child, hope and expectancy factors on the part of the child, increased

University of Pretoria, etd - Human, S
motivation and positive response to the task because of individual or increased attention, and not only to any particular approach to cognitive intervention.

Cognitive intervention is a collaborative process of joint problem-solving which involves both the instructor and the child on cognitive, psychological and social levels. It is fairly widely acknowledged that real-life problems are complex and that children need to learn to deal with such complexity if they are to become effective problem-solvers, regardless of the context of the problem. To help them, we need to address cognition as a complex phenomenon and this could mean less attention to idiosyncratic aspects of cognition as they are revealed in particular tasks and domains and more attention to the complex cognitive dimensions that inform all cognitive intervention efforts.

In meta-narrative 1.2, the research questions and subquestions that guided Chapter One are addressed and refined in order to provide the modified research problem that will direct the literature review in Chapter Two.

META-NARRATIVE 1.2



University of Pretoria, etd - Human, S

CHAPTER TWO

The relationship between science, psychology and cognition

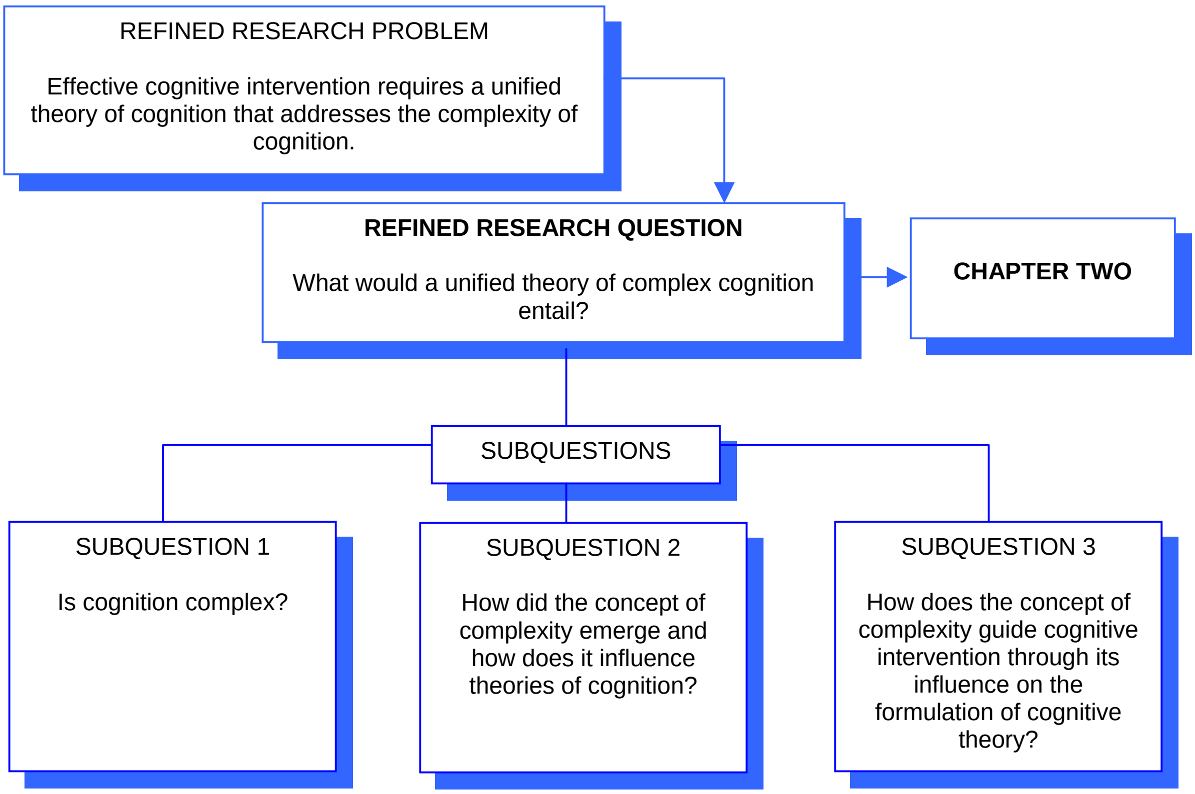
Over the last century, psychology has become much less of an art and much more of a science. Philosophical speculation is out; data collection is in.

Ben Goertzel, *The structure of intelligence*

Scientists rarely consider the limitations and biases of the mind to be important. They see the human mind as a collection of problem-solving abilities which can be applied to any complex problem. Aided by fast computers, they believe that its logic will prevail given enough time.

John D. Barrow. *Impossibility: The limits of science and the science of limits*

META-NARRATIVE 2.1



University of Pretoria, etd - Human, S

2.1 INTRODUCTION

The two central arguments which provide the direction for this study dealing with children's thinking in formal contexts, are that cognition is a complex phenomenon and that this complexity is not addressed in most cognitive interventions that are used to teach children thinking skills. Both arguments are reasonable statements with which many people would probably agree. But what does it really mean to say that cognition is complex, and are we agreeing on the same thing when we say that cognition is complex?

The Oxford Complete Wordfinder (Reader's Digest, 1993) defines something that is *complex* as something that consists of related parts. When something is complex, it is also thought to be complicated. The Oxford (Readers Digest, 1993) further defines *complicated* as something that is intricate, difficult or confused. What we currently know about cognition (Wittrock, 1991; Goertzel, 1993; Coltheart, 2001) indeed suggests that it consists of related parts, such as attention, perception, memory, thought, motivation, comprehension and metacognition, and therefore is complex. Barrow (1999, p. 86) says that 'the largest supercomputers that we have constructed so far pale into insignificance compared with the *complexity* [own emphasis], flexibility and compactness of the human brain.' The wealth of literature on various 'components' of cognition confirms the fact that the phenomenon of cognition is intricate and can be difficult to understand, while the abundance of loosely defined, ambiguous terms associated with cognition attests to the current theoretical confusion that exists in the field (Vosniadou, 1996).

Lorenz (1993) remarks that words are not living creatures in the sense that they can breathe, walk or experience feeling. Yet, like humans, they can lead unique lives. Although words may be born into a language with one meaning, they often grow up to acquire new meanings (Lorenz, 1993). So it is with *complexity* – in recent philosophical and scientific literature one finds that the construct has acquired some additional qualities which readers unfamiliar with complexity theory, may not be aware of. These additional meanings make it likely that theorists from various disciplines who agree that cognition is complex, are probably not agreeing on the same thing. Cilliers (1998, p. 2) remarks that "a complex system is not constituted merely by the sum of its components, but also by the intricate *relationships* [author's emphasis] between these components." It means that complexity does not refer only to the number of constituent parts of a system, but also to the *nature of the interaction* between those parts. Therefore, studying cognition as a complex construct should not only interest us in terms of the number of componential structures and processes that we can isolate, it necessitates an understanding of the nature of the interactions between the components of cognition.

I believe that current cognitive research reflects significant misconceptions regarding the nature of cognition. The most important misconception in the context of the present study concerns the lack of agreement among theorists and researchers on an appropriate metaphor that could reflect what the construct of cognition could possibly entail. While many theorists and researchers agree that there are non-cognitive factors (e.g. language, social interaction, emotion, power relationships, and so on) which influence thinking, such agreement is often only a superficial recognition of the *role* of non-cognitive factors in thinking. Attention to non-cognitive factors is more frequently found in theories addressing themselves to the social realm of human experience and less in theories that are biased toward the physical or psychological realms of human experience. Non-cognitive factors are rarely recognised as integral features of cognition, features without which cognition as we know it would not be possible. Perhaps that is why literature on the biological, social, emotional and political dimensions of cognition exists largely in isolation from one another. For example, despite much research on *language* and *cognition*, central issues related to both fields remain vague and controversial (Bowerman & Levinson, 2001). Indeed, it appears that it is only within the context of intra- and interpersonal problem-solving (counselling and therapy contexts) that a true integration of cognition, emotion, personal and social relationships is actively pursued.

Apart from its traditional denotations, the construct of complexity has recently acquired some additional technical connotations in mathematics and the physical sciences. Complexity is now also associated with terms that complexity and chaos theorists use to explain the behaviour of certain systems, such as self-organisation (Cillliers, 1998), chaos and sensitivity to initial conditions (Lorenz, 1993). These terms will be discussed in more detail in Chapter Three.

The theories that physicists employ to explain reality are constantly evolving towards a more complex and sophisticated picture of the world. Physics, especially the “new physics” (Zukav, 1980) as represented by quantum mechanics and relativity theory, has been termed the study of consciousness[13] (Goertzel, 1993) and has been regarded by some to be inextricably connected to the discipline of psychology (Zukav, 1980) because both disciplines study consciousness. This brings one to the point where, in order to appreciate what it means to

[13] The Oxford Complete Wordfinder defines consciousness as *the totality of a person’s thoughts and feelings* (Reader’s Digest, 1993) while Cairns-Smith (2000) says that feelings should be central in a definition of consciousness.

say that cognition is a complex construct, one needs to understand the historical development of the construct of complexity as it is reflected in the physical sciences.

META-NARRATIVE 2.2

The meaning of complexity has changed quite dramatically in response to developments in the physical sciences over the last hundred years. Taking cognisance of these changes and accommodating them in psychological theory is an important step towards an understanding of why cognition is not only a psychological phenomenon, but also a social and cultural phenomenon. Understanding the relationship between psychology and physics will assist us in understanding some of the reasons for the theoretical confusion that exists in the field of cognitive psychology. It will also serve to put the current upsurge towards postmodernism into proper perspective and, perhaps most importantly, it will help us to understand why we have reached a point in the study of cognition that requires a fundamental re-examination of the way we perceive it, and the way we teach it. Such a re-examination will certainly require paying closer attention to the emotional, social and cultural aspects of cognition and hopefully show too, why it would be important to promote a metaphor of cognition that makes room for complexity in cognitive intervention.

Because physics is acknowledged as an important catalyst for psychological theory development (Perna & Masterpasqua, 1997; Strube, 2000), it may be helpful to consider how developments in the physical sciences have shaped the destiny of psychology as a science in order to judge how it may have affected the study of human cognition. To do this, I will first consider the emergence of psychology as a discipline, and then demonstrate how its development has been profoundly influenced by three distinct periods in the development of modern science.

The first period in the development of modern science covers the *classical physics* of the 17th to the 19th century. The second period, that of *modern physics,* began in the early 20th century with Einstein's relativity theory and quantum mechanical theory and stretches all the way to the present. Contemporaneous with modern physics is a third period, the *postmodern (post-structuralist)* period, currently less well-acknowledged, and characterised by chaos theory and complexity theory, which began in the early 1970s and continues into the present. In each case I will show how the scientific worldviews attached to the period shaped the nature of psychology as a science.

University of Pretoria, etd - Human, S

Bearing in mind that the ultimate goal of this chapter is to establish how physical science has shaped psychology and the study of human cognition, I will attempt to show how each period has given rise to specific conceptions about cognition. I will conclude by providing a summary of the most crucial ways in which physical science has directed 120 years of human psychology in general and in respect of human cognition in particular.

2.2 PSYCHOLOGY AS A SCIENCE

2.2.1 Definitions of psychology

Plug, Meyer, Louw and Gouws (1988) define psychology as a science which investigates human behaviour by means of observation, experiments and measurements. Plug *et al.* acknowledge that various schools of psychology (such as developmental psychology, social psychology, experimental psychology, mathematical psychology and so on) may define psychology differently, but ultimately it is generally associated with the study of all forms of observable and non-observable human behaviour. Recently, Fröhlich (2000) has described psychology as a science which concerns itself with human experience (*Erleben)*, behaviour (*Verhalten)*, and actions (*Handeln)*. In addition, Long (2000) states that psychology involves the logical investigation of people's thoughts and behaviours.

Wertsch (1985) says that psychology is supposed to say something about what it means to be human, but also adds that psychology has not succeeded in this endeavour because psychologists have isolated and studied phenomena in such a way that it has prevented them from communicating with one another. In this regard, Wertsch (1985) says that psychologists have lost sight of the fact that "their ultimate goal is to contribute to some integrated, holistic picture of human nature" (p. 1). Psychology is defined by The Oxford Complete Wordfinder (Reader's Digest, 1993) as "the scientific study of the human mind and its functions, especially those affecting behavior in a given context." The Oxford (Reader's Digest, 1993) further defines the human mind as "the seat of consciousness, thought, volition and feeling or attention, concentration, the intellect, remembrance, memory."

Psychological studies are concerned with the scientific study of the mind as it finds expression in our awareness, thoughts and feelings and include processes of attention, concentration, and memory which are crucial to the intellectual functions of thinking and learning, and therefore, cognition.

University of Pretoria, etd - Human, S

2.2.2 A definition of cognition

Fröhlich (2000) describes cognition as all those functions and processes that are associated with memory (*Gedächtnis)* and information processing (*Informationsverarbeitung).* Fröhlich (2000) further describes cognitive psychology (*Kognitionspsychologie)* as a general term that includes the study of perception (*Wahrnehmung)*, thinking (*Denken)*, intelligence (*Intelligenz)*, and memory.

The term cognition is defined in the Oxford Complete Wordfinder (Reader's Digest, 1993) as 'knowing, perceiving or conceiving as an act or faculty distinct from emotion and volition.' The Oxford (Reader's Digest, 1993) further defines *thought* as "the process or power of thinking, the faculty of reason" and furnishes such synonyms as intellect, intelligence, reasoning, rationality.

But what exactly does it mean to say that psychology, and by implication the study of cognition, is a science? More importantly, what do we regard as "good" science and does current research in psychology reflect good science?

2.2.3 The birth of psychology

The event often quoted as signifying the birth of psychology as a science, is the establishment of Wilhelm Wundt's school of experimental psychology in 1880. It is routinely recognised as the point at which psychology largely disengaged itself from philosophy. However, few scholars seem to realise how complex questions from diverse scientific disciplines combined to make this event happen. Goertzel (1994) explains that the break between psychology and philosophy had a great deal to do with arguments about the nature of psychology and philosophy at the time. The arguments specifically centred around the way logic (an area of philosophy) and psychology addressed the issue of human cognition.

2.2.4 Philosophical conceptions of cognition

Indeed, the main question which has occupied philosophers from antiquity to the modern time, is whether human knowledge can ever be a true representation of the world as it is. The transition from *myth* to *logos*, i.e the earliest beginnings of philosophy, was initiated by the Greeks in c. 600 B.C. (Delius, Gatzemaier, Sertcan & Wünscher, 2000). Even then, there were differences among philosophers as to the nature of knowledge. Among the Presocratics there was Xenophanes (the founder of epistemological scepticism), whose basic

University of Pretoria, etd - Human, S

epistemological principle was that thinking and being are the same, and therefore, anything that is impossible to imagine, cannot exist. One of Xenophanes' contemporaries, Parmenides, opposed Xenophanes by saying that thought and empirical experience should be kept apart because perception is only deception and mere opinion. This was also the position of the Sophists (Socrates being the most notable figure), who believed that no secure foundation for knowledge was achievable since perception and judgments are relative (Delius *et al.* 2000).

2.2.5 Psychology and logic

John Stuart Mill (1843, in Goertzel, 1994) believed that logic was a branch of psychology and thus believed that all knowledge was psychological (Delius *et al.,* 2000). Logic deals with the laws of thought. Thought takes place in the mind, which falls under the discipline of psychology, which defines itself as the scientific study of the mind and all its processes. Therefore, laws of thought that are formulated necessarily deal with a phenomenon that is inherently psychological by nature. Delius *et al.* (2000) say that Mill's position had great support in the 19th century, although it later came under attack.

Indeed, logicians such as Gottlob Frege insisted that logic is concerned with truth and that truth must be given a non-psychological definition (Goertzel, 1994). The object of scientific pursuit was truth, and at the time, truth meant the discovery of the laws of nature. Frege reasoned that psychology studied subjective experience, which (as postmodernist constructivists today would agree) makes an objective truth impossible. Goertzel (1994) explains that it was a major conceptual battle for Frege to free mathematical logic from psychologism. The battle can be considered by and large to have been successful because few modern-day logicians give psychology a second thought, just as most psychologists are able to study cognition without special knowledge of logic.

For a considerable time, psychology and logism existed in parallel universes, each addressing human thought along discrete lines. The early experimental psychologists purposefully avoided logic in their attempts to explain thought, while the logicians were intent on explaining thought along mathematical lines that were completely dissociated from everyday human thought. All of that would change with the arrival of the computer. Goertzel (1994) says that the advent of artificial intelligence (AI) in the sixties and seventies brought logism back with a vengeance. The goal was to produce a thinking machine that would obey the laws of logic, but logicians discovered to their dismay that mathematical logic had to be modified and augmented to bring it closer to human reasoning if it were to have any practical

University of Pretoria, etd - Human, S

relevance. And so the logicians looked to psychology to obtain (what they hoped would be) a more complete picture of the nature of cognitive processes in order to build a science of reasoning (Goertzel, 1994).

As we shall see in later sections, the battle for independence between logism and psychology was part of a larger struggle that reflected deeper questions about human nature that were beginning to take shape in the latter half of the nineteenth century.

Saying that the birth of psychology *as a science* occurred in 1880 means that psychological thought existed before then, only it was not recognised as a science. Indeed, it was not only philosophy that accommodated psychological thought at the time. The physical sciences played a significant role, so much so that it might even be said that physics evolved to the point where human nature became the object of study, and psychology became a special branch of physics where the focus of inquiry shifted to the relationship between the physical body and consciousness (Zukav, 1980). Tracing developments in the physical sciences will enable one to see how significant its influence was on an emergent psychology.

2.3 THE CLASSICAL PERIOD

2.3.1 The nineteenth century Zeitgeist

In order to expound the notion of psychology as a branch of physics, let us examine various events in the period between the sixteenth and nineteenth century that conspired to provide the impetus for the emergence of psychology as a science.

Cole and Scribner (in their foreword to the Vygotsky publication of 1978) mention three events that took place almost simultaneously in 1860 which they believe led to the establishment of psychology as a science. All three events revolved around the publication of various authors. The first was Darwin's well-known *Origin of the Species.* Lesser known, was Gustav Fechner's *Die Psychophysik*, and the third was I.M. Sechenov's publication entitled *Reflexes of the Brain.*

As Cole and Scribner (in Vygotsky, 1978) say:

> These books by Darwin, Fechner, and Sechenov can be viewed as the essential constituents of psychological thought at the end of the nineteenth century. Darwin linked animals and humans in a single conceptual system regulated by natural laws; Fechner provided an example of what a natural law describing the relationship between physical events and human mental functioning might look like; Sechenov, extrapolating from muscle twitches in frogs, proposed a physiological theory of how

University of Pretoria, etd - Human, S

> such mental processes worked within the normally functioning individual. None of these authors considered themselves (or were considered by their contemporaries) to be psychologists. But they provided the central questions with which the young science of psychology became concerned in the second half of the century. (p. 3)

In order to understand how three publications, all by non-psychologists, namely a biologist (Darwin), a mathematician (Fechner) and a physician (Sechenov), could revolutionise the study of human behaviour (and profoundly influence the study of human cognition), it is important to understand the *Zeitgeist* of the late nineteenth century. At that time, Einstein's theory of relativity and quantum mechanics had not yet been discovered, and the reigning scientific paradigm was Newtonian physics, or classical physics.

With his discoveries of the law of gravity and the laws of motion, Newton and his contemporaries were convinced that they had unravelled, completely and finally, the mechanics of how nature worked.

Barrow (1999) explains that

> Newton's discoveries had been so impressive for nearly two hundred years that they had the hallmark of being the last word. No refinements of his laws had been suggested. His law of gravitation had successfully explained every astronomical observation (with the tiny exception of a wobble in the orbit of the planet Mercury round the Sun). In fact, during his own lifetime the success of his mechanics had led to speculations that his approach might provide the panacea for the investigation of all questions. The impressive completeness of Newton's *Principia* (1687) and the deductive power of his mathematics led to a bandwagon effect with thinkers of all shades aping the Newtonian method. There were books on Newtonian models of government and social etiquette, and Newtonian methods for children and 'ladies'. Nothing was imagined to be beyond the scope of the Newtonian approach. (p. 40)

As it turned out, neither was psychology. The publications of Darwin, Fechner and Sechenov opened up the possibility that man was an extension of the natural world and that it was quite possible, even desirable, to study human behaviour by the same scientific method that had proven extremely successful for Newton. Understandably, scientists from all disciplines were very receptive to Newton's theory in the nineteenth century, especially since Newton's ideas were being reinforced through the positivist philosophy of Auguste Comte (1798 – 1857) who encouraged scientists to study only that which was observable and reducible to laws.

Comte regarded the search for the source or the cause of natural phenomena as immature and to be avoided at all costs. It meant that, instead of searching for the cause of gravity, scientists should content themselves with the laws of gravitation. Comte viewed the evolution of human thinking as a process which must pass through three stages, namely the theological, metaphysical and positive stage (Barrow, 1999; Delius *et al.,* 2000). Comte viewed the first two stages as immature because of the emphasis on supernatural or abstract forces as the source of natural phenomena. The positive stage was more desirable since the mind had then given up its desire to explain the unexplainable (Barrow, 1999). The positivism of Comte therefore required a rejection of metaphysics and saw the source of knowledge in sensory experience, with observation being the only reliable method by which to obtain knowledge (Delius *et al.,* 2000).

The apparent perfection of the Newtonian paradigm and the success with which it explained natural phenomena made it a natural step of progression, that experimental psychology would adopt its scientific method of observation and experimentation as the method of choice.

2.3.2 Physics envy in psychology

Ever since its birth as a science toward the close of the 19th century, the young discipline of psychology has been characterised by a kind of *physics envy* (Masterpasqua & Perna, 1997) in the sense that it has remained responsive to developments in physics to this day.

Barrow (1999) suggests that "[scientists] see the human mind as a collection of problem-solving abilities which can be applied to any complex problem. Aided by fast computers, they believe that its logic will prevail given enough time (p. 90)." As Masterpasqua and Perna (1997) remark, this is because psychologists "self-consciously proceeded as though human affairs were as pre-determined, linear and predictable as Newton's and Laplace's universe (p. 4)." The relationship between psychology and physics was already recognised much earlier by Zukav (1980) who believed that René Descartes' vision of the world as a machine and Newton's formulation of the laws which govern that machine, made it deceptively easy to view nature and everything in it as linear, deterministic and predictable. In that sense, it is relatively simple to see how Newtonian physics contributed to the emergence of a definition of complexity that emphasised the structural nature of phenomena and downplayed the dynamic interactional nature of the components. Of course, cognition suffered the same fate as psychologists studied cognition mostly as a structural phenomenon which could be discovered fully by analysis of its components.

The perceived completeness of scientific knowledge in the physical sciences at the end of the nineteenth century was such that many thought there was not much left to know or discover. It was widely thought that it would only be a matter of time before Newtonian physics would explain the laws governing all natural phenomena. The fact that human consciousness was considered to be one of the last challenges which had not yet been adequately addressed and explained and which some influential scientists like Emil Du Bois-Reymond believed would never be explained (Barrow, 1999), probably increased the challenge to those scientists who called themselves psychologists, to discover how the laws of nature give rise to human behaviour and consciousness.

The intoxication of psychology with the scientific method implies that the central questions that have concerned psychologists for more than a century have mostly been generated outside the discipline of psychology, by the physical sciences. This is an important statement, because it suggests that the research questions which interest psychology as a discipline, are often not generated by psychologists from within the discipline, but by physical scientists from outside it.

For example, as early as the seventeenth century, it was *technological* creations moved by hydraulic power that gave rise to René Descartes' view of the world as a machine (Zukav, 1980) and also to his hydraulic model of the brain (Groves and Rebec, 1992). The discovery of *electricity* led to the discovery of electrical impulses in the brain (Groves and Rebec, 1992). Newton's law of *gravity* and laws of *motion* convinced psychologists that there must also exist universal laws that determine human behaviour, hence the stimulus-response theory of behaviourists like Pavlov and Skinner, and the psychoanalytic determinism of Freud (Masterpasqua & Perna, 1997). Even Jean Piaget's adaptive theory of cognitive development was inspired by Darwin's theory of evolution (Luis & Jansen, 2001).

In respect of behaviourist theory, Grace (2001) relates how its operationist[14] methodology was imported from a 1930 publication of the Nobel prize winning physicist, Percy Williams Bridgman, called *The logic of modern physics.* In fact, O'Donohue and Kitchener (1996) say that the behaviourists were initially quite adamant that psychology should be regarded as an empirical, natural science, and were convinced that psychology could learn nothing from philosophy.

In recent times, subdisciplines of cognitive psychology which research topics related to *artificial intelligence* and *computer science,* have continued to spawn theories of human cognition based on linear and deterministic laws that are supposed to govern human information processing (Strube, 2000).

[14] Operationism is described as a positivist approach to psychology in which operational definitions of concepts or constructs are believed to be necessary for meaningful research (Grace, 2001).

2.3.3 *Cognitive psychology and the study of cognition*

Cognitive psychology is the field in psychology which has been the most strongly influenced by the deterministic methodology of Newtonian physics. The cognitivist (information-processing) paradigm has been the dominant paradigm in cognitive psychology and is represented by three distinctive components, namely experimental psychology (information processing), computer modelling (neural networks), and cognitive neuropsychology (Coltheart, 2001).

The cognitivist paradigm views cognition as “processes of computation that solve problems about the world and the relation of the cognitive agent with its environment” (Gurney, 1999). In this definition, there is nothing to suggest that cognition is anything other than problem-solving through computation. No mention is made of the social, cultural or emotional aspects of cognition. Although mention is made of the “agent” and its “environment”, Strube (2000) assures us that the context of cognition remains a secondary consideration in the cognitivist paradigm. Coltheart (2001) states that cognitive psychology is a science dedicated to studying the nature of the mental processes responsible for people’s ability to perform basic cognitive activities such as understanding, producing language, recognising people, storing information in memory and acting intelligently upon the physical world.

Bowers (1999) mentions that much of the criticism surrounding a cognitivist focus on cognition is associated with the fact that social, cultural and other dimensions of cognition are ignored in favour of exclusive emphasis on cognitive processes in the mind. This, Groome (1999) says, is because humans are viewed as “limited-capacity processors” (p. 8) whose thought processes are compared to the workings of a telephone exchange, and so the notion of cognition as a phenomenon that is seated exclusively in the mind of the individual is an enduring theme of research in the field of cognitive psychology.

Strube (2000) confirms that modern cognitive psychology, as one of the fastest growing subfields of scientific psychology, has strictly adhered to the experimental methodology of the natural sciences, which entails experimentation and statistical techniques for data analysis. The adherence to the Newtonian worldview has specifically led cognitive psychology to reduce cognition as a phenomenon to isolated variables which could be observed and controlled.

University of Pretoria, etd - Human, S

Potter (2000) neatly captures this point when he says:

> Cognitivists are so used to pre-defining the world – in stimulus materials, in vignettes, in fixed-choice questionnaires – that they never have to address the flexibility and theoretically contested nature of everyday life where the world is not given in a single particular way, in particular fixed categories, but is reaccomplished and transformed. The mess is relatively invisible from within the standard cognitivist framework because its familiar methods break up the occasioned and action-oriented nature of participants' practices as well as predefining input and output. There are hardly any methodological cracks through which participants' constructions and orientations can seep out (p 35).

Such a focus, argues Strube (2000), makes research in cognitive psychology effect-driven rather than theory-driven. Experimental psychologists who study cognition are notoriously well-known for refraining from theorising about their experimental results, allowing themselves rather to be guided by observable results and nothing else.

Strube (2000) suggests that one of the main reasons for effect-driven cognitive psychology, is the prominence of physics in the 20th century. As a result, Strube (2000) finds himself in partial agreement with Groves and Rebec (1992), who took the critique of the relationship between psychology and physics a step further by pointing out that the physical sciences have succeeded in providing theories and technologies that continue to serve as psychological models for human functioning simply because the belief persists that the same deterministic laws which govern nature, must also govern human consciousness:

> Working from a less-than-complete knowledge base, investigators of brain function have been forced to think in terms of something they did know in order to make sense of what they did not. In most cases, this meant comparing the brain with the latest mechanical contrivance or engineering marvel. Any new technological achievement that came along – the telephone, the camera, the radio, the hologram, the computer – had its day as a model of how the brain works (p. 5).

Yet, such comparisons rest on the false assumption that technological devices are as complex in their workings as the human brain, when the truth is that they are merely complicated. The difference, Cilliers (1998) points out, is that systems which can be analysed completely and accurately, even though they may consist of a very large number of components and perform very sophisticated tasks, are complicated, not complex. They can be given an exact description. In contrast, Cilliers (1998) describes a complex system as one which defies exact description because of the intricate, non-linear relationships and feedback loops that exist in the system. Complex systems are almost always living systems. It is not possible to learn the behaviour of a complex system by studying the discrete components

University of Pretoria, etd - Human, S

which it consists of. The very act of breaking up a complex system into its parts "destroys that which it seeks to understand" (Cilliers, 1998, p. 2).

2.3.4 Complicated versus complex

I argue therefore that the Newtonian scientific paradigm, and especially the application it has found in cognitive psychology, has encouraged psychologists to view cognition as a *complicated* structure, rather than a *complex* system. The classical physics paradigm has seduced psychologists into believing that the brain, the mind and cognition render themselves accessible to exact description, and that the study of cognition can be reduced to the study of a collection of physical and cognitive components with precise laws that govern them.

Even though Barrow (1999) acknowledges that nothing we have discovered in nature, from elementary particle physics to outer space, remotely compares to the complexity of what lies inside our heads, mankind's inclination to explain cognition in terms of scientific theories and technological devices has had a definitive impact on our current understanding of human cognition. This, Cilliers (1998) says, is because the technologisation of science is changing the relationship between science and philosophy in a radical way, and he warns that

> …a clear description of what is happening is not easy, but the heart of the matter is that our technologies have become more powerful than our theories. We are capable of doing things that we do not understand. We can perform gene-splicing without fully understanding how genes interact….We can create new sub-atomic particles without knowing precisely whether they actually exist outside of the laboratory. We can store, and retrieve, endless bits of information without knowing what they mean. Central to all these developments are the phenomenal capacities of the electronic computer….The power of technology has opened up new possibilities for science (p. 1).

One of the strongest possibilities that the computer has opened up, is the one which allows the classical physics paradigm to be perpetuated in the study of cognition. Powerful computer programmes allow scientists to create ever more complicated models of how the brain might work, and the more powerful computers become, the more scientists are deluded into thinking that it can capture the complexity of human cognition accurately. Cilliers (1998) points out that the rise of powerful technology is not an unconditional blessing because "we have to deal with what we do not understand, and that demands new ways of thinking" (p 2).

In the next section, I will consider how computer technology, as an extension of the principles of classical physics, is shaping our thinking about human cognition.

2.3.5 Cognition and technology

In the early twentieth century, long before the arrival of the micro-chip, the potential for technology to dictate the course of human development was recognised unwittingly by Vygotsky (1930/1978) when he suggested that “man’s alteration of nature alters man’s own nature” (p. 55) and explained that the “use of artificial means, the transition to mediated activity, fundamentally changes all psychological operations just as the use of tools limitlessly broadens the range of activities within which the new psychological functions may operate” (p. 55).

The “artifical means” and “tools” of which Vygotsky spoke in the 1930s could not have been the computer, yet the computer remains the one artificial tool which has changed the psychological operations which Vygotsky mentioned, in significant and fundamental ways. Technology has transformed the way in which humans interact with reality, and so we could even say that modern technology has been instrumental in changing the nature of reality itself, thereby demanding “new ways of thinking”, as in Cilliers’ (1998, p. 2) phrasing.

Technology has had a pervasive influence on theories of brain functioning and thinking, a fact readily acknowledged by brain researchers (Groves & Rebec, 1992) and cognitive psychologists (Groome, 1999). Computer technology has not only transformed human thinking by providing a (albeit imperfect) metaphor of humans as data processors, it has also served to perpetuate classical physicist themes and methodology in cognitive research to the extent that intelligence is now increasingly being equated to the ability to access and process information.

The South African Green Paper on E-commerce (RSAa, 2000) says: “Distance education, virtual campuses and technological training will dominate the education sector in the future”. The Green Paper markets its vision statement as “Generating a knowledge-based society to help create an information economy”. The Green Paper vision statement reminds strongly of Bowers’ (1999) warning against neo-Social Darwinism, where he warns that the enthusiastic but indiscriminate adoption of information and communication technologies (ICT) can lead to a situation where a particular society’s survival in the global economy is guaranteed by its capacity to participate in the technological race. Social Darwinism is regarded as a meta-narrative that is steering an evolutionary process in which computer technology has become the basis of human intelligence, and where societies who do not conform to the technological paradigm as the new cultural metaphor, become extinct (Briggs & Peat, 1999). More

University of Pretoria, etd - Human, S

specifically, Bowers' (1999) main concern centres around the increasing dominance of computer technology in education, and the advancement of a view that equates human intelligence with access to information.

Because contemporary psychology does not recognise cognition as the complex, self-organising system that it is (Goertzel, 1993), most approaches to cognitive intervention based on psychological theories of cognition are inclined to focus on the instruction of discrete component skills associated with expert problem-solving, while ignoring the complexity and richness of the contexts in which real-life problems often occur. In real-life situations that require individuals to learn through complex problem-solving, one is confronted by others' perceptions, reactions and biases, as much as one is confronted with the facts of the situation. Theories of cognition that perpetuate the classical physicist principles of linearity, determinism and predictability are ill-equipped to deal with cognition as it is expressed in the real world.

Warning against the dominance of information-based approaches to intelligence, Bowers (1999) points out that

> anyone who claims that the public, including classroom teachers and teacher educators, is not being indoctrinated with a new orthodoxy that is both "scientifically" based and heavily promoted by the computer industry is in a state of deep denial about the scale and significance of the cultural change now being legitimated in the name of progress (p. 26).

Bowers' thoughts are echoed by Briggs and Peat (1999) who warn that scientific theories can become cultural metaphors that act like a two-edged sword, beneficial only when viewed within the context in which it was created. Bowers' (1999) concern specifically centres around the fact that computer technology is creating a reality which facilitates and promotes a cognitivist approach to cognitive development despite a large body of evidence that shows that human cognition is (at least) partially socially and culturally determined. Earlier, Goertzel (1993) observed how cognitive scientists and behaviourists tend to agree on the structure of the mind and the futility of arguing about the processes underlying behaviour, and the tendency of the cognitive scientists to regard the mind as a "hodge-podge of special-case algorithms, pieced together without any structure" (p. 1). Such a dialogue is possible because, in principle, cognitive scientists and behaviourists follow the same reductionist philosophy characteristic of classical physics.

Through computer technology, virtual realities have been created that require individuals to adapt to an artificial world mediated by the computer. The artificial world is bringing about a marked shift in emphasis in the mental processes required for problem solving. In a fast, technology-driven world, *accessing* and *processing* information (gathering facts) efficiently are viewed as the hallmarks of successful problem solving, while *contemplating* and *understanding* information (exploring ideas) are under-emphasised. It is probably at least partially because of this trend, that Goertzel (1993) maintains that contemporary psychology lacks the tools to confront comprehensive questions about the nature of the mind.

Potter (2000) finds himself in agreement when he exclaims that "it is exciting that, despite the quantity of psychological research that has already been produced, virtually all of the work is still to be done" (p. 36).

2.4 THE MODERN PERIOD

2.4.1 Quantum uncertainty and multiple realities

2.4.1.1 <u>Introduction</u>

"For most of us, life is seldom black and white. The wave-particle duality marked the end of the 'Either-Or' way of looking at the world" (Zukav, 1980, p. 65).

After a period of approximately three hundred years during which classical physics had gone unchallenged, discoveries were made which were to change the course of scientific inquiry not only in physics, but in psychology as well. The first discovery was that of Max Planck, considered to be the father of quantum mechanics, who demonstrated in 1900 that energy is not transmitted smoothly and continuously, but explosively in energy packets of a certain value. The second discovery was Albert Einstein's theory of the nature of light in 1905 which challenged for the first time the fact that light was made of waves (Zukav, 1980).

The relevance of Planck and Einstein's discoveries to psychology was that they would later compel psychologists to acknowledge the fact that not everything in nature behaves in a predictable manner as classical physics had dictated. It was Einstein's particle theory of light (discussed in section 2.4.1.3) which led some physicists to speculate that photons (light particles) are conscious organic matter, and that the study of physics really entails a study of consciousness (Zukav, 1980). But it was not only Planck's and Einstein's discoveries that impacted upon the study of cognition in a dramatic way. There were other discoveries that contributed to the theory of quantum mechanics that later influenced theories of cognition in a significant manner. The most important of these are the formulation of Erwin Schrödinger's wave theory in 1926 and Werner Heisenberg's Uncertainty Principle in 1927.

In the next section, the basic principles of the theories of Einstein, Planck, Schrödinger and Heisenberg will be discussed and their relevance to the study of cognition will be elucidated. It is important to note however, that the contribution of these theories does not lie in the single contribution of any particular theory per se. It is rather the way in which the theory of quantum mechanics changed scientists' way of seeing reality, that impacted upon psychological and cognitive theory.

As Perna and Masterpasqua (1997) claim, "quantum physics embraced uncertainty as both fundamental and worthy of scientific exploration" (p. 4).

2.4.1.2 1900 : The quantum hypothesis and the birth of non-linearity

After being advised by his mentors at the close of the nineteenth century to study biological science since all the important problems in physics had been solved (Barrow, 1998), Max Planck persisted with his studies in physics and later became one of the founding fathers of quantum theory. Planck's major discovery was that energy is absorbed and released by atoms only in specific amounts, called quanta (Zukav, 1980). His discovery revolutionised the study of physics because no longer was change in nature viewed as smooth and regular, but it became possible to view change as something that could occur in leaps and bounds.

The notion of developmental change and learning as dynamic, asynchronous processes (as opposed to classical, linear processes) already appeared in the writings of Vygotsky in the 1930s when he stated that "there are highly complex dynamic relations between developmental and learning processes that cannot be encompassed by an unchanging hypothetical formulation" (Vygotsky, 1935/1978, p. 91). More recently, cognitive therapists have been using the term "perceptual shift" to indicate how significant qualitative changes can occur instantaneously in the way people structure their cognitions (McMulllin, 2000).

But it would take more than Plank's quanta to revolutionise the study of physics and ultimately, the study of cognition in psychology.

2.4.1.3 1905 : The dual theory of light and the notion of conscious matter

Albert Einstein is well-known for his famous equation $E = mc^2$, that expresses the relationship between mass and energy. But he made another important contribution to physics that is more pertinent to the discussion in the present study: the photo-electric effect of light.

When Einstein discovered that light shining on the surface of a metal could knock electrons out of the metal, and that certain frequencies were better at knocking electrons out of their orbits than others, the stage was set for the formulation of a particle theory of light which used Planck's quanta to explain why certain light frequencies have more energy than others and are thus better able to knock electrons out of the metal (Cairns-Smith, 2000). However, apart from contradicting the widely held notion that light consisted of waves, the photoelectric effect of light also appeared able to demonstrate that electrons may be "conscious", in that it is possible to show how a single photon travelling through a small opening will hit a metal plate in different spots depending on whether a second small opening is open or not (Zukav, 1908; Cairns-Smith, 2000). This dual theory eventually led to the theory that electrons only look like particles because they are actually standing waves, which really means that an electron is represented by a collection of probabilities (almost like an energy pattern), rather than a particle.

Much later, Erwin Schrödinger's theory helped to explain just how electrons could be viewed as standing waves (Cairns-Smith, 2000).

2.4.1.4 <u>1926 : Wave theory and multiple perspectives of reality</u>

Erwin Schrödinger's wave theory is possibly the one theory that has been the most influential in the development of theories of cognition that emphasise multiple subjectively constructed realities instead of one, objective reality. Shrödinger's theory is also the theory that gave rise to the notion that man's study of nature, and his study of himself, alters nature and therefore it is not possible to know (like the classical physicists believe) what an objective reality would be.

Shrödinger's wave theory deals with possibilities and probabilities, instead of actualities. Shrödinger said that everything is uncertain until it is observed or measured. Once a phenomenon is observed, one possibility is actualised and all the other possibilities collapse. The famous Shrödinger cat paradox illustrates this phenomenon well because, as Zukav (1980) points out, it helps to illuminate the basic differences between classical physics and the new physics.

The Shrödinger cat paradox poses the following problem: A cat is placed inside a box with a device which can release a gas capable of instantly killing the cat. A random event will determine whether the gas is released or not. As the box is sealed and the experiment begins, there is no way to see inside the box to observe whether the cat is killed or not. The interpretation of the outcome of this experiment varies whether one views it according to classical physics or quantum physics (Zukav, 1980).

Classical physics tells us that the cat is either dead or not, we only need to open the box to see which it is. However, according to quantum physics, the cat is both dead and alive until we open the box and observe it. When we do so, one possibility collapses and the other possibility which we observe, is the one that has been actualised. Zukav (1980) explains that "this is known as the collapse of the wave function because the hump in the wave function representing the possibility that did not occur, collapses. It is necessary to look into the box before either possibility can occur. Until then, there is only a wave function" (p. 86).

However, this interpretation represents only one possibility of what may actually be happening. Zukav (1980) explains that there is another interpretation, known as the Many Worlds Interpretation, which states

> At the instant that the atom decays (or doesn't decay, depending upon which branch of reality we are talking about), the world splits into two branches, each with a different edition of the cat. The wave function representing the cat does not collapse. The cat is both dead *and* alive. At the instant that we look into the box, our wave function also splits into two branches, one associated with the branch of reality in which the cat is dead and one associated with the branch of reality in which the cat is alive. Neither consciousness is aware of the other. In short, classical physics says that there is one world, it is as it appears, and this is it. Quantum physics allows us to entertain the possibility that this is not so (p 86).

Quantum physics therefore shows us that instead of one reality, there may well be multiple realities. Multiple realities is a key aspect of constructivist approaches to cognition that assume that reality does not exist "out there" but is construed through our minds. Therefore, the world can only be experienced as we construe it and our representations of the world reflect our access to the world by an act of knowing, so there is no way of knowing to what extent we have modified the representation that is being constructed (Zietsman, 1995). The notion of multiple realities is probably what Perna and Masterpasqua (1997) had in mind when they contrasted the postmodernist self as "an open system suspended in a milieu of multiple perspectives" (p. 6) to "the modernist self, who assumed that there was only one reality to be observed" (p. 6). Here, we glimpse for the first time evidence that postmodernist thought in psychology (but also in the social sciences at large) was catalyzed by quantum physical theories of the nature of reality outside the discipline of psychology.

Zukav (1980) said about our experience of reality that "we cannot eliminate ourselves from the picture. We are a part of nature, and when we study nature there is no way around the

University of Pretoria, etd - Human, S

fact that nature is studying itself" (p. 31). Regarding the role of the self in scientific endeavour, Zukav (1980) reflects on the classical notion that human beings are "outside" the natural world that they observe and goes on to say that

> Scientists, using the "in here – out there" distinction, have discovered that the "in here – out there" distinction may not exist! What is "out there" apparently depends, in a rigorous mathematical sense as well as a philosophical one, upon what we decide "in here." The new physics tells us that an observer cannot observe without altering what he sees. Observer and observed are interrelated in a real and fundamental sense (p. 92).

According to quantum physics the interrelationship between the observer and the observed is very important, because "what we experience is not external reality, but our interaction with it" (Zukav, 1980, p. 93). What we observe in nature, depends on how we interact with it. Whether we view light as particle-like or wave-like in nature depends on how the experiment is set up, both are possibilities. In other words, our picture of reality depends on our *perception* of it. As such, scientific knowledge does not reflect the structure of reality – reality has no definite structure – but rather the result of a dynamic interaction between various elements in nature, of which we are one.

Similarly, whether we assume that cognition is symbolic or connectionist depends on how we set out to prove it. In a symbolic model of cognition we can draw on language and concepts as symbols and prove how people think in terms of them. We may even say that such a model corresponds to a particle-theory of the mind. On the other hand, a connectionist model of cognition assumes no symbolic activity and will draw on the rich pattern of relationships between neural networks in the brain to prove that cognition consists of relationships. Such a model corresponds to a wave-theory of the mind. Quantum theory tells us that both models are possible, in other words, a theory of cognition need not be either one or the other, it can be both.

As we shall see later, the principle of interaction is at the core of Vygotsky's dialectical approach to conceptual development, and it is at the heart of all approaches to cognitive development that emphasise cognitive development as the result of an interaction with our social and cultural environment. In respect of our interaction with reality, quantum physics demonstrated through the Heisenberg Uncertainty Principle that there is no such thing as an exact science and that human knowledge can never be certain or complete (Zukav, 1980).

University of Pretoria, etd - Human, S

2.4.1.5 1927 : Heisenberg's Uncertainty Principle and multiple realities

Simply stated, Heisenberg's Uncertainty Principle states that we can never simultaneously know the position and the momentum of a particle in space. We can only know one of the two variables with certainty, the other will remain uncertain (Zukav, 1980). Barrow (1999) confirms that "quantum mechanics gives no exact predictions for the future location and speed of motion of an object given its starting state. It gives only probabilities that it will be observed to be at some location with some velocity" (p. 24).

Shrödinger's wave theory explains why this is so. The moment we interact with that which we observe, all possibilities but one which is represented by the observed object's wave function collapse and we are left with one reality, the one which we are observing (or the one of which we are conscious). Alternatively, the Many Worlds Interpretation states that the moment we observe something, reality splits and we see only the branch of reality which contains us and that which we are observing. Together, Schrödinger's wave theory and Heisenberg's Uncertainty Principle question the existence of an objective reality in the same way constructivism does.

Zukav (1980) explains that

> The tables have been turned. "The exact sciences" no longer study an objective reality that runs its course regardless of our interest in it or not, leaving us to fare as best we can while it goes its predetermined way. Science, at the level of subatomic events, is no longer "exact," the distinction between objective and subjective has vanished, and the portals through which the universe manifests itself are, as we once knew a long time ago, those impotent, passive witnesses to its unfolding, the "I"s, of which we, insignificant we, are examples. The Cogs in the Machine have become the Creators of the Universe. If the new physics led us anywhere, it is back to ourselves, which, of course, is the only place that we could go (p. 114).

2.4.2 Complex cognition: A classical and quantum perspective

One of the greatest differences in the way that classical physicists and quantum physicists view the world, is to be found in their views about the complexity of reality.

In terms of classical physics, complexity entails a discovery of the components of the universe as they are governed by exact laws. Classical physicists see a predictable one-to-one correspondence between elements of reality and the elements of the theory which explains reality. It is this one-to-one correspondence between reality and theory which led Einstein to believe that quantum theory is incomplete (Zukav, 1980).

University of Pretoria, etd - Human, S

The information-processing approach to cognition provides a good example of how the classical physicist approach of one-to-one correspondence permeates theories in cognitive psychology. An important assumption of an information processing approach to cognition is that cognition consists of a finite amount of elements, functions and processes and that it is possible to capture each component of cognition and map it in a theory of cognition.

Essentially, the information processing model reflects an *input system* (visual, auditory, tactile, and so on), a *central processing unit* (CPU, containing the sensory register, short term memory, working memory, and long term episodic and semantic memory), and an *output system* (thought and behaviour). The CPU is guided by the executive control in the form of metacognition, which helps a person to plan, monitor and adjust her processing of information (Lerner, 2000).

Figure 2.1 below captures the essential elements of the information processing model of learning.

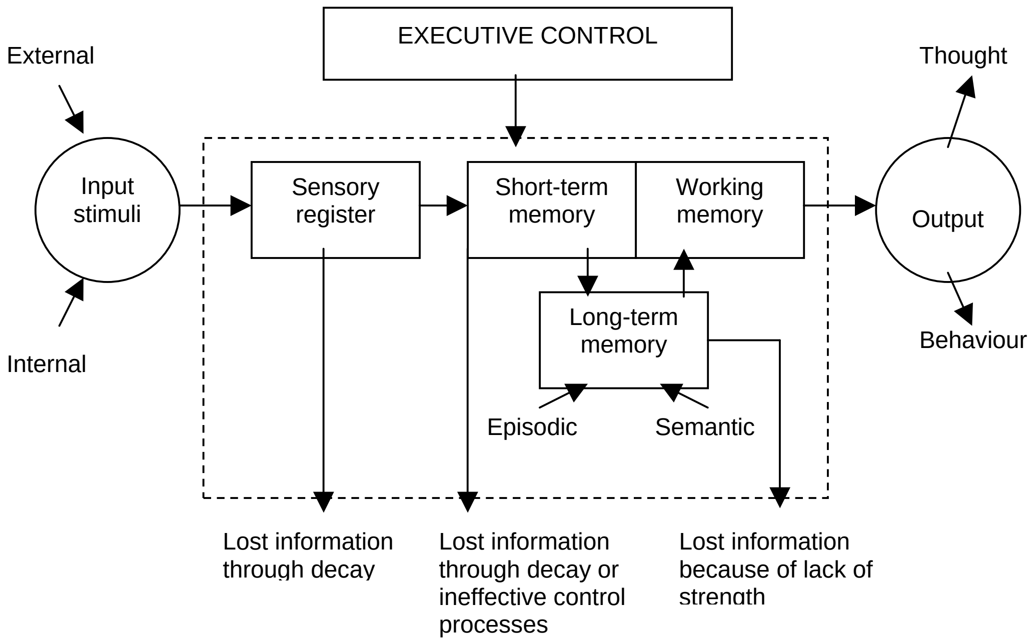


Figure 2.1: An information processing model of learning adapted from Lerner (2000)

Figure 2.1 shows that the information processing approach essentially conceives of cognition as a relatively stable and predictable process. Any unpredictability in the processing system is explained as lost information through decay, ineffective control processes or loss of memory strength. Instead of incorporating unpredictability in cognition into the explanatory model as an essential feature of cognition, it is depicted as a uni-directional flow (or loss) of information out of the system. The information processing approach provides a convenient way of thinking about cognition in a crude way, but it remains a classicist approach to cognition that does not succeed in capturing the complex nature of cognition.

Quantum physics has an entirely different picture of what a complex reality is. Probability and uncertainty are viewed as necessary and integral aspects of complexity. Quantum physics opened up the possibility for psychologists to consider the existence of multiple subjective realities. More importantly, the publication of Bell's theorem in 1964 showed that the realisation of one actuality from all the possibilities and probabilities contained in the wave function of a subatomic object when the wave function collapses, is not subject to chance as was previously thought, but may be dependent upon a distant action happening across space. In other words, Bell's theorem suggests – and can prove experimentally – that information can travel faster than the speed of light i.e. superluminally. Therefore, it is possible that an action in one locality can somehow affect the behaviour of a separate part across space. Zukav (1980) quotes David Bohm as saying

> Parts are seen to be in immediate connection, in which their dynamical relationships depend, in an irreducible way, on the state of the whole system (and, indeed,on that of broader systems in which they are contained, extending ultimately and in principle to the entire universe). Thus, one is led to a new notion of *unbroken wholeness* which denies the classical idea of analyzability of the world into separately and independently existent parts…(p. 297)

The implications of this position is that the world does not consist of separate components, but that everything in one place is connected to everything else in another place (Zukav, 1980). This brings us to the third period in physical science, marked by the emergence of chaos theory, which is concerned with the interconnectivity of complex systems.

2.5 THE POSTMODERN PERIOD

2.5.1 The new paradigm

At a meeting of the American Association for the Advancement of Science in 1972, a meteorologist called Edward Lorenz asked the following question: "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?" (Lorenz, 1993).

The subject of this paper dealt with the complexity and inherent chaos of weather systems and, more importantly, how miniscule changes in a complex system can produce appreciable changes in the end-states of the system. This effect, called The Butterfly Effect, has since become the leading symbol of chaos theory, which since its early beginnings in the 1970s,

University of Pretoria, etd - Human, S

has been called "the new science" (Lorenz, 1993), "the new paradigm from the physical sciences" (Perna & Masterpasqua, 1997), and "the science of change" (Briggs & Peat, 2000).

2.5.2 Cognition and the science of change

The applicability of chaos theory to the study of cognition is mainly contained in the way chaos theory describes complex systems. Traditionally, theories of cognition have focused on reducing chaos and complexity in order to discover the structure of cognition. In the next chapter, I will suggest that the contrary is desirable, namely that theories of cognition must embrace the complexity and unpredictability of cognition, rather than reduce and control it. For the moment, I would like to point out two important implications which postmodern developments in the physical sciences hold for the study of cognition, which influenced the direction of the current study.

One of the most important questions that postmodern science raises about our scientific pursuits concerns the *scientific methods* which we use. In previous sections, I have shown how classical physics established the superiority of the experimental approach and dictated the implementation of controlled studies in which every variable must correspond to and be explained by a particular element of theory. In contrast, chaos theory dictates that complex systems must be studied naturally as they occur (Lorenz, 1993). This is because the behaviour of complex systems are extremely sensitive to initial conditions. If the conditions upon which the complex system is dependent, are changed or reduced (as would be done in a controlled experiment), then the behaviour of the system will change and lose its complexity. The entire experiment will be invalidated because the behaviour we observe will not be characteristic of the natural behaviour of the system.

The second implication that postmodern science holds for the study of cognition, concerns the *phenomenon* that is studied. In addition to studying a system as it occurs naturally, chaos theory also suggests that the phenomenon (in this case, cognition) we study is much broader in scope than cognitive psychologists were heretofore prepared to acknowledge. In essence, it requires the study of cognition not only as a physiological phenomenon, but also as a social, emotional, cultural, perhaps even political phenomenon. It calls for an approach to cognition that acknowledges the many and varied ways in which the context, as representative of the initial conditions of the system, is co-responsible for the phenomenon of cognition.

University of Pretoria, etd - Human, S

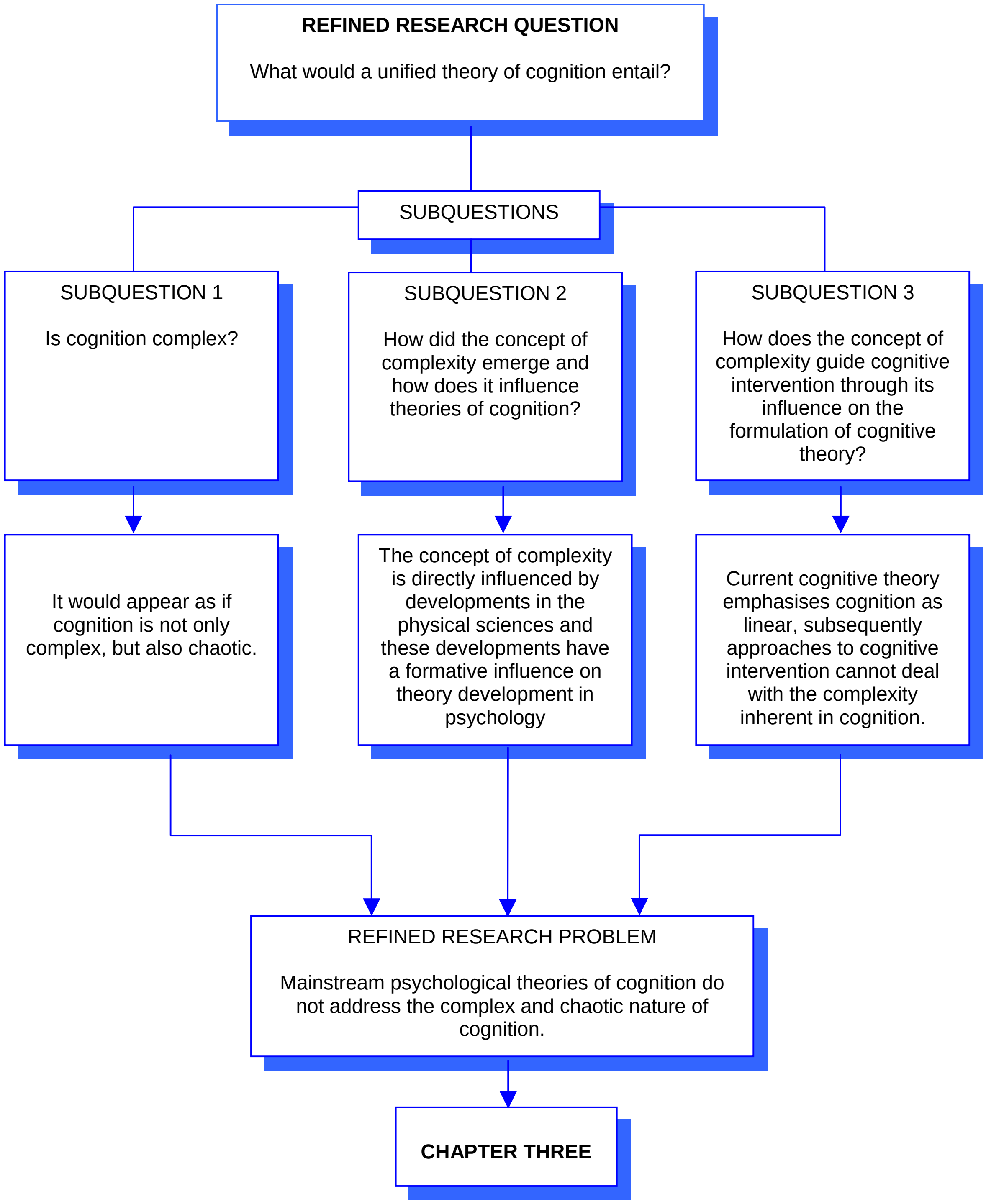
The physical sciences have shown us that it is possible to "prove" that light consists of particles **and** waves depending on how we choose to set up the experiment. Both states are possible if we accept that light is a wave function which contains both possibilities (particle and wave) and that one is realised the moment an observation is made. Similarly, if we devise our "experiments" in certain ways because of our belief that cognition is either predetermined or chaotic, we can "prove" both. Information-processing theorists have had considerable success with their model of cognition because the existence of the computer "proves" that the input-processing-output model of information processing is plausible (Lerner, 2000).

On a more sophisticated level, but still within the realm of cognitive psychology, cognitive neuroscientists use statistical techniques such as structural equation modelling to "prove" the relationship between variables such as age, intelligence, domain knowledge and metacognitive knowledge and their combined direct and indirect impact on children's ability to recall information from a text (Schneider, 1998). In mathematical psychology, scientists have created stochastic computers (a computer which involves chance as well as precision) that "prove" that cognition involves a large element of chance, and quantum computers that "prove" that cognition is not deterministic (Goertzel, 1993). The point is that cognition can be conceived of as being both deterministic *and* chaotic depending on the way we choose. Both views are needed to understand what cognition truly is.

The larger part of the twentieth century has been taken up by a preoccupation with the deterministic nature of cognition. Postmodern developments in science advise us to spend the time to come investigating the complex and chaotic nature of cognition.

In the next chapter, I will look more closely at what it could mean to investigate cognition as a chaotic phenomenon.

META-NARRATIVE 2.3



University of Pretoria, etd - Human, S

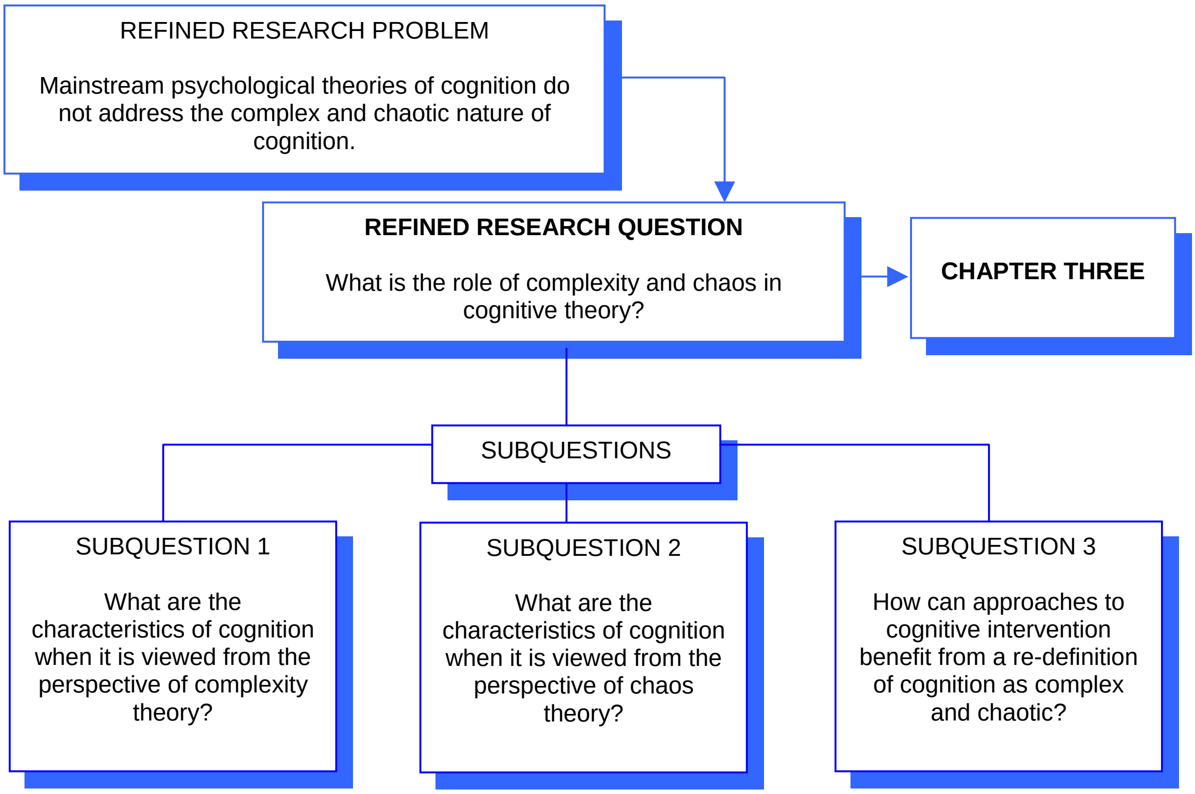
CHAPTER THREE

Accommodating principles of complexity and chaos in cognitive theory

Chaos is not just one direction that we may stray too far toward. It is all around us and partly within us.

Mahoney and Moes, *Complexity and Psychotherapy*

META-NARRATIVE 3.1



University of Pretoria, etd - Human, S

3.1 INTRODUCTION

In the previous chapter I discussed how the discipline of psychology and the study of cognition were shaped by changing paradigms in the physical sciences. It appears that philosophers and psychologists have predominantly taken their cue from mathematicians, biologists and physicists. Whether it was to agree with them, or to oppose their ideas, philosophers and psychologists have looked to discoveries in the physical sciences for many of their questions and their answers.

For example, Barrow (1999) relates how the discovery of Euclidian geometry[15] (3 B.C.) established a style of reasoning that was characterised by the application of definite rules of reasoning from a collection of self-evident axioms, and how theologians and philosophers imitated this method of reasoning in their speculations. With Euclidean geometry, it was possible to establish absolute truths, and it was believed that Euclidean geometry described the world as it was. Euclidean geometry occupied the same position of authority then that Newton's classical physics enjoyed approximately a century and a half later.

However, when mathematicians discovered other geometries (hyperbolic and spherical)[16], each with its own set of logically self-consistent rules, it was apparent that Euclidean geometry was only one of many logical systems, and none could lay claim to the status of absolute truth (Barrow, 1999). Nonetheless, many philosophers still adopted the style of reasoning that Euclidean geometry established because it provided structure and credence to their arguments. Some philosophers, like Spinoza, exponent of the rationalist philosophy (Delius *et al.,* 2000), even laid out their arguments "like the definitions, axioms, theorems, and proofs in Euclid's works" (Barrow, 1999, p. 42).

This chapter continues the discussion of the third period in the sciences in more depth in order to continue the discussion on how psychology and the physical sciences have converged at a point where both disciplines acknowledge the inevitable complexity of their subject. I will reflect on the possibility that the postmodern period in science and psychology offers a promising new direction for cognitive research, and indeed psychology generally (Mahoney & Moes, 1997), since postmodern theory appears especially able to address the complexities of human cognition.

[15] Euclidean geometry deals with the measurement of flat spaces.
[16] Hyperbolic and spherical geometry deals with the measurement of curved spaces.

University of Pretoria, etd - Human, S

However, a note of caution is in order. Just as it is possible to live in a world where the principles of classical physics and modern physics both hold under different conditions, so it is possible to live in a world in which human cognition can be conceived of as being both linear and unpredictable, depending on the conditions under which it is studied. If quantum theory has taught us anything, it is that cognition is a 'potential' phenomenon, not an 'actual' one. Cognition does not exist exclusively in one form or another. By this we mean cognition is not seated either in the mind, or in social experience. Rather, cognition is a collection of possibilities and probabilities, some of which are realised when we observe them in a particular way. Depending on how we structure our observations, cognition may be actualised in a number of different ways.

In this case, Heisenberg's uncertainty principle is particularly relevant to the study of cognition. If we structure our observations in order to measure the neuronal activity in the brain, we lose sight of the complex interactions between different structures of the brain, and we gain little knowledge of social aspects of problem solving. When we focus our attention on the role of perception in thinking, we tend to lose sight of the creative aspects of thought. If we study thinking in groups, we are inevitably unable to focus simultaneously on what happens in the brain.

META-NARRATIVE 3.2

My aim in this study is not to discredit current theories of cognition. Rather, I wish to reflect on the limitations within which current theories of cognition operate. It has been pointed out repeatedly that cognitive research is fragmented and lacks coherency (Vosniadou, 1997; Newsome, 2000) and I believe this may be the result of our failure to commit ourselves as scientists, to building an integrated picture of human development. There is too much focus on theoretical differences and too much interest in advancing one particular theory over another. Perhaps it could be fruitful to cognitive theory development in general if one were to consider adding a basic feature of cognition that is not being addressed adequately in mainstream cognitive psychology. The dimension I am referring to is *chaos*, believed to be the essence of complex systems.

In this chapter, I will explore two theories considered to be relevant to an investigation of cognition within a postmodern context, namely complexity theory and chaos theory. Finally, I will examine some of the implications that complexity theory and chaos theory might hold for cognitive intervention in a postmodern context.

University of Pretoria, etd - Human, S

3.2 PSYCHOLOGY, COMPLEXITY AND CHAOS

3.2.1 Complexity and chaos in psychology

At the beginning of the twenty-first century, the symbiotic relationship between psychology and the physical sciences continues its existing trend. Mahoney and Moes (1997) remark that

> It is interesting, if not ironic, that formal studies of chaos and complexity began in areas far removed from human systems and human affairs. The historical classics in these studies have originated in the areas of mathematics, physics, biology, and meteorology. This is not to say that there were no precedents in philosophy or the social sciences, but only that the vast majority of formal inquiries into "chaotics", complexity and spontaneous self-organization has [sic] been in the physical and biological sciences. With few exceptions, this remains the case today (p. 182).

Of course, this is not to suggest that mathematicians and physicists recognised complexity in human nature when psychologists would not. Even the very earliest students of human behaviour would readily have acknowledged the complexity of their subject. Speaking of the relevance of chaos theory to applied psychology, Perna and Masterpasqua (1997) point out that

> This new paradigm from the physical sciences…resonates more closely with the vagaries of human development and the therapeutic experiences that are so much a part of the everyday life of practicing psychologists. In this sense, these discoveries from the physical and natural sciences have caught up with the tacit acceptance, especially among practicing psychologists, that ours is a science of qualities rather than of quantities that must include an acceptance of unpredictability and free will (p. 5).

Yet Goertzel (1993) believes that contemporary psychology simply lacks the tools to confront comprehensive questions about the nature of mind and behaviour:

> Psychologists tend to become annoyed when their discipline is compared unfavourably with physics – and indeed, the comparison is unfair. Experimental physicists have many advantages over experimental psychologists. But the facts cannot be ignored. Physics talks about the properties of baseballs, semiconductors and solar systems, but also about the fundamental nature of matter and space, and about the origin of the cosmos. The physics of baseball is much more closely connected to experimental data than is the physics of the first three minutes after the Big Bang – *but there is a continuum of theory between these two extremes, bound together by a common philosophy and a common set of tools…*It seems to me that the key to understanding the mind lies not in contemporary psychology, but rather in a newly emerging field which I will call – for lack of a better name – "complex systems science." (p.2, own emphasis)

Despite Goertzel's (1993) doubts about the ability of contemporary psychology to confront the complexity of the human mind, developments in complexity and chaos theory over the past thirty years are generally thought to be of significant relevance to the science of psychology.

In applied psychology, psychotherapists especially are greatly inspired by the possibilities which chaos theory as a conceptual framework presents to psychology. For example, Lewis and Junyk (1997) suggest that chaos theory offers a plausible alternative to personality functioning as a causal, linear process. Lewis and Junyk (1997) describe personality functioning as a behavioural system that includes both predictability and uncertainty and describes personality self-organisation as "the emergence and crystallization of interpretive attractors over developmental time (or macro development)" (p. 50). Other applied areas of psychology in which chaos theory has found application include the study of *regression* (Perna, 1997), *dissociative disorders* (Derrickson-Kossmann & Drinkard, 1997), and *childhood trauma* (Lasser & Bathory, 1997). Finally, Masterpasqua & Perna (1997) comment that the sciences of chaos and complexity offer new models and metaphors from which to construct an understanding of the postmodern self.

This study is concerned mainly with human cognition, and it is the complex nature of thinking that is of particular interest. Although some texts briefly mention the relevance of chaos theory to the study of the brain (Groves & Rebec, 1992), the use of a conceptual framework that accommodates chaos and complexity in cognition is mostly restricted to mathematical psychology texts (Goertzel, 1993) and philosophical texts (Cilliers, 1998). A common phenomenon across all these texts, one that Lorenz (1993) acknowledged earlier, is that 'chaos' is often used synonymously with other terms such as 'non-linearity' or 'sensitive dependence'. Similarly, 'complexity' is often used to denote some form of chaos (Briggs & Peat, 1999).

Seeing that chaos and complexity can have such different meanings depending on the contexts in which they are used, it will be important to develop a clear description of what chaos and complexity might mean in the context of this investigation. The next section will briefly review the relevance of complexity and chaos to cognition, after which both theories will be discussed in greater detail.

University of Pretoria, etd - Human, S

3.2.2. Complexity and chaos in the study of cognition

Chapter Two started with a consideration of the meaning of complexity and the relevance of complexity to the study of cognition. I pointed out that our conception of complexity has evolved to acquire new meanings, and that this evolution was in large part due to evolving paradigms in the physical sciences.

I have begun to develop the notion of cognition as a complex phenomenon, and offered some preliminary ideas on what it might mean to speak of cognition as being complex. I have hinted at several concepts that are generally associated with complexity, namely chaos, sensitivity, dynamic interrelationships, and interconnectivity. However, what complicates matters considerably, is the fact that a term such as complexity is frequently used synonymously with chaos, as are terms like non-linearity and fractality (Lorenz, 1993).

In the next section, some of the central concepts in chaos theory will be developed by contemplating complexity within a postmodern context and relating the study of complexity to the study of cognition. The acknowledgement that one of the main characteristics of complex systems could be their chaotic nature, will inevitably lead us towards a consideration of some key features of chaos theory in Section 4.

3.3 COMPLEXITY THEORY AND COGNITION

3.3.1 Definitions of complexity

Defining complexity is a complex endeavour. Goertzel (1993) mentions that complexity does not mean ‘complicated’, but rather refers to structures that are diverse, intricate and in interaction, and have the capacity to organise themselves.

Lorenz (1993) states that complexity is often defined differently in different contexts. Consequently, the term may be used to indicate a system’s sensitive dependence on initial conditions, irregularity in space, or the length of a set of instructions that one would have to follow to depict or construct a system. The first two criteria are often used within the context of meteorology, while the last criterion is generally favoured by mathematical psychologists.

Cilliers (1998) says of complex systems, that they are not constituted merely by the sum of their components, but also by the intricate relationships between their components. Therefore, complexity is manifested at the level of the system itself. Luhmann (1985 in Cilliers, 1998) states that complexity means that there are more possibilities than can be

University of Pretoria, etd - Human, S

actualised. In this regard, Cilliers (1998) agrees that complex systems contain such intricate sets of non-linear relationships and feedback loops that only certain aspects of the system can be analysed at a time, and even then such analyses will be characterised by distortions. Some of the complex systems that Cilliers (1998) identifies as complex, include mostly 'living' things such as bacteria, the brain, social systems and language.

Whether the mind is represented mathematically (Goertzel, 1993), or metaphorically (Perna & Masterpasqua, 1997), there is much evidence that suggests that cognition is a complex and chaotic phenomenon. In the next section, I will explore the complex nature of cognition by reviewing some characteristics of complex systems.

3.3.2 Complexity in a postmodern context

3.3.2.1 Objectivism and relativism

Cilliers (1998) contrasts modern and postmodern contexts by pointing out that modern approaches to complexity aspired to find a fixed point of reference that would serve as a foundation from which everything else could be derived, whereas postmodern theories highlight the open-endedness of phenomena. Earlier, Bernstein (1983) described the tension between modernism and postmodernism as one that involves an opposition between objectivism and relativism, or objectivity and subjectivity.

Perna and Masterpasqua (1997) assert that postmodernism challenges two fundamental modernist assumptions, namely that there is an objectively verifiable universe and that there is a self-contained, individuated self who can know the truth. Bernstein (1983) says that objectivism has frequently been associated with the claim that a world of objective reality exists independently of us and that what is "out there" (objective world) is independent of what is "in here" (subjective world). Bernstein (1983) contrasts such objective knowledge with a relativist position by saying that

> Relativism is the basic conviction that when we turn to the examination of those concepts that philosophers have taken to be the most fundamental – whether it is the concept of rationality, truth, reality, right, the good, or norms – we are forced to recognize that in the final analysis all such concepts must be understood as relative to a specific conceptual scheme, theoretical framework, paradigm, form of life, society, or culture (p. 8).

In Chapter Two we saw that the Heisenberg Uncertainty Principle and the Schrödinger wave function in quantum physics were largely responsible for stimulating the development of such relativist arguments in philosophical discourses on knowledge as proposed by Bernstein

University of Pretoria, etd - Human, S

(1983). However, the dichotomy between objectivism and relativism is not a twentieth century phenomenon. From the very beginnings of Western philosophy in 600 B.C., tension existed between the subjectivism and relativism of the Sophists, and the objectivism of Plato (Delius *et al.,* 2000). It continued throughout the Middle Ages which were characterised by the problem of universals. The problem of universals concerned itself with the question of whether general terms had any reality or whether they were simply constructs of thought and language (Delius *et al.,* 2000).

3.3.2.2. Complexity and relativity

There has been a tendency to describe postmodern theoretical developments as relativistic, a tendency which Cilliers (1998) dismisses as a sign of ignorance. Cilliers (1998) states that post-structuralism (deconstruction) is often (incorrectly) presented in anti-scientific terminology that stresses the proliferation of meaning, the shortcomings of logic and the breaking down of existing hierarchies.

Cilliers (1998) specifically takes issue with "over-zealous post-structuralists (especially literary theorists)" who should "transform their rhetoric into something cooler and clearer, something that can be argued with" (p. 22). Cilliers (1998) insists that post-structuralism is "not merely a subversive form of discourse analysis, but a style of thinking that is sensitive to the complexity of phenomena under consideration" (p. 22) and says that "post-structuralism has a more 'playful' approach" (p. 23). The playful approach that Cilliers (1998) argues for essentially refers to a recognition of the fact that most complex phenomena are open systems consisting of a multitude of possibilities which cannot possibly be known by controlling either the phenomena or the conditions under which they are studied.

As Perna and Masterpasqua (1997) rightly acknowledge, certain theories and discoveries in quantum physics had much to do with the introduction of the notion of openness and uncertainty in knowledge systems, although this is frequently not acknowledged in educational and philosophical discourses on postmodernism. In their discussion of the postmodernist self, Perna and Masterpasqua (1997) draw on concepts within complexity theory and chaos theory to describe the self as an open system, consisting of possibilities, sensitive to perturbations in the environment, and "always in a state of becoming" (p. 6).

This study aligns itself with Cilliers' (1998) definition of postmodernism as one which recognises the complexity of phenomena, as well as the responsive and dynamic interaction of phenomena within various contexts in their environment. The relativism with which

University of Pretoria, etd - Human, S

postmodernist approaches are associated at times is re-conceptualised within this study as an acknowledgement that complex systems are a collection of probabilities rather than actualities, and that it is impossible to know on an *a priori* basis which probabilities will be realised when the observer interacts with the system within a particular context and time frame.

However, at the moment when the complex system is being observed, some probabilities will indeed have crystalised within a particular context, and others will have collapsed. It is also recognised in this study that, contrary to relativist beliefs, some patterns of probabilities do in fact actualise with relative consistency across time and context. It is such consistency that gives rise to the emergence of a common human experience that allows the continuity in experience that makes it possible for humans to interact with one another meaningfully.

3.3.3 Universal features of complex systems and their relation to cognition

3.3.3.1 Open systems

Depending on the context, it is possible to generate different definitions of complexity. However, all complex systems display some characteristics that make it possible to classify them as being complex or not. Cilliers (1998) observes that, for the human mind and cognition to be considered as a complex system, it must be possible to show that they are *open systems* which interact with their environment and which can be modified by their environment.

There are various examples that show how the environment can modify the functioning of the brain. For example, the results of electrophysiological experiments with congenitally deaf people and normally hearing people show that left-right asymmetry in brain waves is present in normally hearing people, but not in congenitally deaf people for whom English is a second language after sign language. However, congenitally deaf people who are very skilled with English grammar do show left-right asymmetry in their brain waves. As a result, Groves and Rebec (1992) conclude that these experiments show convincingly that left hemisphere language specialisation may very well be a function of the early introduction of language, and that ”the early acquisition of grammatical competence in a language is both necessary and sufficient in the development of left hemisphere specialization for that language” (p. 488).

Moreover, studies on the environmental effects on the plasticity of the brain have thus far shown that the amount of visual stimulation that enters the eye strongly affects the structure and function of the visual cortex in the brain (Groves & Rebec, 1992). Studies on animals which had been raised in rich environments as opposed to animals which had been raised in isolated conditions, indicated that animals raised in rich and stimulating environments had heavier brains, the cerebral cortex was thicker and also contained higher levels of certain enzymes and other chemicals, and the neurons had formed greater numbers of branches, which were also longer than those of the control group (Groves and Rebec, 1992).

It appears as if the environment can even change the genetic blueprint that determines cell differentiation. For example, Purves and Lichtman (1985) in Groves and Rebec, (1992) have shown how a group of developing cells from one tissue change their pattern of development when they are transplanted within a new tissues. In addition, Pennington (1999) suggests that “subcortical structures which develop earlier, appear to be more strongly genetically influenced, whereas the cortex, which develops later, appears to be under both genetic and environmental influences” (p. 314).

The brain is therefore extremely flexible in its development, so flexible in fact, “that entire populations of developing cells may live or die depending on how they interact with other cells” (Groves and Rebec, 1992, p. 454).

3.3.3.2 Absence of equilibrium

Complex systems operate under conditions far from equilibrium. Briggs & Peat (2000) describe equilibrium as the maximum degrees of freedom of the system, which refers to the maximum amount of behaviours (an indication of chaos) that are available to the system. Masterpasqua (1997) claims that the concept of chaos indicates, in psychological terms, “a state of maximum readiness for an emerging reorganized self-system” (p. 37). Waldrop (1992 in Masterpasqua, 1997) describes the system as being in a state of perpetual novelty, life at the edge of chaos.

Cognition is not stable and unchanging, but actually thrives on ambiguity and change. People constantly review and change their thinking as a result of interaction with their environment. We recognise the complexity of a person’s conceptual structures by the diversity of their ideas and the richness of their thinking. Groves and Rebec (1992) quote various brain studies that convincingly show how complex experiences lead to increased complexity in brain structures and functioning, which in turn leads to increased complexity in behaviour. The implication is that complexity and unpredictability in the environment is necessary in order for complex cognition to emerge.

University of Pretoria, etd - Human, S

Clinical disorders which are associated with a disorder in thinking, such as mental retardation, may be associated with a loss of cognitive complexity, heightened levels of cognitive rigidity (perseveration) and reduced responsiveness to the environment. Also on a cellular level, mentally retarded children often show reduced dendritic growth, making the cerebral cortex appear more primitive (Groves & Rebec, 1992). On the other hand, psychotic disorders such as schizophrenia appear to be associated with higher levels of complexity as evidenced by increased chaotic functioning (Tschacher & Scheier, 1997). From these examples, it is important to note that complex cognition does not require constant chaos, but chaos is a necessary phase in the development of a system as it self-organises towards higher order.

3.3.3.3 Historical development

Complex systems have a history as they evolve over time, so it is critical to consider how their past influences the trajectory of the system over time. Complex systems theory emphasises the importance of gaining an understanding of the historical development of the system as a prerequisite for understanding the system's present behaviour.

On a physical level, the process of synaptogenesis provides compelling evidence that, as the brain evolves, its cognitive processes emerge and reveal increasing complexity. Most of the synapses in humans are formed over time and occur most prolifically in the first few years after birth. Groves and Rebec (1992) report that the nervous system continues to change and re-organise itself throughout the lifetime by re-arranging its synapses.

On a conceptual level, Piaget (Lerner, 2000) and Vygotsky (1935/1978)[17] both recognised the importance of studying the historical origins of thought in order to understand present thinking. Vygotsky (1935/1978) was adamant about studying the historical origin of an organism or function as opposed to merely describing its current appearance or function. The main reason for his position was that processes that appear to be the same on a descriptive level, may be qualitatively different when examined from a historical perspective.

3.3.3.4 Number of elements

Complex systems consist of a large number of *elements* that interact with each other on physical, as well as relational levels. It is critical to the understanding of a complex system to

[17] This reference (and others to follow) refers to an unpublished manuscript originally written in Russian by Vygotsky in 1935, and published posthumously in 1978 in English.

note that individual elements of the system are considered to be ignorant of the behaviour of the system as a whole, so that the system is not centrally controlled. Rather, control is thought to arise out of the interplay of the agents (Waldrop, 1992 in Masterpasqua, 1997). In this respect, Cilliers (1998) reminds us that a large number of elements is a necessary, but not sufficient condition for complexity because it is really the dynamic interaction between the elements that is of interest.

Cognition is the result of the dynamic interaction of billions of elements on various levels. For example, on a physical level, Groves and Rebec (1992) estimate that the human brain has "well over ten billion nerve cells and probably more than ten times that number of glial cells."(p. 42)[18] Cairns-Smith (2000) estimates that there may be about a hundred billion (10^{11}) neurons altogether in the human brain. On a social level, cognition emerges from complex interactions between language, culture and social interaction.

An indicator that is frequently used to distinguish between complex and complicated structure, is to see whether a structure lends itself to complete description. Whereas a computer can be described completely in terms of its components and programs, the brain cannot. Most living organisms are open and dynamic systems that do not lend themselves to complete description, which is why cognition, the brain, indeed the human body, can be thought of as a complex system.

3.3.3.5 Dynamic Interaction

The interaction between elements in the complex system is *rich*, with each element influencing and being influenced by a number of other elements. It is therefore critical to study complex systems as they occur naturally and to use experimental procedures that concentrate on historical development (Kellert, 1993 in Perna & Masterpasqua, 1997). Cognition arises from a rich interaction of various elements. Cairns-Smith (2000) says that the richness of the connections between neurons in the brain is evident from the fact that each brain cell is in touch with another through approximately six or seven intermediates, and that each neuron can have up to thousands of axons from other cells attached to it.

On a physiological level, learning and memory are believed to be linked to many cellular and subcellular processes, which "is greatly complicated by the large number of neurons and larger number of synapses that may be involved in even the simplest learning task" (Groves

[18] Glial cells support nerve cells and cannot transmit information. Some glial cells form the myelin sheaths around neurons and others "clean up" neurotransmitters (Groves and Rebec, 1992; Cairns-Smith, 2000).

University of Pretoria, etd - Human, S

& Rebec, 1992, p. 513). On a structural level, Parkin (2001) reports that memory is associated with various structures in the brain's limbic system (hippocampus, thalamus, frontal lobe, amygdala and the lateral temporal lobe). Incidentally, these structures also play an important role in emotional behaviour (Groves & Rebec, 1992). Finally, Groves and Rebec (1992) conclude that "emotional behaviour is regulated by complex neural circuits, each one of which is modulated by other systems" (p. 408). Emotions play an important role in learning and memory because emotions, learning and memory processes all require some involvement of the same brain processes. In fact, particularly strong emotions can often make learning experiences more memorable and can have a decidedly positive or negative influence on a person's inclination to seek out certain learning experiences.

The interactions of various elements of the brain may even be responsible for the emergence of the mind. Nobel Prize winning physiologist, Roger Sperry, demonstrated convincingly in the early seventies that severance of the corpus callosum (which is responsible for relaying information between the hemispheres) effectively creates two independent minds. Sperry showed that individuals with split brains could learn a different task with each eye, independently of the other, without one hemisphere knowing what the other hemisphere was learning. This evidence leads Groves and Rebec (1992) to speculate that Sperry succeeded in dividing consciousness and the mind, a compelling demonstration "that the mind is an emergent property of the brain" (p. 495). Kak (1996) agrees when he remarks that "whereas the mind is emergent and based on the capabilities of neural hardware, it cannot exist without the universal self. One implication of these ideas is that machines, which are based on classical logic, can never be conscious." (p.189)

However, knowing that a complex system consists of a multitude of interactions among millions of elements is not enough to distinguish between systems that are complex and those that are complicated. Very sophisticated computers exist with many components and processes that could then equally well be regarded as complex. The main difference between a supercomputer and human cognition is to be found in the **nature** of the interactions between elements of the system. The interactions in complex systems are characterised by non-linearity.

3.3.3.6 Non-linearity

Non-linearity refers to the system's sensitive dependence on initial conditions (Lorenz, 1993). Sensitive dependence means that a relatively small change can lead to the system achieving end-states that show significant variance.

For example, various clinical disorders with dramatic behavioural and social implications often arise from small changes on a cellular and even subcellular level in the brain. Current research suggests that the difference between normal intellectual functioning and mental retardation may be associated with chromosomal errors (as in the case of trisomy-21), a change in the structure of neurons in the cerebral cortex, or specific conditions (e.g. nutritional factors) in prenatal and postnatal development. All of these changes occur on a small scale, but they lead to significant and dramatic variations in the ultimate behaviour of affected individuals.

As a system, cognition is very sensitive to initial conditions. The sensitivity arises from the non-linear interactions between the electrical, chemical, emotional, social and cultural dimensions of thinking. Schizophrenia for example, a debilitating condition characterised by a disruption of thought, emotional instability and psychotic episodes, is thought to arise from raised levels of dopamine in the brain. Moreover, the brain's apparent sensitivity to dopamine in such cases only occurs at the onset of adulthood after a period of apparent normal functioning, since the onset of schizophrenia is normally in early adulthood (Kaplan, Sadock & Grebb, 1991; Groves & Rebec, 1992). On the other hand, inadequate production of dopamine in certain areas of the brain is thought to lead to Parkinson's disease because the part of the brain (striatum) that controls the muscle actions required for complex voluntary movements does not receive enough dopamine from the substantia nigra, a group of neuronal cells that manufacture dopamine (Cairns-Smith, 2000).

Similarly, on a social interpersonal level, an event that may be construed as non-significant by one person, for example criticism from a significant other, may have a very significant impact on the thinking of the next person. For example, on an emotional level, attribution theory shows how people can feel very different emotions depending on their attributions of the outcomes of a situation to different antecedent causes (Byrnes, 2001). Emotional expression can also vary as a result of chemical interactions in the brain. For example, Groves and Rebec (1992) report on animal studies that suggest that predatory aggression in animals is associated with raised levels of serotonin, whereas aggression arising from irritation is associated with raised levels of norepinephrine. Similarly, Cairns-Smith (2000) reports that emotions can be severely disrupted if monoamine transmitter systems are interfered with.

University of Pretoria, etd - Human, S

3.3.3.7 Short range interaction

The interactions between elements in a complex system typically have a *short range* in the sense that they inform and transform their immediate environment, but not the behaviour of the system as a whole.

Cognition is characterised by many interactions that have the power to transform their immediate environment, but not the behaviour of the system as a whole. For example, Groves and Rebec (1992) point out that although the midbrain is responsible for the expression of aggression, the hypothalamus and amygdala play a mediatory role in the midbrain's response. On an even smaller scale, each synapse in the brain can only act on the next synapse with which it makes contact through chemical neurotransmitters, and billions of synaptic interactions and associations are necessary to produce certain patterns of behaviour. For example, Cairns-Smith (2000) says that spinal reflexes especially (like drawing one's hand away from a hot source), can be understood in terms of a subsystem that is connected by means of only a few neuronal cells.

On a structural level, electrical stimulation of certain parts of the brain show that certain functions are localised in particular areas of the brain (specialisation), and are not distributed throughout. For example, studies that use positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), show increased blood flow and metabolic activity in the frontal lobe during a card sorting task (Groves & Rebec, 1992), while other areas of the brain show less activity. It is important to note in such cases that other brain regions are not completely inactive, but just show reduced metabolic activity.

Therefore, particular areas of the brain are responsible for particular cognitive behaviours associated with the activity in those particular regions, but one region alone cannot explain all dimensions of thinking. Moreover, even though certain brain areas are specialised for particular behaviours, those behaviours can be mediated by other areas in the brain. The point is that certain brain regions are responsible for particular functions, but no brain region has perfect knowledge of the total functioning of the brain. The concept of short range interaction therefore makes the emergence of cognition especially dependent on integrated functioning of the whole brain.

University of Pretoria, etd - Human, S

3.3.3.8 Feedback loops

In complex systems, a *feedback loop* exists in the interactions that allow the effects of any element to feed back into itself. Briggs and Peat (1999) distinguish between positive feedback loops that amplify a particular effect, and negative feedback loops that diminish some effects.

The existence of feedback loops is a central feature of cognition because feedback loops allow the dynamic, non-linear interactions between elements of cognition that may ultimately lead to the emergence of patterns associated with personality types, emotional styles, and cognitive dispositions. The importance of feedback loops therefore lies in the recognition that they can lead to stable patterns of behaviour around which a system organises itself. In this regard, positive feedback loops increase chaos in a system, negative feedback loops keep activity in a restricted range, i.e. reduce chaos in the system, and a coupling of positive and negative feedback loops creates a dynamic balance, also known as a bifurcation point, where chaotic activity is thought to branch off into order, i.e. a higher level of self-organisation (Briggs & Peat, 1999).

For example, Byrnes (2001) remarks that the so-called hemispheric asymmetry model of emotion suggests that the distribution of positive and negative emotions may be asymmetrically organised, leading to individuals developing various affective styles. Experiments by Davidson (1992, in Byrnes, 2001) in which EEG recordings taken from adults who were watching video clips designed to elicit either amusement or disgust were compared with video recordings of their facial expressions, indeed showed that 100% of the subjects had EEG activation patterns consistent with the notion that the left frontal region of the brain is specialised for approach (positive emotions such as happiness) and the right is specialised for withdrawal (negative emotions such as disgust). Other studies cited by Byrnes (2001) confirm the existence of stable patterns of reactivity in infants and college students, and which correlate with approach-avoidance behavioural strategies such as sociability and shyness.

Studies such as the aforementioned clearly point to the tendency of complex systems to self-organise and to develop adaptive (and maladaptive) patterns of behaviour. It may be possible that the mechanisms by which complex systems self-organise are governed by universal dynamic processes (positive and negative feedback loops) that lead to the development of certain patterns (also called attractors, which will be discussed in the next section) which may or may not lead to bifurcations in the development of the system.

I suggest that the universal features of complex systems may form the basis of the fundamental mechanisms which determine the emergence of human cognition.

3.3.4 Mechanisms of cognitive change

In the previous discussion, I reviewed some of the most important characteristics of complex systems. What has emerged from the discussion, is a picture of the brain and cognition as an open, living and dynamic system which does not easily render itself to complete description.

Cognition, as it emerges from various processes in the brain, is truly complex. However, if one were to stop at a mere description of cognition as a complex system, and not consider the processes by which such complex systems evolve, one would not know by which mechanisms cognitive change becomes possible. Gauvain (2001) insists that an understanding of the mechanisms of cognitive change is important, because

> Without an understanding of how change occurs, it is unclear what processes instigate and organize human intellectual development. It is evident from observations, across a wide range of contexts in which people develop and in the many domains of functioning in which the mind is capable of performing competently, that cognitive development proceeds in an organized fashion. This suggests that a set of common principles underlies much of what occurs over the course of intellectual growth (p. 22).

Various attempts have been made to explain the mechanisms by which cognitive development takes place. Candidates include Piaget's concepts of assimilation and accommodation, Vygotsky's Zone of Proximal Development (ZPD), the Behaviourist concept of reinforcement as a mechanism to strengthen stimulus-response bonds, and the information-processing concept of automatisation, to name a few. More recently, Gauvain (2001) has argued for social experience to be considered as the principle mechanism of cognitive change in informal contexts.

Although the mechanisms of cognitive change as proposed by various cognitive theorists do offer suggestions on how such cognitive changes can take place, they are by no means universal explanations for cognitive change on all levels of human experience. For example, Piaget was mostly concerned with changes in people's cognitive schemas, and less so with chemical or biological mechanisms of change. Vygotsky focused on the role of social interaction in conceptual change, but was less concerned with cognitive change on a physical level. Behaviourist theory altogether fails to account for the changes in complex systems such as cognition and language, whereas automatisation may describe skill acquisition adequately but fails to account for the complexities of emotional development. Even Gauvain's (2001) proposal that social experience be viewed as the main mechanism of cognitive change does not make room for other contexts which are not necessarily social in nature, but in which learning also occurs.

Therefore, some of the questions that arise in terms of cognitive development, are whether such universal mechanisms of change exist, whether these mechanisms could be at the root of cognitive change, and whether they can shed light on the historical development of cognition as a complex system. In considering these questions, I believe it is important that universal mechanism(s) of change allow(s) psychologists to explain change at all levels of the complex system, irrespective of the context in which the change occurs. A universal mechanism of change will therefore have to be capable of coping with change on cellular, structural, psychological and social levels, and will therefore have to incorporate as a central feature, the notion of fractality, or self-similarity. Briggs and Peat (1999) describe fractality as follows:

> Nature's patterns are the patterns of chaos. "Fractal" is the name given by scientists to the patterns of chaos that we see in the heavens, feel on earth, and find in the very veins and nerves of our bodies….fractals refer to the traces, tracks, marks, and forms made by the action of chaotic dynamical systems (p. 100).

Chaos and fractality would be central features of a universal mechanism of cognitive change. An important question is whether such a universal mechanism of change in complex systems can offer a sound basis for the development of a plausible framework, or a continuum of theory, as Goertzel (1993) has suggested[P1].

At present, it appears that the best candidate for such a comprehensive theoretical framework, may be chaos theory.

3.4 CHAOS THEORY

3.4.1 Origins of chaos theory

The question that meteorologist Edward Lorenz posed to his audience in 1972, namely "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?" addressed a central feature of chaotic systems, namely sensitivity to initial conditions.

University of Pretoria, etd - Human, S

Lorenz was especially intrigued by tentative evidence that small perturbations could produce different weather systems that differed considerably in their nature and impact, suggesting that the global weather system was in fact unstable. Although Lorenz was unable to answer the question at the time, it stimulated the adoption of a whole new paradigm in the mathematical and physical sciences known as dynamical systems theory[19] (Lorenz, 1993).

In Section 3.4.2 I will discuss three key features of chaos theory, namely sensitive dependence, non-linearity and self-organisation. In each case I will point out the relevance of these features to the study of human cognition.

3.4.2 The core principles of chaos theory

3.4.2.1 Sensitive dependence

Lorenz (1993, p. 207) defines **chaos** as "the property that characterizes a dynamical system in which most orbits exhibit sensitive dependence; full chaos." Chaotic systems show varying levels of chaos, and so the presence of chaos in a complex system does not refer to uniform state in the system. Rather, a chaotic system alternates between states of full chaos and states of organised chaos.

Masterpasqua and Perna (1997) describe chaos as

> The unpredictable and irregular evolution of the behaviour of many nonlinear dynamical systems. Because of their sensitive dependence on initial conditions, the error in predicting the future state of the system becomes essentially unknowable in a relatively brief period of time. Although *chaos* means unpredictability, it should not be understood to mean that the system was not or is not determined. After considerable debate, the Royal Society in London in 1986 defined *chaos* as "stochastic behaviour occurring in a deterministic system" (p. 304).

Sensitive dependence is also known as the *Butterfly effect*, and is defined by Lorenz (1993) as "the phenomenon that a small alteration in the state of a dynamical system will cause subsequent states to differ greatly from the states that would have followed without the alteration" (p. 206). Such alterations are known as bifurcations, defined as "an abrupt change in the long-term behaviour of a system, when the value of a constant is changed from below to above some critical value" (p. 206).

In essence, sensitive dependence refers to the fact that very small changes in the initial conditions of a chaotic system can change the trajectory of the system exponentially. As

[19] The terms *dynamical systems theory* and *chaos theory* are often used synonymously.

Lorenz (1993) pointed out, ‘initial conditions’ need not refer to the conditions that were present at the time when the system was created, it may refer to any point in the evolution of the system which is chosen as the point from which the system will be observed and compared. It is from sensitive dependence that complex systems derive their non-linear character.

It can often be difficult to distinguish between chaos and complexity. To maintain a clear distinction between chaotic systems and complex systems, can be fairly difficult because many important features are shared between the two. For example, some of the characteristics which have been described as characteristics of complex systems will be revisited in the next section within the context of chaos. The most important distinction between chaotic systems and complex systems is that chaos is only one phase (albeit a very important one) in the emergence of a complex system.

It may help to bear in mind that all complex systems are chaotic, but chaotic systems are not necessarily complex. For example, Lorenz (1993) describes pendulums and pinball machines as simple systems which exhibit chaotic behaviour. On the other hand, complexity cannot emerge without chaos because chaos is necessary for self-organisation.

3.4.2.2 Non-linearity

(1) Definition

A **non-linear system** is defined as “a system in which alterations in an initial state need not produce proportional alterations in subsequent states” (Lorenz, 1993, p. 210) and by Masterpasqua and Perna (1997, p. 306) as “the concept that qualitative, not quantitative, change describes the dynamic course of a system across time or that small changes early on can result in unpredictable changes late in development.”

The concept of non-linearity was already introduced in the context of complex systems in section 3.3.3.7 by considering how non-linearity is expressed on a physiological level in the brain. In this section I will address non-linearity within the sociocultural context and attempt to highlight the usefulness of the concept in the study of cognition.

(2) Non-linearity and Vygotsky’s psychology

The non-linearity of human development was described earlier by Vygotsky (1935/1978) when he remarked that

> Child development is a complex dialectical process characterized by periodicity, unevenness in the development of different functions, metamorphosis or qualitative transformation of one form into another, intertwining of external and internal factors, and adaptive processes which overcome impediments that the child encounters. Steeped in the notion of evolutionary change, most workers in child psychology ignore those turning points, those spasmodic and revolutionary changes that are so frequent in the history of child development….Where upheavals occur, where the historical fabric is ruptured, the naïve mind sees only catastrophe, gaps, and discontinuity (p. 73).

Within the context of chaos theory, *catastrophe* and *discontinuity* are no longer seen as “upheavals” , but are recognised as creative moments that allow complex systems to evolve to a higher order through a process of self-organisation. Vygotsky (1935/1978) rejected the traditional view of cognitive development as the result of the gradual accumulation of separate changes. According to Wertsch (1985), it was the revolutionary shifts in the development of thinking that interested Vygotsky. As a result, Vygotsky (1935/1978) was adamant that experimental methods should encourage moments of catastrophe and discontinuity if one were to discover how children organise their behaviour.

Vygotsky (1935/1978) reiterated that

> What is crucial is that in all these cases we must adhere to one principle. We study *not only the final effect of the operation, but its specific psychological structure.* In all these cases, the psychological structure of the development appears with much greater richness and variety than in the classic method of stimulus-response experiment. Although stimulus-response methodology makes it extremely easy to ascertain subjects’ responses, it proves useless when our objective is to discover the means and methods that subjects use to organize their own behavior (p. 74, author’s emphasis).

The Behaviourist stimulus-response mechanism of cognitive change used to be very influential in the development of school curricula, where it led to instructional approaches that were teacher- and curriculum-centered, with an emphasis on the mastery of content (Lerner, 2000). Since behaviourist approaches to learning tend to focus on reducing the complexity of learning content, rote learning, and stepwise mastery of discrete skills, ambiguity in the presentation or solution of problems is rarely tolerated or encouraged. By contrast, Vygotsky (1935/1978) believed that a disruption of automatised processes caused by presenting children with unfamiliar or advanced problems, disrupted children’s cognitions and thus allowed him to observe the psychological process by which children attempt to organise their learning experiences.

University of Pretoria, etd - Human, S

(3) Non-linearity and Vygotsky's zone of proximal development (ZPD)

Even though the birth of chaos theory and complexity theory would take place many years after Vygotsky's death in 1934, I suggest that it was essentially Vygotsky's tacit acknowledgement of the chaotic and complex nature of cognition that led him to introduce the concept of the zone of proximal development (ZPD).

The ZPD is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." (Vygotsky, 1935/1978, p. 86). The ZPD therefore defines functions that are in the process of maturation, in an embryonic state as it were (Vygotsky, 1935/1978). Wertsch (1985) describes the ZPD as "a dynamic region of sensitivity" (p. 67) where the transition from social speech to inner speech is made. Vygotsky's psychology is, as is chaos theory, essentially concerned with the study of change and more specifically, the nature and the mechanisms of change.

Vygotsky (1935/1978) further said of the ZPD that it provides psychologists with a tool through which to understand the internal course of development because it permits one to discover the child's immediate future and his "dynamic developmental state, allowing not only for what already has been achieved developmentally but also for what is in the course of maturing" (p. 87). In essence, the ZPD is therefore a tool that allows the study of non-linear change in a complex system.

Vygotsky's formulation of the ZPD and the conceptual foundation on which it rests have two major implications for cognitive education. The first implication is that chaos and ambiguity are necessary (although not sufficient) features of cognition. The further implication is that approaches to cognitive intervention could perhaps consider introducing ambiguity and complexity purposefully in problem solving in an attempt to encourage chaos since chaos appears to be a necessary precondition for self-organisation.

Both of the aforementioned implications can be linked to Vygotsky's (1935/1978) conceptualisation of the relation between learning and development in children. Vygotsky (1935/1978) proposed that learning (and by implication, teaching) should not be oriented towards developmental levels that have already been reached, but should be pitched at a level higher than current development. It means he viewed learning and teaching as processes that can stimulate cognitive change by periodically introducing chaos, from which higher levels of cognitive organisation become possible. Referring to the relation between learning and development, Vygotsky (1935/1978) remarked that

> Although learning is directly related to the course of child development, the two are never accomplished in equal measure or in parallel. Development in children never follows school learning the way that a shadow follows the object that casts it. In actuality, there are highly complex dynamic relations between developmental and learning processes that cannot be encompassed by an unchanging hypothetical formulation (p.91).

The 'complex dynamic relations' that Vygotsky speaks of is relevant to another central feature of chaotic systems, namely their ability to use chaos as a means of evolving to higher levels of self-organisation. A system is in a state of chaos when it exercises its maximum degrees of freedom. It is believed that these states of chaos can be described as a state of maximum readiness for order to emerge (Masterpasqua & Perna, 1997). Using the brain as an example of a chaotic system, Masterpasqua and Perna (1997) cite a number of studies that seem to indicate that the chaotic activity of brain waves seems to increase the greater the mental challenge or novelty of a task, suggesting that self-organisation from chaos may be a fundamental aspect of cognitive problem solving. Further, a body of evidence appears to be accumulating which suggests that the central nervous system is a complex dynamical system, and that a number of disease states, such as epilepsy, manifest themselves through a loss of complexity in brain functioning (Masterpasqua & Perna, 1997).

However, it is important to note that complex systems are not chaotic all the time, they merely possess the capability to alternate between chaotic and stable phases. Secondly, chaotic phases are viewed as an essential quality of complex systems, because it is from chaos that higher order is thought to emerge (Masterpasqua & Perna, 1997). The emergence of order from chaos is often referred to as the system's potential for self-organisation and it is believed that systems in chaos are those most capable of reorganisation (Masterpasqua & Perna, 1997).

3.4.2.3 <u>Self-organisation</u>

(1) Descriptions of self-organisation

Masterpasqua and Perna (1997) describe self-organisation as "order for free" (p. 307). Mahoney and Moes (1997) describe self-organisation as the "ongoing and spontaneous emergence of self-order" (p. 183).

University of Pretoria, etd - Human, S

Cilliers (1998) asserts that self-organisation is a general property of a complex system because self-organisation is what gives a complex system its plasticity, i.e. it allows the system to develop and change its internal structure spontaneously and adaptively in order to cope with unpredictable changes in the environment.

Self-organisation may be observed at various levels within the same system. In terms of the brain, self-organisation is evident on a cellular level as neuronal cells organise themselves to perform a particular function, and it is also evident on a molecular level as atoms organise themselves into chemical structures that facilitate brain functioning in various ways. The integrated and self-organised functioning of the brain may be what allows the mind to emerge and may also give rise to the brain's most unique, but poorly understood property: consciousness.

Cilliers (1998) elaborates on a number of general attributes of self-organising systems.

(2) Non-determinism

The structure of a self-organising system is not considered to be the result of an *a priori* design, but of complex interactions between the system and the environment. At any point in a child's lifetime it means that the environment exerts a powerful influence on the brain being what it is, and becoming "what it not yet is" (Vygotsky, 1935/1978).

The most compelling evidence of the brain's non-deterministic nature comes from research that points to the critical importance of the environment in brain development. For example, Richek, Caldwell, Jennings & Lerner (2002) report on research that shows that brain development before age one is more rapid and extensive than previously realised, that brain development is much more vulnerable to environmental influences than suspected, and that the environment affects the number of brain cells, connections among them, and the way connections are wired.

Richek *et al.* (2002) further estimate that one third of the American nation's children are at risk for school failure before they enter *kindergarten* because they have been subjected to environmental stresses such as malnutrition and smoking during the mother's pregnancy, child abuse and lack of early cognitive and language development. In South Africa, a large part of the population experience extreme poverty which is known to be related to low achievement in school (Richek *et al.,* 2002).

(3) Dynamic adaptation

Because the environment with which a complex system interacts is unpredictable, the internal dynamics of the complex system must be able to handle such unpredictabilities through dynamic adaptation. It is impossible to say exactly which situations any person will face in her life time, and so it is important that the brain has the resources to deal with most eventualities.

As children grow up, they are subjected to a variety of influences in social, emotional and cultural contexts in the home and school environment. Children learn to negotiate unpredictable events in their environment through dynamic adaptation. Sometimes children adapt successfully, but when they don't, they may experience emotional difficulties such as anxiety, low self-esteem, depression, learned helplessness and hostile-aggressive behaviours which are associated with low achievement in school (Richek *et al.,* 2002).

Dynamic adaptation essentially refers to the self-organising system's capacity to be flexible in its repertoire of responses. Flexibility in response can be observed at all levels of a complex system. In the case of the brain, flexibility may refer to *physiological flexibility* (higher activation of appropriate brain regions in response to particular tasks), *emotional flexibility* (adaptive and appropriate emotional responses to various situations), and *cognitive flexibility* (interpreting the demands of a situation, generating suitable alternatives and orchestrating an appropriate verbal, emotional and behavioural response).

At times, constraints within the system such as visual impairment, hearing impairment and neurological factors may restrict the system's capacity for flexible response. For example, with reference to neurological factors, Richek *et al.,* (2002) report that fMRI has shown patterns of underactivation of the large posterior regions of the brain, and overactivation in the anterior brain regions in dyslexic subjects. Richek *et al.,* (2002) also cite research that appears to confirm the fact that dyslexia may be caused by an abnormality in brain structure, difference in brain function, and genetic factors. In addition, Pennington (1999) suggests that dyslexia may be due to a genetic susceptibility locus that may cause variations in reading skill or make a child vulnerable to the development of dyslexia. Because a genetic susceptibility locus is neither necessary nor sufficient for the development of dyslexia, Pennington (1999) argues that the development would necessarily have to include other factors related to brain structure and cognition.

The factors that could potentially influence the development of dyslexia can be viewed from a neurodevelopmental perspective (Pennington, 1999) as well as a deficit perspective (Rapp, 2001). It would appear as if a neurodevelopmental perspective emphasises the emerging, self-organising (plastic) capacity of the brain more than does a deficit perspective that appears to emphasise a structural non-variance in cognitive architecture (Pennington, 1999). Nevertheless, both perspectives acknowledge that reading is a complex skill that requires a flexible and integrated response in terms of activation of brain structures and also in terms of cognitive processes (lexical and sublexical) involved, and that genetic and structural deficits, as well as variations in brain functioning, can inhibit or impair the individual's ability to generate a flexible and integrated response to a complex task.

Loss of flexibility, and by implication impaired ability to adapt dynamically to the environment, is almost always associated with a lack of complexity and an increase in rigidity, at least in chaos theory. For example, Briggs and Peat (1999) suggest that mental illness, which appears to be chaotic (Tschacher & Scheier, 1997), can actually be viewed as the reverse of chaos, because "mental illness occurs when images of the self become rigid and closed, restricting an open creative response to the world" (Briggs & Peat, 1999, p. 29). As a result, the system experiences a reduction in its degrees of freedom and may organise itself around a limited and restrictive pattern of behaviours, also known as a periodic attractor[20].

The point is that adaptation to the environment requires a complex system to achieve a dynamic balance between chaos and order. Whenever a complex system fails to use chaos or disequilibrium to self-organise, the system becomes closed off to the environment. When a complex system finds itself organised exclusively around chaos and disequilibrium, it is also rigid in its development because it fails to reach higher levels of integration. The presence of chaos in itself is not necessarily good or bad, it is the response of the system to such perturbations that determine whether it is adapting or not. Similarly, the presence of learning opportunities (as potential perturbations) in the lives of children are not by and of themselves good or bad, it is how the child respond to such learning experiences that determine whether the child will reach higher levels of development or not.

Since a child's behavioural response represents the outcome of an integrated process which involves genetic, structural, and cognitive factors, it follows that a deficit in terms of any of these processes has the potential to limit the quality and flexibility of the total response on a behavioural level. It is also important to note that chaos deals with the basic mechanisms by

[20] Masterpasqua and Perna (1997) define a periodic attractor as a pattern of behaviour in phase space which shows never-ending repetitions of the same behaviour.

which complex systems are thought be become capable of changing *i.e.* self-organising. Chaos theory does not explain the very specific cognitive processes by which disorders such as dyslexia develop, but it does provide a plausible explanation of the underlying mechanisms of change that enable the development of such disorders.

(4) Dynamic non-linear relationships

Self-organisation is not the result of a linear process of feedback. Cilliers (1998) mentions, for example, that a thermostat that responds to its environment by switching itself on and off, is dependent on a linear set of information, and this precludes it from being called a self-organising system. Reflecting on the evolution of the brain, Cairns-Smith (2000) suggests that, contrary to popular depictions of the brain as a kind of computer, primitive brains were more like thermostats than computers.

Modern technologies that incorporate fuzzy logic, such as washing machines and microwave ovens, though they are more responsive than ordinary appliances, are not yet self-organising. Although these systems are more capable of responding to information in the environment, they have to be designed with such capability in hand. Moreover, self-organising systems preclude the necessity of an external designer because they create their own internal structure through their interaction with their environment. Cairns-Smith (2000) refers to self-organisation as self-assembly and offers the following amusing example:

> A dew drop, a soap bubble, or a sugar crystal are familiar examples of self-assembled objects: they are higher-order structures whose molecules have come together (in a more or less organised way) and hold together (more or less firmly) under the combined influence of kinetic motion and secondary forces. This is not like the construction procedures of human engineering; at least I have not heard of machines being put together just by shaking up pre-made components….Self-assembly is the "hands off" part of the construction system of cells. The secondary-tertiary folding of a protein chain is an excellent example of it: this folding occurs more or less spontaneously without detailed external control (p. 78).

The "hands-off" aspect of self-assembly that Cairns-Smith (2000) mentions is indicative of the main characteristic of a self-organised system: the absence of an external designer because self-organisation (or self-assembly on a molecular level) can only occur if the relationships (feedback loops as they were discussed in section 3.3.3.9) among the components of the system allow for spontaneity, i.e. non-linearity.

(5) Emergent property

This feature refers to the relationship between the elements of the system and the system as a whole. The elements of the system are ignorant of the behaviour of the entire system, and so the complexity in self-organising systems is considered to be an emergent property of the system.

For example, it has been suggested that the mind is an emergent property of the brain (Groves & Rebec, 1992), and so it is not possible to reveal the complexity of the mind by focusing on discrete elements in the brain only. Cilliers (1998) further points out that the various levels of the complex system cannot be given independent descriptions because they are intertwined with the behaviour of the system as a whole, although they do not "know" the large-scale effects they can produce on the total behaviour of the system.

(6) Increasing complexity

Self-organising systems are not stable. They increase in complexity because they have the ability to learn from experience.

Cilliers (1998) suggests that it is the system's increasing complexity that may explain why self-organising systems age, because complex systems are bound by the constraints of a physical world and will inevitably become saturated at a certain point. However, I believe that such a view may be somewhat simplistic. Saturation in terms of complexity does not explain why, for example, the synaptic density in the visual cortex of humans reaches a peak in childhood (approximately 9 – 11 years) and then declines markedly throughout the further lifespan (Groves & Rebec, 1992). Secondly, a saturation model of aging would fail to address the aging process at all levels of the human body (a complex system in its own right). For example, certain chemical reactions at a molecular level (e.g. the formation of free radicals in response to high frequency ultraviolet radiation) that are known to damage cells and accelerate aging, cannot be explained adequately in terms of increasing complexity alone.

Moreover, Groves and Rebec (1992) report that aging is associated with the loss of large numbers of neurons and glial cells since the size and weight of the human brain begin to decrease when individuals reach approximately fifty years of age. However, physical exercise has been shown to reverse the effects of aging on some functions of the central nervous system such as reaction time and brain signals associated with decision making (Groves & Rebec, 1992).

I would therefore propose that a linear association between self-organisation and saturation directly contrasts with the notion of non-linearity in complex systems. All living systems operate within certain genetic constraints, genetic information being one of the variables present in the initial conditions of a system. Knowing that complex systems are sensitive to initial conditions, it may help to explain why there is such variability in the aging process among individuals, and also why certain environmental influences can accelerate or slow down the aging process.

(7) The necessity of memory

Of course, learning from experience involves some form of memory, which Cairns-Smith (2000) argues is not only situated in the structures of the limbic system, but also on a microscopic level in and among cells and their molecules. Here, Cairns-Smith (2000) refers to the phenomenon of "long-term potentiation" in which signals become easier to pass between neurons and which is thought to provide a basis for associative learning.

The memory of a complex system is tied to its history. In this regard, Cilliers (1998) suggests that the history of a complex system should form an important facet of its study, since the system's history reflects the conditions from which it emerged. The assumption that a system's history is important to its understanding was also central to Vygotsky's scientific method. Vygotsky (1930/1978) formulated two principles that formed the basis of his approach to the study of cognitive development: process *versus* object, and explanation *versus* description.

(a) Process versus objects

It was important to Vygotsky to distinguish between psychological analysis that treated psychological processes as fixed, stable objects and psychological analysis that emphasised their historical origin (Vygotsky, 1930/1978).

Emphasising the history of psychological processes by focusing on their developmental and dynamic nature prompted Vygotsky to develop, what he termed, an "experimental-developmental" method of investigation which artificially provokes or creates a process of psychological development (p. 61). As stated in paragraph 3.4.2.2.2, provoking development in his view had much to do with instigating chaos and disrupting automatised patterns of thought in order to discover how thought develops.

University of Pretoria, etd - Human, S

(b) Explanation versus description

To comprehend how the history of a complex system can inform our understanding of it, Vygotsky (1930/1978) thought it important to distinguish between phenotypic and genotypic analysis. Whereas phenotypic analysis focuses on the description of externally observable features, genotypic analysis aims to explain a system on the basis of its origin (Vygotsky, 1930/1978). By studying a system developmentally, Vygotsky wanted to understand its causal dynamic basis, its genesis. Vygotsky (1930/1978) acknowledged that, although some systems may appear to be similar in terms of their external manifestation, they may differ profoundly in terms of their origin and nature, and "in such cases special means of scientific analysis are necessary in order to lay bare the internal differences that are hidden by external similarities" (p. 63).

(8) Functional description

Cilliers (1998) asserts that it is often difficult to talk about the function of a complex system because doing so often introduces an external reason for the structure of the system.

The function of a system can often be described only in terms of a specific context (Cilliers, 1998). For example, while it is quite plausible to talk about the function of the frontal lobes, visual cortex, or some other part of the brain in cognition, it is much more difficult to talk about the function of the mind, or consciousness for that matter. Doing so, would immediately invoke an external designer who, by implication, constructed the system for a particular purpose. Self-organisation cannot be driven by the attempt to perform a particular function (Cilliers, 1998).

Self-organising systems emerge toward greater complexity as a result of interactions with their environments. The presence of non-linearity within these systems as a function of their sensitivity to initial conditions, makes it difficult to determine or predict exactly the precise developmental trajectory of the system. Yet, certain characteristics of a complex system are determined to some extent by their initial conditions, such as genetic make-up. It is such determinism that makes it possible for humans to develop along roughly the same lines.

For example, Groves and Rebec (1992) report that, as the nervous system matures, neuronal cells "know" they must migrate to specific areas in the cortex before they specialise to fulfill their function in the brain. Such evidence perhaps describes what is meant by

University of Pretoria, etd - Human, S

deterministic chaos, i.e. a complex system may appear to be random, but is not. In fact, periods of chaos are only transient states which enable the system to self-organise.

3.4.3 The relevance of chaos theory to the study of cognition

3.4.3.1 Chaos at all levels of the central nervous system

In the preceding sections numerous examples were provided of evidence that appears to support a chaotic view of cognition on various levels. On a physical level, cognition manifests itself through structural change, as well as complex electrical and chemical processes in the central nervous system. The structural changes and processes in the brain show some of the hallmarks of chaos because they are sensitive to initial conditions, are characterised by non-linear interactions, and show a remarkable capacity for self-organisation.

The brain's capacity for self-organisation is partly what makes the emergence of the mind possible. The mind is a psychological construct rather than a physical one and is thought to refer broadly to conscious and unconscious processes (Cairns-Smith, 2000). By contrast, cognition can refer to a *physical* construct (when we describe metabolic activity in the brain during a problem solving task), a *psychological* construct (when we describe cognitive skills and strategies such as categorisation and problem solving), a *social* construct (when we emphasise joint problem-solving and collaborative learning) or a *cultural* construct (when we view cognition as the internalisation of cultural patterns of social interaction).

Irrespective of which aspect of cognition we address, the fact remains that cognition arises from the brain. Since the brain is a complex and chaotic system, it is logical to expect that which emerges from it (cognition) to show the same properties. One would not expect complex and chaotic behaviour to evolve from a simple, linear system (such as a computer, for example) any less than one would expect simple and linear behaviours to emerge from a complex, non-linear system. Whether we are engaged in studying the physical aspects of the brain, or developing a psychological theory of cognition in the brain, or whether we are interested in describing the social and cultural dimensions of cognition, we have to ensure that our theory can form a continuum between two extreme points. On the one extreme are those phenomena which are closely related to our observations of the physical world, namely the brain. The other extreme represents a psychological universe, one which is removed from direct experimental reality, which contains the social and cultural nature of cognition.

Goertzel (1993) has already pointed out that complex systems science (incorporating complexity and chaos) may be the key to a common psychological theory, and I agree. One

University of Pretoria, etd - Human, S

of the distinguishing characteristics of chaotic systems is a measure of self-similarity (fractality) which arises from deterministic chaos. Self-similarity refers to the repetition of certain patterns on different levels of magnification. A tree is a good example of a natural fractal form. The tree's basic pattern remains the same, whether one is observing the entire tree, a branch or even a twig. A mountain range is another example. The same degree of roughness is evident on different levels of magnification, so that the mountain range mirrors itself on an increasingly minute level. Natural fractal forms (ferns, butterflies) have also been created with mathematical equations that behave chaotically, providing further evidence that the universal mechanisms which underpin the evolution of all natural phenomena are chaotic by nature. It is perhaps not surprising that our models of our universe on a macro-level and our models of atoms (on a micro-level) show the same type of fractality: a nucleus (the sun) with revolving electrons (planets). Exhibit A shows some examples of fractal forms.

The human body also shows self-similarity in the sense that chaotic behaviour and self-organisation are evident on different levels of magnification. Whether we are considering synaptogenesis, metabolic activity, specialisation and localisation in the brain, cognition, emotion and behaviour, all are governed by chaotic processes that, combined, make possible the emergence of the mind. The principles of chaos theory can explain the emergence of cognition on a physical, psychological, social and cultural continuum more effectively than any other theory of cognition because it is not bound by the constraints of a particular context. Chaos theory decribes universal patterns of evolution in nature and helps to focus our attention on the fundamental mechanisms of change in complex living systems. In respect of the present study, the principles of chaos theory are understood to form the universal mechanisms of cognitive change and development. We turn our attention now to some practical and applied aspects of chaos theory, namely its implications for the development of cognitive theory and the practice of cognitive intervention.

3.4.3.2 Implications for research : cognitive theory

Cairns-Smith (2000) warns that

> "we may set up our chess board with a restricted number of pieces operating under a restricted set of rules. And we may have fun for a time and gain new insights; but sooner or later, if history is anything to go by, we will lose touch with the game that Nature is playing" (p. 49).

The game that Nature is playing requires a "playful approach" (Cilliers, 2000), one that recognises its complexity (Goertzel, 1993) and addresses its chaotic qualities (Lorenz, 1993).

Cairns-Smith (2000) made the above statement in the context of a discussion about scientific models and warned that although one can learn much from constructing models (analogies) of reality, it would be wise not to view scientific models as reality. I believe that this is what is happening in cognitive psychology, where psychologists' model of the brain as a computer has become so pervasive that the brain is actually viewed as a computer. Scientific model and reality have become one and the same thing. For this reason, cognitive psychology has lost touch with the "game that Nature is playing" although new insights have been gained.

To apply the metaphor of Cairns-Smith (2000), cognitive psychology has set up a chess board (cognition) with a limited number of pieces (cognitive components) operating under a restricted set of rules (information processing). From previous sections we have seen that the brain may appear to be deceptively linear, but that the linear processes are governed by associative and quantum processes that behave chaotically. There are more fundamental rules (universal mechanisms of change) that form part of Nature's game. Eliminating them also eliminates any chance of discovering the true complexity of cognition.

If psychologists who study cognition wish to avoid losing touch with Nature's game, they have to become more receptive to the complexities of cognition by not restricting the playing field unneccessarily through controlled experiments and rigidly defined variables. Instead of manipulating cognition, psychologists have to allow it to emerge naturally.

3.4.3.3 Implications for practice : cognitive intervention

Cognitive theory is about the nature of cognition and cognitive change and development. It is inevitable (and desirable) that cognitive theory will inform the praxis of cognitive intervention in research and applied contexts.

There is no doubt that the relationship between theory and application is a linear one because simplistic theories lead to simplistic applications of those theories. For example, the behaviourist theory that views cognition as the formation of S-R bonds will in its application (and depending on its goal) look for ways to strengthen or extinguish S-R bonds. Information-processing approaches to the study of cognition which deal with the study of cognitive components and processes such as attention and memory, likewise will emphasise the importance of attention and memory in learning.

The theoretical framework presented in this study emphasises the complexity of children's thinking. Since the theoretical framework will necessarily influence the application of theory in research and applied contexts, it is to be expected that, in terms of the research in the present study, the research method will in all likelihood study cognition as a complex phenomenon by not restricting the investigation to include only variables that can be controlled. In fact, we may assume that the whole notion of experimental control over variables might have to fall away, leaving the researcher and her subjects to deal with ambiguity and uncertainty. Thus the accommodation of chaos and complexity in the research method will have far-reaching implications for the choice of research instruments, data collection and data analysis.

Cognition will have to emerge naturally within an unrestricted context. Consider the following statement by Schostak (2002):

> How then does one handle this incredible complexity and uncertainty that seems inextricably melded with the nature of being an individual within the multiple possible and actual 'worlds' of everyday life? One solution has been to ignore it. The principal rule adopted by many is to simplify in order to control. Thus, for example, by concentrating only on what can be seen and measured all the messy feelings, emotions and 'insideness' of human life can be eliminated from the equations, the models, the procedures by which to explain and control individual and social life (p. 93).

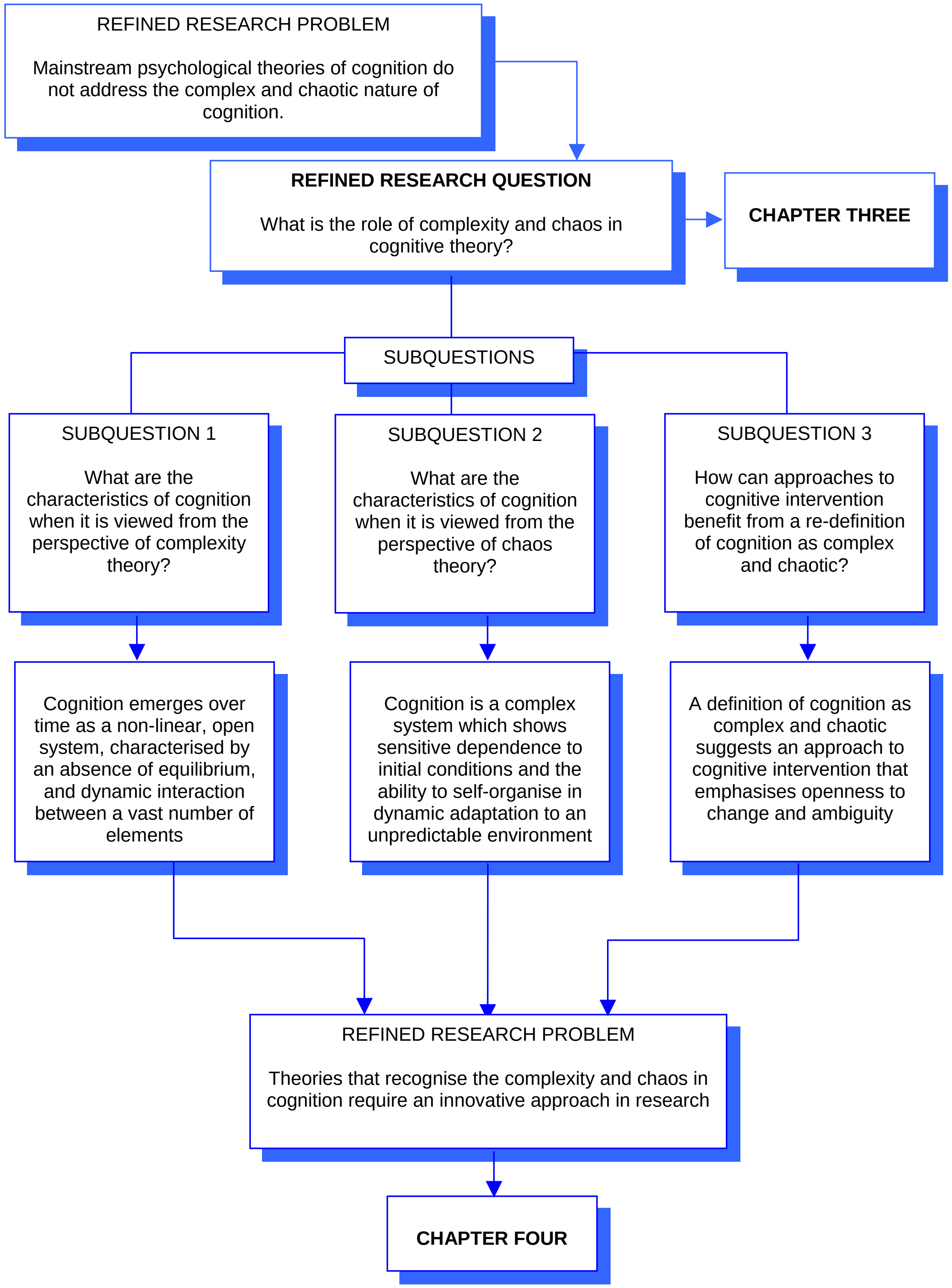
Instead of trying to control complexity and uncertainty in research, one should embrace it because "complexity and uncertainty is not to be feared and shunned but is the lure, the field of research that never ceases to amaze" (Schostak, 2002, p. 94). Likewise, in an applied context where cognitive intervention takes place, complexity and chaos require embracing a view of learning as a process of self-organisation where order evolves from chaos. Self-organisation reflects a process during which children are confronted with uncertainties and ambiguities and learn how to make sense of them, all the while learning to integrate experiences into a meaningful whole. When children begin to learn how to manage the process of making sense of ambiguity and uncertainty on a metacognitive level, they are also beginning to learn how to self-regulate their own learning behaviour. One may perhaps even say that self-organisation essentially refers to a cognitive process, whereas self-regulated learning reflects an executive process that adds a metacognitive component to learning.

One can then expect that the learning situation should not be controlled, but as Vygotsky (1935/1978) suggested, should employ ambiguity in such a way as to disrupt learners'

University of Pretoria, etd - Human, S
normal thinking processes in order to make self-organisation and therefore also the emergence of self-regulated learning, possible.

In Chapter Four I will address in greater detail the principles of complexity and chaos in an applied context. Research conducted with children in the first three school years (Foundation Phase) at an inner-city school will provide the context for the discussion.

META-NARRATIVE 3.3



University of Pretoria, etd - Human, S

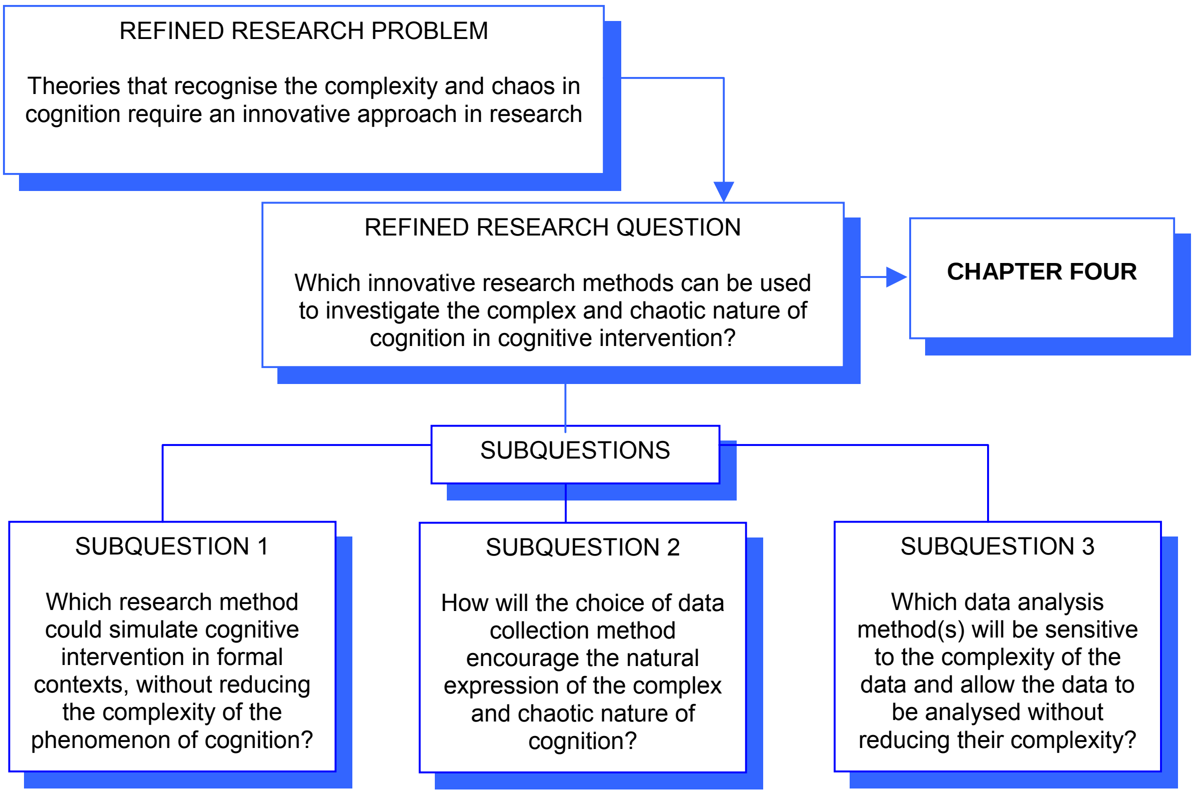
CHAPTER FOUR

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



University of Pretoria, etd - Human, S

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.

University of Pretoria, etd - Human, S

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.

University of Pretoria, etd - Human, S

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

University of Pretoria, etd - Human, S

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.

University of Pretoria, etd - Human, S

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.

University of Pretoria, etd - Human, S

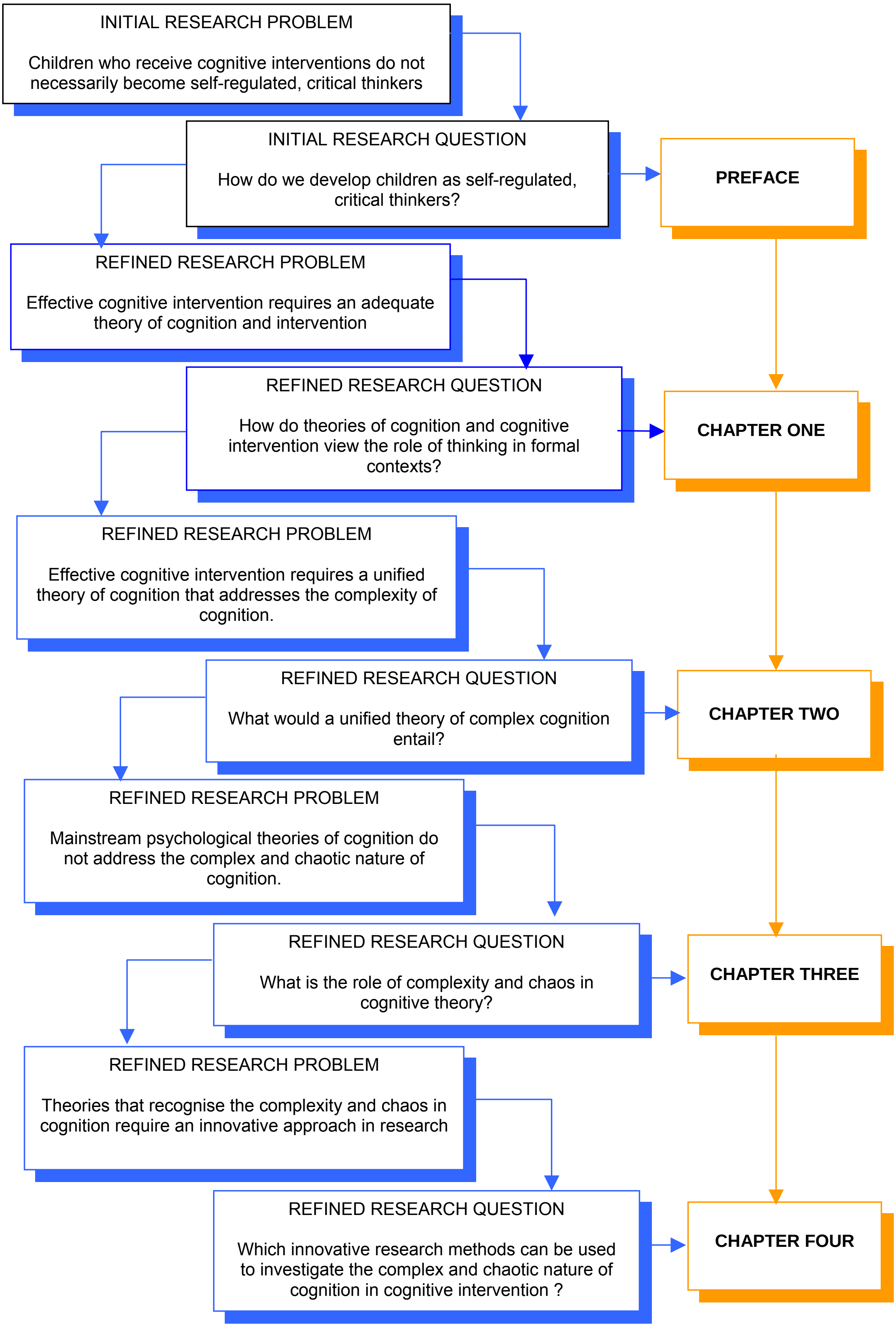


Figure 4.1 The flexibility of the complex research process

University of Pretoria, etd - Human, S

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:

University of Pretoria, etd - Human, S

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)

University of Pretoria, etd - Human, S

- 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

University of Pretoria, etd - Human, S

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.

University of Pretoria, etd - Human, S

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:

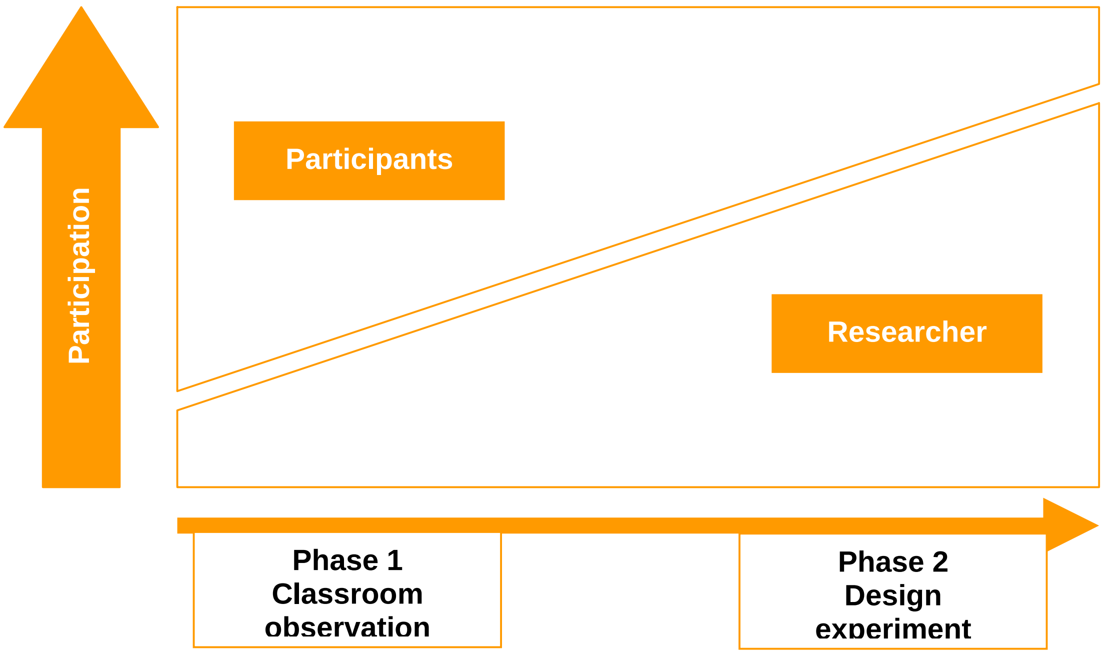


Figure 4.4 The researcher's involvement with participants during the course of the study

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.

University of Pretoria, etd - Human, S

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.

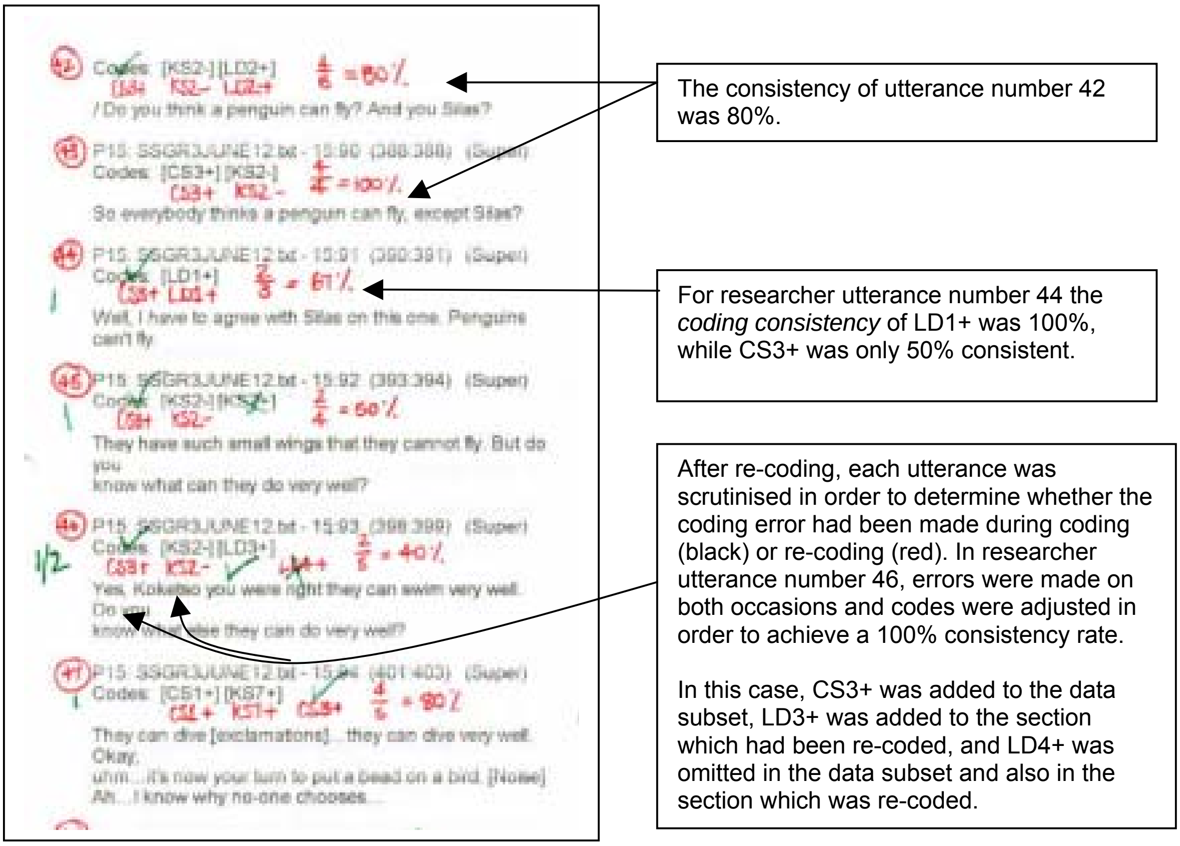


Figure 4.5 Sample from data subset (DS9) that shows the re-coding process

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.

University of Pretoria, etd - Human, S

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

University of Pretoria, etd - Human, S

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

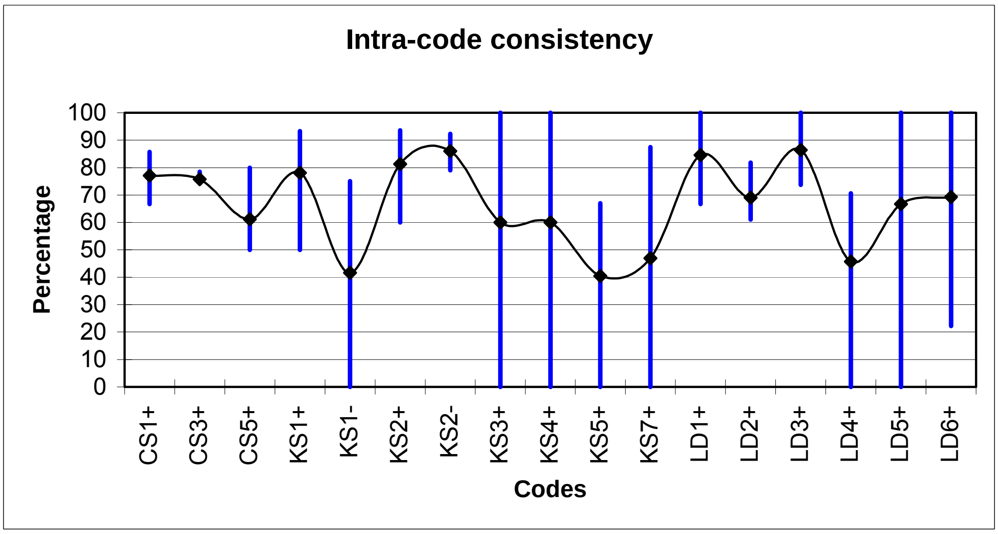
Table 4.6 shows that most of the codes for DS1, DS2 and DS3 transcriptions on Day One were clustered in the fair to high consistency range. Certain codes, most notably CS1+, CS3+, KS2+, KS2-, LD1+, LD2+, and LD3+ steadily[22] show fair to high levels of intra-coding consistency. The majority of the codes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



• Mean | Highest and lowest value

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%.

University of Pretoria, etd - Human, S

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.

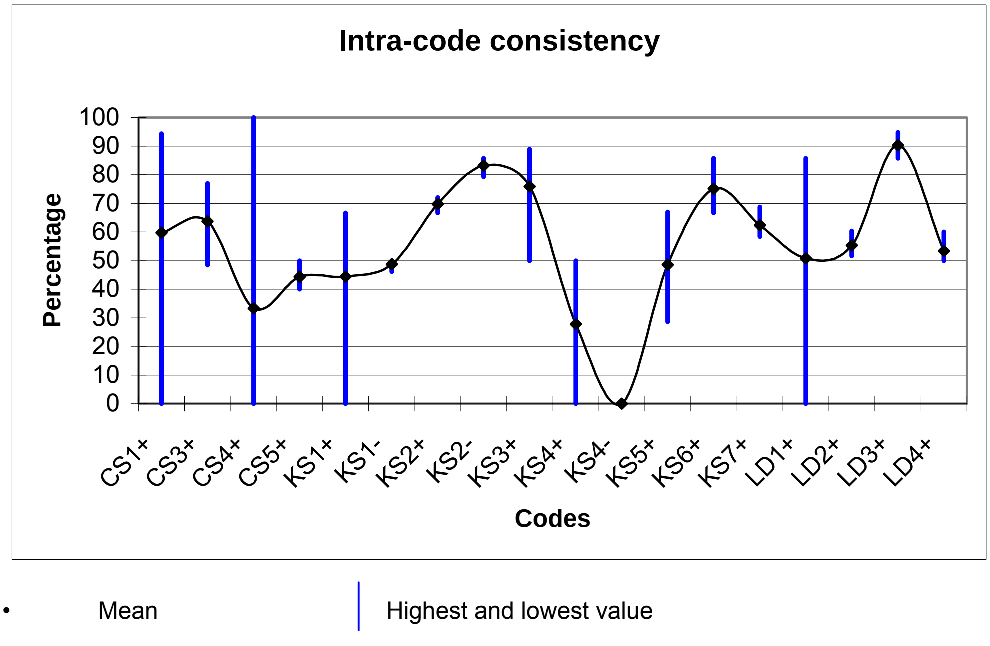


Figure 4.7 Day Two: Intra-code consistency for selected codes.

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.

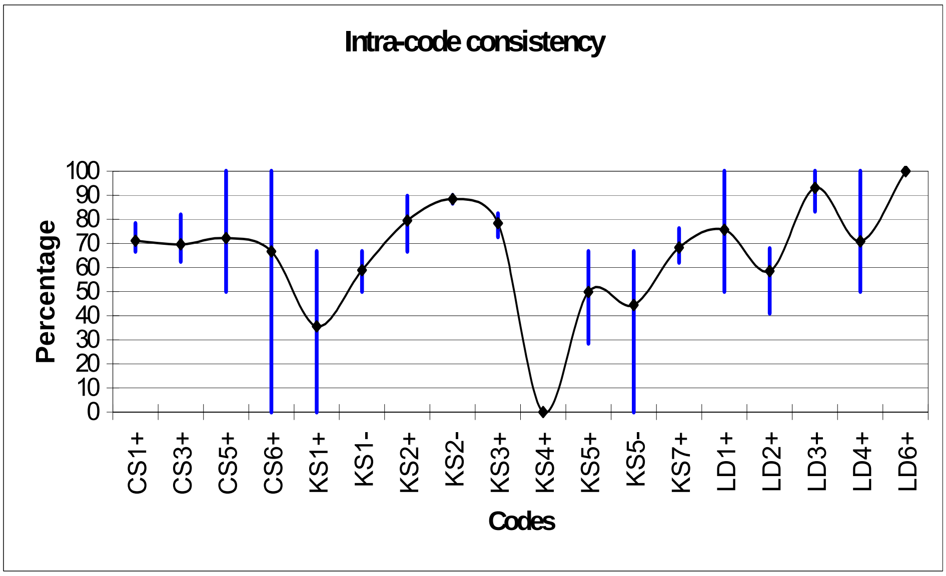
Table 4.8 Day three: Intra-code consistency rates for DS7 – DS9.

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



• Mean | Highest and lowest value

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
<u>CS4+:</u> The researcher points out to learners unhelpful behaviours that lead to incorrect responses. <u>CS6+:</u> The researcher points out helpful behaviours that lead to correct responses	<u>CS4+:</u> 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.

University of Pretoria, etd - Human, S

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

University of Pretoria, etd - Human, S

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.

University of Pretoria, etd - Human, S

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

University of Pretoria, etd - Human, S

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

University of Pretoria, etd - Human, S

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

University of Pretoria, etd - Human, S

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.

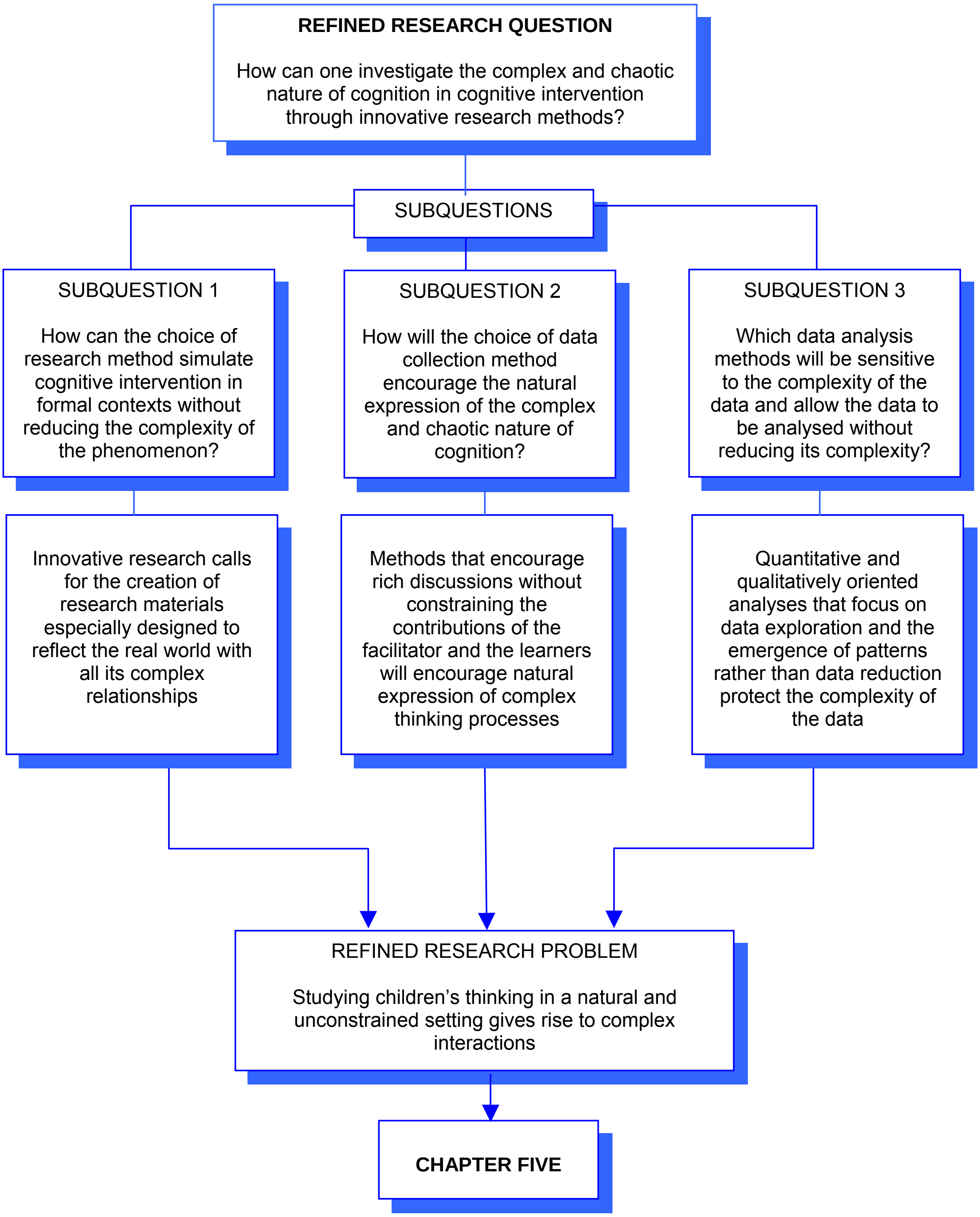
4.3.9 Design limitations

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



University of Pretoria, etd - Human, S

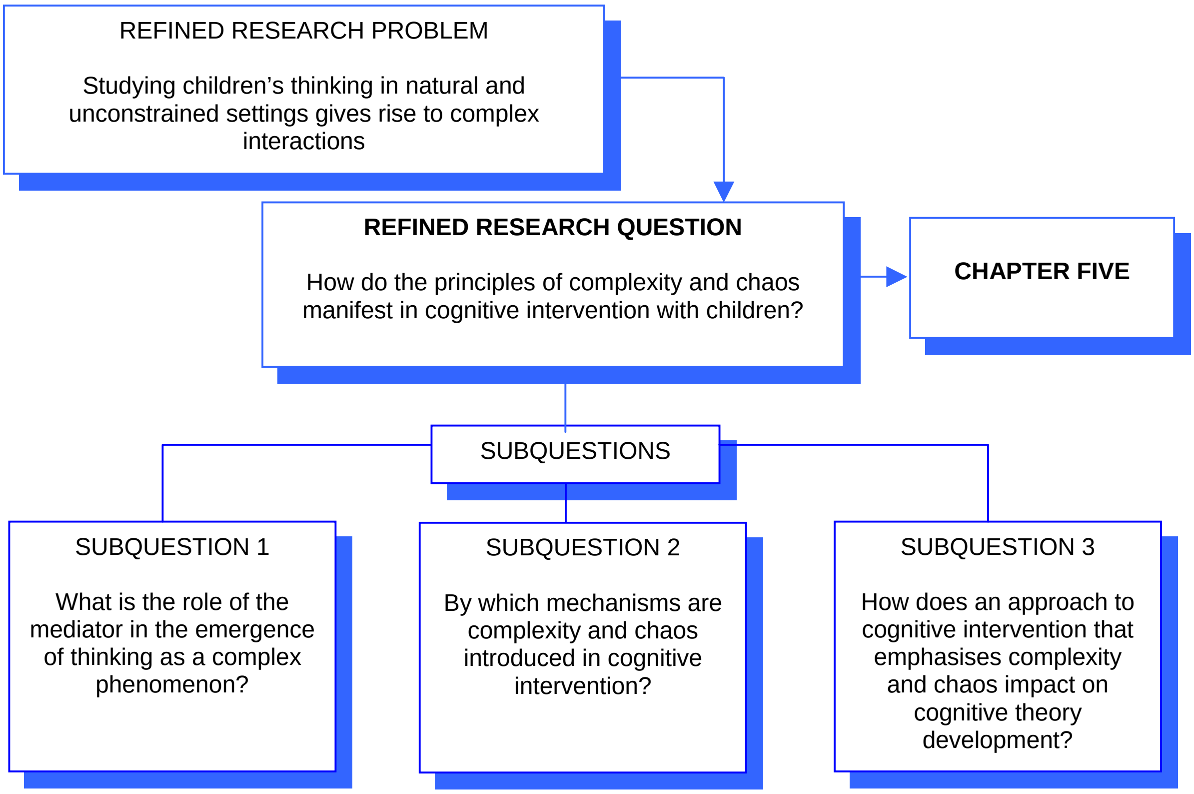
CHAPTER FIVE

Data Interpretation

There is nothing as beneficial to practice as a good theory.

R.E. Mayer (2000), *What good is educational psychology? The case of cognition and instruction*

META-NARRATIVE 5.1



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5.1 INTRODUCTION

An important aspect of any study that employs verbatim transcriptions of interactions as its main data source, is the formation of categories and the search for meaningful patterns in the data in order to investigate certain assumptions that the researcher has about the data and ultimately to develop a theory that fits the data. McMillan and Schumacher (2001) distinguish between emic[26] and etic categories that researchers use to develop patterns in the data and say that pattern-development starts with informed hunches about relationships in the data.

In the context of the present study, the "informed hunches" can be described as the expectations of the researcher about the insights which the data might yield. For example, the design experiments were set up to conform to a central assumption of complexity theory, namely that complex phenomena can only be studied in their natural settings with methods that allow the complexity of the system to emerge. Having suggested in Chapters 2 and 3 that children's cognition can indeed be regarded as complex, the expectation is that the data will also reflect such complexity. It is also expected that the principles central to complexity and chaos theory will reveal themselves in the interactions between the researcher and the learners.

Quantitative studies are generally directed by research hypotheses, which McMillan and Schumacher (2001) describe as tentative statements that describe expected relationships between two or more variables in the research data. In the present study, the variables that are expected to influence the results are so numerous and complex that the formulation of research hypotheses is not considered a viable option. Furthermore, the formulation of research hypotheses necessitates data reduction in order to investigate the strength and directionality of certain relationships in the data to the exclusion of others, whereas the aim of the present study is rather to explore the nature and quality of cognitive intervention under particular circumstances without confining the study to the investigation of certain variables only. Therefore, the data interpretation in this chapter will be guided by assumptions about relationships in the data and these assumptions will be presented visually in the form of conceptual schemes. The data interpretation in this chapter will thus adhere to the principles of grounded theory, which McMillan and Schumacher (2001) describe as an approach to forming theoretical ideas that begins with the data.

[26] Emic categories refer to insiders' views such as terms and explanations that are distinctive to the setting whereas etic categories refer to the outsider's view of the situation (McMillan & Schumacher, 2000).

A grounded theory approach is generally used in qualitative studies where the researcher has collected primarily qualitative data in the form of interviews or, as in the case of this study, has recorded and transcribed the verbal interactions of group sessions. Grounded theory requires that the researcher generally makes sense of the data by searching for themes and patterns and then developing a conceptual scheme of the relationships that are observed. This is done by using a comparative method that simultaneously employs techniques of induction, deduction and verification (McMillan & Schumacher, 2001).

5.2 A GROUNDED THEORY APPROACH

5.2.1 Theory building and testing

The present study commenced with personal beliefs about cognitive intervention which had formed from personal experience and previous study of children's cognitions. These beliefs formed the basis of an intuitive and as yet untested theory about cognitive intervention with children in formal contexts. In order to examine the viability of the intuitive theory, the relevant literature was scrutinised to gain an understanding of the main problems confronting cognitive intervention practice. Fieldwork was undertaken which led to further refinements in the intuitive theory of cognitive intervention. As time progressed, the researcher developed certain expectations of what results the data might yield upon analysis and these expectations necessarily led to the formulation of assumptions about the data. A part of this process has been illustrated visually in the meta-narrative of each chapter and can be summarised in the conceptual diagram in Figure 5.1, which clearly reflects grounded theory methodology.

The diagram in Figure 5.1 depicts the relationships between the formal aspects of the study as represented by the yellow boxes (literature review, design experiments, data analysis), and the epistemological aspects of the study as represented by the grey boxes (personal experience, prior beliefs, assumptions and propositions).

The formal aspects of the study are subject to temporal and practical demands, whereas the epistemological aspects of the study operate as a flexible psychological process during which knowledge about the phenomenon is being construed. The blue arrows which open-frame the entire process represent the meta-theoretical dimensions of the study. Theoretically, the process of theory building is never complete, since data analysis will continue to modify the researcher's beliefs, which may lead to new data being collected in a different context, new assumptions leading to new propositions being formulated and further data-analysis and synthesis being conducted.

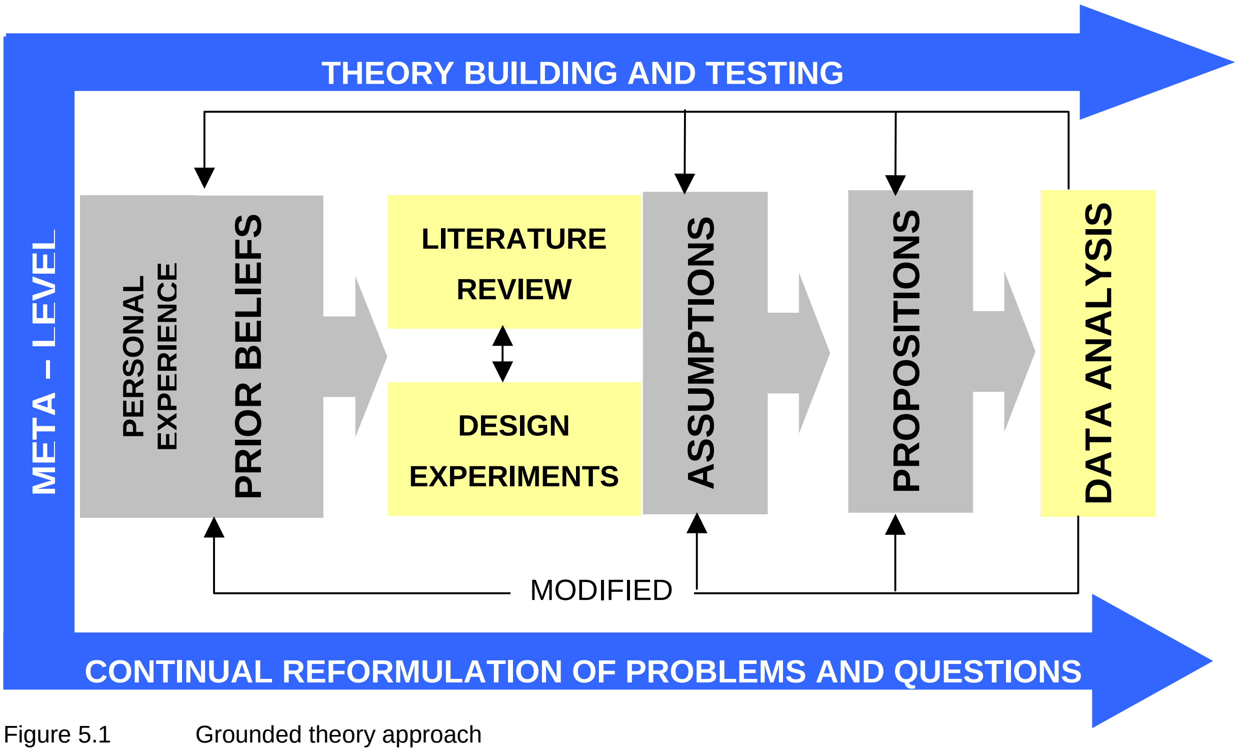

Figure 5.1 Grounded theory approach

This chapter will pick up on the process illustrated in Figure 5.1 by clarifying some of the researcher's assumptions about the data that were collected. The researcher's assumptions will lead to the formulation of conditional propositions (McMillan & Schumacher, 2001) which are offered as the initial theory and which will be "tested" by searching for evidence in the data that would support the initial theory.

5.2.2 Assumptions about children's thinking

People are complex systems. The dynamics that govern the development of complex systems are universal, and so they can be observed on all levels of a system, which is the main reason why complex and chaotic systems are regarded as fractal. In human development, one can distinguish at least four increasingly complex dimensions of "being" in the world.

The body and all its physiological and electro-chemical processes represent our *physical dimension* and most basic (although not simple) way of being in the world. The body, as a complex physical system, accommodates the brain, our primary thinking organ. In the context of the present study, an acknowledgement of the complexity of the brain is especially important since it is the brain's complexity that makes the emergence of a complex mind possible. The mind represents a person's *psychological dimension* and symbolic presence in the world. It is important to note that the distinction between physical and psychological dimensions of being human is not mutually exclusive. Cognition can be described

University of Pretoria, etd - Human, S

simultaneously as the firing of neurons in specific patterns (physical and connectionist dimension), or the construction of a mental schema (psychological and symbolic dimension). In a postmodern world, we have come to acknowledge that humans do not experience reality directly, but in a mediated form through mental representations. These mental representations constitute our psychological presence, and although they are dependent upon complex physical processes, they constitute more than just a physical process. The psychological dimension reflects the meaning of physical processes rather than the processes themselves.

META-NARRATIVE 5.2

The distinction between a physical dimension and a psychological dimension is important for several reasons. Firstly, it can help to place various theories of cognition in perspective by showing at which level of analysis they are operating. Connectionist theories all reject the notion of symbolic representation which is inherent to symbolic theories of cognition which use psychological constructs to represent cognition rather than physiological processes. Secondly, from an anthropological point of view, it is helpful to distinguish between human characteristics that are considered universal and those that are considered unique. A complex physical system is the most basic and comprehensive system necessary to provide the requirements for the emergence of other ways of being in the world. It is therefore on the basis of the features of our physical system alone that we are called human beings. However, it is the emergence of a symbolic, psychological mind which distinguishes us as persons. It is in our minds that we create and use symbols to represent reality, to talk about it and to give meaning to it. Our symbolic representation of reality is personal and unique and usually reflects and represents the diversity of the environment and context. A forced choice between cognition as a physical construct or a psychological construct is therefore unnecessary, because within our human experience both are viable.

However, human beings would perhaps not be described as complex systems if they consisted only of a physical and a psychological dimension. Human beings are gregarious and people live in families and social groups which have facilitated the emergence of societies and cultures. Through their societies people have developed informal and formal social practices that unite them as people. These social practices have emerged from the collective psychological presence of people in the world which represents our *social presence* in the world. It is within this social realm that cultural and political practices are conceived and maintained.

Although not within the boundaries of the present study, one may also wonder about the existence of a fourth level, the transcendental level, which represents human beings' spiritual presence in the world. Our spiritual presence is the least understood, and perhaps most complex dimension of human existence and it is in this dimension of human existence that spiritual and religious practices find meaning. What is important though, is that the psychological, social and spiritual dimensions of existence cannot exist independently of one another or the complex physical system from which they emerged. Complexity is necessary at each level of the system in order to sustain the continued development towards greater complexity.

Figure 5.2 shows the dimensions of human existence. Note that although the physical system is represented as a simpler dimension of existence than the social dimension, for example, this is an illusion characteristic of all complex systems. As the circle which represents a magnification of a section of the physical dimension indicates, the fractal nature of complex systems makes them appear like worlds within worlds so that the complexity of the system is mirrored on increasingly minute levels of analysis.

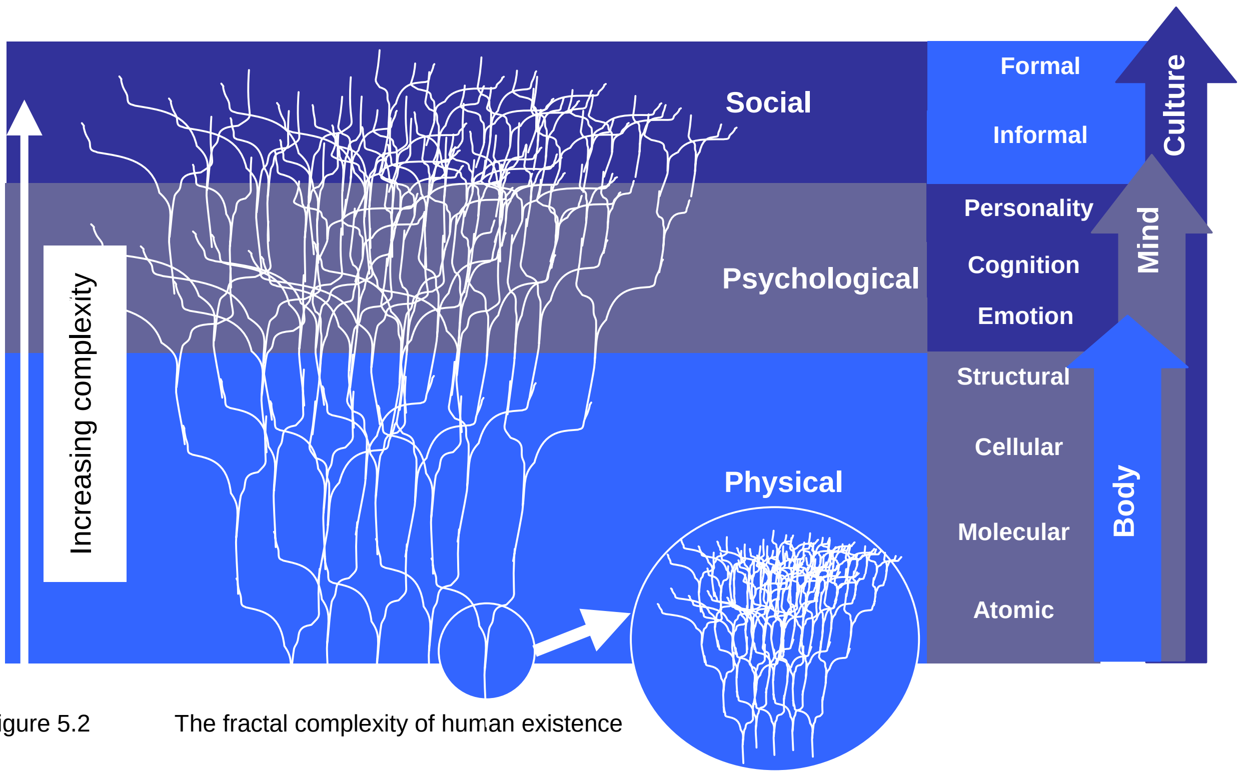

Figure 5.2 The fractal complexity of human existence

Figure 5.2 represents the various dimensions of human existence as they emerge through self-organisation. Note that even though one can recognise more than one dimension of existence, they are interdependent and in reality cannot be regarded separately. As human beings we experience reality simultaneously on all these dimensions. Children are physically present when they see or touch objects, on a psychological level they represent those objects in their minds, and they may feel interested, excited, apprehensive etc. about the environment in which they learn. On the social dimension they collaborate with others, wonder out loud and ask for assistance, and learn from members of their society how to solve problems. On a spiritual level, children learn to respect life and the living, learn to recognise that learning can be a path to personal fulfilment. To learn effectively, children need the full range of experiences that can be offered to them and teachers need to ensure that children engage in learning in totality: physically, psychologically, socially and spiritually.

What Figure 5.2 also indicates, is how psychological phenomena such as emotion, cognition and personality are partly biologically determined since they emerge from physical systems and are therefore partially dependent on the prior interactions of the physical system with the environment. Here, the reader is reminded of Byrnes' (2001) hemispheric asymmetry model of emotion which was mentioned in Chapter 3, and which refers to the biological component in emotion. Also, from an evolutionary point of view, the part of the brain that is associated with the expression of emotion (the limbic system) is more primitive in structure than the part of the brain that is associated with cognition (cerebrum) and therefore cognition is assumed to be more complex purely from an evolutionary point of view. Of course, from a psychological point of view, this may not be true. Although the expression of emotion is mediated by cognition, certain thoughts (as cognitive appraisals of events within a particular social context) can also elicit powerful emotions.

Also, the fact that personality functioning is viewed as a dynamic balance of complex interactions in the brain and with the environment, is a purely psychological description that would not necessarily make sense from an evolutionary point of view. Psychological descriptions such as these often have to suspend the influence of the social context temporarily even though social context is an important factor in personality development. For example, Lewis and Junyk (1997) suggest that personality attractors can be construed as a relatively stable constellation of cognitive, emotional and behavioural elements and propose that psychological self-organisation is the result of two processes, feedback and coupling, by which patterns of thinking and feeling emerge. They explain it as follows:

> Cognitive and emotional elements coalesce into global interpretations of emotionally relevant events, through the process of feedback and coupling, within interpersonal transactions. As these emotional interpretations recur over development, they guide the organization of interpersonal activity in consistent and familiar patterns, and these patterns constitute *personality* (author's emphasis) (p. 47).

Lewis and Junyk's (1997) theory of personality functioning is one that primarily addresses the psychological dimension of human existence. However, the psychological dimension of human existence is not solely determined by factors within the individual because individuals also interact with others in a social environment as they evolve towards greater complexity. In fact, I would suggest that personality patterns, emotional styles and cognitive preferences fulfil the function of attractors in the mind as they draw people towards particular patterns of behaviour. I would suggest that when personality traits, emotional styles and cognitive preferences combine through what Lewis and Junyk (1997) call processes of feedback and coupling, learning dispositions develop that could predispose a child towards the selection of certain learning experiences over others.

In Figure 5.3, I propose an initial theory on the development of learning disposition.

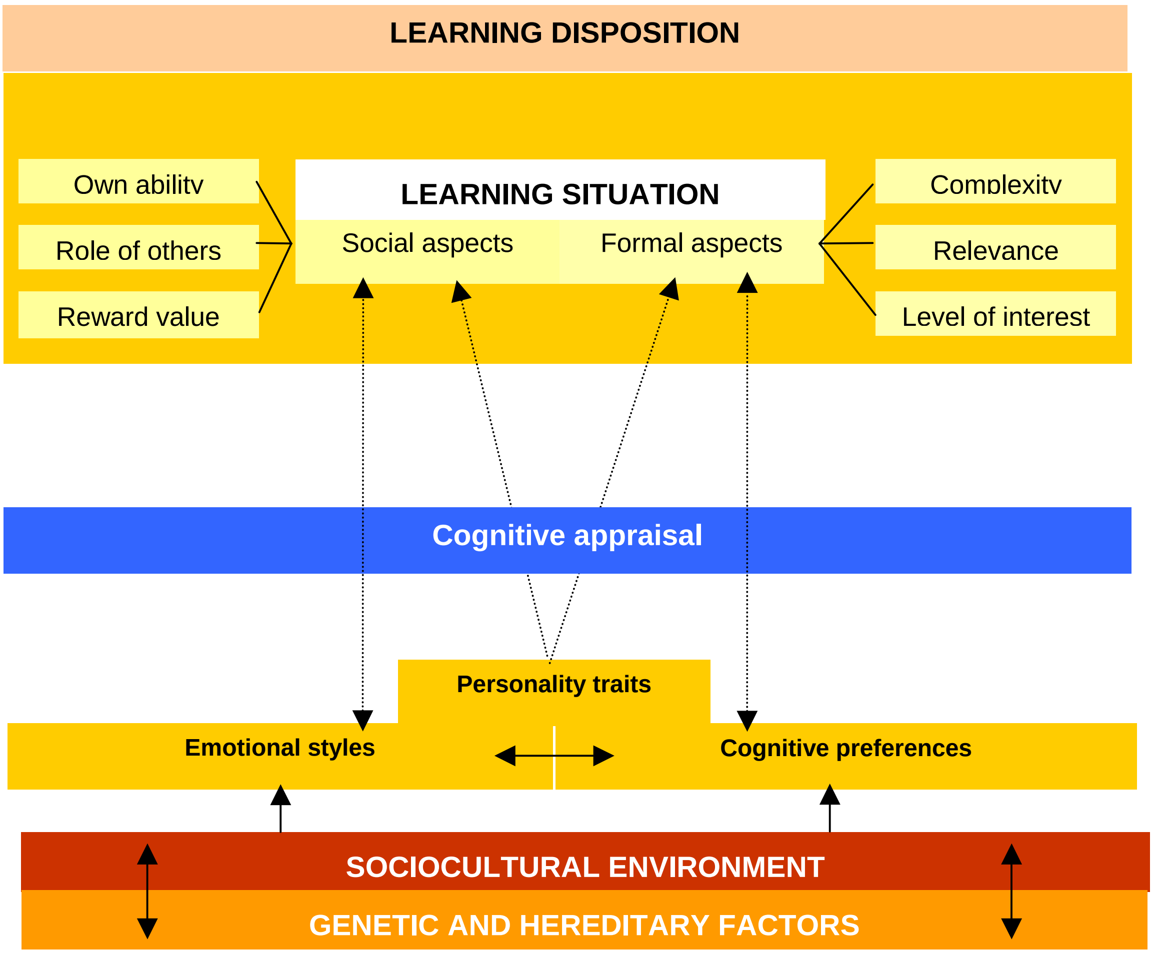

Figure 5.3 The development of learning dispositions

Cognitive appraisal is the mechanism through which children organise their experiences. Cognitive appraisal involves not only cognition, but personality, emotion and the socio-cultural environment as well. In order to learn, a child approaches a situation by appraising its various formal and social aspects. The mechanism of cognitive appraisal is important because it is at this point that children combine their prior knowledge with new knowledge in

University of Pretoria, etd - Human, S

order to construe meaning and adjust the viability of their knowledge. Cognitive appraisal involves not only appraisal of formal aspects of the learning situation, but also an appraisal of one's own role in the learning situation. Paris and Paris (2001) point out that self-appraisal is an important aspect of self-regulated learning because it increases personal awareness of different ways of learning and promotes feelings of self-efficacy.

Various personality traits influence how the child perceives the value of particular types of learning. Extraverted personalities may value learning opportunities which offer social interaction with others more favourably, whereas strong-willed children with a high level of self-sufficiency may appraise learning situations which allow limited freedom less favourably. Various studies discussed by Long (2000) indicate that personality factors such as extraversion-introversion, warmth, stability, conscientiousness, self-assurance and self-discipline can account for up to 20% of the variance in general academic achievement. Similarly, children with emotional styles which are associated with approach behaviour (sociabilitiy) are expected to approach learning opportunities differently from children with avoidance behaviour (shyness). Recognising cognitive preference, for example to approach tasks either passively or actively, one can then begin to appreciate how personality, emotional style and cognitive preference can unite to enable the development of either a positive or a negative learning disposition.

Learning requires active self-organisation as the child construes knowledge. The construct of self-organisation is a central feature of theory on children's cognition. Self-organisation essentially describes the capacity of the system to utilise chaos from the environment as a way to organise itself towards greater complexity. Self-organisation also explains the remarkable flexibility of the brain in adapting to the environment and maintaining the dynamic balance between chaos and equilibrium. Children are especially accomplished in adapting to their environment as they learn how to acquire cultural patterns of behaviour, relate to others, master language, solve culturally defined problems and so on. Children do not have a "ready-made" concept of the world in which they live, they have to acquire it through interaction with their environment and this is made possible through the process of self-organisation.

Self-organisation occurs as a system continually varies between chaotic and stable phases. The transition from chaos to order is called a bifurcation point and is caused by the sensitivity of the system to initial conditions or the "Butterfly Effect". In terms of children's cognition, the Butterfly Effect can be found on various levels of development. On a physical level, early environmental conditions (pre-natal and post-natal) exert great influence upon brain

University of Pretoria, etd - Human, S

development, directly and indirectly influencing the emerging mind. On a psychological level, children are equally sensitive to environmental conditions that can stimulate or constrain their cognitive development. Nutritional factors, emotional bonding and security, cultural beliefs and customs and socio-economic opportunies are all butterflies in the developmental trajectory of the child's mind. On a social level, the child's involvement with others over a period of time can also exert a great influence upon the child's development.

5.2.3 Assumptions about cognitive intervention

The present study does not only address the nature of children's cognition, but also considers possible ways in which approaches to cognitive intervention may be informed by a metaphor that describes children's thinking as complex and chaotic. To be effective, cognitive intervention has to be able to accommodate all the complexities associated with cognition. In section 5.2.2 I suggested an initial theory of complexity and chaos in children's thinking. In this section, I discuss the ways in which cognitive intervention might possibly address children's thinking in formal contexts.

Firstly, cognitive intervention needs to address the active role of the child in the construction of knowledge and should provide opportunities for children to organise their experiences as they attempt to make sense of the world. Children act upon their environment and are shaped by their environment, so new information and experiences should not be divorced from their context as this prevents the child from appreciating their complexity. Self-organisation is an active and reflective process as children make meaning of their experiences, and so it is important to encourage children to investigate and question new experiences. This is in contrast to the mere rote learning of new information, where new information is committed to memory without affecting the organisation of prior knowledge. True self-organisation must bring about a change in the way children's prior knowledge is organised. Cognitive intervention should provide learning opportunities and not merely training opportunities (Von Glasersfeld, 1989).

Secondly, cognitive intervention should also take into account sensitive dependence in cognition and therefore the unpredictability inherent in learning. Cognitive interventions should provide experiences that encourage children to experience a sense of disequilibrium in their knowledge organisation. Proximal and peripheral factors can influence knowledge construction in countless and unpredictable ways. Proximal and peripheral factors are those factors in the child's physical, psychological and social environment that contribute to the development of a positive or negative learning disposition. Proximal factors include the

University of Pretoria, etd - Human, S
child's physical health and psychological health, the quality of social interaction with parents, peers and educators, availability of physical, psychological and social learning opportunities. Peripheral factors that influence knowledge construction include the genetic and hereditary factors which contribute to the child's physical and psychological status, the socio-economic status of the community in which the child is raised, political aspects of education such as the implementation of a particular language policy, the education policy in general, and so on.

Accommodating the proximal and peripheral factors that act on the complex nature of children's thinking requires a flexible approach to cognitive intervention. Flexibility in cognitive intervention can take on many different meanings. In the context of the present study, flexibility can be directly tied to the notion of chaos in the sense that a flexible approach to cognitive intervention will not seek to structure learning opportunities unnecessarily to make them more "manageable" for young minds. In contrast, flexibility in cognitive intervention will reflect a conscious attempt to include in learning as many variables as possible and allow children to respond to complex learning situations holistically while addressing their learning needs as they arise. Flexibility also requires educators to view learning as more than just memorisation of content or acquisition of skills. The willingness to accommodate and address aspects that have traditionally been regarded as non-cognitive, such as personality, social and cultural factors, is crucial in a complex learning environment that requires children to respond as more than just learners, i.e. as people. Education should ultimately be about the development of people, not brains.

Complex thinking does not happen in a vacuum any more than people live in a vacuum. From the moment children are born, they have to deal with and make sense of a complex world by organising their experiences and attaching meaning to them. As they grow older, children's worlds become increasingly complex as the psychological and social realms of experience emerge and grow in their own complexity, and so thinking is a tool that is not based on the mastery of nature alone, but also the mastery of oneself. Thinking allows us not only to investigate, describe and analyse our natural environment, but it is the primary means through which we regulate our own behaviour in a particular social context.

5.3 DATA INTERPRETATION

5.3.1 Introduction

In this section I will examine the data subsets for evidence of the themes that were developed in the previous chapters. The main research question was modified continually and each chapter considered different dimensions of two basic assumptions, namely that

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children's thinking is complex, and cognitive intervention should address the complex nature of children's thinking.

Cognitive intervention requires the mediator to mediate knowledge construction and the acquisition of cognitive skills. Within the context of cognitive intervention, mediation generally refers to a collaborative approach taken by the mediator as she guides children in their thinking. However, within certain theoretical contexts concerning cognitive intervention, mediation takes on particular meaning. In the context of the present study, I will be investigating how mediation accommodates chaos and complexity in cognitive intervention, making the emergence of complex cognition possible. It follows naturally then that the investigation will also lead to a contemplation of the kind of complex thinking that emerges, and consideration of the possible implications for the cognitive intervention of young children.

5.3.2 Defining mediation in cognitive intervention

Possibly the earliest reference to mediation in the context of learning comes from Vygotsky (1930/1978), when he referred to the mediating role of tools and signs in man's quest to master nature and himself. For Vygotsky, language mediated the development of thought as external actions were internalised and transformed to become thinking. However, Vygotsky also defined mediation as the transformation of biological processes into culturally mediated forms of expression, and so he distinguished between elementary (biological) processes and higher (psychological) processes (Vygotsky, 1930/1978).

In the early 1970s, the concept of mediation was introduced to Western psychology by Reuven Feuerstein as he expanded Vygotsky's concept of the ZPD in a theory of mediated learning experience (MLE). Feuerstein described MLE as the interaction between the child and his/her environment in a complex process that requires a human being as an initiate who is more capable to organise the environment meaningfully, to mediate both the inner and outer environments to other, less initiated human beings (Rand, 1991). The goals of MLE are described by Egozi (1991) as increasing cognitive modifiability (primary goal) by correcting deficient cognitive functions, enriching the subject's cognitive repertoire, establishing the need to learn, producing reflective, insightful learning processes, creating task-intrinsic motivation and arousing retarded (*sic*) performers to become originators of new information.

Following Feuerstein's lead, other authors have provided further descriptions of mediation that include establishing an affective and reciprocal relationship with learners, helping learners find value in their learning, guiding lessons in a certain direction and helping

University of Pretoria, etd - Human, S

learners with goal-setting (Greenberg, 1990). More specifically, Haywood, author of *Bright Start,* a cognitive intervention programme for young children, suggested that mediation involves the use of process-oriented questions, challenging correct and incorrect responses, requiring justification of answers and emphasising order, structure and predictability (Costello, 2000).

Many of the descriptions of mediation above are too vague when it comes to assisting teachers to translate and implement them on a practical level in the classroom. How exactly would a teacher go about increasing cognitive modifiability, or helping learners find value in their learning? What does it mean to emphasise order, structure and predictability in thinking, especially as it appears that thinking entails a measure of complexity and unpredictability? Although order and structure play an essential role in the emergence of complex thinking, these concepts unfortunately might suggest to some teachers that they must encourage learners to be docile, passive and unquestioning. Predictability can easily imply that thinking tasks should be manageable, i.e. simple, structured and unchallenging. In such cases, the well-meant concern that many teachers have to ensure that children experience success in order to develop positive self-esteem may also prevent teachers from ever presenting learners with tasks that will stretch their ability to think and solve problems. By only solving predictable problems, they fail to learn how to cope with the unpredictability of problems in real life.

In the present study, I suggest that some of the basic goals of mediation are to facilitate the emergence of learning as self-organisation by enhancing psychological flexibility, by serving as a tool for the differentiation of children's mental representations, and by encouraging the construction of knowledge in an intersubjective space.

5.3.3 Mediating learning as self-organisation

5.3.3.1 <u>Enhancing cognitive flexibility</u>

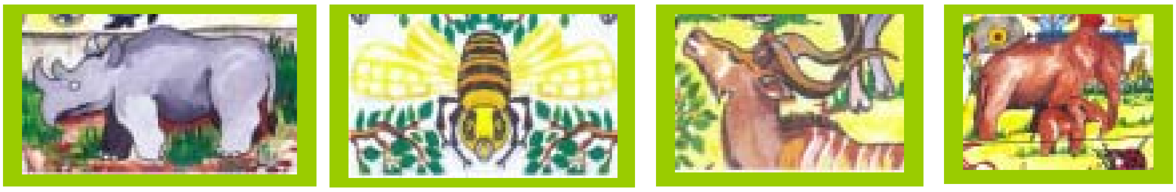
Self-organisation requires a dynamic balance between chaos and order for a system to emerge into increasingly higher levels of complexity. Self-organisation also requires the system to adapt to a changing environment. Therefore, mediation for self-organisation must help children learn how to be responsive to their environment and how to adapt to it by inviting children to be actively involved in shaping and being shaped by the environment.

Psychological flexibility, more specifically cognitive flexibility, is an important aspect of dynamic adaptation, and involves coping with unexpected demands from the environment. In the context of the present study, psychological flexibility refers to the total range of cognitive, emotional and social behaviours available to a child, whereas cognitive flexibility refers to the total range of cognitive processes that children can select and apply to solve problems. Flexible problem solving is recognised to be an important aspect of self-regulated learning (Paris & Paris, 2001). Dynamic adaptation requires children to have a wide repertoire of behaviours available that can be used to orchestrate an adaptive response. The complexity which characterises a system enables it to respond adaptively and intelligently to the environment. Children who find it difficult to identify, select and apply appropriate problem-solving strategies, or children who fail to adjust their strategies according to the demands of a learning task, are typically children who have difficulty in responding adaptively to changing demands in the environment.

In the context of cognitive intervention, cognitive flexibility suggests an ability to attend to more than one aspect or dimension of a problem, to develop a differentiated understanding of a situation, and to re-organise one's thinking in response to additional information. If children are to master these skills, they need adequate opportunities that require the use of such strategies. For example, in the following dialogue from DS1, the researcher (SH) and the learners (L) in the group[27] are engaged in a discussion about the rhinoceros which appears on the poster:

Blue text represents meta-level comments about the dynamics of the interaction between the researcher and the learners and green text represents an interpretation of a particular utterance.

Dialogue 5.1 Cognitive flexibility



SH That is great! What is this?

L It's a rhino!

SH It's a rhino. Yes. What are these funny things on his head?

Comment The researcher involves learners actively in the discussion. When it is apparent that they know what a rhino is, the researcher asks them a question that requires more

[27] The audio-recordings did not permit the identification of individual learners and L will therefore refer to any learner in the group.

detailed knowledge. Since the learners in this group are learning in English as the language of learning and teaching (ELoLT), and since the transformation of social speech to inner speech depends to a large extent on language proficiency, the researcher wants to know how effectively learners can verbalise their thinking.

L Like…it's like a nose. (Transfer of prior knowledge)
L /It's like a nose.
L /…and he have two eyes, yes.
SH Yes. Can you see two eyes there? (Accepts response and asks a closed question by repeating child's response.)
L Here, but the other side there's another one. (Recognises dimensionality of representation)
SH On the other side. Do you think we can call those things on his head horns? (Probes child's thinking in order to understand how her knowledge is organised, and to provide a clue since child does not know the English label. Responsibility still remains with the child to accept or provide an alternative.)
L Yes! They are horns!
L Yes, horns. Like when you get like a cow. (Spontaneous generalisation)
SH But instead it's here in front. (Differentiation that encourages analytical thinking in the form of comparison.)

Comment The researcher invites active participation and develops differentiated understanding using mainly closed questions. Learner shows evidence of self-organisation as he attempts to assimilate this information into his mental model of "animals with horns" Researcher further differentiates by pointing to the difference between a cow's horns and a rhino's horns. In the interaction above, the function of closed questions is to mediate knowledge construction by attending to analytical thinking.

L What is this name?
SH Show me another animal on this picture that has horns? Which other animals also have horns?

Comment Researcher does not respond to the learners question and continues her line of questioning. Learners are encouraged to transfer information to other objects. Cognitive flexibility requires learners to generalise existing knowledge to new situations. The question above is an example of what is commonly referred to as near transfer as discussed by Alexander and Murphy (1999).

L Here!
SH That's right, Nkosi. That one also has horns.
L Also this one.

SH This one looks like it…

(Learners talking simultaneously)

SH Let's just look at the bee. This one looks like it has horns, but it actually is NOT horns. We call it something else. (Researcher makes learners aware of an anomaly in order to get them to reflect on their current knowledge, and to adapt to the new anomalous information. The learning situation is not structured to control children's thinking, but to disrupt it as Vygotsky (1935/1978) advised)

Comment One learner generalises his concept of a horn to include the feelers on the bee's mouth. The researcher does not reject the learner's attempt to use her knowledge, but uses it as an opportunity for differentiation and self-organisation. It represents a conscious attempt from the researcher to introduce disequilibrium so that learners can reflect on the viability of their current knowledge, and re-organise it to reflect increasing differentiation and complexity. Such conscious intervention to prompt children to re-organise their experiences reflects a fundamental aspect of mediation.

L Like this. It doesn't bite. This.

L It's a snail!

SH It's a snail.

(Learner says something which is incomprehensible)

SH The elephant, you said that the elephant has horns. But we…you're right, actually…but we call it another word. (Researcher acknowledges a spontaneous attempt to generalise knowledge and provides support in terms of the child's knowledge of appropriate verbal labels.

L Uhm…uhm…

SH We call it? Tusks!

L Tusks.

Comment New information leads to differentiation of the concept of "horns" and re-organisation of information. It also shows how ELoLT learners are sometimes thwarted in their attempt to apply their knowledge when their language skills are not fully developed. In terms of mediation, it is important to distinguish between the child's ability to generalise knowledge, and her ability to select and apply the appropriate verbal label. Mediation in terms of vocabulary would probably reflect a lower level of support while mediation in terms of the application of relevant knowledge itself would reflect a higher, more intense level of mediation.

In the dialogue above, the researcher engaged learners in a process of hypothesis-testing through social interaction and collaboration. Learners were confronted with concepts that in each case forced them to re-evaluate what they knew and adapt their knowledge if necessary. Such a "trial-and-error" approach is characteristic of complex problem solving

University of Pretoria, etd - Human, S

where one typically would try out different courses of action or solutions in one's mind before taking actual physical action. As Wood (1998, p. 20) notes, thinking is a substitute for overt actions and permits "trials" whose "errors" are only imagined. In a sense, then, thinking discourages unconsidered, impulsive action and saves time by imagining alternatives and finding the best one before choosing a course of action. Thinking therefore mediates physical action by permitting a psychological response which is literally (and also from an evolutionary viewpoint) aimed at conserving time, energy and effort.

Such cognitive flexibility does not exist from the moment when children are born. Children first learn to adapt to their environment through primitive behaviours such as crying, babbling and squealing, pointing, and so on. At first, the child has no conscious understanding of what these behaviours may mean in a particular culture. Gradually, these behaviours are differentiated and they acquire cultural meaning. The child learns to use these behaviours consciously as a means of achieving certain goals. When this happens, we see the first evidence of the emergence of the psychological mind from biological processes. Crying becomes a way of influencing others' behavior, babbling evolves into a sophisticated cultural system for communication, squealing becomes a way of showing pleasure, pointing becomes a way of expressing needs.

As children master the language of their culture, they change forever the way in which they relate to the physical world by transcending it and constructing a psychological universe through which they experience the world. The psychological universe that is constructed can be based only on the children's experience of their physical world and the way in which others mediate the children's experience of the physical world through the use of physical tools and cultural signs. In a sense, all verbal interaction reflects a form of mediation since language is used to organise, direct and transform one's experiences by allowing one to re-construct one's experiences and by creating a past and a future.

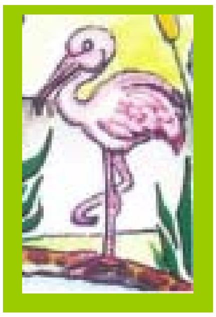
5.3.3.2 Differentiating children's mental representations

With each new situation that children face, confirmations of, and/or exceptions to, their current knowledge arise which they must accommodate in their mental representations. Children's mental representations of the world emerge from interactions with the world on a physical and interactional level. Self-organisation is what makes an emerging psychological mind possible (cf section 5.2.2). When discrepancies arise, the information becomes differentiated and learners learn, for example, that not all long, round and pointed external animal appendages are called horns, they can also be feelers, tentacles, or tusks. When learners are sensitised to the finer nuances of their experiences, self-organisation enables them to represent these nuances in their cognitive structures, enhancing their ability for dynamic adaptation to the environment.

Mediation should therefore be used as a tool that allows the mediator to sensitise the learner to the complexities around her. It can be viewed as a mechanism through which positive feedback loops are developed so that the child becomes able to respond to the environment with a wide variety of appropriate behaviours. When the mediation takes place in the context of problem-solving, it becomes a way of helping the learner to develop a detailed and differentiated mental representation of the problem. It also helps the child to develop a flexible approach to problem-solving by helping the child to respond and adapt to chaos in the environment. In the context of self-regulated learning, chaos refers to a myriad of personal variables that influence the child's construction of meaning, and to social and cultural variables that create a complex context to which the child must learn to respond appropriately. In a sense, chaos in SRL represents the total learning potential of a complex situation as well as all the variables that a child could be required to potentially respond to. To this end, it may be very important to create complex and chaotic environments that allow children sufficient interaction with the mediator and the learning materials. For example, Paris and Paris (2001) report that learners in open-ended environments use more strategies, are more motivated and persist longer in the face of adversity because they were faced with open-ended tasks that required them to be more thoughtful and to derive feelings of self-efficacy as a consequence of their engagement with tasks.

Because self-organisation is the primary mechanism through which complex systems develop, it is not enough to tell the child that a problem is complex, the child has to experience it as such. Consider the following interaction between the researcher and the learners from DS1 (Grade 1) about birds (Dialogue 5.2). The researcher had asked the learners to put beads on all the birds on the poster and one bead was put on the bat:

Dialogue 5.2 Differentiating concepts


SH Okay, why do you think it is a bird? (Open question to understand learner's personal construct and to encourage child to verbalise his thinking. The researcher foresees that the child will offer some suggestions that will lend themselves to further investigation)

L It has wings.

SH Because it has wings and it can fly? (Extending child's response to introduce a central characteristic, but also to create an opportunity to challenge the belief that all birds can fly. It reflects a conscious attempt to introduce disequilibrium and to force learners to investigate the viability of their knowledge structures.)

L Because they have wings, because…

Comment Researcher questions learner's thinking in order to determine what his mental representation of a bird entails. Since the learner thinks a bat is a bird, the most obvious reason would be that a bat, like a bird, can fly. This points to a vague and undifferentiated representation of the bird-concept, and provides an opportunity for the researcher to challenge the learner's thinking.

SH Okay, why do you say it's not a bird? (Question to a different learner; open question designed to introduce more uncertainty and to use the information as a platform for inquiry.)

L Because…that thing have nails.

SH Okay, well let me tell you something. He is right. That is not a bird. It can fly like other birds, but do you know what? It doesn't, it doesn't lay eggs! (The researcher's provides structure when it becomes evident that the children find it difficult to focus on the defining characteristics of birds.)

Comment The researcher attempts to introduce discrepant information through active involvement of another learner. It turns out that the second learner, although his answer is correct, either has an even more primitive concept of what birds are, or may be finding it difficult to communicate his thoughts. The researcher challenges the learners' concept of birds by introducing an additional characteristic of birds: they lay eggs.

L You have something in your hands!

SH Just a second, just a second. Only animals that can fly, <u>and</u> lay eggs, are called birds.

L Yes. (Support is structured and chaos – disequilibrium – is reduced).

SH Only animals that fly <u>and</u> lay eggs. Okay? So this one doesn't lay eggs, and that's why it is not a bird, and you were right. But it is a funny animal, because it can fly.

L Because… (this learner's comment was lost in the group; his voice was only heard during a playback of the tape.)

Comment It frequently happened that some learners' responses were not acknowledged by the researcher. Sometimes, as in the case above, a learner's voice was simply lost in the interaction among various group members. At other times, children interrupted one another, or began a sentence without completing it. At times, it was necessary for the researcher to consciously ignore a learner's attempt if the learner was responding off-task, or if the researcher thought responding would be detrimental to the task at hand. Situations like these do arise frequently in group settings, particularly with young children and should not cause undue concern except when a particular learner withdraws from the group interaction altogether as a result of feeling ignored.

SH Are these birds?

L Yes…in the water, it does lay eggs.

SH What lays eggs?

L A turtle.

SH A turtle? Yes, but it doesn't fly. If it can fly, <u>and</u> if it can lay eggs, <u>both</u> of them, then it's a bird.

L But it can lay eggs. That one that stay in the water, it can lay eggs. (This response shows inflexible application and generalisation of a concept by attending to only one feature at a time and is characteristic of children whose cognitive structures show that they have not yet learned to utilise chaos for self-organisation.)

Comment As the learner attempts to apply his knowledge to other animals, it becomes apparent that he has only incorporated egg-laying into his mental schema of birds, and so comes to the conclusion that a turtle must also be a bird. Ordinarily, one would often simply dismiss such an answer as incorrect and correct the learner's misconception. However, in terms of complexity theory it provides an opportunity for the researcher to help the learner to adjust and re-organise his mental representation of what a bird is, by helping him to attend to more than one defining characteristic of birds: they fly and they lay eggs.

SH Okay, you're right. A turtle?

L Yes.

SH You're right, it does lay eggs. Do you know where it lays its eggs? Where? (The researcher decides that further examination of the nature and habits of turtles may provide an opportunity to compare them with birds and may eventually lead to the learner adapting his mental schema of birds.)

L It get out of the water and then…(indecipherable because of noise outside)

SH Tell me, do you think a flamingo is a bird? (Closed question functions to introduce another possible source of ambiguity designed to create disequillibrium.)

L No! No!

University of Pretoria, etd - Human, S

L It can't fly…(This answer was foreseen and presents an opportunity to further refine children's mental schema of birds.)

L But it stands higher…

SH Who says a flamingo can't fly?

L Me!

SH Who says the flamingo can fly?

L Me!

SH Ah! This time you and you are right. A flamingo can fly. An ostrich cannot fly, but a flamingo can fly. So maybe you were thinking of an ostrich? Because an ostrich can't fly. But an ostrich is still a bird.

Comment The interaction is temporarily diverted by the egg-laying turtle and then the researcher redirects attention again to add yet another piece of inconsistent data: Ostriches cannot fly, yet they are birds. Once again, challenging learners' mental representations with discrepant data forces them to reconsider the viability of their knowledge, and accommodate this additional information by reorganising their representations.

L This is four: one, two, three, four.

SH Okay, but is this a bird? I want to know if this is a bird (Researcher pointing to flamingo.)

L No, no, it's not a bird.

L It's a flamingo.

SH But is a flamingo a bird?

L No! (This child resists having to adjust his concept of what a bird is, an example of inflexible cognitive structure where the child has either not learned how to deal with ambiguous or anomalous information, or is limited in her ability to accommodate ambiguity.)

L It's very higher, more higher than a bird.

Comment Here it is evident that for one particular learner, a flamingo is not necessarily part of a superordinate class of birds, indicating that the concept is not differentiated enough to capture all the detail. For this particular learner, birds are apparently small, and apparently only small birds can fly. It is therefore possible that it is primarily the size of the flamingo that convinces the learner that the flamingo cannot be a bird.

SH Okay…but, let me tell you a secret: a flamingo is a bird. If you want to know if something is a bird, you must look for three things: it must be able to fly, it must be able to lay eggs…

L Yes?

SH And…it must have feathers. If it has feathers, you can be sure it is a bird. Anything with feathers is a bird. If it can fly, or if it cannot fly, if it has feathers, it is a bird. Do you believe me? (New information acts to create disequillibrium and learners must accommodate the new information with their current knowledge).

L But…uhm…

L I know that a flamingo fly…I know.

Comment After the introduction of a third dimension – the presence of feathers – it becomes possible for the learners to re-organise their concept of what birds are. Suddenly one learner can say with confidence that a flamingo is indeed a bird. The uncertainty of one learner (But…uhm) indicates that her mental representation of a bird is undergoing change – the new information has created an upheaval in her current thinking and she is as yet uncertain how to accommodate it.

SH You know that a flamingo flies? So how many birds do we have on this picture? Can you count for us?

L One, two, three, four, five…seven!

SH Do you agree?

L Yes.

Comment The correct number of the birds on the poster is actually nine. The two birds that had been omitted, were the penguins in the centre of the poster. Two possible reasons exist for their omission. Firstly, they are spatially removed from the other birds and it could have been an oversight. Secondly, they appear in another context – together with seals in a pond – which might make them appear not to be birds. Further mediation would have revealed which is more likely – but unfortunately the time had expired and the session was terminated.

The interaction between the researcher and the group of learners in Dialogue 5.2 shows an important aspect of learning as self-organisation, namely questioning of learners' thinking as a tool for guiding the emergent organisation of their cognition. According to Paris and Paris (2001) two metaphors for self-regulated learning exist, one which emphasises self-regulated learning as the acquisition of skills, and the other which focuses on the learner "becoming" a self-regulated learner as she develops new competencies. Learning as self-organisation can be aligned with a metaphor of "becoming" rather than "acquiring" because children give meaning to their experiences in unique ways, they learn in unique ways and they need to organise their learning experiences in a way that makes sense to them. Acquiring strategies amounts to little more than training and, as I have pointed out in previous chapters, training does not lead to authentic understanding and learning because it does not require the active deconstruction and reconstruction of conceptual structures.

In the present study, children's emergent cognitions were taking place very much in a social sphere, where the researcher and the children were engaged in construing knowledge by creating a mutual understanding of birds through social interaction and speech.

5.3.3.3 Construing knowledge in an intersubjective space

The social construction of knowledge refers to an important concept in Vygotskian thought, namely intersubjectivity, which is defined by Wink and Putney (2002) as "the collective history and mutual meanings shared by a group of people." The notion of intersubjectivity relates meaningfully to the notion of self-organisation because it creates the conditions necessary for self-organisation to occur, and it helps to explain by which mechanism viable knowledge is construed. Wertsch (1985) describes intersubjectivity as a phenomenon that arises when interlocutors share some aspect of their situation definitions. Social situations that involve learning can be created in many different ways and on many different levels, and children each approach learning opportunities with their own personal meanings. When participants begin to share their understanding with one another, a new social space is created, one which transcends the personal and private world of the individual. Meyer and Turner (2002) point out that intersubjectivity is a critical aspect of self-regulated learning and requires methods that can explore the complexities of teacher-learner interactions.

Consider in Dialogue 5.3, taken from DS3 (Grade 3), how the researcher and the learners create an intersubjective space in which they explore their own personal understanding of the group process and use external means to create new meaning:

Dialogue 5.3 Construing understanding of the group process

SH	Okay, let's go!
Ls	[together] Jesus loves me yes I know, 'cause the Bible tells me so…
SH	Very nice. Now tell me your names on the recorder.
L	My name is Siyabonga.
L	My name is Koketso.
L	My name is Tumi.
L	My name is John.
SH	Okay, I have a set of cards here and…well, I'm sure your teacher has taught you already how to take turns.
Ls	[chorus] Yes!
SH	Okay. When is it important and why is it important to take turns?

Comment The researcher introduces the topic of taking turns in the group session, signalling that it will be relevant to the group session with the children. The researcher wants to establish whether the children have acquired a personal understanding of the importance of regulating one's behaviour and having respect for other group members by respecting each participant's turn to speak. Thus the process of establishng mutual understanding about group processes is begun.

L Because, because, because, that…uh…to take turns…because…uhm…like…not speaks and speaks ma'am, you know.

SH So that everybody gets a chance. (Interpretation of the response can help learners to use language to organise their thoughts more coherently).

Comment The children in the group are all learning through English as the language of learning and teaching (ELoLT), and so an important aspect of developing the children's thinking is to support them in developing their language skills. Throughout the group interaction the researcher repeats, paraphrases, interprets or extends children's responses in order to reflect their developing thinking.

Ls [chorus] Yes, ma'am!

SH That's right.

L Like me, I am a captain, Ma'am. Siyabonga, and Koketso and John never got a chance to be a captain. They gonna cry because they never had a chance and I had a chance for a whole year.

SH Okay, so you feel it's unfair that you have been a captain the whole year and they must also get a chance. (An empathic response that communicates acceptance and understanding of children's experiences is an important aspect in the development of positive learning dispositions.)

L Yes.

Comment The learners begin to share their understanding of what it means to take turns and through the social interaction they begin to construct a common experience. As one learner shares her experiences on an emotional level she makes it possible for the interaction between group members to become transformed as other learners respond to her cue. Such exchanges are very important to children's social skills development, as Frederickson and Cline (2002) point out that peer relationship skills such as prosocial behaviour and empathy can have positive effects on children's social adjustment, which in turn is associated positively with school achievement.

L [talking together]…and I am feeling angry! (Learner's admission creates a bifurcation point in the group interaction).

SH Why are you feeling angry? (Researcher requests child to elaborate and justify his statement, which is not only an important aspect in the development of critical thinking, but also essential to children's development of social skills.)

L Tumi is my enemy, that's why.

SH Yeah?

L We talk with each other all the time.

SH Do you fight with each other all the time?

L No.

Comment At this point in the interaction, a transformation has taken place on two levels. First, learners are construing knowledge about taking turns not only on a cognitive level, but expanding the construct by including their emotional experiences as well. Secondly, the fact that the researcher allows and pursues the discussion of learners' personal emotional experiences as these relate to taking turns also transforms the nature of the group process. In other words, the social space that the researcher creates encourages free expression of personal feelings as they relate to learning experiences.

L I steal! (laughing) (This rather surprising confession creates another bifurcation in the group interaction and emphasis shifts towards personal experiences)

L (all talking and laughing in response to the learner's admission)

L If I don't have something I take it and I give it back at the end of the day. But mostly I just take it and then I go to my table and then I…[unclear]

SH Do you ask them before you take their things?

L No. (Other learners agree)

L When they say no I get angry.

SH And what do you do when you get angry?

L I just go like this (demonstrates on another child)

Comment Creating a social space that allows children to share their personal experiences requires acceptance from all participants as they are encouraged to share their experiences. The emotional sharing among learners has created an exceptionally safe social space for the learners in this group.

The shared social space which results from interaction between the researcher and the learners then forms the setting within which children re-evaluate personal meanings. Intersubjectivity is not only a necessary prerequisite for self-organisation, it is also necessary to create an authentic experience in which children can think and learn collaboratively, and so mutual trust and respect is of prime importance (Meyer & Turner, 2002). Since self-organising systems emerge as a result of complex interactions between the system and the environment, it makes sense that the learning opportunities which we provide to children should afford the opportunity for complex interactions that include some measure of chaos.

However, the development of psychological processes from social interaction is not a linear process that refers to the mere transfer from social to inner speech, as Vygotsky (1930/1978) and Wertsch (1985) have rightly noted. Rather, the non-linear nature of self-organisation confirms that social speech is not only internalised, but transformed in the mind of the individual.

5.3.4 Self-organisation in Vygotsky's Zone of Proximal Development

The notion of qualitative change introduces an important concept that stands central to Vygotskian theory as well as chaos theory. First of all, Vygotsky's (1935/1978) formulation of the ZPD as a dynamic region of sensitivity in which learning occurs with the assistance of a more capable person, points to the importance of self-organisation in specific ways. The ZPD makes it possible to study how children organise their knowledge, and also to study children's responses when their mental schemas are disrupted by confronting them with new information. As Wink and Putney (2002) advise, children find instruction meaningful when they are given opportunities to construct their own knowledge by using speech as a tool for thinking. The teacher can facilitate this process by disrupting children's mental schemas so that they are forced to review the viability of their knowledge and to re-organise it to accommodate new information, which is probably what Vygotsky had in mind when he asserted that development should follow instruction and not *vice versa*.

Secondly, the non-linear characteristic of self-organisation as it is described in chaos theory might help to explain how and why most children feel compelled to accommodate new knowledge and adjust their theories of the world upon being faced with new information. The Butterfly Effect, which refers to the sensitive dependence of a chaotic system, states that small, seemingly insignificant factors can have large, qualitatively different effects on the developmental trajectory of the system. In Chapter Three, Section 3.3.3, I gave examples of how chaos and complexity can be witnessed on a physical level in the central nervous system. Given the fractality of chaotic systems, it is therefore logical to assume that the same effects will operate (qualitatively differently) in the psychological mind that emerges from the physical body.

Because, as complex and chaotic systems on all levels of existence we are open to our environment, it follows that we will influence and be influenced by natural and contrived

University of Pretoria, etd - Human, S

conditions in the environment. The Butterfly Effect suggests that anything and anyone with whom we interact have the potential power to shape our development in significant ways. In the case of the extracts above, the Butterfly is the mediation that the researcher provides to the learners in the group. In fact, it is the total experience of being in that group that could have affected (or not) the learners who were present. It could be the collaborative nature of the session that promotes an atmosphere of acceptance, the challenge to defend one's reasoning, the absence of criticism, the choice of words – any number of possibilities work together in such a situation and any number of them could have an impact on the cognitive development of the child. When one considers that all these factors are ever-present in a learning situation and can affect learning outcomes in any number of ways, one can begin to appreciate the significance of viewing learning as a non-linear, chaotic phenomenon.

The Butterfly Effect tells us that one cannot know which combination of factors will have effect, and it is very likely that the experience will affect every child in different ways, and therefore it is possible that some children will not be affected by the interaction at all. I will consider this point in greater detail in Section 5.3.2.3 when I examine how mediation might encourage the emergence of complex cognition and evaluate the role of learning dispositions in complex cognition. As we shall see, the development of learning dispositions is an important aspect of cognitive intervention because it may explain why some learners simply do not benefit from cognitive intervention despite ability and opportunity.

Learning as self-organisation is a natural human activity because self-organisation is how the brain organises acquired information from the environment. Creating an environment that encourages the natural inclination towards self-organisation can offer a familiar and non-threatening experience to children as they continue to learn about their world in a more formal manner. It can also offer children exciting and pleasant opportunities to learn, to which children may respond favourably. Emphasising learning as self-organisation places the responsibility for learning on the child and her active role in construing meaning, which may contribute towards the emergence of an internal locus of control where children will choose positive learning experiences because they are inherently motivated to learn.

Dialogue 5.4 from DS9 (Grade 3) will illustrate the principle of self-organisation and motivation:

Dialogue 5.4 **Self-organisation and motivation**

SH Okay, all right. Okay, we're finished for today. Thanks a lot for helping me with this picture.

L Ma'am, can we hear it?

SH I can't wind it back because I have to use it for another group and then I don't know where the end is. That's why I let you listen to your names.

L Ma'am, what's in here?

SH Cards are in here.

L What kind of cards?

SH I can show you the cards, but you have your break and you're missing your break at the moment.

L Ma'am, show us the cards.

L I don't need to eat.

SH You don't need to eat?

L [unclear]…for the whole day.

L [noise, speaking all at once] Play cards, ma'am.

SH Okay, I'm going to look at a card and I'm going to describe it. You must guess what it is that I have on this card.

The researcher and learners continue with this activity until the end of the break, when they have to return to their classes….

SH And now we have to finish. So I'm going to take the next class and I'm going to take you back to your class.

L …it was fun.

SH I'm glad it was fun for you. It was fun for me too and thank you for helping me with the tape.

L Can we keep this? (Learners want to keep the camera cards)

SH Yes, you can keep it.

L Yes!

It was especially encouraging that this group wanted to continue with the session, because they had been very boisterous and generally more difficult to control than the other Grade 3 groups. For example, a word frequency search in ATLAS/*ti* on DS9 revealed 37 instances of laughter and 2 instances of giggling as opposed to 12 instances in DS6 and 8 instances in DS3. Inspection of the text revealed that the instances of laughter in the DS9 group were unproductive, i.e. related to jokes rather than pleasure as a result of learning. Also, in DS9 4 instances of inappropriate shouting and shrieking were coded as opposed to none in DS3 and DS6. The frequency with which learners interrupted the researcher or each other was 6 times for DS6, 5 times for DS9, and one instance for DS3, although one should remember that interruptions occur frequently in groups where the interaction is fairly spontaneous and unstructured.

In terms of chaos and complexity theory, this group session appeared to be more chaotic and one might generally expect such situations to be counterproductive to effective learning. However, the learners' response at the end of the group session perhaps indicate the beginning of an awareness that learning can be a positive experience. Throughout the group session the researcher accepted and validated learners' responses, no matter how inappropriate or frivolous they may have seemed at the time, and expected learners to take responsibility for their behaviour. Learning opportunities which leave children with positive feelings therefore can play a significant role in the development of positive learning dispositions.

5.3.5 Mediation using concrete symbols and cultural signs

5.3.5.1 Mediating attention using concrete symbols

According to Vygotsky (1935/1978), social interactions such as those that are described in Dialogue 5.1 are gradually internalised and transformed through the use of language to become mental operations, i.e the psychological mind emerges from the social interactions that take place on a physical plane.

The quality of the social interactions between people, especially teachers and their charges in the early years of education, can have a significant impact on the quality of mind that emerges. In the transcription from DS1 (Grade 1, Dialogue 5.5) to follow, the researcher harnesses the disorganised problem-solving efforts of the children in the group by introducing concrete materials as a means of mediating the importance of structuring awareness. Here one may also begin to appreciate that accommodation of chaos in learning is not simply about creating uncertainty in learning, but about creating a dynamic balance between unpredictability and predictability so that children can learn to harness the potential of complex situations to learn by. The balance between unpredictability and predictability will differ for each child since such a balance should be created in the ZPD, where a balance is struck between children's established knowledge and skills and their emerging knowledge and skills.

Cognitive intervention that keeps learners in a constant state of uncertainty will be detrimental to children's cognitive development because they never learn how to use chaos productively. Correspondingly, cognitive intervention that never requires children to respond to novel and unpredictable events will likewise lose the potential to help children adapt to a changing environment.

The researcher requested the learners to find out how many black ants are hidden on the poster (10 in total).

Dialogue 5.5 Mediating attentional processes

SH	See how many black ants you can find, there are more than one. Count them, try to find them on the…
Ls	[together] One! Two! Three! Four!
Ls	[others] One! Two! Three!
L	…and five!
L	Hey, we already counted this one!
L	There are one, and two and three…yeah, and four…
L	There are four!
L	There are five!
L	Oh! Here is another one…
L	…and six of them!
L	Here's another one!
L	Seven of them!

Comment Immediately after the researcher makes the request, the young Grade 1 learners impulsively begin to count the ants they see on the poster. Such behaviour is to be expected because young learners still have to learn how to approach tasks systematically. Very soon, the learners disagree about the exact number of ants on the poster and they become aware of the fact that they are counting some ants more than once. However, despite their awareness of the problem they are unable to generate a solution on their own. The beans, which the researcher will refer to shortly are on the table in full view, but the children are not yet capable of recognising on their own that the beans can possibly mediate the solution.

SH How can we make sure? Sometimes we get confused…I'm going to ask you now…sometimes we count one of these and we forget that we counted it, and then we count it again. How can we make sure that we count one and not more than one? Do you think it will help if we take a bean and we put it on the ant so we know that we have already counted it?

Comment The researcher draws the learners' attention to the fact that they are confusing themselves by approaching the task unsystematically. The researcher then proposes an alternative approach which requires beans as a means of mediating selective attention and systematic planning. The moment the learners acknowledge the researcher's suggestion, the beans are no longer just objects, but they are modified to become cultural symbols through which a particular kind of behaviour is internalised.

The beans are therefore transformed in the minds of the learners and they acquire new meaning.

L I know which blue bean goes…
SH Okay, so we know there's one ant. There are two ants…
L …and five ants!
SH [as learners put beans on ants] …two, three, four…(Using language to approach task systematically)
L …and then five…
SH [together with learners] …five…six…
L Where's another one? (Using language to direct own attention)
SH Look, Look…can you find more ants?
L No…this are not ants. (Using language to monitor progress)
L Did you put on the umbrella?
L Where's the umbrella…oh here. (Using language for selective attention)
SH Seven ants…did you find all the ants?
L No! There's a ant.
L No.
SH There's another one on it.
L Where's it?
SH No, I mean…you already put a bean on that one.
L Okay.

Comment The learners' interaction becomes slightly more structured and planful as they go about placing beans on ants they have found. Their interaction with each other becomes goal-directed and purposeful. Individual learners are no longer counting ants individually. The learners are also using their private speech to assist them in directing their attention and monitoring their progress. This extract shows how language and thinking is used to master one's own behaviour.

SH So did we find all the ants? (Using language to monitor progress on a metacognitive level)
L [together] Yes!
SH So how many ants are there?
L [together] One, two, three, four, five, six, seven, eight, nine!
SH Okay, three…
L What about this one? (Using language to clarify exceptions)
SH Nine…Ah! How many are there? No, no, no! Put it back, it was on the board, so it must have been an ant!
L One, two, three, four, five six…
L There are ten of them!

SH Ten ants…okay. Now try to do the same and see if you can find….the blue butterflies.

Comment With the help of the beans as a cultural tool for mediating selective attention and systematic behaviour, the learners are more capable of working together collaboratively and their efforts are more productive. When they master the task, the researcher makes a similar request to give them the opportunity to generalise their behaviour to a new situation.

In trying to find the blue butterflies, the group of learners spontaneously used the beans in order to ensure they wouldn't become confused by counting butterflies more than once. They were able to locate and count the butterflies with less confusion among themselves and only needed one reminder when they were ready to count them.

5.3.5.2 Mediation of systematic learning behaviour using concrete symbols

Once the learners had learned how to use the beans to focus their attention selectively on the ants, they were more capable of systematic behaviour on a similar task. The extract below (Dialogue 5.6) follows their interaction as they attempt to find the blue butterflies:

Dialogue 5.6 Mediating systematic behaviour

L What! What! What! Blue, there's another blue.

L Two…

L That…that's not a butterfly. (Using language to monitor progress)

L It's a butterfly…

SH A blue butterfly. How many have you found already? (Using language to monitor progress)

L [Excited and sing-song while busy with the task] (Child feels competent and suitably challenged)

Comment Helping learners to structure their learning experiences can help them feel confident about learning because they do not feel overwhelmed by the task facing them. Thus far, instead of forcing the learners to approach the task in a certain way, the researcher has only made suggestions at the appropriate times and learners have voluntarily and spontaneously accepted these suggestions. If children believe that they have choices, they are more inclined to develop positive feelings about learning.

L I'm going to use blue, not red. (Using language to direct behaviour)

L A butterfly is blue. (Using language to mediate declarative memory – child is reminding herself to search for the blue butterflies only)

L Where is another one?

L This is not for eating, I know.

SH Uh-uh. No, I painted them so you mustn't put them in your mouth.

L You gonna die.

SH No, you won't die, but maybe you'll get sick. Can you find another butterfly? A blue butterfly?

Comment It appears as if the learners relax more as they carry out the task of locating the butterflies. Because everyone is working collaboratively, it appears to reduce the tension and conflict that could arise in a group where learners focus on their own efforts only. Learners are applying their efforts collaboratively, are working together productively and this allows for other topics of conversation to emerge.

L Blue.

L But this one…

SH Ah, Onkopotse! You found one!

L Awua! This one is not a butterfly!

SH Simphiwe, I can see some butterfly close to you on this side of the picture.

L Oh! Oh!

SH See if you can find it. We don't count this butterfly because this one is not only blue. There's a blue butterfly right in front of you Simphiwe, you are looking at it.

L Ah!

SH Ah! There, Simphiwe has found it! Okay, let's just put that blue bean back. Okay, can you see, that you've covered all the butterflies?

Comment The researcher uses low level mediation which entails drawing the child's attention to an oversight. Only when the child does not use the guidance productively does the researcher offer a higher level of mediation that is designed to offer more specific guidance about the location of the required object.

L [together] Yes!

L I wanna cover this one! (Using language to regulate intention)

L No!

SH Only the butterflies.

L Put that down…

SH So how many butterflies are there?

L [To another learner] Put this down! Put this down!

SH Okay…

L There are four, there are four! One…two…

L Uh-uh! Throw them down, they can count…

L One, two, three…four, [together] five, six.

L Six of them!

Comment The learners have correctly located six butterflies by using the beans as a tool for mediating attention and systematic behaviour. They have succeeded largely on their own and there is evidence that the regulation of the group's behaviour is beginning to shift from the researcher to the group itself as learners decide amongst themselves who should do what.

SH Okay, so she says it's six. Okay, how can we check and make sure that it is six? How can we make sure? Fezile? You have an idea.

L Because…

SH What do you think, Fezile?

L Because…there was butterflies…

L [interrupting and shouting] Butterflies! Butterflies!

L [talking together]

Comment The researcher is introducing another theme central to effective problem-solving, namely checking one's answers. This is done to extend the mediatory use of the beans by using them as tools for the development of metacognition.

SH How are we going to know…

L [interrupting] …on the table!

SH How are we going to know if there are five butterflies? What did we do with the ants to count them? What did we do with the ants?

L [doing something]

SH No, no, no! Listen to what I am asking you. How did we count the ants? What did we do? (Using language to focus attention, mediate memory and structure the task)

L We did take them off.

SH Yes…Okay, so do that?

L I think there are five.

L One, two, three, four, five, six.

SH Ah! There are six! All together…Okay.

Comment After a vague reference by the researcher to the earlier location of ants, one learner immediately recognises the main similarity between the counting of the ants and the butterflies and is able to connect the two experiences.

Whereas the Grade One learners in the extract above needed considerable mediation in order to use external objects as mediators of attention and systematic behaviour, the learners in Grade Three (DS3) were able to effect this tranformation with minimal guidance.

University of Pretoria, etd - Human, S

Dialogue 5.7 will be used to suggest that the ZPD of the learners in DS3 differs qualitatively from the younger learners in DS1:

Dialogue 5.7 Mediating systematic behaviour - continued

SH	Okay, I want you again to work together and tell me how many butterflies.
L	Butterflies?
L	One…
SH	Blue butterflies…sorry….blue butterflies.
L	One…
L	One…
L	One…
L	One…two….
L	Two…
L	Three…
L	Three…
L	[counting together] four….five…five!
L	Six!
L	We counted five butterflies.
L	Five!
L	Six!
L	No! We count it!
SH	You see that you are getting a bit confused because you are counting butterflies that you have counted already?

Comment From the beginning, these learners are less impulsive in their approach, as one might expect of learners who are in their third year of school, but they still make the same mistake that the Grade One learners made when they counted the butterflies on the poster. Young children have to learn to keep track of their attention and visual path while at the same time carrying out the task of counting, a mental feat that requires considerable metacognitive awareness and being able to hold in one's mind's eye the memory of which butterflies have already been counted.

L	Ma'am, let me try!
SH	Do you think it might help if you close one part and you only look here, and you count all the butterflies that you see on this side… (Researcher uses suggestion rather than instruction in order to keep the children responsible for their choices. Also, making a suggestion would reflect a lower level of mediation whereas an instruction would probably represent a higher level of mediation.
L	Okay!
SH	…and then you move on and count the…

L …this side, I know!

L Okay! [talking together] …give me the card…just put a card over there…a card over there…a card over there [covering butterflies with cards as he locates them]

SH That's a clever idea, Thabo! (Positive feedback to help learner associate positive feelings with a sense of being competent and able to deal with challenging learning tasks)

Comment The learners in this group show that they are on a higher developmental level than the Grade One learners because not only is there immediate shared understanding about the purpose of the researcher's suggestion, but learners are able to use that knowledge to transform a card into a tool for semiotic mediation. The cards are used as a tool for the development of metacognitive control.

L Talking simultaneously, one learner suggests putting a bean on each butterfly to know which ones have been counted

SH That's an even better idea! Why don't you try that? Try that!

L Okay, there is…one [taking beans out of container]…[all the learners joining in]…two…[talking simultaneously]….three…

L We'll count them when we are finished, just put over the butterflies.

L It's one…two…three…three…four…

L I saw another one somewhere…but I can't remember where…

L There, I found it!

Comment The intersubjective space that has been created is allowing children to share and build on each other's knowledge so that their problem-solving strategies become increasingly sophisticated. In this case, the researcher has created a situation in which children could be more effective in collaboration with one another than they would be alone. Such collaboration refers to learning in the Zone of Proximal Development.

5.3.5.3 Mediating memory with concrete objects

Whereas Dialogue 5.6 and 5.7 show how concrete objects (coloured beans) can be used to mediate attentional processes and systematic behaviour, dialogue 5.8 illustrates the use of physical objects (make-believe cardboard cameras) to mediate memory by helping learners to create a mental schema of an object.

University of Pretoria, etd - Human, S

Dialogue 5.8 **Mediating memory**

SH	Camel! How are you going to remember it? How will you remember? Shall we take a picture of it?
L	Yes.
SH	Let's take a picture of it. Each one take a camera…There's your camera…okay. Where's the camel? Where's the camel?
L	Here, this one.
SH	Ah, this is a camera. Okay, we put the camel there…and we…click! Take a picture! And we remember it's a….? Camel!
L	[all together] Click!
L	I'll remember!

Comment The children immediately respond to the task of "remembering" a picture by using artificial and external objects. The complex task of creating a mental representation is therefore mediated with the use of concrete, physical materials.

SH	Will you remember? Yes, click your camel. Take a picture of the camel.
L	Click!
SH	Through the circle. What do we call it? We call it a…?
L	Camel.
SH	We call it a camel. Okay…Okay, let's take one more picture. Okay? Uhm…who must have the next one? You must have the next one, because he had the camel. What do you have there?
L	Uhm…kangaroo.
SH	Kangaroo! Does it have a friend?
L	Yes!
L	Yebo, yes!
SH	Yebo, yes! Okay, what do you have?

Comment The researcher repeats the colloquial expression used by one learner as he expresses his pleasure in participating. The researcher has established a safe social space which encourages free expression and some use of home language.

L	[indiscernable because of noise outside room]
SH	It's a dog…what sort of dog is it? A….?
L	Wild dog!
SH	Good for you! It's a wild dog! We must listen to the others, what do we call that one? Tshediso? Did you listen to what she said? [to another learner] Just a second. No, you didn't listen because what were you doing? You were singing a song?
L	[laughing in response]

L Ma'am, I know.

SH No, he's going to first try and remember. Show us the picture? What do you think that is?

L A dog.

SH What sort of dog, you're right, it's a…?

L Wild dog.

Comment The researcher focuses on a learner in the group who has not been participating by drawing him into the activity. Simultaneously, the researcher creates a social space in which children learn that it is important to listen to one another because we can learn from others. The researcher also demonstrates that it is possible to preserve the self-esteem of children by firmly insisting on participation as opposed to forcibly commanding submission.

SH Wild dog. Wild dog. [to all learners] Take a picture of the wild dog?

L [all making clicking noises]

SH And remember it is a wild dog.

L Okay, wild dog.

L Wild dog.

L Let me! Let me! Let me see the picture.

SH It's a wild dog. It's a wild dog. He's got a picture of a wild dog. Okay?

L It's a wild dog!

L I've got a picture of a wild dog!

SH Okay, put the wild dog back again. Put the wild dog back again where it belongs. Okay, I'm going to show one more, I'm going to show one more…

Comment In the exchange above, the researcher encourages children to name the wild dog and she repeats it many times as children focus on the task of taking pictures. It is generally more difficult for children to remember facts in a foreign language than it is for them to remember in their home language, and so the researcher continually uses the name of the wild dog.

As the children use the make-believe cameras to take a picture of the animal on the card, they are re-creating the picture of the animal in their minds and so forming a mediated memory of an object that is not tied to their natural perception, but rather a kind of psychological perception. A mental schema can be recalled in the mind at any time, whether the actual physical stimulus is present or not, and this illustrates the basic distinction between natural and mediated memory as defined by Vygotsky (1930/1978): Natural memory is tied to perception and has an immediate quality to it. Images do not acquire any conscious psychological meaning. Mediated memory, on the other hand, is transformed and

University of Pretoria, etd - Human, S

extended in the minds of the learners as their memories are infused with cultural meanings. Nelson (1996) remarks that most studies of memory in the pre-school years recognise that young children's memories are closer to the natural memory of infancy than to the cultural memory of the school years. Being able to visualise in the mind what one intends with one's behaviour not only is the essential difference between natural (elementary) and cultural (higher) forms of behaviour, but also the source of metacognitive behaviours that allow children to regulate their behaviour by thinking through solutions before choosing and implementing one.

Forming a culturally mediated mental schema of an object is a good example of how children's cognition self-organises from a biological to a psychological form. Here, complexity plays a vital role in the sense that memory can be aided by mental schemas that are rich, connected and complex in their meaning. Complex systems are described as such *inter alia* because there are many varied and rich connections between elements of a system. Memory is vital to effective learning because it is the primary form of all mental representation (Nelson, 1996), but if memory cannot be used flexibly to recall previous and relevant experiences, all new learning remains disconnected from previous experience and children's mental schemas are greatly impoverished as a result.

For example, Nelson (1996) distinguishes between mothers who engage in pragmatic and elaborative memory talk with their children and say that mothers who focus on elaborative memory talk are more inclined to reconstruct memories as stories while inviting their children to co-construct the memory. Mothers who engage in pragmatic memory talk are focused more on practical matters such as where a child has left a toy and consequently not as much social co-construction of memories is evident. It stands to reason that elaborative memory talk might lead to more complex memory systems than would pragmatic memory talk, facilitating the development of complex and differentiated mental representations. Research evidence suggests that verbal interchange between the parent and the child is an important factor in determining whether topics or events become memorable, suggesting that language is very important in the development of mental representations.

In dialogue 5.8 above, the focus of the interaction was pragmatic because children were required to commit to memory the verbal label for an object and there was no evidence of any elaboration of the context. In fact, most of the talking between the researcher and the children may appear to have been pragmatic since there was a great deal of naming of animals on the poster. However, the high frequency of closed questions and guidance on tasks show that elaboration was an integral part of the group interaction. The elaboration mostly took the form of requesting learners to provide reasons/evidence for their statements, asking them to point out similarities and differences between animals or talking about background experiences relevant to the poster.

5.3.6 Language mediation

5.3.6.1 <u>The link between language and cognitive development</u>

It is generally recognised that children's language experiences are an important aspect of children's cognitive development (Nelson, 1996). Vygotsky (1930/1978) asserts that social speech is actually internalised and transformed to become mental functions, thus saying that cognition stems from social interaction mediated by language. Boroditsky (2001) demonstrates that language shapes thinking by showing how English speakers primarily think about time horisontally, while Mandarin speakers think about time vertically. Boroditsky (2000) concludes that this distinction was due to the prevalence of horisontal time metaphors in the English language and vertical time metaphors in Mandarin. Thinking about time horisontally or vertically is more positively correlated with the length of exposure to the first language than length of exposure to the second language.

In a two-and-a-half year longitudinal study of three and four-year old children's talk in the home, Hart (2000) focused on the parent's talk during conversations and came to the conclusion that attention from the parent, the partnership between the parent and child, and the sheer amount of varied and complex talk from adults are important contributors to children's language and cognitive development. Hart (2000) focused on conversations between parents and children, but she recommends that research is also needed to study teacher-child relationships in an effort to discover what expert teachers say to children and to know how to arrange environments, materials and activities that prompt and facilitate talking.

The present study has examined the nature of interactions between the researcher (as expert mediator) and children while engaging in conversation, with the poster as medium. In Chapter Four it was pointed out that questioning emerges as a dominant mediational strategy for engaging children in the discussion, and that closed questions are most frequently used to guide children in their thinking and to encourage systematic exploration of tasks. Open questions are frequently used to engage children in discussion, guide them in their thinking, and to encourage analytical thinking.

University of Pretoria, etd - Human, S

5.3.6.2 Using language to mediate self-regulatory behaviour

Apart from using physical materials to structure learners' awareness, the interaction in Dialogue 5.4 also points to the importance of using language to regulate behaviour. Hart (2000) points out that children's language experiences are important to cognitive development because the complexity of children's language often influences the complexity of others' responses to them. In terms of complexity theory, language is an important instrument for the creation of an environment that is conducive to complex interactions, cognitions and behaviours. In terms of chaos theory, language becomes an import tool by which the apparent chaos of interactions among children in a class can be organised. By requiring children to relate their experiences to a task or problem or by encouraging them to find similarities, patterns and themes in their thoughts and interactions with others, learning becomes a process by which chaos is utilised to self-organise to greater complexity.

Vygotsky (1930/1978) asserted that the transformation of social speech to private (inner) speech is mediated by the use of language which helps children to guide their activities. At first, learners in the group (Dialogue 5.6 and 5.7) randomly shout out numbers, but then there is evidence that some learners are facilitating a focused search by using language to mediate focused attention. When one learners says: "*There is one…two…three…"* (Dialogue 5.7) she is not addressing other learners, but constructing a kind of private, self-mediatory speech that serves to focus her own attention and organise her own efforts. This is in contrast to an adult who would have been able to locate and count the ants on the poster in his/her mind. For the adult, it is possible because attentional processes have already become internalised and transformed to psychological processes. In other words, adults are capable of regulating their cognitive behaviour internally, whereas children in earlier stages of development first have to rely on physical and cultural tools to regulate their cognitive behaviour.

The children in Dialogue 5.7 are in the process of internalising psychological functions by means of physical (beans) and cultural (language) tools. Vygotsky (1930/1978) asserted that the most significant moment in intellectual development occurs when speech and practical activity, previously independent lines of development, converge. Language becomes a tool for mastering the environment and, as a result, the child's relationship with the environment is transformed. This is what we see happening in the moments when children talk to themselves when solving a problem (in this case, locating all the ants on the poster).

University of Pretoria, etd - Human, S

However, not all the children in the study were capable of using language to mediate their thinking. Most of the children who participated in the study were learning in through the medium of English and not their home language. The children's capacity for using English to mediate cognitive processes was sorely limited, and this is where verbal interaction becomes important. Hart (2000) reports that a major influence on children's later conversation in school is the extent to which parents engage their children in activities at a young age while talking about the objects of engagement and pointing out their properties and relationships. Also important are parents' responsiveness to their children's topics, and providing guidance through questions rather than commands. In this study, engagement was an important objective of the interaction between the researcher and the children in the group and it was mostly achieved through questioning children's responses, encouragement to respond verbally and generally creating an environment conducive to varied and complex language usage. In this regard, Hart (2000) points out that optimum conditions for learning occurs when a social dance is created where what one partner says, is governed by that which the other has said. According to Hart (2000), it is the attention, amount of talking and partnership that give naturally occurring interactions their power in shaping children's use of language, and subsequently their cognitive development.

The importance of language in thinking will be examined in Dialogue 5.9 when the researcher wants to know from the Grade 2 learners in DS2 if they know the name of the vulture:

Dialogue 5.9 The importance of language in learning

SH	So do you know the name of this animal yet?
L	[chorus] No! Uhm…
SH	[hinting] Vul…vul…
L	[Guessing something]
SH	Vulture! It's a…vulture!
L	I was gonna say that!
SH	Were you gonna say that? You must say it!
L	Sometimes when you want to say something, you forget what you were going to say!

Comment The frustration that this child experiences reflects an important aspect that should be addressed in contexts where children learn through a language other than their home language. In the extract, some children feel they cannot participate because they do not remember the English word. This particular learner shows good metacognitive awareness of the shortcomings of her own memory system by reflecting on the reasons why she sometimes forgets a word. While it is frustrating to wish to participate and be unable to do so, it is also a disempowering experience when children cannot contribute their experiences because they lack the vocabulary to do so. Over time, children may develop a kind of learned helplessness which may make them approach learning passively. Such passivity does not help children to develop greater complexity and flexibility in their thinking.

L [chorus] Ja!

L Sometimes I get angry…but why did I forget it? And then I start saying it wrong. Let's say for instance I wanted to say bird…I go: bi..bi…bi..bi…Sometimes I learn a word and I say, let's say for instance I say, my jacket. My jacket, my jacket, I forget and then I say, my ja…something like that. (This example suggests the learner is well aware of the shortcomings of her declarative (semantic) memory).

SH So it's frustrating to forget a word. (Empathic response to communicate understanding of frustration when one is learning in a second or third language).

L [talking simultaneously]

SH Olga, what language do you speak at home?

L English.

L No! That is not your real language! (From a young age, language is part of children's identities).

SH Let me just hear what Olga says?

L She speaks Bulgaria.

L Ja, Bulgaria.

SH Bulgarian? Do you come from Bulgaria?

L Yes.

SH Can you give us the word in your language for this bird?

L Uhm…

L [incredulous] You forget your language!

L That's impossible!

L I also do that.

SH Choose, choose any animal on this picture and give us…

L In Bulgarian I must give the name of any animal?

SH Yes.

L Slon.

L Slon.

SH Slon?

L Yeah.

SH For elephant. Are we going to remember? Slon. (Communicates the importance of respecting other languages and cultures by showing an interest in learning them.)

L [chorus] Yes. Slon.

L	Can I tell you in my language what we call this? (points to rabbit) (For the first time in this group, a learner spontaneously offers information that was not solicited by the researcher)
SH	Yes.
L	Lokwatsha. I have many stories about these animals.
L	Ja!
SH	Tell me one story that you know.

Comment The group process takes a new direction the moment the researcher communicates interest in children's home languages and offers them an opportunity to share with others. Actions like these communicate to children that their cultural knowledge and experiences are important and that they too, have something to offer other children. It provides a form of acknowledgement that allows learners to be culturally present in their learning, thereby helping to establish positive dispositions towards learning.

Children may withdraw from participation if they feel unable to express themselves. Lack of communication prevents children from using language to organise their experiences and as a result their cognitive development can be delayed. On the other hand, recognising the importance of children's home language not only facilitates their cognitive development, but can also enhance their feelings of self-worth and serve to develop children's listening and communication skills, as well as encourage respect for each others' cultures.

5.3.6.3 Language, participation and self-esteem

In Dialogue 5.10 (DS5, Grade 2), the researcher is encouraging children to name animals on the posters in their home language:

Dialogue 5.10 Home language and self-esteem

SH	Uh-huh? All of you? All of you think it's about the zoo? Well, all of you are right! It is about the zoo. Tell me, if you can see…what sort of animals do you see on here? What…
L	Ma'am I see a lion!
L	A lioness!
L	Elephant!
L	And a elephant!
SH	Just a second…
L	And a seal!
SH	[attempting to quiet them down] Ah! Ah! Ah!
L	Shhhh!

University of Pretoria, etd - Human, S

SH I know you're excited and there are lots of things…

L Yes.

SH …but let me point to the animals, and then you tell me what they are.

Comment The interaction begins with children randomly shouting out names of animals they recognise. Being Grade 2 learners, they have not yet learned how to regulate their behaviour in a group and so the researcher provides some structure by introducing a gesture as an external cultural device to focus attention and regulate behaviour.

L Lion!

SH What is it called in Sotho?

L Uh…tao!

L [chorus] Tao!

L [laughing]

SH Good, what's this?

L [chorus] A giraffe.

SH Giraffe. Does anybody…who speaks Xhosa?

L Me.

SH Do you know what giraffe is in Xhosa?

L [laughing]

L I speak French!

Comment The researcher begins to encourage learners to participate in their home language and it has quite a remarkable effect as one child eagerly volunteers information about her own language. Recognising the importance of children's home language may do a great deal towards raising self-esteem and encouraging participation. Immediately after the researcher introduces children's home language, some learners begin laughing, perhaps a sign that the introduction of their home language by the researcher is welcomed.

SH Do you speak French? Parlez vous Francais?

L Qui!

SH [laughing] That's all I know, I don't know more French.

L I know Bonjour!

SH Bonjour?

L Yeah.

SH That's very nice!

L Bonjourno.

Comment — Children continue to volunteer information and take risks as they participate in experimenting with their languages. The researcher is careful to provide positive feedback to encourage expression and participation by all learners in the group.

SH — Okay…what do we call a giraffe in French?
L — [saying "giraffe" with French accent]
SH — [imitating] Giraffe? That's good, and a lion? Can you remember what a lion is?
L — No.
SH — You must ask your parents.

Comment — An important issue that can be raised in school contexts where children learn through a medium other than their home language, is the extent to which their home language development suffers as a result of learning in a predominantly English environment, and especially if the use of the home language is not encouraged at school or in the home.

L — …it's my language! I know what's it!
SH — Ah! Ah!
L — N'est ce pas.
SH — N'est ce pas…you don't know?
L — I know!
Ls — [all talking together]
SH — Okay…one, one at a time. Who speaks Xhosa?

Comment — At this point it appears that the participation of children in the group is much more active. Children's home language is part of their cultural identity (…it's my language!) and if they are encouraged to express their cultural identity fully, they develop positive feelings of self-worth and learning becomes an affirming experience.

L — Me.
SH — Okay, what's a snake in Xhosa?
L — Inyoka.
SH — Inyoka. Okay, who speaks Zulu?
L — No one.
L — Me.
L — You! You!
L — I don't speak Zulu. I only speak English, that's all.
L — I know…copycat!
Ls — [fight ensues among some learners]
SH — Hey! [whistles]
Ls — [laughing but quiet]

University of Pretoria, etd - Human, S

Comment In this extract it appears that one particular child has discarded his home language as a tool for learning. He insists on speaking English only and it almost appears as if he is ashamed of his own language. Children who do not grow up with the message that multilingualism is an advantage, may continue to hide parts of themselves. It prevents such children from living and learning authentically and their self-esteem can suffer significantly. In addition, children's cognitive development is hindered because they are unable to use language effectively to organise and represent their experiences symbolically, and also because they tend to withdraw from learning opportunities.

The extract in Dialogue 5.10 shows how the use of children's home language in learning can directly enhance or limit the development of healthy self-esteem, and positive feelings toward learning which can play an important role in the learning dispositions which children develop. In Dialogue 5.11 (DS2, Grade 2) we can see how encouragement to use a home language can affect children's participation in the group:

Dialogue 5.11 Home language and group participation

L …what's it called again?
SH Do you know the Xhosa word? Tell me the Xhosa word.
L [hesitant] No…
SH No, you must be proud of your language, no one will laugh at you.
L Isintaka.

Comment In this exchange between the researcher and a learner, the learner is hesitant to use his home language in the context of learning. Encouragement from the researcher brings positive results. When children in multi-lingual learning contexts are discouraged from using their home language because others will not understand them, children learn that language is an obstacle to learning and this may cause them to refrain from participation.

SH Isintaka?
L Can I tell you what's this in my language?
SH Okay, you can tell me in a second, let's just finish this one. So this one is…
Ls [talking simultaneously]

Comment The researcher's comment changes the interaction between the researcher and the learners as they become willing to volunteer information in their home language. Children can feel empowered if they perceive themselves as the carriers of valuable information. In the extract above the children have knowledge that the researcher does not have. By being willing to learn from the children in the group, the researcher reinforces the message that each child has something valuable to contribute. Children who are prevented from using their home language lack these empowering experiences and they may become negative about learning.

SH [gives a whistle to silence children] Just a second. So this is in Xhosa, isintaka.
L Yeah.
SH Do you know…do you also speak Xhosa?
L No!
SH Do you know the Sotho?
L I know it!
SH Do you know it?
L Uhm…it's leba.
L Uh-uh! Leba is a big bird!

Comment The children become quite loud as they discover that their cultural identities are valued and they are eager to share their knowledge. In the extract above one can see that children become quite comfortable reasoning with one another through the partial use of their home language and English. Children are also able to share similar background experiences as the meaning of words becomes more transparant.

SH What do you think?
L I speak English only.
SH Only English? Okay, do you know the name for that bird?
L It's an eagle!

However, the use of children's home language in learning can also influence learning and cognitive development in a more indirect manner by creating a multi-lingual space which enhances the construction of meaning. As Dialogue 5.12 (DS2, Grade 2) will show, the use of the home language in learning can provide an excellent means for developing language and listening skills.

Dialogue 5.12 Home language and language development

SH Wow! Okay, before we listen to her story…can you hear that when somebody tells a story, there's always a beginning, and then something that happens, and then an end.
Ls [chorus] Ja.
SH All stories always have that.
L But when you know it in your language and you don't know how to say it, there's some words you don't know in English. Like me, I know English, I'm even forgetting Sotho.

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Sotho is my real language because my father speaks Sotho and my mother speaks Tswana. So I'm forgetting Sotho because I'm used to…uhm…

L I talk Zulu.

L …uhm…try to talk…I used to try to talk…another language.

SH Of course you all know that your home language is important…and you must not forget it.

Ls [together talking in their home language]

L Could you tell us in Afrikaans?

SH What would you like me to say in Afrikaans?

L Lion.

L You like to put…[indecipherable]

SH As jy jou neus in iemand se sake steek.

L Oh!

[Learners fighting to have the next turn]

SH She's been waiting a long time…to tell about her…11 o'clock…we have ten minutes.

L It's…I'll say it in my language.

SH Okay, you want to tell about the monkeys and your language is…?

L Sotho.

SH Okay. Let's do this: she will tell the story in her language and one of you…

L I will, ma'am!

SH …you will tell me in English, okay?

L Can I do it, pleeease?

SH Okay, both of you….both of you.

L [Telling story in Sotho]

SH Let her finish?

L [continuing with story]

L …don't speak English because you can't say all of it in English.

L [Finishing story]

SH Okay, the two of you must decide how you are going to tell the story.

L I know! I know!

SH Decide between the two of you.

L I'm going to talk and then she's going to talk…

L Half!

The interaction above illustrates how language need not be perceived as a barrier in linguistically diverse environments, but can be used as a resource in language development. In such cases, children benefit from hearing their own language as well as the language of learning and teaching and they are able to use both for their own benefit and the benefit of others. It gives children a sense of empowerment as they are able to contribute to the group process and are able to use their home language to express themselves.

Allowing learners the opportunity to communicate in their home language also plays a significant role in their cognitive development. Firstly, it is likely that the mere fact that children feel that the use of their home language is accepted in a predominantly English environment will help to create learning experiences that they perceived as more positive. Regarding learning as a positive experience in itself can cause children to seek out additional learning opportunities, which could have a positive effect on children's general attitude about learning and also their involvement in their own learning.

Secondly, children use language to mediate their thinking, to direct their attention, to regulate their learning behaviour and to solve problems. The mediating function of language thus plays a critical role in cognitive development, as was initially pointed out by Vygotsky (1930/1978). Children who are learning in English as the language of learning and teaching (ELoLT), especially if they have not mastered it, have a special disadvantage in the sense that they cannot rely on English to be an effective cultural tool for the internalisation of social speech.

To summarise, Long (2000, p. 204) points out that "language abilities depend on and also support the development of both knowledge and understanding, which are the main determinants of children's educational progress." Encouraging children who are learning in ELoLT to use of their home language thus may provide much needed additional support.

5.3.7 Mediation and dynamic adaptation

When the researcher mediated the construction of knowledge on the design experiments, she purposefully influenced the interaction among learners and between learners and the poster in order to structure the experience so that some aspects were more salient than others. In doing so, the researcher required learners to respond to new experiences by adapting to them and then assisting them to adapt. However, as Vygotsky (1935/1978) notes, stating that learners are capable of doing more in collaboration with others than they can on their own, does not automatically mean that they can learn to do anything. There are limits to what learners can master and these limits are determined by that dynamic region of sensitivity, the ZPD, which is qualitatively different for every person.

Mediation for self-organisation can only be effective if it is directed at the ZPD of the learner, and if it is aimed at creating disequilibrium by introducing anomalous information. In the present study, the researcher made extensive use of questioning to achieve this goal. The way in which open and closed questions were used in the study was related to the level of mediation that was required in the particular situation. Open questions generally offered less support than closed questions because they did not focus learners' attention on salient aspects of a task as much as the closed questions did. In Chapter Four, I mentioned the three basic functions of open questions as (1) engaging children in discussions, (2) guiding children in their task execution and (3) focusing on analytical thinking. The functions of closed questions were (1) guiding children in their thinking and task execution, (2) engaging learners in discussion, and (3) encouraging systematic exploration of tasks.

However, the basic functions of open and closed questions do not reveal to what extent they might have revealed different levels of mediation required by the researcher. For example, on an intuitive level, it may appear as if open questions could represent a lower level of mediation since they do not provide much guidance in terms of how learners should structure their responses. But mediation is not just about structuring learning experiences, and so it is conceivable that open questions could also provide a high level of mediation. For the same reasons, it is unwise to assume that closed questions necessarily reflect higher levels of mediation. Similarly, the researcher's interaction with the children did not take place exclusively in the form of questioning, there may also be other utterances that would reveal differentiated levels of mediation.

Generally, mediation requires the mediator to offer as little support as is necessary for a child to complete a task competently. It is only when the child does not benefit from a low level of support that more support is given. Mediation requires a fair amount of flexibility from the mediator as she responds to rich points that emerge and that can be used for higher level problem-solving. Figure 5.4 shows the assumed relationship between the level of mediational support and learners' competence on a task.

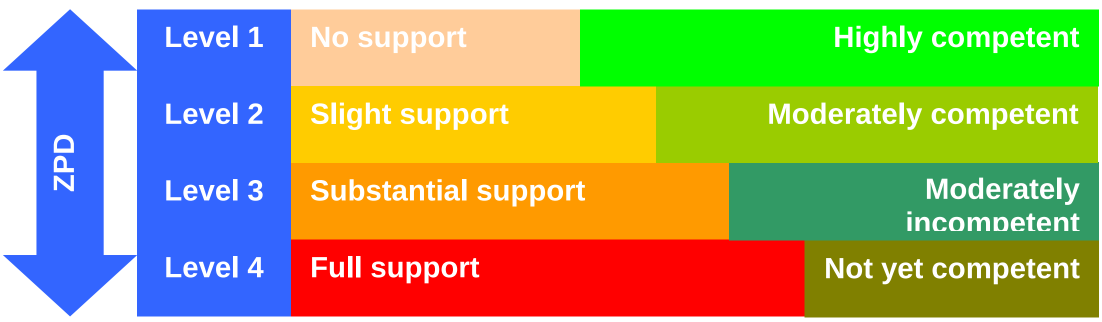

Figure 5.4 The relationship between mediational levels and competency levels

In order to examine the relationship between the various levels of mediation offered by the researcher and the competency levels of the learners, I will analyse some of the interaction that occurred between the researcher and the children in the group sessions. The first dialogue, 5.13, is taken from DS7 (Grade 1).

Dialogue 5.13 Levels of mediation

SH Just a second, just a second, only one person, only one person at a time. You wanted to know why people kill animals, and Adi wants to tell us why. (Instruction, full support in terms of self-regulatory behaviour) So why do people kill animals? (Open question, slight support offered in terms of analytical and critical thinking)

L Because when they are hunting animals…animals are having fun…playing…behind the house or somewhere next to the house. Then people get angry, then some of the people…kind human beings come and take them, then they take them to the zoo, then those kind people take care of them at the zoo. (Correct answer in terms of animal conservation, but inappropriate in context of hunting.)

SH Yes…Why do we kill animals? (Open question, slight support calling for evidence)

L Because, animals they doesn't have food. (Inappropriate answer)

SH Do we kill animals because they don't have food? (Closed question and repetition of child's response, slight support)

L Yes!

L No! (Appropriate answer that requires further investigation)

SH No…why do we kill animals Zindzi? Why do we kill a buck? What do we do with animals that we kill? Yes? (Open question, slight support to another child followed up by a closed question, substantial support in terms providing a clue, i.e. "what do we do with animals we kill?")

L When they kill the…hmmm, the….animals, they….they eat them… (Appropriate answer)

SH Yes, we kill animals because we eat them! (Accepts answer, no support needed)

L Because they're hungry, ma'am! (Elaborates on preceding response)

SH Who's hungry? The people that eat them? (Closed question, substantial support because the answer is implied in the question)

L Yes, ma'am.

SH Where do we get the meat that we eat, in the shop? It's animals that were…? Killed! (Open question, substantial support because answer is implied in previous interactions, followed by a statement of fact which offers full support in the form of the answer)

L ….killed!

SH Okay…Some people also kill animals for fun. Did you know that? (Closed question, full support because question is preceded by a statement of fact)

L Yes, ma'am.

SH Okay, they just hunt the animals. So you can kill animals because you… (Statement, full support, facts are stated)

L …some people kill them [rest unclear]

SH That's right, so they kill them because they want to defend themselves. (Confirming response, no support) Okay…they are scared the animal is going to kill them, and…if you see a lion, and the lion is coming at you…Will you try to kill him, or not? (Closed question, substantial support because the answer is implied)

L No.

SH No? (Repetition in the form of a one-word prompt, slight support that calls for a justification of the preceding response)

L I will be kind to him. (Inappropriate answer)

SH Do you think he will be kind to you? He will eat you. (Closed question, substantial support with answer implied, followed by a statement of fact, full support)

L Huh?

SH Yes, animals…lions are wild, and lions are dangerous. (Statement of fact, full support)

L Yes, if you see like a lion, don't run away…but just stand still and call somebody else. If somebody can't hear you, you must just stand, and then you run away. (Elaborates on response and provides new information)

L It…it will run…

L …looking at you!

SH Okay, what do you want to say? (Open question, no support aimed at engaging another child in the discussion)

In dialogue 5.13 it is evident that the interaction that took place required different levels of mediation although much of the support reflected level three (substantial support) and four (full support) mediation.

Level one (no support) mediation was evident when the researcher simply accepted an answer, confirmed a learner's response, or invited a child to participate in the discussion. Level two (slight support) mediation mostly took the form of open questions that focused on eliciting particular cognitive skills such as analytical thinking, and also included questions that were formulated to repeat a part of children's responses. Level three (substantial support) mediation was mostly associated with closed questions in which either a clue was offered or the answer was implied. Level four (full support) mediation was associated with instructions (focusing on self-regulatory processes) and a statement of fact from the researcher.

Dialogue 5.14 (DS9, Grade 3) provides some additional examples of various levels of mediation in the interaction between the researcher and the learners. The illustrations in Figure 5.5 provide the context for the interaction where the researcher requires the learners to work out how many animals there would be if the two leopards are put in the cage with the lions. Along with the lions in their cage is an oversized ant crawling up a tree, a snake on the ground, and a porcupine. The snake in the tree in the upper right hand corner appears to be in the cage, but is not.

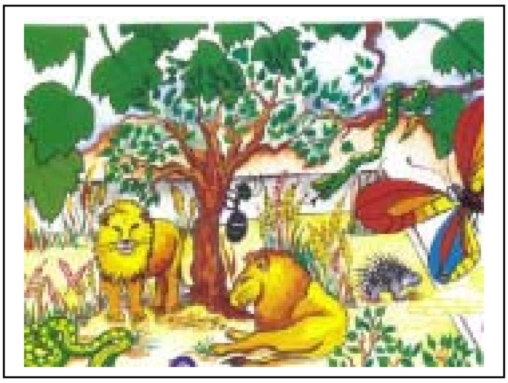

Figure 5.5 Leopards and lions

Dialogue 5.14 Levels of mediation - continued

SH Okay. Listen to this question. There are two lions in this enclosure. (Instruction, full support to focus attention)

L Enclosure.

SH One lion, two lions. (Modelling of systematic behaviour, full support) Okay, or cage…let's call it a cage. There are two lions in this cage. If we put – if we take the two leopards and we put them also in this cage, how many animals will we have? (Closed question, slight support because only an answer is required) And I want all of you to work together and when everybody has agreed on the answer then I want Refilwe to tell me what the group's answer is. (Instruction, full support in terms of task requirement) Okay, there are two lions in the cage if we take the two leopards and we put them all in this cage, how many animals will we have? I'm only going to listen to Refilwe. You just talk to her and you must see if all of you agree on what the answer is. (Substantial support, instruction given about process to be followed)

L Four.

L Four!

L Four!

L I don't think so, ma'am.

SH Tell me what you think. (Instruction, no support, learner is simply requested to voice her thoughts).

L Here, four animals. (Learner is busy assimilating information by stating how many animals are in one cage)

L 1, 2, 3, 4, 5, and then 6, 7. 8. (Incorrect response since learner is counting an ant which appears to be in the cage, but is not really)

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SH Ok, if we put 2 leopards in this cage how many animals will it be … (Repetition of question, slight support)

[Noise from outside makes recording unclear]

SH Okay, if we put two leopards in this cage, how many animals will there be? (Repetition, slight support)

L Four.

L One, two three four five six..

L Four!

L Five!

[noise as all learners count on their own]

SH Okay, do you have an answer? (Closed question, no support as researcher requests an answer) Do all of you agree on the answer, Refilwe? (Closed question, slight support as researcher requests an answer) Okay, Refilwe, what's the answer?

L Eight. (Incorrect answer)

SH Eight? Tell me how you worked that out? Tell me how all of you worked that out? (Open request for information, slight support)

L [speaking together – laughter]

SH Maselilo…Maselilo. Okay, how did you work that out? (Open question, slight support, request for procedural knowledge)

L I counted. (Appropriate answer, but vague)

SH Which animals did you count? (Closed question, substantial support because question requires specific information)

L I count these two ma'am, plus this..this…this…this.. (Provides appropriate information and reveals his error)

SH And how many is that? (Closed question, substantial support, request for specific information)

L One, two, three, four, five, six, seven, eight.

SH But it's not inside, can you see? (Closed question, substantial support, drawing attention specifically to discrepant information which will form part of the answer)

L Yes, ma'am!

SH Is this ant inside that cage? (Closed question, substantial support, answer is implied from preceding interactions)

L [chorus] - No, ma'am!

SH We only want to know about the animals in this cage. (Statement of fact, full support)

L Five.

L Five.

SH And we put them in there. (Statement of fact, full support in terms of systematic behaviour)

L Seven.

SH Okay, do all of you agree it's seven? (Closed question, full support, answer is provided)

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L [together] Yes!

SH So you see, sometimes when you have to work out an answer, that it's very easy to shout the answer out very quickly and you think you have the right answer. And then in the end you don't. (Statement of information, full support) So what do you have to do when you work out a problem? (Open question, substantial support, change focus of inquiry from domain knowledge to procedural knowledge)

L Think.

SH What do you say, Maselilo? (Open question, no support, inviting participation)

L See properly.

SH See properly? And you, Nosipho? (Open question, no support, inviting participation)

L Ma'am, I think you have to think before you say the word.

SH Okay.

L That's why we like saying: Think before you speak.

SH Yes. Yes, Itumeleng? (Open question, no support, inviting participation)

L You have to count the animals.

SH You're right! You have to count the animals. Otherwise you can't calculate how many there are. (Statement of fact, full support) Okay? Very good! Just one more and this is then Koketso's answer.

In the dialogue above, level one mediation (no support) was mainly given in the form of open questions that merely invited learners to participate in the dialogue, but also with a closed question where an answer was requested, and with an instruction that required the learner to verbalise her thoughts. Level two mediation (slight support) was characterised by closed questions that either required or implied an answer, and open questions. Level three mediation (substantial support) was mainly characterised by closed questions aimed at eliciting specific information or focusing learners' attention on aspects of the task. Whenever a question was asked in which the answer was implied or where only the correct answer could be given, it could be characterised as level three mediation (substantial support). Level four mediation (full support) was characterised by instructions to focus on particular aspects, modelling of certain behaviours of statements of fact in which the researcher imparted information or provided an answer.

On the basis of the analysis of the dialogues above, one can now begin to conceptualise in greater detail how the quality of mediation emerges from the interaction between the mediator and the learner. This qualitative description of the mediational levels is contained in

Figure 5.6.

Level of mediation	Qualitative description		Level of competence
	Mediator characteristics	**Learner characteristics**	
Level One No support	No support is needed. Mediator's involvement is characterised by facilitation rather than mediation, where learners are invited to participate, or requested to voice their opinions and thoughts.	Learner able to focus attention; needs no help to complete a task; only occasionally requests help; mostly works systematically; little evidence of impulsivity; able to provide appropriate answers and elaborate on responses; use of ELoLT is appropriate in terms of age and developmental level.	Highly Competent
Level Two Slight support	Support consists mostly of one word reminders or prompts; a strategic question is sufficient to guide learners' execution of tasks; learner knows the steps to solve a problem, but needs occasional prompts; solutions only have to be initiated; only draw attention to mediational materials; repetition of questions and instructions.	Learner able to focus attention long enough to complete a task; asks for help when an obstacle is reached; can readily see mistakes with help of mediator; evidence of systematic approach to task; beginning to curb impulsivity; responds appropriately to broad questions; use of ELoLT is more fluent and longer, more complex sentences are used.	Moderately Competent
Level Three Substantial support	Support consists of guiding learner step by step in solving a problem; solutions have to be suggested by focusing leaner's attention on discrepant data; mediator has to show learner the steps needed to solve a problem; show learner how to use mediational agents; frequently engaged in confrontations with learners; has to repeat questions often.	Learner only able to focus attention with support from mediator; distractible but able to focus for a short while; able to correct responses with help of mediator; able to stay on task only with help; able to explore tasks or work systematically only withs support; able to respond appropriately to questions requesting specific information; has mastered basic English vocabulary but is restricted to short, simple sentences.	Moderately incompetent
Level Four Full support	Continuously directs learners' attention to task at hand; helps learner to focus attention with mediational agents; frequently brings learner back on task; has to provide answers; shows learner systematic and organised approach to task; has to reprimand the learner frequently, shows learner step by step how to execute tasks; has to solve problem for the learner.	Learner not able to focus attention or inhibit impulsive behaviour; distractible; incorrect or irrelevant reponses; guesses answers; avoids tasks; copies from other learners; inadequate comprehension and/or expression of language of instruction; lack of exploratory behaviour; low risk taking; unsystematic and disorganised approach to tasks; no interest in learning	Not yet competent

Figure 5.6 Qualitative description of mediational levels

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The description of the mediator characteristics in Figure 5.6 summarises the behaviours that require the mediator to show differential levels of involvement depending on the competency of the learners. The differences between facilitation and mediation are captured more clearly when one compares the mediator behaviours associated with Level One, that requires no support, and Level Four, that requires full support. The mediator behaviours associated with Level One assume that the learner is highly competent in carrying out a particular task, and therefore the mediator's support is geared toward enabling the learner to participate by creating the conditions that will make this possible. This hands-off, more passive support is more consistent with teaching as a process of facilitation than it is with teaching as a process of mediation. On the other hand, the mediator behaviours associated with Level Four describe the role of the mediator as being more actively involved in influencing the learner's behaviour. When the mediator is actively involved in structuring activities, directing attention to aspects of a task or solving a problem for a learner, the mediator is placing herself between the task and the learner where she plays a more directive role in the child's construction of meaning because she is purposeful in the kinds of aspects she wants to make salient.

If learning is viewed as a process of self-organisation in which the child actively construes meaning, mediation of learning is likely to involve all levels of support at one stage or another. As coherent patterns of self-regulated behaviour emerge in the course of learning, children will develop different learning needs and the mediator will probably find herself responding differently to these needs.

When mediation is focused on providing support that is only associated with a particular level, it may be quite likely that the teacher is not being responsive to the child's learning needs and is probably not creating the conditions necessary for the learner to respond flexibly to her environment.

6. SUMMARY

I began this chapter by articulating some assumptions about cognition as a complex and chaotic phenomenon. It was stated that cognition, as emotional and personality, are psychological constructs that emerge from a complex physical organ, the brain. The physical, psychological and social realms of human experience were discussed as increasingly complex ways of being in the world with the understanding that each emerging level of the system mirrors the complex organisation of the preceding levels, but with still greater complexity.

The most notable features of complex and chaotic systems are their sensitivity to perturbations, and the rich connections that exist among the elements in the system, which make self-organisation possible. The sensitivity and richness that exist in the brain is perpetuated in the psychological system through interaction among processes of emotion and cognition and personality. In respect of the sensitivity of the system, I have indicated how the interaction between the researcher and the children in each group were responsive to the researcher's and children's interpretation of the situation, salient aspects of their life experience and stimuli inherent in the poster. Although the group sessions followed a basic procedural framework, the researcher was responsive to the knowledge and experience that children brought with them. It necessarily meant that a child could change the direction of the researcher's enquiry completely by a simple observation or comment. Sometimes, such comments were intentional, such as when a child was interested in something other than what was being discussed. At other times, the comments arose from children's personal experiences as they related these to the group. Sometimes comments were off-task and reflected the child's distractrability.

The richness of the children's connections was evident on different levels. Firstly, on an intrapersonal psychological level, children made emotional connections with themselves, with other children and with the role that learning plays in their life by disclosing their feelings about themselves, other learners and their personal experiences. On an interpsychological, social, level, children related experiences about other children, their teachers and their parents, and experiences at home that pleased or displeased them. At best, connections such as these are often viewed by teachers as the necessary background against which thinking takes place. At worst, such connections are sometimes viewed by teachers as irrelevant or as something that only distracts learners from the important task of thinking. However, rarely do teachers acknowledge that these connections are necessary for children's complex thinking to emerge. A linear approach to cognition that promotes an algorithmic view of thinking where solutions or outcomes can be predicted, is not flexible and connections outside of those made in the cognitive system are usually regarded as noise that could detract from clear thinking (Potter, 2000). Within a theoretical framework that emphasises complexity and chaos, such connections help to establish the coherent behaviours that contain the "hot" and "cold" cognitions necessary for self-regulated learning (Paris & Paris, 2001).

On the other hand, a non-linear approach to cognition actually seeks out the "noise" (chaos) which ensures the adaptive flexibility that enables self-organisation. When children were

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attending to only one dimension of a problem-solving task, the researcher made them aware of other dimensions. In each case, the researcher's mediation was targeted at structuring the situation so that the children would re-examine their thinking, verbalise it and subject it to the opinions of others in the group.

Discussion proved to be invaluable to create a learning environment in which children could organise their learning. Specific mechanisms that were used by the researcher to encourage the accommodation of complexity and chaos were for example the use of *open questions* that required learners to organise their thoughts and represent their knowledge verbally, the use of *elaborative responses* in which the researcher extended learners' responses and used them as a basis to further the interaction, and the presentation of *ambiguous information* so that learners would re-examine their beliefs. However, the accommodation of complexity and chaos in cognitive intervention is not just about inviting ambiguity, chaos and disequilibrium.

Structure is important in creating a dynamic balance between periods of growth and integration. In terms of the researcher's interaction, structure was provided by using language as a mediatory tool to focus learners' attention on salient aspects of the task and to structure tasks so that learners would not be overwhelmed. To this end, concrete materials were also used to anchor psychological functions in physical experience. During such activity, the learners showed how they began to use private speech as a means of approaching tasks systematically, directing their attention, monitoring their progress, selectively attending to certain aspects of a task and creating metacognitive awareness. Thus, it was possible to see how children used language to create a sensitive balance for themselves as they explored certain activities.

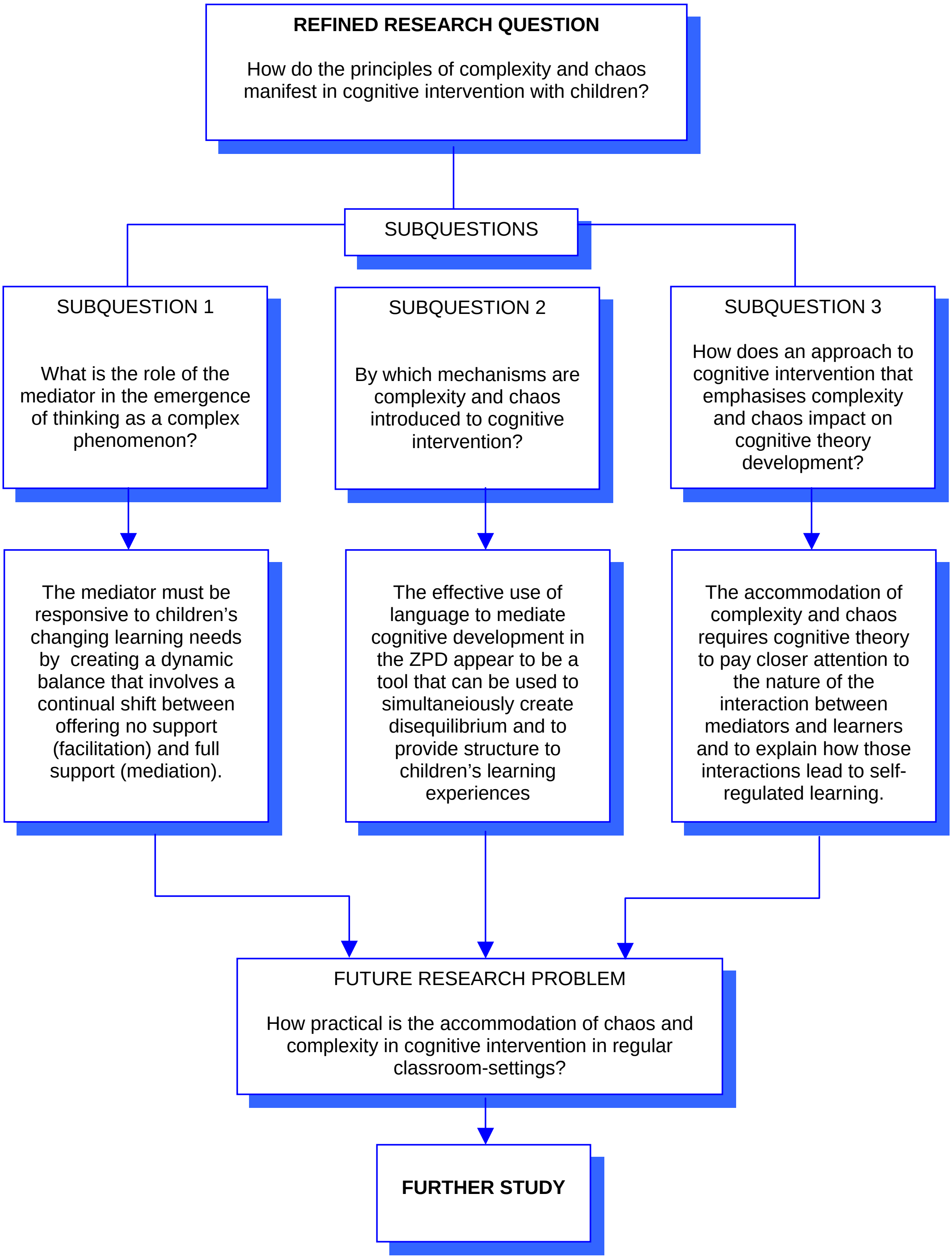
Certainly one of the most important aspects of accommodating complexity and chaos in cognitive interventions with children, lies in the way it views the role of children themselves in learning. Complexity and chaos allows children to be viewed as active agents of their own learning who have their own knowledge, skills and resources to construe meaning. Instead of acting upon the child and imposing specific problem-solving strategies on the child, the mediator who accommodates complexity and chaos allows children to negotiate the terms and boundaries of their problem-solving. It promotes a sense of self-efficacy as children learn that they can act upon and shape their environment through their participation and this is important in the development of self-regulated learning (Paris & Paris, 2001).

Having indicated throughout the interpretation of the interaction in the group sessions how the accommodation of complexity and chaos and consequently, a view of learning as self-organisation brought about positive learning experiences for children by creating a safe psychological environment in which children could respond, question, disagree, argue and reveal themselves, some questions still remain. How do these experiences impact on children so that they might become self-regulated learners?

Self-regulated learning involves skill and will, the propensity to choose and use behaviours that are called self-regulatory (Paris & Paris, 2001). Some children tend to become self-regulated learners while others do not. It was evident from the learners' general level of participation in the group sessions that they found the experience to be a rewarding one. However, it is difficult to say at this point why this was so. Was it the relatively unstructured nature of the group session? Was it the encouragement to use home language in learning? Perhaps it was because the researcher accepted most responses, even partially correct ones, to acknowledge learners contributions. It may also simply have been the fact that learners had been pulled from their regular classes and were enjoying the novelty of the learning task.

Meta-narrative 5.3 summarises the the main research questions and subquestions that directed Chapter Five.

META-NARRATIVE 5.3



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CHAPTER 6

Summary and future directions

6.1 INTRODUCTION

The emphasis throughout this study was a reflection of the research process as a flexible, emerging narrative about cognition and cognitive intervention. The preservation of complexity and integration, and therefore coherence, have been important features of the entire study.

The study began with an initial research problem which led to the formulation of the initial research question. In subsequent chapters, the conclusions that were drawn at the end of each chapter was presented in the form of a refined research problem. The refined research problem led to a new research question, new conclusions and more refined research problems. The emerging nature of the research was guided by the meta-narratives presented at the beginning and end of each chapter.

The process of reflecting the emergent nature of the research will be continued in the current chapter. As the research is summarised, conclusions that were drawn throughout the study will be revisited, selected findings will be presented and where necessary, limitations will also be addressed. Finally, future directions in the study of children's learning in formal contexts will also be addressed.

6.2 SUMMARY

In the present study the initial research problem was an observation that children who receive cognitive interventions do not necessarily become self-regulated critical thinkers. The research problem led to the initial research question which was formulated as: How do we develop children as self-regulated, critical thinkers?

The initial research question led to a refined research problem and the refined research problems generated more research questions which were accommodated in each chapter of this study.

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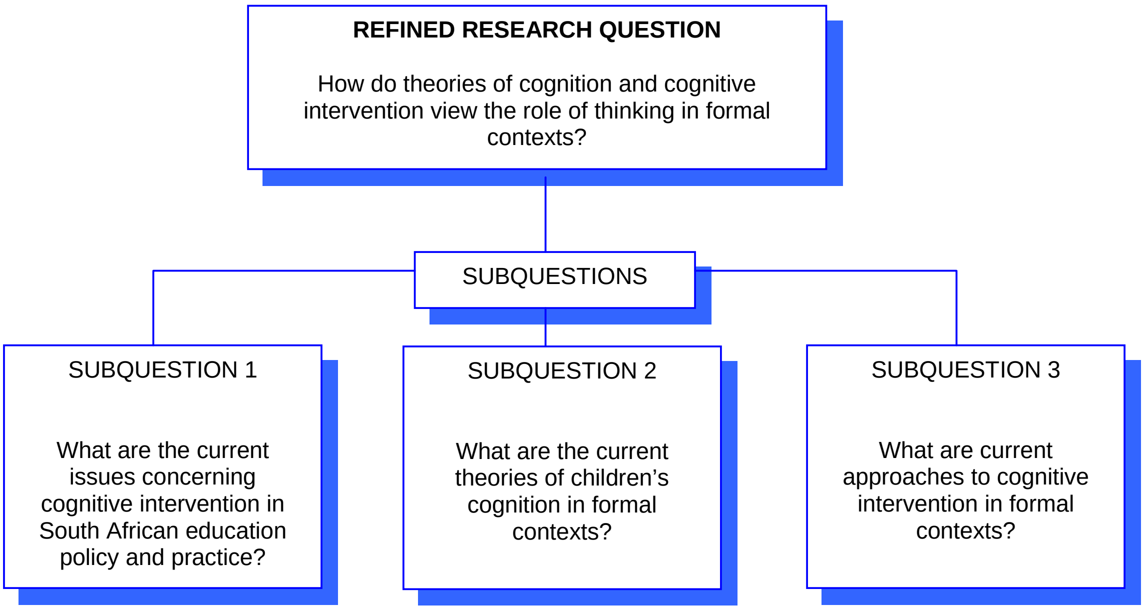
In *Chapter One*, the research question was formulated as follows:



An examination of current issues in children's thinking in formal context within a South African context revealed that cognitive intervention in formal contexts in South Africa appear to be inadequate and related to the problematic nature and implementation of outcomes-based education in South Africa, as well as a legacy that left many teachers demoralised, undertrained and inadequately prepared for their role as mediators.

In terms of the psychological theory that informs educational practice, it appeared as if current theories of children's cognition in formal contexts are generally characterised by a lack of a unified theory, while cognitive intervention approaches seemed to be fragmentary, incoherent attempts at teaching children thinking. All of the above issues led to the conclusion that, for cognitive intervention to be effective, it would require a unified theory of cognition that would address the complexity of cognition. This research problem led to the research question that was addressed in *Chapter Two.*

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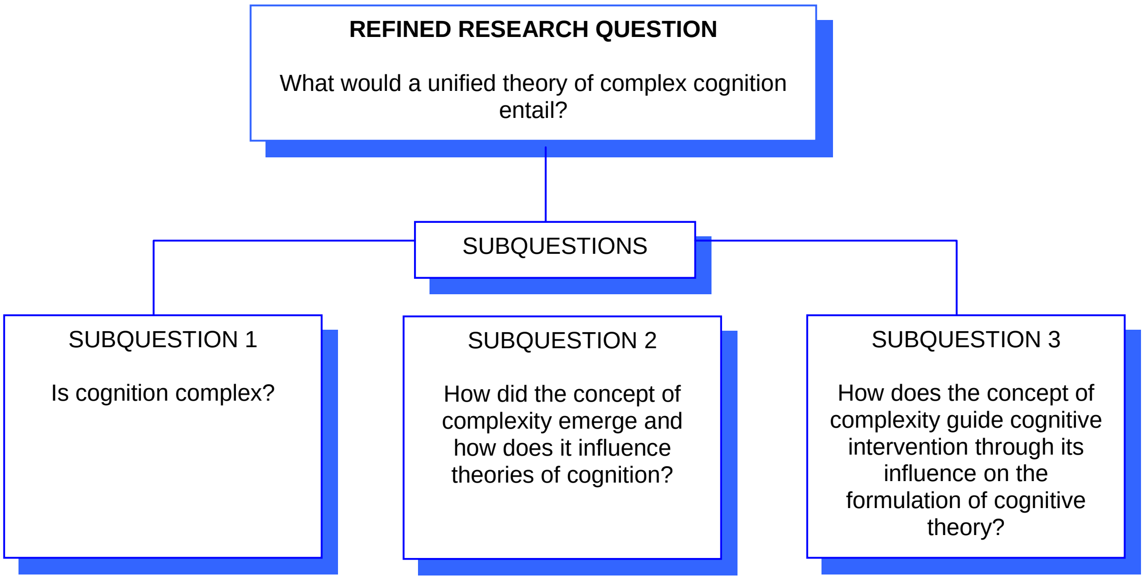
In *Chapter Two* the research question was formulated as follows:



An examination of current theory on cognition revealed that cognition not only appears to be complex, but chaotic as well. An examination of complexity and chaos revealed an interesting relationship between the disciplines of physics and psychology insofar as theory development in psychology is concerned.

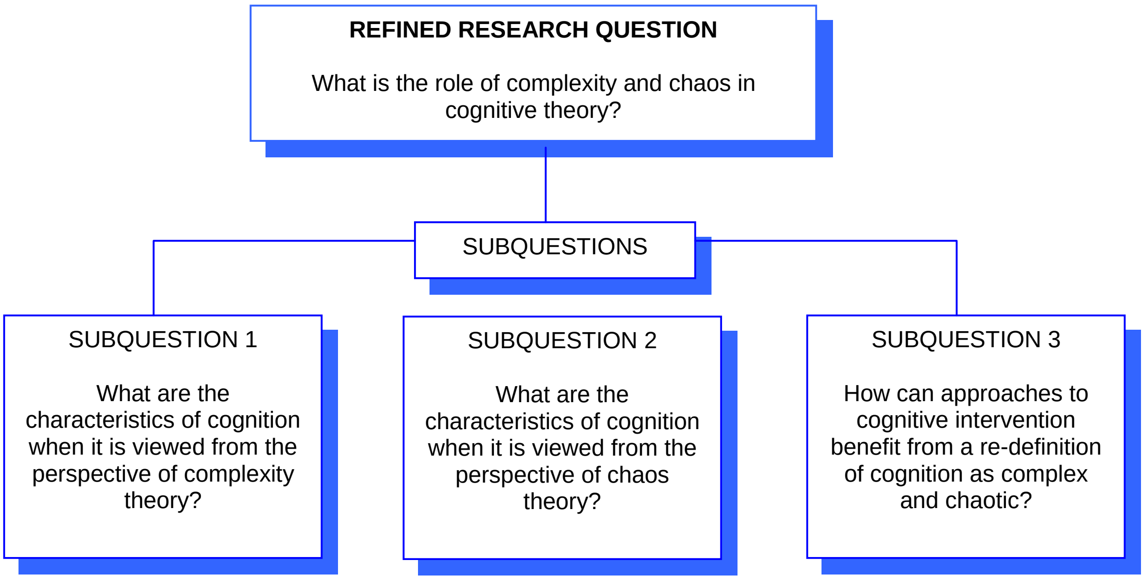
Although an examination of major developments in physics may appear to be irrelevant in the context of this study, it proved to be necessary for several reasons. Firstly, as human beings we are part of nature, physical organisms that inhabit a physical world, and we are subjected to the constraints the physical world as much as any other natural organism is. For that reason alone, it makes sense that it would be important to have knowledge of physical science. Secondly, with the emergence of the mind, human beings have transcended their physical nature by constructing a psychological world that contains our thoughts and beliefs. Perhaps it would make sense then that psychological theory development would be strongly influenced by theories in the physical sciences. Thirdly, in the context of this study, the meaning of complexity has undergone considerable change in the past thirty years as a result of recent developments in the natural sciences. It is crucial that psychologists take note of this important shift in meaning because it affects the way we view people in their various contexts, and the way people change in their contexts.

Unfortunately, mainstream cognitive psychology still views cognition as a linear and predictable phenomenon. Current approaches to cognitive intervention do not appear to deal effectively with

University of Pretoria, etd - Human, S

the complexity inherent in cognition, an observation which led to the formulation of the research question that was addressed in *Chapter Three*.

In *Chapter Three* the research question was formulated as follows:



Current literature on complexity theory and chaos seem to indicate that cognition is a phenomenon that emerges over time as a non-linear, open system, and is characterised by an absence of equilibrium while a dynamic interaction between a vast number of elements make change in cognition as complex system, possible. Furthermore, cognition also shows a sensitive dependence to initial conditions within the system as well as the remarkable ability to self-organise in dynamic adaptation to an unpredictable environment.

In the context of cognitive intervention, a definition of cognition as complex and chaotic suggests that cognitive intervention should emphasise openness to change and ambiguity. What ambiguity and openness to change could mean in the practical context of research and intervention would require an innovative approach to the study of children's thinking, especially because complexity and chaos demand flexibility. This was the research problem that led to the formulation of the research question which was addressed in *Chapter Four.*

University of Pretoria, etd - Human, S

In *Chapter Four* the research question was formulated as follows:

REFINED RESEARCH QUESTION

Which innovative research methods can be used to investigate the complex and chaotic nature of cognition in cognitive intervention?

SUBQUESTIONS

SUBQUESTION 1

Which research method could simulate cognitive intervention in formal contexts, without reducing the complexity of the phenomenon of cognition?

SUBQUESTION 2

How will the choice of data collection method encourage the natural expression of the complex and chaotic nature of cognition?

SUBQUESTION 3

Which data analysis method(s) will be sensitive to the complexity of the data and allow the data to be analysed without reducing their complexity?

The innovative research methods required by complexity and chaos led to the creation of research materials that would reflect a complex world with complex relationships. In Phase One of the research, classroom observations were made and the Mediational Behaviour Observation Scale (MBOS) was especially designed for this purpose. Phase Two of the research was carried out in an intervention context by means of a design experiment. It was particularly important that methods were used that would encourage rich and meaningful discussions between the mediator and the learners so that the expression of complex thinking processes would be encouraged.

The researcher acted as mediator in all group sessions with learners and although this may limit the validity of the findings for other contexts, such as classroom settings for example, there were good reasons why the research was not conducted in a classroom setting. The exploratory nature of the research required a very specific context in which certain conditions could be ensured.

Firstly, since the study is about chaos and complexity in cognitive intervention, it was important that the data actually reflected a process of cognitive intervention and that behaviours associated with chaos and complexity was accommodated. In regular classrooms, cognitive intervention efforts are often constrained by interruptions, administrative duties and other teaching activities which are required but do not necessarily constitute cognitive intervention or provide opportunity for cognitive intervention (copying letters, singing songs, learning rhymes).

University of Pretoria, etd - Human, S

Secondly, the popular view of the teacher as facilitator very often create classroom conditions in which much group work is being carried out and where the role of the teacher is one of coordinator rather than mediator. In the context of this study, some periods of classroom observation indeed reflected very little cognitive intervention from the teacher because the focus was more on the timely completion of required tasks. Thirdly, cognitive intervention in this study is defined to reflect not only cognitive intervention which takes place in the context of teaching, but also includes dedicated cognitive intervention efforts that are often addressed separately from the school curriculum.

In terms of the data-analysis, it was important that the complexity of the data would be preserved and for this reason the analyses focused on describing the emergence of patterns in the data. The data categories of the MBOS were used to guide the data-analysis. For this purpose, *ATLAS/ti*, a computer programme for qualitative data-analysis was used. The MBOS categories were created as codes in *ATLAS/ti* and they were then used to code the researcher utterances. To enhance the reliability and validity of the data, verbatim transcriptions of the actual interaction between the mediator and the learners were made and re-coding and intra-coding consistencies were calculated. The re-coding consistencies ensured that the subsequent analysis of patterns would enable reliable conclusions to be drawn, whereas the intra-coding consistencies helped to refine the MBOS by indicating which categories may have been flawed, poorly described or impure. As such, the examination of the intra-code consistencies could perhaps be likened to factor analysis which resulted in some codes being merged and others being rejected. This data were used to construct a revised and shortened version of the MBOS. However, despite the MBOS being shortened it still requires the researcher to code 26 categories during an observation session. For this reason, the MBOS is probably more suited to judging electronically recorded behaviour than live behaviour.

Some of the more important results of the data-analysis on the design experiment indicated that when complexity and chaos is encouraged in cognitive intervention, some of the mediator behaviours that are most likely to be observed are the following:

- Guidance in the way learners execute tasks
- Closed questions
- Attempts to engage learners in group discussions
- Modelling or requiring learners to explore tasks systematically
- Positive interactions such as acknowledging responses or praising learners

University of Pretoria, etd - Human, S

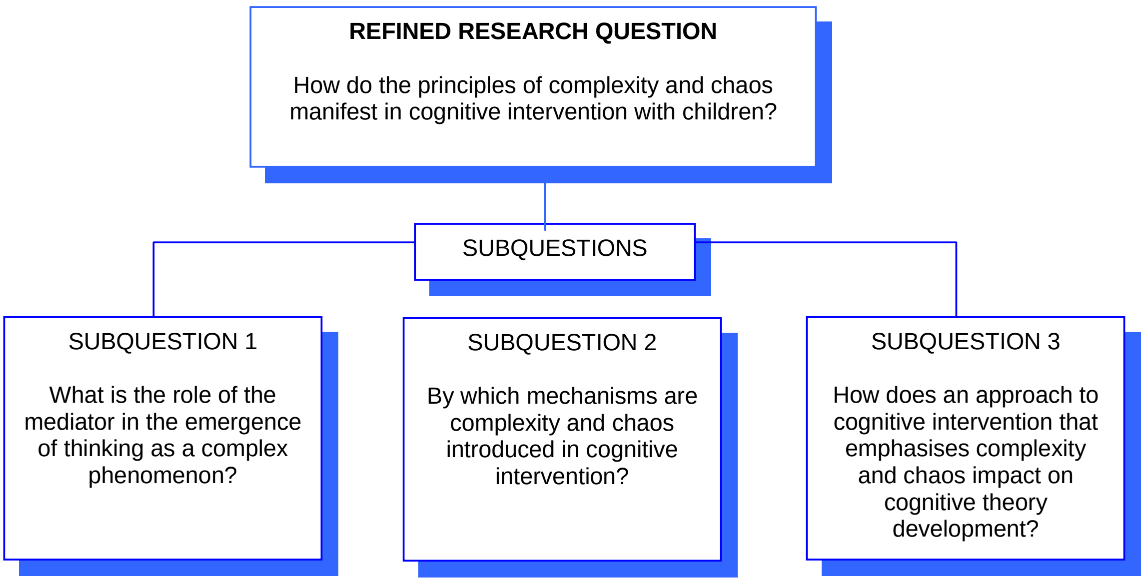
- o Open questions
- o Modelling analytical thinking
- o Probing of learners' responses

Correspondingly, mediator behaviours that are unlikely to occur because they point to a reduction of the complexity and chaos of cognitive intervention, include the following:

- o Allowing a disorganised approach to tasks
- o Supplying correct answers at the first sign of difficulty
- o Failing to point out to learners the behaviours that enhance/impede effective problem solving
- o Negative interaction by rejecting children's answers and contributions, or criticism
- o Accepting vague and ambiguous statements from learners without expecting clarification
- o Rejecting partially correct responses and failing to use them as a learning opportunity
- o Discouraging discussion among learners and between the mediator and the learners

An analysis of the mediator's questioning also revealed that closed questioning can be used effectively to guide children in their thinking and task execution with effective probing, to encourage discussions and to encourage systematic exploration of tasks. A dynamic balance between open and closed questioning emerged as an effective strategy to create the dynamic balance between order and chaos that complex systems (in this case the children) needed for self-organisation. The most important conclusion that was drawn from the results of the data-analysis, was that the study of children's thinking in a natural and unconstrained setting gives rise to complex interactions. The complexity of the children's interactions provided the research question for *Chapter Five.*

In *Chapter Five* the research question was formulated as follows:



A thematic analysis that focused on the interaction between the mediator and the learners indicated that cognitive intervention in a complex and chaotic context requires responsiveness and flexibility from the mediator to create a dynamic balance that involves continual shifts between offering learners no support (defined as facilitation) and full support (defined as mediation).

Verbal interaction enabled the use of language as a tool to mediate cognitive development in the Zone of Proximal Development (ZPD) and was used at times to create disequilibrium, and at other times it was used to provide structure and support. Cognitive intervention that accommodates chaos and complexity requires us to pay closer attention to cognition as an emerging narrative and therefore the quality of the verbal interaction between mediator and child is crucial. Language also serves to open the process of cognitive intervention so that learning is not viewed as a cognitive process only, but one that involves interaction between many different subsystems.

Cognitive intervention is about creating the context for complex systems to change. Complexity theory and chaos informs us about the conditions that are necessary for complex systems to be able to change. An important aspect of such change involves the emergence of patterns of behaviour that forms over time as a result of countless interactions between the system and its environment and that a system tends to gravitate to. In the context of cognition and cognitive intervention, one of the most important patterns that could possibly emerge from children's experiences with learning, is the development of a positive or negative learning disposition. It would perhaps be plausible to assume that some of the most basic coherent patterns of behaviour that can emerge from an interaction of genetic/hereditary factors and the sociocultural environment would be emotional styles, cognitive preferences and personality.

It is perhaps also possible that cognitive interventions that emphasise chaos and complexity could ensure continued complex interaction between children's personalities, emotional styles and cognitive preferences so that a more general learning disposition pattern would emerge that would cause children to gravitate towards certain learning experiences.

University of Pretoria, etd - Human, S

6.3 FUTURE DIRECTIONS

In this study I wanted to examine whether a theory that describes cognition as complex and chaotic could be relevant to cognitive intervention in formal contexts. Through the use of a design experiment I have discussed how the accommodation of complexity and chaos can create the conditions that are associated with children becoming independent, self-regulated learners capable of complex problem solving. However, the question whether cognitive intervention methods as described in this study will actually lead to children becoming independent and self-regulated learners, must remain unanswered until longer-term follow-up studies can demonstrate the viability of such methods in classroom settings where teachers' communication with their learners are often confounded by factors such as class-size, time-constraints and workload.

As Meyer and Turner (2002) point out, the kinds of activities and interaction that self-regulated learning demands (and those that were used in this study certainly qualify as such) remain problematic in classroom settings because of a number of factors. The size of classes, teachers' evaluation of learners' responses in class, teachers' limited knowledge of learners' cognitive, emotional, motivational and social competencies and time demands which limit teachers' choice of learning material all constrain teachers' efforts to engage in quality interaction with their learners. However, all cognitive interventions, regardless of their particular approach, need certain minimum requirements, such as a competent teacher and ample opportunity for purposeful interaction with all the children in the class. Cognitive interventions that accommodate complexity and chaos are no different. In this case, it is perhaps interesting to note that many so-called classrooms that are described as being ineffective for various reasons, may not be ineffective at all, but merely overwhelmed by the demands placed on the teacher as well as her learners. In South Africa, teachers have had to cope with massive and radical educational reform in a relatively short space of time, and without proper preparation or in-service training opportunities (Pithouse, 2001).

Another possibility for further research would be to study in greater detail how mediators' behaviours affect children. How do the kinds of behaviours that are associated with complexity and chaos achieve salience in the mind's of some children and not others? Children differ in their capacity to attend and they also attend to different aspects of a task. Is it therefore at all possible to suggest that the accommodation of chaos and complexity will necessarily lead to children becoming capable of complex thinking? Chaos and complexity may provide the

University of Pretoria, etd - Human, S
necessary conditions for the development of positive learning dispositions and self-regulated thinking, but is their presence *sufficient*? One cannot assume that all children's personalities, emotional styles and cognitive preferences contribute equally to the development of learning dispositions in the same manner, so individual differences in self-regulated learning would necessarily arise. To what extent should this be accepted in practice?

Regarding the development of learning dispositions and their role in self-regulated learning, the themes that were identified in *Chapter Five* suggest that complex interactions in the context of cognitive intervention involves a variety of cognitive and non-cognitive factors such as attention, systematic behaviour, language development, self-esteem, motivation. It may be reasonable to suggest that these factors could, over time, contribute to the strengthening of patterns of personality, emotional style and cognitive preference which, in turn, would contribute to the development of learning disposition patterns. Research on learning dispositions could therefore focus on the relative contributions of personality, emotional style, cognitive preference to children's appraisals of learning contexts and possibly also how these three factors mediate children's awareness of and responsive to learning situations.

The research presented in this study represents the first attempt at constructing a narrative in which the complexity and chaos of children's thinking in formal contexts are explored and accommodated in cognitive intervention. Many important questions were not addressed in this study. For example, the cognitive intervention described in this study focused on verbal interactions with children and did not involve academic tasks. How chaos and complexity would feature in the development of academic skills such as reading, writing and mathematics still requires intensive research. Not only do these skills require complex cognitive processing and require intact neurophysiological and neuropsychological functioning, but they are also cultural activities that require the construction of meaning in particular contexts. It remains a challenge to examine whether chaos and complexity have anything to contribute to our understanding of formal academic tasks.

An interesting topic in chaos theory concerns the development of attractors, or patterns of behaviour. In this study, some patterns that were identified include those that emerge in the moment-to-moment interaction between the researcher and the learners, and those that appear to develop over time and represent patterns of a higher order, namely personality, emotional styles, cognitive preferences and learning dispositions. Much research is still needed to examine

University of Pretoria, etd - Human, S
how attractors in a complex system would translate into psychological and educational contexts and how they could be described and studied.

Another issue that has remained unaddressed in this study is the question of bifurcations in a complex systems. A bifurcation is generally a rather permanent change in the trajectory of a complex system and they usually represent the transition between order and chaos. How exactly one would conceptualise a bifurcation in cognition or in learning for that matter, or the conditions that are required for such transitions cannot be answered by this study.

Finally, it may very well be difficult to be an educational psychologist these days, but it is also exciting. It is my hope that more educational psychologists will embrace the complexity and chaos around them and within them, and that this study will at the very least inspire others to be curious about all that is unpredictable.

University of Pretoria, etd - Human, S

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University of Pretoria, etd - Human, S

Children's thinking in formal contexts: Accommodating chaos and complexity in cognitive intervention

Volume II

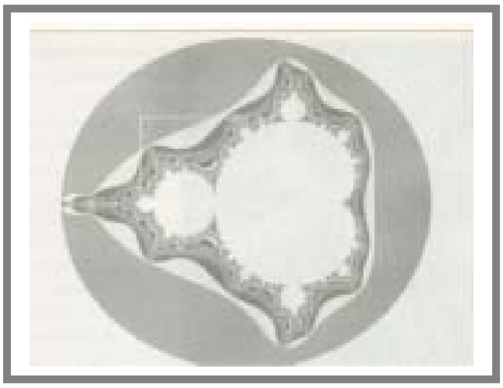
Exhibits

University of Pretoria, etd - Human, S

TABLE OF CONTENTS

University of Pretoria, etd - Human, S

The Mandelbrot set:



From Briggs & Peat, 1999.

Fractal detail from the Mandelbrot set:

From Briggs & Peat, 1999.

Fractal fern created by a non-linear equation:

From Briggs & Peat, 1999.

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Poster **EXHIBIT B**

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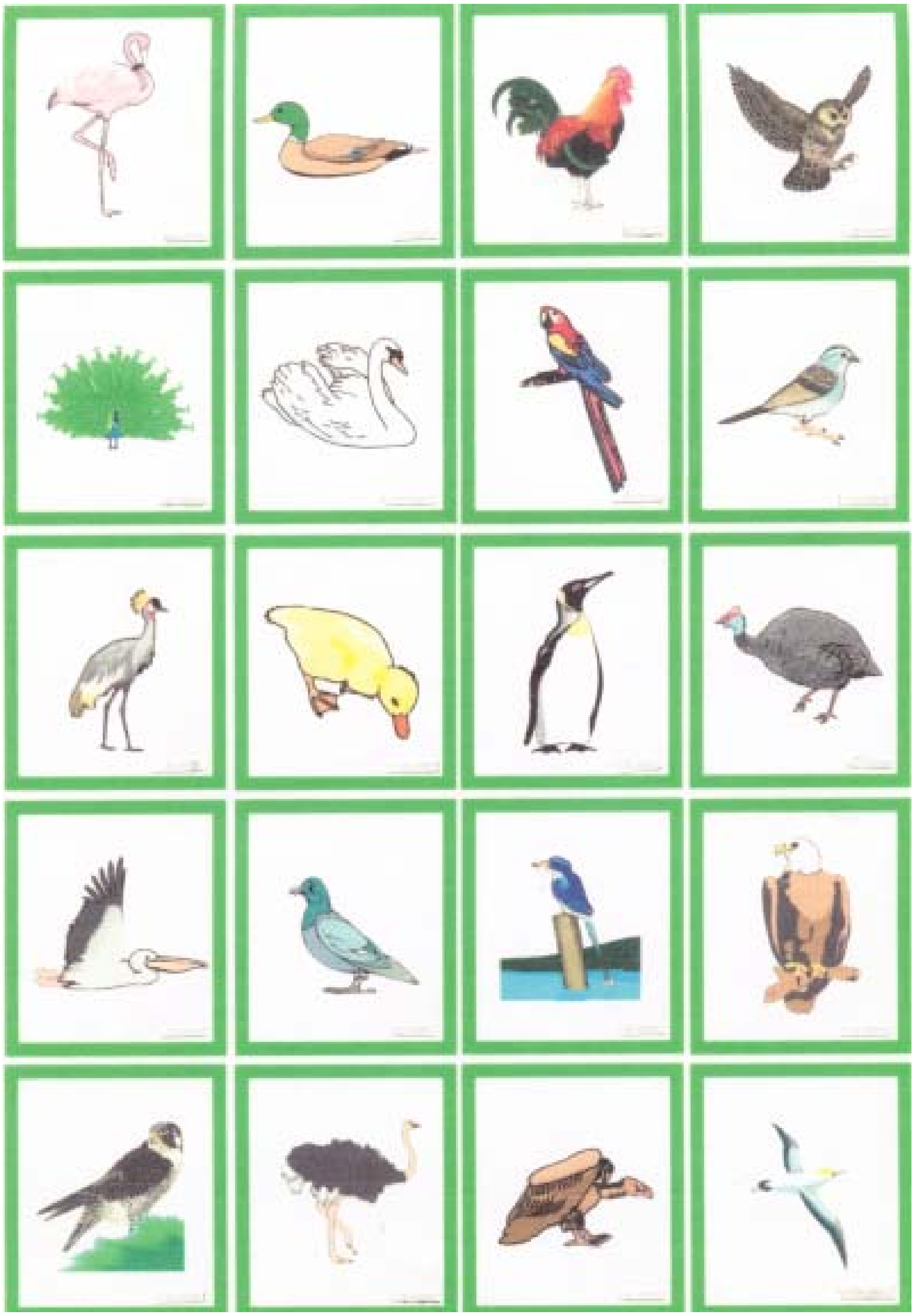
Board with animals **EXHIBIT C**



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ANIMAL CARDS **EXHIBIT D**

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Go! Cards **EXHIBIT E**

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Classroom observation (CO1-1) **EXHIBIT F**

CLASSROOM OBSERVATION (40 minutes)			
School		**Date**	5 June 2000
Class	Grade 1	**Class size**	29
Teacher	Ms A		
Comments: 09h15 – 09h55			

Class progression:

1 - Group: reading story and some individuals try alone

2 – Worksheet: answer questions about the story

1: *9:15 "Freeze, put homework away, sit on the carpet.*

2: *What's the matter with your nose?*

3: *Take tissues to blow your nose.*

4: *Everyone flat on your bottom! Come, Robbie.*

5: *Quiet!*

6: *What word is this? (Run)*

7: *Can you sound it? (r-u-n)*

8: *This book is all about run [sic]*

9: *What is the title of the book?*

10: *What is the exclamation mark?*

11: *Who is the author of the book?*

12: *Who drawed [sic] the picture, the illustrations?*

13: *What will happen in this story?*

14: *Now you must all concentrate,*

15: *Run! Said the lion, Run! Said the elephant,*

16: *Run! Said the zebra. Run! Said the leopard*

17: *Run! Said the giraffe, Jump! Said the…?*

18: *Try to remember who are all the animals in the story.*

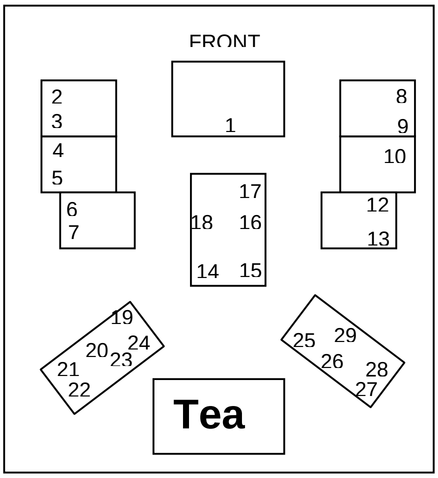
19: *Two learners at the back talking*

20: *Why jump into water?*

21: *Can a fire burn in water? Learners: No!*

22: *Ls ask questions*

23: *What animals do we have? Zebra etc.*



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24: *Did you enjoy this story? Easy enough?Like to read it on your own?*

25: *Yes! (learners eager)*

26: *When is an easy time for fires? Which season are we in?*

27: *L: Autumn*

28: *L: Winter*

29: *Worksheet:*

30: *Write the title of the book*

31: *Draw what happened in the end of the story*

32: *Circle all the words that says "the"*

33: *[Everyone collecting their worksheets]*

34: *Let me see who is going on with their work?*

35: *[Teacher plays music while learners are busy with worksheets]*

36: *Are we quiet now?*

37: *You can make your own ending.*

38: *- Prior to this Karl drew his mate's attention to a mistake that he had made*

39: *Teacher calls twice on Karl (who made a mistake) You must concentrate.*

40: *Kids relatively quiet, doing work.*

41: *Group 1 can get a smiling face.*

42: *One learner (Karl) urging others at this table to whisper.*

43: *Who would like a smiley face, a merit [show of hands] Then show me!*

44: *Picture: What must you draw?*

45: *Ls at table A draw animals, did not understand the task. Teachers asks*

46: *someone to tell themwhat to do.*

47: *E26: Think of the end. Draw a picture.*

48: *E got the most merits.*

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Classroom observation (CO1-2) **EXHIBIT F**

CLASSROOM OBSERVATION (40 minutes)			
School		**Date**	5 June 2000
Class	Grade 2	**Class size**	32
Teacher		Ms B	
Comments: 11h00 – 11h40			

1: *And here I am wearing my new…*

2: *What do you think after this, what do you have to do?*

3: *Read the sentence and tell me.*

4: *L: You must draw the picture!*

5: *T: Will the leaders get the blue books please.*

6: *I'm counting three and then I want all the books on the desk!*

7: *Look at how you page your book!*

8: *Write the date!…Do it!*

9: *Lovely. Good girl. I see there's some angels in my class. I'm so glad.*

10: *Who knows what the heading is going to be?*

11: *Fekile, You've got one line left. What do you think you are doing?*

12: *What is the title?*

13: *Right! My clothes.*

14: *Bernhard, he knows what he's going to do. Bernhard is ready! Don't shout*

15: *out…how do you show me you are ready?*

Teacher introduces me by saying I am there to see if they learn, to check them up and see what they do. This focused attention on me and learners took a while to settle down and ignore me.

16: ***Activity***

17: *My clothes.*

18: *My favourite thing to wear is…….because….*

19: *I like to wear…….because…….*

20: *I think children (should / should not) wear*

21: *school uniforms because…..*

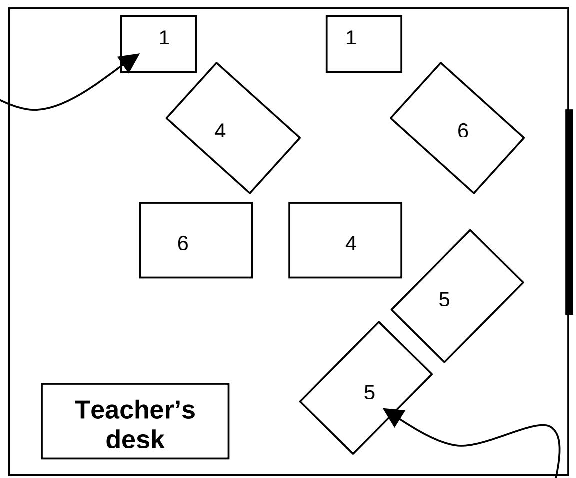
22: *If I could buy one thing I would like*

23: *to buy a/an……Because…..*

24: *And here I am, wearing my new……..*

25: *Must you write should and should not?*

Works quietly



Cross, problems with favourite, draw my attention to group. Say they are stealing, not learning. No help and support. Problems with phonic skills. L becomes quiet, no response.

26: *L: No! You must choose one!*

27: *T: Which one are you going to choose?*

28: *T: Shhh! I want to heas something special! Tula!*

29: *T: Don't like wearing a school uniform, why not?*

30: *L: [unclear]*

31: *T: Yes, right.*

32: *At one table: One learner says to another learner: Get going!*

33: *Own work! No talking about it, you do your own work!*

34: *L activity while they complete their own work.*

35: *Why you turning over, what is this nonsence? Sit properly!*

36: *Can you see the letters in that word? Tell me what they are!*

37: *You're also doing the same nonsense! Excuse me!! What did the metacog say?*

38: *Now they're just writing anything they want!*

39: *[Teacher moves around helping learners]*

40: *T: Metacogn on wall, points to picture (upside down) asks learners to sound* ***41:*** *out words.*

42: *Frequent praise, good girl, wonderful.*

43: *L example: "My lcothes" Teacher shows me book*

44: *Goes about*

45: *Read this for me..does that sound right to you?*

46: *T: If you answer why, you say…because!*

47: *To me: C L reckons its very good for them to do this (head upside down}*

48: *[children have to read and sound out words that are upside down]*

49: *L: Spelling "warm"*

50: *T: Catchy word, sound out, it's like ball, remember?*

51: *Teacher going about helping learners individually.*

52: *T: No! I want <u>her</u> to think! (Bride) If I tell you it's the "I" with the magic "e"?*

53: *Last 10 minutes no teaching but learners finishing their work. L shows*

54: *book T" I don't want to read it, go on."*

55: *Bernhard, what did I tell you if you go there? Rather go and do some perfect*

56: *work.*

57: *Ls running around, doing what they want.*

58: *T: Is "because" on the transparancy? Show me where it is?*

University of Pretoria, etd - Human, S

Classroom observation (CO1-3) EXHIBIT F

CLASSROOM OBSERVATION (40 minutes)				
School			**Date**	5 June 2000
Class	Grade 3		**Class size**	29
Teacher				Ms C
Comments: 10h20 – 11h-00				

1: *Animals*

2: *Talk about animal homes.*

3: *Teacher draws house on board*

4: *L: That looks like a jail, ma'am!*

5: *T: No response*

6: *Why do we live in a home?*

7: *L: To protect us from weather.*

8: *L: To keep us warm.*

9: *T: What do you need to live?*

10: *L: Food, clothes*

11: *L: Vegetables.*

12: *T: Vegetables are food.*

13: *L: Money.*

14: *T: To pay for what?*

15: *L: Electricity, rent, bond*

16: *Draws white sheet down.*

17: *Teacher shows only the part they must do now.*

18: *The heading is: Animals need homes too!*

19: *I want your own thoughts, you're not going to talk with anyo*

20: *L activity as they get ready to do the worksheet.*

Activity
Draw a picture of own home, with lines that say what things you need. Must have at least 7 lines.

21: *T: Are my managers helping me or are they the ones talking?"*

22: *T: Three minutes then your picture must be done.*

23: *To me: The children work slow, can express themselves reasonably but*

24: *difficulty with writing and reading. They don't understand what they*

25: *read. Sometimes they do not understand the teacher.*

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T: What kind of animals are pets?

Children name them.

L: Squirrel.

T: Will you keep a squirrel in your house?

T: Which animals are farm animals?

L: Tortoises.

T: What do they need tortoises for on a farm?

L: Sheep

T: Sheep! Now we're getting there! Wild animals?

Children name crocodiles, lions, leopards, snakes, cheetahs, tigers

T: Now, choose either a pet, farm or wild animal. Draw the animal with the home of this animal. Then we going to think what these animals need. You must know where the animals live. Write down the things you know that animal will need to live.

L: How do you spell "window"

L: How do you spell "light"

Reading groups

One learners draws teacher's attention to the fact that the learner next to him put down pizza and food, and pizza is food. Teacher's response: Pay attention to your own work, my boy!

Three more minutes. They were getting ready for computers. Now you've done [all this] now, reasons that people need homes. Full sentences. Three reasons why animals need homes. In the end you are going to have six sentences which will sound like "People need homes to…Animals need homes too…

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Classroom observation (CO2-1) **EXHIBIT F**

CLASSROOM OBSERVATION (40 minutes)				
School			**Date**	6 June 2000
Class	Grade 1		**Class size**	29
Teacher		Ms A		
Comments: 09h15 – 09h55				

1: *Handwriting*

2: *Doing the "b" sound*

3: *09h25: Ls sitting in front for story. Sitting on bottom, hands in*

4: *their laps.*

5: *09h30: Knock on door. Little girl delivering teacher a letter.*

6: *09h32: Start singing: Quack! Quack! Quack! Head, shoulders, knees and*

7: *toes! And eyes, and ears and mouth and nose!*

8: *T: Karl, I'm looking at you!*

9: *Finish*

10: *Good, you must all join in!*

11: *Next: Toby toe, where are you, where are you. Here I am, and how do you*

12: *do! Finger small, finger small, where are you, where are you? Here I am*

13: *and how do you do! Etc. Continue with all the fingers of the hand*

14: *Let's see who can do the best, boys or girls!*

15: *09h36: Song is finished. Ls get their lunch boxes. First girls then* ***16:*** *boys.*

17: *Everyone back on the carpet.*

18: *Who do [sic] not have food?*

19: *Who will share with Tshepang/John?*

20: *Who wants to say a prayer for us?*

21: *Thank you, eyes closed, hands together.*

22: *Whose got healthy food today?*

23: *Ooh! Cheese!*

24: *Boys: You will not go unless you are all on this carpet!*

25: *09h40: Class concluded*

26: *Are you quiet now?*

University of Pretoria, etd - Human, S

Classroom observation (CO2-2) **EXHIBIT F**

CLASSROOM OBSERVATION (40 minutes)				
School			**Date**	6 June 2000
Class	Grade 2		**Class size**	32
Teacher			Ms B	
Comments: 10h15 – 10h55				

1: *So where is the "s"*

2: *Who had a drink? So why don't you say so?*

3: *So how many do you have left?*

4: *Does that sound right?*

5: *And I'm now getting tired of this!*

6: *Metacog of the picture, then start writing a story about it?*

7: *You girls, especially <u>you</u> will stay in and finish your work!*

8: *10H22: Don't draw lines please, I can't stand it!*

9: *What's that there? (knowledge)*

10: *They did not eat four, what kind of a sum is that?*

11: *What did I say to you…but our ears are a big problem!*

12: *Go on! You've got four minutes to finish!*

13: *If it is done, put it down!*

14: *Kelly, I think you must write it straight into your book.*

15: *Did I say…no, but you don't listen.*

16: *10h30: Boys in front and girls ready for a story.*

17: *You must take that rubber home and leave it there!*

18: *How did I teach you to blow your nose! You didn't do anything good!*

19: *Put your book down, I don't care if you have finished.*

20: *Write a story on clothes.*

21: *L: It looks like black*

22: *T: No, it doesn't look like black.*

23: *I wanted to show you the other day when I had my coat on…*

24: *Who remembers another sound that says the –er sound.*

25: *L: e and r*

26: *T: Where do we find this sound?*

University of Pretoria, etd - Human, S

27: *L: Spur*

28: *T: Uh-uh, spur is the other sound. How do we write spur?*

29: *T: Spar, does that say –er? (Exasperated) What about mother, father, quicker,* **30:** *better, bigger?!*

31: *T: My picture….*

32: *L: …is all about clothes.*

33: *T: I was going to describe, but you've got a good sentence there.*

34: *T: Are you listening Martin? Use describing words.*

35: *Okay, but there's more about the blouse. I was going to write about the scarf.*

36: *L: The colour is rusty!*

37: *T:…beige, rusty brown.*

38: *L: I don't think that is red, it is brown.*

39: *T: Shall I stop showing you? And then you can do your own and then we'll see* **40:** *what happens!*

41: *T: No, I don't want that. What would make a nice last sentence?*

42: *10h55: Reading together. Ls continue with their own metacog. They* ***43:*** *must write their own story.*

44: *T: What's in the middle of your metacog?*

45: *L: Words*

46: *T: No! Clothes!*

University of Pretoria, etd - Human, S

Classroom observation (CO2-3) **EXHIBIT F**

CLASSROOM OBSERVATION (40 minutes)			
School		**Date**	6 June 2000
Class	Grade 3	**Class size**	40
Teacher			Ms C
Comments: 11h-00 – 11h40			

1: *Today, we are going to talk about nouns.*

2: *Any language that you speak, any language (quiet) words all have names.*

3: *[Tears up a learner's paper who was not listening]*

4: *A noun is a word, we use for many things.*

5: *Something you can see is a noun.*

6: *[Asks for examples after giving some of her own]*

7: *Another word: adjective*

8: *If I say it's a short pencil. If a say a fat teacher, what is fat?*

9: *L: Teacher.*

10: *T: No, adjective.*

11: *Do you agree with me, Fekile?*

12: *11h09: Class interrupted by announcement*

13: *L: Amedium cow.*

14: *T: What's a medium cow?*

15: *L: Its when it's fat, but not that fat! (Demonstrates)*

16: *T: I've never heard of a medium cow.*

17: *T: Crocodile, what about a crocodile?*

18: *L: A scary one.*

19: *T: Octopus?*

20: *L: A fat one.*

21: *L: A beautiful octopus!*

22: *T: That's a new one!*

23: *L: A dangerous.*

24: *T: A dangerous. (writes on board)*

25: *11h15: Worksheets (List of words – adjectives – Match adjectives with sea*

University of Pretoria, etd - Human, S

26: *creatures, use all the adjectives that describe a creature)*

27: *The little rabbit behind the big tree.*

28: *You must look for…*

29: *If it says, you must not…*

30: *I'm going to see if you can think for yourself a bit.*

31: *11h20: Ls continue with their worksheets*

32: *T: Do you see, words, you must write into boxes. Then you go to the next box. See*

33: *which word you must write?*

34: *T: First do your whole worksheet, then…*

35: *T: The easy thing to do, is to find the noun. Then you find the word that*

36: *describes…*

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Data subset 1 (DS1) **EXHIBIT G**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 11:22:52 AM

P 1: SSGR1JUNE8.txt [C:\phd\SSGR1JUNE8.txt]

Group Grade 1
Date 8 June 2000
Time 11:00 – 11:40

SH	What do you think is going to be on that paper, L?
L	I don't know.
SH	You don't know! You want to take a guess?
L	I know what it's going to be. Its going to be a…plan.
SH	Is it going to be a plan? Okay…did you write your name?
L	My name is…
L	Is that a tape?
SH	Yes, it is a tape.
L	It's a small one.
SH	It's a very small one. Do you want to see? Write on!
SH	Tell me what your name is?
L	Thedi.
L	Mashaole
L	Reneilwe
L	Khumo.
SH	No, I want him to say his name.
L	Khumo.
SH	Do you have those books at class. Okay. L is writing her name.
L	L always copy. She likes to copy me, because she don't want Ma'am must hit her.
L	My mommy she teach me my name.
SH	Who teach you your name?
L	My mummy.
SH	Your mummy?
L	I don't copy anyone.
SH	Don't you copy anyone?
L	No.
SH	That's good. Okay, who wants to guess what is on this paper? Take a guess, what do you think is on there. Anything, any guess. What do you think, learner? [silence] Shall I show you? Do you want to see what is on this paper [turning it around] ?
L	Animals!
L	It is too small, it is…
SH	What did you say? Are they too small?
L	Yes.
SH	Okay, why…
L	This one is too big!
SH	Yes!
L	And look at the eyes.

SH	What about the eyes?
L	The eyes are white inside.
L	I can tell you what that is.
L	..because the neck is long.
SH	..are their necks long?
L	Yes. Because…that they eat trees.
SH	Yes, if their necks aren't long then they can't eat the leaves!
L	The lions eat people, because the snakes like to take blood out.
SH	Do lions eat people?
L	But the..I like it.
L	I like the zebra.
SH	Do you like this one?
L	A lion eats meat.
SH	Yes, you're right! A lion eats meat!
L	…eats scary people?
SH	Does the snake eat scary people?
L	Uh-Uh, it sucks out our blood! [indecipherable]
SH	Yes, there are poison on a snake's teeth. What else do you see here that you like, that is interesting.
L	Hmm…a leopard!
L	Elephant
L	Lion
L	Elephant, it is good!
SH	Is an elephant good?
L	An elephant…it is strong.
L	It can kill a crocodile!
L	And look this is a crocodile.[pointing to the immersed hippo]
SH	This is a crocodile?
L	Uh-uh, a hippopotamus.
SH	A hippopotamus…can everybody say that? L, can you say hippopotamus?
L	[shaking head]
SH	Try it! [breaking into syllables] Hip-po-po-ta-mus!
L	Hi-po-ta-mus!
SH	That's nice! That's good!
L	[trying it all at once]
L	Hi-po-po-ta-mus!
SH	Let's hear if L says hippopotamus?
L	Hippopotamus.
SH	That's nice, that's very good. Do you know the short word for hippopotamus?
L	No?
SH	You can just say hippo.
L	I think you can give me this thing.[referring to the dictaphone]
SH	You think I can give you this? Then I won't be able to tape all the other children's voices on. So, I'm sorry. Who can tell me where…the frog is? Who can look for the frog? Show me the frog.
L	[singing in the background while researcher is busy with one learner]
L	The frog.
SH	Very good, there is the frog.
L	This is a ostrich.[pointing to the flamingoes]
SH	Does it look like an ostrich?
L	No.
SH	No? Why not?

L Because…the feet are big.
L It's a flamingo.
SH Because their feet are big?
L Yeah, because it's a flamingo.
SH Ye…You are clever! It's a flamingo! And a flamingo, what colour is a flamingo?
L Pink.
SH Yes, a flamingo is pink. What colour is an ostrich?
L A ostrich is purple.
SH [incredulous] Purple!?
L Ostrich?…it's like white.
SH Do you think and ostrich is purple, learner?
L No.
SH No…what colour do you think it is?
L There's an ostrich.
SH Let's just think, what colour is an ostrich? You know, learner?
L Brown and black.
SH Yes…black and brown and white.
L Oh! I'm scared of this!
SH Are you scared of it? What is it?
L It's…
SH Do you know what it is?
L It don't know what it is?
SH It's a bee.
L It stinks…it stinks.
SH Do you know what bird that is? What do we call it?
L Uh…I think it's a…
SH …vulture!
L [together] Vulture!
L But it's a Sotho one, I think so.
SH Is it a Sotho vulture?
L Yeah, if you kill it's going to be called a Sotho.
L But this I'm not scared of this.
SH Which one?
L This..I'm not.
SH What is it, what do we call it?
L It's…
SH What do we call that bird?
L [indecipherable]
SH Owl. What sound does an owl make?
L [together sounding the initial "o"]
SH It makes like this…hoo-hoo, hoo-hoo!
L They do that.
SH Have you heard it before?
L In the night they do that!
SH In the night! You're right, in the night! What do we call this?
L A tiger!
L A leopard!
SH Is it a leopard? How do we know it's a leopard? L, how do we know it's a leopard?
L No…our teacher was telling this story about it.
L I can read that story.
SH Did you read that story? Whose going to tell L why we call this a leopard?
L Because uhm…because… he has dots on his body.
SH Yes, he has SPOTS on his body. That's right!
L I'm scared of a gorilla.

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SH	What's this, what do we call this?
L	[everyone talking at once]
SH	[whistling to get everyone's attention] Let's hear what L wants to say.
L	..when you …light…it goes.
SH	When you switch off the light it goes?
L	Yes.
SH	You're right, it flies and you know what we call it?
L	..and it gets into your hair.
SH	It gets into your hair, that's what they say.
L	[indecipherable]
SH	Can anybody tell me what we call this animal..
L	I know it…
SH	…what it's name is?
L	It's…it looks like a monkey.
SH	It begins with a "b".
L	A bee.
L	[talking together]
SH	Okay, let me tell you what we call it…it's a bat!
L	A bat! A bat!
SH	A bat. Can you sound that word?
L	b – a – …
SH	Just a second, sound the word for me…
L	b – a – t , bat!
SH	That is great! What animal is this?
L	It's a rhino!
SH	It's a rhino. Yes. What are these funny things on his head?
L	Like…it's like a nose.
L	It's like a nose.
L	…and he have two eyes, yes.
SH	Yes. Can you see two eyes there?
L	Here, but the other side there's another one.
SH	On the other side. Do you think we can call those things on his head horns?
L	Yes! They are horns!
L	Yes, horns. Like when you get like a cow!
SH	But instead it's here in front.
L	What is this name?
SH	Show me another animal on this picture that has horns. Which other animals also have horns?
L	Here!
SH	That's right, L. That one also has horns.
L	…also this one.
SH	This one looks like it…
L	[learners talking together]
SH	Let's just look at the bee. This one looks like it has horns, but it actually is NOT horns. We call it something else.
L	Like this, it doesn't bite, this.
L	It's a snail!
SH	It's a snail.
L	[indecipherable]
SH	The elephant, you said that the elephant, learner, has horns. But we…you're right, actually…but we call it another word. We call it another word.
L	Um..um..
SH	We call it? Tusks!
L	Tusks
L	Yeah, they're over here.

SH What is that? What is that?
L Shark!
SH Why do you say it's a shark, what makes it look like a shark?
L Because it's got…
L Teeth!
L Teeth.
L Teeth.
L …big teeth.
SH It has big teeth. What…
L [pointing to something else]
SH Wait, wait, wait! What else makes it look like a shark?
L [persistent] This one.
SH No, no, no…what else makes it look like a shark, let's focus on the shark.
L It's a fish.
SH Yes, it's a fish. It's teeth makes it look like a shark, and maybe that fin on the back also makes it look like a shark.
L I know what is this animal!
SH Okay, tell me….you're right.
L It doesn't have a big mouth.
SH Yes…did you hear what he said this animal is?…Ah! we must listen when someone speaks.
L It's a crab.
SH Yes, you're right. You listened…it's a crab.
L The shark gets in the water…
L [interrupting] ..and…
SH Shhh…let's hear what learner says.
L …then he get into the water…then he's gonna eat you!
SH Ooh..the shark is going to..
L [interrupting] I know..
SH ..wait, wait, wait…L says a shark is dangerous because when you are in the water it's going to eat you. Do you all agree?
L [together] Yes!
L [all together]
SH One, one, one! One at a time.
L Because, when you see a shark, and then he's going to eat your arms, and your feet and your legs.
L What is this?
SH I'll tell you now. L, what did you want to say?
L The shark eat the fish…there's more fish.
SH When the shark eats the fish there is more fish?
L When we eat the crab…when we eat the crab [indecipherable]…and then the shark will come and eat them.
SH Yes, the shark will come and eat them when they jump inside. What did you say about this girl, L? How does she look?
L She's cross.
SH She's cross. Why do you think she's cross?
L Because uhm…
SH What is happening?
L Because uh..the sealions are out of the water. No, here's the water!
SH Okay, maybe it's because the sealions are out of the water. Why else could she be cross?
L Because, because the girl is putting this..whose giving the sealions fishes.
SH Okay, what is this boy doing?
L He's uhm…he's taking his bag, because the ant wanna steal his bag.

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SH Do you think maybe he could be stealing her bag and that's why she is cross?
L [together] Yeah! Yeah! Yeah!
SH Does it make sense?
L [together] Yeah!
L He is running.
SH Yes, he is running. He's running very fast because he stole her bag.
L Here's a ant on a umbrella. The ant is too small.
L [indecipherable]
SH Yeah, an ant must be smaller than that, and ant is not as big as an umbrella, nê?
L Hmmm, it's just small like this.
SH Very, very small.
L But he crawls like this and this and then he goes.
SH See how many black ants you can find, there are more than one. Count them, try to find them on the …
L [together] One! Two! Three! Four!
L [other]One! Two! Three…!
L …and five!
L Hey we already count this one!
L There are one, and two and three…yeah, and four..
L There are four!
L There are five!
L Oh! Here is another one…
L …and six of them!
L Here is another one!
L Seven of them!
SH How can we make sure? Sometimes we get confused…I'm going to ask you now…sometimes we count one of these and we forget that we counted them, and then we count them again. How can we make sure that we don't count one and more than one? Do you think it will help if we take a bean and we put in on the ant so we know that we have already counted it?
L I know which blue bean goes…
SH Okay, so we know there's one ant. There are two ants…
L …and five ants!
SH [as learners put beans on the ants]…two, three, four,
L …and then five…
SH [together with learners] …five…six…
L Where's another one?
SH ..seven…can you find it?
L Where's another one?
SH Look, look…can you find more ants?
L No…this are not ants.
L Did you put on the umbrella?
L Where's the umbrella…oh here.
SH Seven ants…did you find all the ants?
L No! There's a ant.
L No.
SH There's another one on it.
L Where's it?
SH No, I mean…you already put a bean on that one.
L Okay.
SH So did we find all the ants?
L [together] Yes.
SH So how many ants are there?
L There are one..[together] two, three, four, five, six, seven!

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SH Uh-Uh! Do you have any beans in your hands at the moment?
L No.
SH Okay. Let's just take all the beans off and then we'll know many ants there are. How many ants are there?
L [together] One, two, three, four, five, six, seven, eight, nine!
SH Okay, three…
L What about this one?
SH Nine…Ah! How many are there? No, no, no! Put it back, it was on the board, so it must have been an ant!
L One, two, three, four, five, six…
L There are ten of them!
SH Ten ants…okay. Now try to do the same and see if you can find…the blue butterflies.
L What, what, what! Blue, there's another blue.
L Two…
L That..that's not a butterfly.
L It's a butterfly…
SH A blue butterfly. How many have you found yet?
L [Excited and sing-song while busy with the task]
L I'm going to use blue, not red. [beans]
L A butterfly is blue.
L Where is another one?
L This is not for eating, I know.
SH Uh-uh. No, I painted it so you musn't put it in your mouth.
L You gonna die.
SH No, you won't die, but maybe you'll get sick. Can you find another butterfly, a blue butterfly?
L Blue.
L But this one…
SH Ah, learner, you found one!
L Awua! This one is not a butterfly.
SH L, I can see some butterfly close to you on this side of the picture.
L Oh! Oh!
SH See if you can find it. We don't count this butterfly because this one is not only blue. There's a blue butterfly right in front of you learner. You are looking at it.
L Ah!
SH Ah! There learner found it! Okay, let's just put that blue one back. Okay, can you see, that you've covered all the butterflies?
L [Together] Yes!
L I wanna cover this one!
L No!
SH Only the butterflies.
L Put that down…
SH So how many butterflies are there?
L [To another learner] Put this down! Put this down!
SH Okay…
L There are four, there are four! One…two…
L Uh-Uh! Throw them down, they can count…
L One, two three….four, [together] five, six.
L Six of them!
SH Okay, so learner says it's six. Okay, how can we check and make sure that it is six? How can we make sure? L? You have an idea.
L Because…
SH What do you think, learner?
L Because…there was butterflies…

L [interrupting and shouting] Butterflies! Butterflies!

L [talking together]

SH How are going to know…

L [interrupting]…on the table!

SH How are we going to know if there are five. What did we do with the ants to count them? What did we do with the ants?

L [doing something]

SH No, no, no! Listen to what I am asking you. How did we count the ants? What did we do?

L We did take them off.

SH Yes…okay, so do that?

L I think there are five.

L One, two, three, four, five, six.

SH Ah! There are six! All together…Okay.

L I think you are going to give me this recorder.

L No!

SH You would really like to have it, wouldn't you?

L Yes.

SH But unfortunately I cannot give it to you.

L I think…

SH Hmmm….what do you think?

L …like a card.

SH Yes….before I show you the cards, tell me, how many lions do you see?

L [together] Two! Two! One! Two!

SH If we take one lion out, how many will there be?

L [together] One! One! One! One!

L …and two giraffes.

SH Okay, if we put the leopards, if we put the leopards and the lions together in one cage, how many animals there be? If we put the lions [pointing to both individually]…

L Hundred of them!

SH No…just a second…how many lions do we have?

L Two!

L Two!

SH How many leopards do we have?

L Two!

L Two!

SH If we put them all into one cage…

L There are going to be four!

SH If we put these two leopards into that cage, how many ANIMALS will there be in that cage?

L [together] Four!

SH Will there be four?

L [sing-song] Yeah, four, four, four!

SH Are you sure?

L No I'm not sure. One, two, three, four….yeah, four!

SH [pointing to the snake and the porcupine in the cage] Are these not animals?

L No, this is not a animal, this is…

L Two penguins and one bee, will be three.

SH Okay, but if we put the the two leopards in here, how many animals will we have in that cage?

L Four!

L Four!

L This one is…[together] one, two, three, four!

SH Four? Do you think we must count the snake and the porcupine? Are they not animals?

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L Sho! I'm scared of this one!
L Let's do sums!
SH That's what we are doing, I want you to figure out for me. How many animals are there in this cage?
L This thing look like…
SH What did I ask now?
L This animals are four.
SH In which cage? No, what did I ask you? I asked…you to count how many animals are in this cage?
L Four!
L Two!
L Four!
SH Okay, there are two lions. But what I want to know, is a snake an animal?
L No?
L Yes, yes!
SH Yes! So we must count the snake too.
L One, two, three!
SH Is a porcupine an animal?
L No.
L Can I go to the toilet?
SH No, no, no. We're almost finished. Five minutes, then you can go. Okay? Is a porcupine an animal?
L [together] No!
SH What is it? If it's not an animal, what is it?
L I know what's it…what it's going to do…it's going to sting you and then you get sore.
SH Yes…but is it an animal?
L No!
SH What is it if it's not an animal?
L It's a…if it's not a animal…it's going to be away.
SH Okay. Let me tell you that all these things that we have here, all the pictures, the warthog, the rhino, the leopard, the snake, the porcupine, the sealions, the penguins, all of them are animals. They are all animals. If we want to put them in one group, then they are animals. What did you want to say?
L I want to say if you put all this …all this…there will be…they are not the same as that one.
L But…but…
SH [One learner wandering away from the table] L? Come…come…come look at this. Okay, let me ask you this: show me all the birds on this picture. Show me all the birds.
L Here.
L And here, one.
SH Okay, put the beads, put the blue beads on all the birds in this picture.
L [talking among themselves]
SH L, can you see some birds that the others have missed?
L There are four. There are four.
L That's not a bird!
SH Okay, why do you think it is a bird?
L [talking together]
SH Just a second, just a second, let's hear what learner says.
L It has wings.
SH Because it has wings and it can fly?
L Because they have wings, because…
SH Okay, why do you say it's not a bird, learner?
L Because…that thing have nails.

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SH Okay, well let me tell you something. L is right. That is not a bird. It can fly like other birds, but do you know what? It doesn't, it doesn't lay eggs!

L You have something in your hands!

SH Just a second, just a second. Only animals that can fly, and lay eggs, are called birds.

L Yes.

SH Only animals that fly and lay eggs. Okay? So this one doesn't lay eggs, and that's why it is not a bird, and you were right. But it is a funny animal, because it can fly.

L Because…

SH Are these birds?

L Yes….in the water, it does lay eggs.

SH What lays eggs?

L A turtle.

SH A turtle? Yes, but it doesn't fly. If it can fly, and if it can lay eggs, both of them, then it's a bird.

L But it can lay eggs. That one that stay in the water, it can lay eggs.

SH Okay, you're right. A turtle?

L Yes.

SH You're right, it does lay eggs. Do you know where it lays it's eggs. Where?

L It get out in the water and then …[indecipherable because of noise outside]

SH Tell me, do you think a flamingo is a bird?

L No! No!

L It can't fly…

L But it stands higher…

SH Who says a flamingo can't fly?

L Me!

SH Who says the flamingo can fly?

L Me!

SH Ah! This time learner and learner is right. A flamingo can fly. An ostrich cannot fly, but a flamingo can fly. So maybe you were thinking of the ostrich? Because and ostrich can't fly. But an ostrich is still a bird.

L This is four: one, two, three, four.

SH Okay, but is this a bird? I want to know if this is a bird.

L No, no, it's not a bird.

L It's a flamingo.

SH But is a flamingo a bird?

L No!

L It's very higher, more higher than a bird.

SH Okay…but, let me tell you a secret: a flamingo is a bird. If you want to know if something is a bird, you must look for three things: it must be able to fly, it must be able to lay eggs…

L Yes?

SH And…it must have feathers. If it has feathers, you can be sure it is a bird. Anything with feathers is a bird. If it can fly, or if it cannot fly, if it has feathers, it is a bird. Do you believe me?

L But…uhm…

L I know that a flamingo fly….I know.

SH You know that a flamingo flies? So how many birds do we have on this picture? L, can you count for us?

L One, two, three, four, five…seven!

SH Do you agree, learner?

L Yes.

L Why don't we do this one?

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SH We don't have time, we are finished. Do you want to know what that is? Okay, learner wants to know what that picture there is. It lives in water, and we call it a jellyfish. A jellyfish. It's a fish, but it doesn't look like other fish, and we call it a jellyfish because if you touch it, it feels like jelly. It's slimy. Okay, are you going to remember that's a jellyfish? Jellyfish.

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Data subset 2 (DS2) **EXHIBIT H**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 11:24:33 AM

P 2: SSGR2JUNE8.txt [C:\phd\SSGR2JUNE8.txt]

Group Grade 2
Date 8 June 2000
Time 10:20 – 11:00

Ls Fezile, Erika, Meisie, Nana, Koketso, Felix
[Ls are told that a recording of their voices will be made so that I can listen to it later]

SH What I have here…are some cards. Like this. And this is going to help us to take turns. Okay? We've got an orange one like this [holding it up for learners to see], we have…
L Red one.
SH Yes.
L Green one.
L Yellow.
L Yellow.
L Yellow.
SH And yellow one! We're going to keep this one, this is our set. Okay? If you have to choose which one of those cards look different from the others, which one would you choose?
L [choosing different ones, but not the green Go card]
SH Yes, each one of them are different. Okay? If you had to make those cards into two groups, which cards would you put together? Which cards look the same and which cards look different?
L Uh…
L Uh…
SH How do those cards look the same? [pointing to number cards]
L They are one shape.
SH Yes, that's right learner, they are the same shape! Is this card the same shape as the others?
L [Together] No!
SH No. This is a special card. Can you read what it says…
L Go!
L Go!
SH Go! It means that whoever has this card in their hands, they are the ones that may speak. The others must wait, okay? It means also that whoever has this card in their hands have the second chance.
L Oh!
SH [talking and seeing who has the next chance] You're right learner, learner and that one have the fourth

chance. So what we do is…we put them all…[arranges
them on the table] if I want to say something, I take
this card and I say something. Okay?
L Okay.
SH If I finish then I put it back so that somebody else can
use it. Now sometimes it's going to happen that all of
us want to say something, so we have to grab a card.
Grab a card! Okay, who has a card? You have one,
what is your name?
L Koketso.
L Nosiphiwo.
SH Nosiphiwo. And you are Erika, and you are Fezile. And
you are…?
L Meisie.
SH Meisie? Okay. Right, so this means I have the green
card so I can say something. But…who has the
number 2 card?
L I do.
SH Okay, if I have finished saying what I wanted to say,
then I must give my card to Fezile because she…
L ..is second.
SH ..is second.
L Oh!
SH Okay, so you give your card to…?
L Her, and she must give her.
SH You're right! Okay, so you her a card, that means you
are the next one…you take that card, and you just put
yours back so somebody else can take it. Okay, so you
have to be fast! Okay, Fezile if you have finished
saying what you wanted to say, to whom can you give
your card?
L To her.
SH Who has the number two card?
L Her.
L Her.
SH Yes, so you give her the card…okay, give her the
green card. Let's just practise this, you give her that
card, you give the number, who has the
number…wait, wait, wait! You have the number three
card, who has the number four card? So number three
gives to number four. Okay, and then you put that one
back. But now remember…
L Back?
SH Yes. [to another learner] …and then you can grab it.
You can grab it. Okay, you say what you want to say,
when you are finished you give her the card and that
way, everybody get's a chance!
L [chorus] Oh!
SH Okay?
L It's difficult.
SH It's difficult to try, but we are going to try and see what
happens. Okay? All right! Now let me put this here.
Now I'm going to show you …what I have on this
poster. What do you think is on this poster?
L Umm…it's a metacog!
L Metacog!
L A metacog!
L It has blue things!

SH Does it have blue things?
L Blue words
SH Blue words! Okay…what do you think?
L Numbers
SH Numbers. L thinks there's something blue on it…learner thinks there's a metacog on it…what do you think?
L A metacog.
SH Okay, so learner also thinks there's a metacog on it.
L Numbers…numbers!
SH You think there are numbers on it.
L I think words…
SH Words that you can read. Okay, and learner what do you think?
L It's a metacog.
SH Do you think there's a metacog on it…well, I have a surprise! [turning it over]
L [Exclamations of surprise]
L Here are blue things!
SH You're right, so you were right! Okay…what can you see?
L It's not a metacog.
L A lion!
L A lion!
L It's a zoo!
SH Ahh…remember who has the green card?
L She must talk first.
SH Okay.
L It's a zoo, it has animals and people.
SH Okay. Okay. Now you must give your card to the yellow one. Go yellow to orange and you give it to her, and you put it down, so somebody else can take it. What else do you see? Who has the green card?
L I can see…
SH You can turn it if you want.
L A monkey, ..a …, and a fish.
SH Where do you see the fish?
L There.
SH Okay.
L And a lion
SH Ahh…
L And a elephant, and a lady bee.
SH A lady..?
L [chorus]…bird!
SH A ladybird…okay.
L Somebody else grab it.
SH Ha! You have to be quicker! …Okay, tell me if you can find the giraffe on this picture. Okay, that's good. Who can show me, and anybody now can join in…what do you want to ask, learner?
L I want to ask you something…
SH Yes?
L Did you do this by yourself or maybe you made it on a computer, something like that?
SH I had somebody draw this for me.
L Oh!
SH And she painted it for me. When I finish with them, each of the classes are going to get three so then the

others can also…yeah, then you can use it in the class as well, if you want to. Okay? Okay, who can tell me where the seals are?
L Seals!
SH What are the beads for? I'll tell you in a second.
L [talking together]
SH That's right, learner we're going to play a game…
L He has…
SH Okay, he has the green card. That's right.
L Can I ask everybody a question?
SH Yes, ask everybody a question.
L Who can see….a person with a blue shirt and a white…
L Here!
L Here!
L Wrong, here!
L I thought I went, and then I went away…
L You went here.
L Yes, I went here and then I went away.
SH Okay, let's each ask a question for the other learners and see if they can get it. Who has number 2? No, no…two goes to three, three goes to four and four puts it down.
L [laughing]
L L, you must also lean over otherwise it's too far to reach.
SH Okay, who has the green card?
L Me.
SH Okay…now ask a question.
L Can you see a giraffe?
L [laughing and pointing]
L Something, just say something like…
SH Describe something.
L Purple dress and a white.
L A purple dress and a white what?
L Socks.
L This one.
L And who can see yellow and red and red..orange balloons.
L Oh, you said balloons!
L Why you said balloons?
SH Okay, change the cards. Green goes to two, two goes to three…three goes to four, three goes to four. [Ls grabbing the four] Okay, let's give learner a chance because she hasn't had a chance for a while. Okay, wait, wait wait! Who has the green?
L I have.
SH L, okay learner. Let's put it like this so that she can also ask a question. L, what's your question?
L L, look around don't look here because if you look straight they will see where you are looking.
SH You're clever. Okay learner, what's your question?
L Look around!
L Um…yellow with green.
L Yellow.
L No, that's not yellow!
L Here! Here!

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SH Okay, let's ask learner: we have a person here with yellow and green, and we have a snake here with yellow and green. Did you mean an animal or did you mean a person?
L Animal.
SH Ahhh! Good!
L But there's also a frog here.
SH 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.
L Put down!
L I took it first!
L Let me have it!
SH Okay, let me put it down.
L Oh! We nearly…
SH Okay, let's hear. What's your name again?
L Nosiphiwo.
SH Nosiphiwo. What's your question to the rest of the group?
L Who can see…something red…red and wh..and…red and orange and yellow and blue.
L Here! I had it first!
SH Okay! Red and orange and yellow and blue. Red is there, yellow is there, blue is there. What colour isn't there?
L Orange!
SH Good! Okay. Green goes to two, two goes to three…
L Three goes to four.
SH …and four puts down.
L [commotion as learners try to grab the number 4 card]
SH L, aren't you grabbing? Okay, let's ask one more question.
L Yeah! Who can see…a person with um…purple and white.
SH Ah! You were too fast!
L Purple and white.
L Purple.
L And I can see it.
L That's blue.
L That's purple!
L Blue!
L Purple!
SH Who thinks it's blue? Who thinks it's purple?
L It's me! I said so.
SH Sometimes colours are difficult to really see.
L But it is blue, purple is supposed to be like this cause…
SH [pointing to the flamingoes] Who knows what this is?
L Ostrich!
L A ostrich [sic]
L …other boy they kick something and they clap you and…and they take it and they eat it.
L [All talking together about ostriches]
SH L, have you seen a pink ostrich before?
L No.
L I have! I have!
L …on a farm.
L No, it was a black one! It was black and brown!

SH If I told you this is perhaps a flamingo, would you say it's an ostrich or a flamingo?

L [all together] Flamingo! A flamingo!

SH One at a time, one at a time. Flamingoes are pink. It's because of the food that they eat. But ostriches aren't pink.

L Yeah, sometimes they are black and brown and white…

SH …and brown and white and coloured. Who can tell me what bird this is?

L Um, it's a…

L …what's it called again?

SH Do you know the Xhosa word? Tell me the Xhosa word.

L No…

SH No, you must be proud of your language, nobody will laugh at you.

L Isintaka.

SH Isintaka?

L Can I tell you what's this in my language?

SH Okay, you can tell me in a second, let's just finish this one. So this one is…

L [Talking all at once]

SH [Gives a whistle to silence learners] Just a second. So this is in Xhosa, isintaka.

L Yeah.

SH Do you know…do you also speak Xhosa?

L No!

SH Do you know the Sotho?

L I know it!

SH Do you know it?

L Um…it's ….leba.

L Uh Uh! Leba is a big bird!

SH What do you think, learner?

L I speak English only.

SH Only English? Okay, do you know the name for that bird?

L It's an eagle!

SH It's almost like a…what makes you think that it could be a kind of an eagle? What about it makes you think that it could be an eagle?

L Yeah. Yeah.

L I think it's the wings.

L Let's hear what learners says. The wings, and what do you say?

L I think so because it's a like..it's a…it's nearly the same at the face.

SH Yes, the beak. The beak, it tells you that it eats meat.

L Yes.

SH Okay…but this is not an eagle. Eagles hunt for their meat. They fly…

L [Talking together]

SH That's right. So do you see this eagle, learner, let's put it like this so learner can also see, do you see this eagle and this bird here has the same mouth.

L No!

L Yes! Yes!

L It's sharp here.

SH It's sharp and it goes down. It's sharp and it goes down!
L [simultaneously] …and it goes down!
SH Okay, there are some ways in which they are the same, and there are some ways in which they are different. They are the same because their beaks are the same: it's sharp and it goes down. It's different because their wings and their colour are different.
L And their legs!
SH …and their legs, and their legs. So both of them eat meat, but this bird catches its meat. It hunts rabbits, and it hunts rats. But this one doesn't hunt. It eats dead meat. It eats meat that other animals...
L …killed.
SH …have killed. So do you know the name of this animal yet?
L [chorus] No! Um…
SH Vul…vul..
L [Guessing]
SH Vulture! It's a…vulture!
L I was gonna say that!
SH Were you gonna say that? You must say it!
L [Talking together]
L Sometimes when you want to say something, you forget what you were going to say!
L [chorus] Ja!
L I also forget it.
L Sometimes I get angry…but why did I forget it? And then I start saying it wrong. Let's say for instance I wanted to say a bird…I go, bi..bi..bi..bi..Sometimes I learn a word and I say, let's say for instance I say, my jacket. My jacket, my jacket, I forget and then I say, my ja..something like that.
SH So it's frustrating to forget a word.
L [Talking all at once]
SH L, what language do you speak at home?
L English.
L No! That is not your real language…
SH Just let me hear what learner says.
L She speaks Bulgaria.
L Ja, Bulgaria.
SH Bulgarian, do you come from Bulgaria?
L Yes.
SH Can yougive us the word in your language for this bird?
L Um…
L [incredulous] You forget your language!
L That's impossible!
L I also do that.
SH Choose, choose any animal on this picture and give us …
L In Bulgarian I must give the name of any animal?
SH Yes.
L Slon.
L Slon.
SH Slon?
L Yeah.
SH For elephant. Are we going to remember? Slon.

L [Chorus] Yes. Slon.Slon.Slon
L Can I tell you in my language what we call this? [points to rabbit]
SH Yes.
L Lokwatsha. I have many stories about these animals.
L Ja!
SH Tell me one story that you know.
L Okay. This animal, the lokwatsha, saw a animal.
What was the animal again?
L Lokwatsha. Saw another animal. How do you call it again? I forgot. He wanted to put that friend of his in trouble…you're so beautiful my friend…and the animal said…
L ..the lokwatsha…
L …you're just kidding, I'm never beautiful. So, let's go and steal some naartjies. They went to steal some naartjies. So the lokwatsha's friend, ate a lot of um..naartjies. So lokwatsha was enough so he went out, and he came in again and said, then he said, naartjies are getting finished! Then the man came with the … and he shooted lokwatsha's friend, so he ran into the hole where they were eating . So, they said, so lokwatsha's friend said, let's go eat some more my friend. I love this fruit. So he closed the hole that lokwatsha ran into, that they couldn't go in. So after that, they wait there and Lokwatsha's friend. Lokwatsha says, naartjies are getting finished! So he ran, and then the hole was closed, and he bumped…and then Lokwatsha's friend ran away. So they..

[Recording interrupted]

SH Okay
L [telling story in own language] So…other time, it went to a river, it went…so that river…that other time…it's dirty and dirty and dirty…so…
L Say it in your language…Say it in your language.
L Namphile…The mother of the …the river was dirty and there was no fishes in the river, so all the friends go to the river and …then…all the rats died.
SH Oh…was her name Namphile.
L Yes
SH Okay, you can do a story, and you can and then you can give a story. Three of you, but then you must make it quick. Okay, [learner], your story. Which animal do you want to tell a story about?
L [points]
SH About the rat? Okay, let's go for it!
L One day we were two rats with the mother living in one tree. The mother said that she's going to shopping so she said…they must stay inside the house and don't run down the tree. So she went to shopping and the …ran down the tree, then they climbed up to the other tree and then there was a snake in the tree and that was his home and then he almost caught the rats. And one rat jumped up and he missed each of them. He went on, the rat went on, he stopped and

then just followed him down the tree, and then the snake came going up the tree, he waited for the second rat. The rat jumped up, up in the tree, the other one also jumped up in the tree. They fell down on the ground and then they ran back up … when they got home their mother came and then they told their mother that they almost got caught, uhm, uhm, by a snake.
SH Wow! Okay, before we listen to her story…can you hear that when somebody tells a story, there's always a beginning, and then something that happens, and then an end.
L [Together] Ja.
SH All stories always have that.
L But when you know it in your language and you don't know how to say it, there's some words that you don't know in English. Like me, I know English, I'm even forgetting Sotho, Sotho is my real language because my father speaks Sotho and my mother speaks Tswana. So I'm forgetting Sotho because I'm used to…uhm..
L I talk Zulu.
L …uhm..try to talk…I used to try to talk…another language.
SH Of course you all know that your home language is important…and you must not forget it.
L [together talking in their language]
L Could you tell us in Afrikaans?
SH What would you like me to say in Afrikaans?
L Lion
L You like to put…[indecipherable]
SH As jy jou neus in iemand se sake druk.
L Oh!
[Ls fighting to have the next chance to tell a story.
SH She's been waiting a long time…to tell about her…11o' clock…we have ten minutes.
L It's…I'll say it in my language.
SH Okay, you want to tell about the monkeys and your language is…?
L Sotho.
SH Okay. Let's do this: she will tell the story in her language and one of you…
L I will, ma'am!
SH …you will tell me in English, okay?
L Can I do it, pleeease?
SH Okay, both of you…both of you.
L [Telling story in Sotho]
SH Let her finish?
L [Continuing with story]
L …don't speak English because you can't say all of it in English.
L [Finishing story]
SH Okay, the two of you must decide how you are going to tell the story.
L I know, I know!
SH Decide between the two of you.
L …I'm going to talk and then she's going to talk…
L Half!

L Once there was a…then I'm gonna say…ja, half the story…and then I'm gonna say the rest.
SH Are you happy with that?
L She says…
L Once upon…
L Once upon a time there was…[names]. They were goats…[part of story indecipherable due to the two learners retelling the story mutually]…so they decided to take bananas and things…[indecipherable due to intercom announcement]
SH You can choose…what do you want to do? The cards…or the beads.
L The beads, I think.
L [exclamation}
SH Is your nose bleeding? Okay, go to the bathroom quickly.
L It's not bleeding.
SH Is it not bleeding? Oh! you want a tissue? Does somebody have a tissue?
L Wait…wait…I'm not sure. Oh God, oh God! Don't you have a tissue?
SH Um…no..wait, wait, wait! …Of course I have a tissue…there you go.
L [together talking]
SH Okay, let's vote. Who votes for the beads? [show of hands] Who vote's for the cards?
L [talking together]
SH Ha! You've got two hands up! Okay, we're going to do the beads [takes beads out]. Okay, what colours do we have there?
L [together] Red! Green! Blue!
SH Red, and green and blue.
SH Okay, I'm gonna make a pattern on this board, over there. I'm going to put them in a row and I want you to tell me how to finish the pattern. So you must first look.…
L Yes?
SH …what pattern I'm making.
L Red and blue.
SH Red and blue, okay so if you want to finish the pattern…
L You must remember I'm going to write…other language.
SH Okay.
L Can you put a bit of green in it?
SH Okay, is the pattern still right? Red…blue…red…blue…red…blue…red…blue…Hm mm…this pattern is much to easy. I'm going to try a new one.
L I know what!
L Why can't we make animals?
SH You could if you want to.
L [all together]
SH [making a new pattern] Okay, I'm going to take your beads and I'm going to make a pattern, I want you to look at the pattern and tell me…how to finish it.
L I'm gonna make a nice big pattern…
L Me…I'm making a big one.

SH	Okay…we've got a minute!
L	Quick, guys!
SH	Okay look at my pattern that I have made…
L	Yeah?
SH	Can you see what pattern it is?
L	Yeah.
SH	What will be the next one to come there?
L	Blue!
SH	Blue..okay…put a blue one.
L	Oh! look at my pattern!
SH	[ignoring the exclamation] What will be the next one?
L	Red.
L	[disappointed]Ah!
SH	Okay, and the next one?
L	Green.
SH	Ah, you're too clever for me! [to another learner] You made an "f", very good. L, what pattern did you make? Red, blue, green, blue, red, green, blue, red. Very nice.
L	I wanna make something else.
L	I can make a letter.
L	I first made a "s", then a "e"
SH	Okay, who can make me…a…
L	I can do it!
L	I can do that.
L	It's too easy!
L	It's very easy.
L	But not the ten rand…
L	If you…then you have to make it round…
L	I'm finished…
L	But it doesn't look like…
L	Are you still taping?
SH	Yes. I can see the "s" yes, I can see the "s", L, very nice. Who can make the "sh" sound?
L	It's an s-h.
L	I'm still doing the "s".
SH	Okay, I think you can all finish up because I have to take the next lot.
L	What are you going to do for them?

Data subset 3 (DS3) **EXHIBIT I**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 02:59:29 PM

P 3: SSGR3JUNE8.txt [C:\phd\SSGR3JUNE8.txt]

Group : Grade 3
Date : 8 June 2000
Time : 09:00 – 09:40

SH Okay, let's go!
Ls [singing] Jesus loves me yes I know, cause the Bible tells me so…
SH / Very nice. Now tell me your names on the recorder.
L My name is Felile.
L My name is Phuleng.
L My name is Ayanda.
L My name is Michael.
SH Okay, I have a set of cards here and…well, I'm sure your teacher has taught you already how to take turns.
Ls [Chorus] Yes.
SH Okay. When is it important and why is it important to take turns?
L Because, because, because, that..uh..to take turns..because..um..like…not speaks and speaks ma'am, you know.
SH So that everybody gets a chance.
Ls [chorus] Yes ma'am.
SH That's right.
L Like me, I am a captain Ma'am, Michael and Ayanda and Phuleng never got a chance to be a captain. They gonna cry because they never had a chance and I had a chance for the whole year.
SH Okay, so you feel its unfair that you have been a captain the whole year and they must also get a chance.
L Yes.
L [All talking together] …and I am feeling angry!
SH Why are you feeling angry?
L [L] is my enemy, that's why.
SH Yeah?
L We talk with each other all the time.
SH Do you fight with each other all the time?
Ls No.
L I steal! [Laughing]
Ls [Talking and laughing in reaction to learner's admission]
L If I don't have something I take it and I give it back at the end of the day. But mostly I just take it and then I go to my table and then I …[illegible]

SH / Do you ask them before you take their things?

Ls No [a number of learners agree]

L When they say no I get angry

SH And what do you do when you get angry?

L I just go like this [demonstrates on L 3]

SH /Okay, okay [learners talk and laugh among themselves]

SH Okay, well I'm going to show you these cards. Can any one of you tell me what it says on this card?

Ls Go! Go!

SH Yes, Go! And this?

Ls Two!

SH Yes, and this one?

Ls Three!

SH And this one?

Ls Four!

L It's baby stuff!

SH It is baby stuff, but I'm going to tell you now what we are going to do with them. What we're going to do when we take turns and we want to speak in the group so that everybody can get a chance, we're going to make a rule. Okay…and the rule is that ONLY the person who has this card [shows green Go! card], may say something. Okay?

Ls [Nodding their heads]

SH So…each one of you take a card. Who wants to say something?

L Me.

SH Do you want to say something?

L Yes, ma'am. No! I'm just thinking.

SH Oh, you are just thinking. Okay, but let's just play. Say you wanted to say something and each one of you take a card. Okay? [All the learners take a card]. It means that Felile can say something now because she has the green card. Okay?

L [Discussion] But how can we take turns then? If she has that card and nobody else has that card, so she can just talk all the time.

SH You're right, but we are not going to let that happen. What we're going to do is, as soon as she…

L Okay, it's like this. When the other wants to talk then I take card number three and you can take the Go! card.

SH It's almost like that. As soon as you have said what you wanted to say, you give the card to number 2. Number 2, you are number 2, that means you are next in line. And you are third in line and you are fourth in line [pointing to individual learners]. So you take this one…you give him that one…you give him that one…and you put the card back. Okay, if she wants to say something she must pick a card up again.

L [same one who said this is baby stuff] It looks easy but it's difficult.

SH It looks easy but it's difficult.

Ls [chorus] Yes!

SH Shall we try it a bit? It doesn't mean…You don't have to get it right, right away. We can play.

L Do we win in this game?

L No

SH No..no..no. We're not playing a winning game.

L Ma'am we are playing it in Grade one!

SH	Did they play it in Grade one?
L	Yes.
SH	Okay, did you play it in Grade one?
Ls	[All talking at once]
SH	Okay, let's put them back. Everything, we put it like this. And like this..and like this. Okay, now…what we're going to do is..oh, let me just put it here. Okay, now I'm going to show you what I have here on this poster. [Turns the poster so learners can see it]
L	[impulsively] A elephant.
L	A blue elephant.
L	A bla..I mean a brown.
SH	A brown elephant. Yes, what else do you see?
L	A..a lion.
L	A giraffe.
L	I see…octopus.
SH	Do you see an octopus, Michael?
L	I see a shark.
SH	A shark!
L	And a giraffe.
L	I see people!
SH	Yes! Lots of people and balloons!
L	I see seals.
SH	What do you see, Michael?
L	Seals.
L	And I see penguins.
L	I see the snake.
SH	..and a snake, Phuleng.
L	And I see a, what you call it, a bat or whatever.
SH	That's right, a bat.
L	I see the trees and flowers.
SH	Okay, trees and flowers.
SH	There are many animals on this picture.
L	A buck.
SH	I see a zebra.
SH	Yes, do you know what kind of buck?
L	I know, I know
L	I think it's a kudu.
L	No, no, not a kudu.
L	No, it's a..it's a..it's a…
SH	It starts with a "g"
L	Gorilla! [pointing at gorilla]
L	No!
SH	Well yes, that is a gorilla. But can you find out what that is ? [pointing at gemsbuck]
L	Ohh, I thought you were talking about that one [pointing at kudu]
SH	Yes, that is a kudu, you're right.
L	What do you call this?
SH	A gemsbuck.
L	Gemsbuck.
L	I see a spider.
SH	And a spider, yes.
L	And a bee
L	I see a octopus.
L	I said that.
SH	Yes, Michael saw the octopus earlier.
L	And I see a jellyfish.

L And a lion!
SH A jellyfish, can anybody tell me what that is?
L …horse!
SH A seahorse? Okay, so that's why we're going to have to take turns. Okay?
L And I see a fish!
L What is this one?
SH Yes, its called an angelfish.
L Is this a angelfish?
SH Yes!
L I don't know it.
SH Have you never seen it before?
L [All together talking]
L That's a cheetah. Why aren't there any leopards here?
L Ma'am that's cheetahs.
SH Why do you say it's a cheetah?
L Cos, cos it's got a line here [draws a line from eye to mouth along his nose]
SH Cos it's got a line there on its cheek
L Yeah
SH That's right. And leopards, do you think leopards have lines on their faces?
L They…they have big dots and there is orange in it.
L It's like…it's like…it's like spots, but it goes 'round…like that.
L And it's orange!
SH Okay, so the leopard's spots are also different from the cheetah's. Okay, that's good.
L No, Phuleng but I forgot!
SH What home language do you speak?
L Xhosa.
L I speak Zulu!
L I speak Sotho!
SH Okay, do you know what the Xhosa word for this is [pointing to vulture]
L No
Ls [laughing]
SH Do you know the Zulu word for that?
L I know Zulu too!
SH Do you know Zulu too?
L I think it's…
SH Michael do you speak English at home?
L I know a little, little Afrikaans
SH Afrikaans…do you know what this word in Afrikaans is?
L No, it's not really my language.
L Tao. [pointing to elephant]
SH Tao. Okay.
L …ikati.
L Ikati.
SH Ikati.
L Isinhaca
SH Isinhaca…it's that the snake? And elephant…what is elephant?
L …Buffalo.
SH Ohhh, that is a..what did you say that is, Michael?
L Kudu.
SH Yes, it's a kudu. A buffalo is a bit bigger. Tell me what animal is this?
L I know, I know

Ls	[All together]
SH	Who has the green card? Where's the green card?
L	A hippo! A hippo!
SH	I am only going to listen to the one who has the green card.
L	Hippo.
SH	Okay. [laughing] Okay, tell me…if you can find on this picture…
L	Put the card back!
SH	…if you can find…a crayfish.
L	Crayfish? [incredulous]
SH	Somebody's got the green card. Somebody must try to get the yellow card because that means you can, you can, you can speak next.
L	What must I look for?
SH	You must look for the crayfish.
Ls	[talking together]
SH	English, crayfish is English. Do you know what a crayfish is?
L	Uh uh, but I think I know.
SH	Okay, you wanna take a guess?
L	This one [points to crab]
SH	Not quite, but a crayfish does live in the water. It does live in the sea.
L	But is there one on the paper?
SH	Yes, there's one on the paper.
L Here	[points to crayfish]
SH	Ahh…okay, so we've got two. This one and this one. So what is this?
L	A crab.
SH	Yes, it's a crab.
Ls	[Talking together]
SH	Somebody look for a frog.
L	A frog!
SH	Only the one with the green card. But you must remember, once you've given your answer you must put the green card back again.
L	Frog! Frog! Frog!
L	No, he's got the yellow one, you must put that there.
L	No, he did not get the frog.
L	No [increasingly agitated], he's got the green card, he must talk.
L	Oh, there's no frog over here!
L	Me, too!
L	A frog.
SH	Are you sure there's no frog?
L	No, I know there is a frog.
L	Ma'am, can you ask me a warthog, that's a warthog.
SH	Yes, that's right. It's a warthog.
L	Is it by the water? [the frog]
SH	Hmmm?
L	Is it by the water?
SH	Can you see something by the water?
L	No.
SH	Are you seeing the whole picture, or is some parts of the picture not visible? [One learner is leaning over and concealing the frog]
L	I can just see…
L	The frog!
SH	Ahh! So who was concealing it the whole time? [laugh]

L	I'm taking the number 3 card.
SH	Okay.
L	You can't have the number two always…!
L	…you must put it back…
L	[arguing together about the cards]
SH	Okay, who can tell me where…
L	No, no, no
SH	Who can tell me where the grasshopper is.
L	[All together]
SH	I'm only going to listen to the one who has the green card.
L	[All together, one gets the card] Here it is, ma'am!
SH	Yes, right! There's the grasshopper.
L	…that's why she's my enemy! [this learner lost the fight for possession of the green card with the "enemy"]
SH	Does it look like a grasshopper?
L	Yes ma'am, it looks like a grasshopper with horns.
SH	With horns?
L	No!
SH	It does have horns…but do you think a real grasshopper also has horns?
SH	No? You'll have to go an catch one to see.
L	It looks like the whiskers of a cat.
SH	Does it look like the whiskers of a cat? Okay, let's see, who can see if they can find the vulture.
L	Vulture!
L	Vulture?
L	Vulture!
L	No!
SH	Who knows what that is?
L	I know, I know, it's a…it's a..what it is.
L	A warthog.
L	No, there's a vulture, see.
L	No, that's a..that's a…
SH	What does it look like, that pink bird?
L	It's a vulture.
SH	Who knows what a vulture eats?
L	It's a bird.
SH	Yes, that's right, but what does a vulture eat?
L	It eat meat.
SH	Uh-huh. Have you ever seen a vulture?
L	Yes, on TV.
SH	Tell me a little bit about the vulture?
L	You see, when somebody comes to steal the eggs, it goes after it.
SH	Does it go after it?
L	Yeah.
SH	Okay.
Ls	[All together]
SH	Let me just hear what Felile asked?
L	[All together] …hair…it's like a helicopter but it's not a helicopter.
SH	Does it fly?
L	Yes.
SH	Is it a small insect?
SH	Is it a dragonfly?
L	[All together]
SH	Michael, I don't know why it doesn't have hair there, it's just how vultures are, they don't have hair there.

L Because it's smooth!
SH Yes! If there are not any hairs then it is smooth! Okay, who can find all the black ants? And tell me how many black ants there are. Now..just hang one a second… L I haven't had the green card for a long time!
SH Okay, I'm gonna ask you…
L Five…
SH Just hang on a second…
L Five..
SH Hang on a second?
L Seven…
SH Before you give me the answer, I want you all to work together. Okay? I want you to give me one answer, so all of you must agree. Okay? How many ants do you think there are?
L [Everyone raising their hands to give an answer]
SH No, No, you must all talk to each other and decide what the answer is going to be.
L [All together] Seven. It's seven. Seven.
L I've already got my answer.
L One…two…three…four…eight
L Where's the nine?
L [Talking all together] Nine. We all agree It's nine.
SH Do you all agree?
L Yes.
L Yes. It's nine.
SH Okay, I want you again to work together again and tell me how many butterflies.
L Butterflies?
L One..
SH Blue butterflies…sorry…blue butterflies.
L One…
L One…
L One…
L One…two..
L Two..
L Three…
L Three…
L [counting together] Four…five…five!
L Six!
L We counted five butterflies.
L Five!
L Six!
L No! We count it!
SH You see that you are getting a bit confused because you are counting butterflies that you have counted already?
L Ma'am, let me try!
SH Do you think it might help if you close one part and you only look here, and you count all the butterflies that you see on this side…
L Okay!
SH …and then you move on and you count the…
L This side, I know!
L Okay![Talking at once] …give me the card…just put a card over there…a card over there…a card over there [he is covering the butterflies as he is counting them]
SH That's a clever idea, learner!
L [Talking at once. A learners suggests putting a bead on each butterfly to know which ones have been counted]

SH That's an even better idea, learner! Why don't you try that? Try that.

L Okay, there is…one [taking beans out of container]…[all the learners joining in]…two…[talking simultaneously]…three…

L We'll count them when we are finished, just put over the butterflies.

L It's one..two..three…three…four…

L I saw another one somewhere…but I can't remember where…

L There! I found it!

SH Okay, make sure you have covered all the butterflies…I can see a butterfly that is not covered…

L Where?

L [excited]…there is it!

L Yeah.

L Ma'am can I put the…I had the wrong bead.

SH Okay…are you sure all the butterflies are covered?

L Yes.

L Can you see another one?

SH No…only the butterflies not the clowns, only the butterflies. Put it there.

L ….butterfly looks like a butterfly.

L It is!

L But it is a butterfly, it's a blue one!

L [Talking all together]..caterpillar..

SH Okay…

L ..It's unfair. How come like if you're a bee…it dies, how come we have to live for like fifty years?

L [All laughing]

SH Do you think it's unfair that we have to live so long and they can live for such a short time?

L Yes. They say…they say…

SH Do you wanna live long, learner, or do you wanna…

L It's cruel!

L I wanna live long.

SH You wanna live long. How long do you want to live?

L [Everyone together]

SH Just a second, I am asking learner.

L I wanna live eleven.

SH Eleven…years, or months.

L Eleven years and seven months.

SH Okay and you?

L …no that's before my birthday.

L [talking at once]

SH Okay, how long do you want to live?

L I want to live for hundred and hundred and hundred and a thousand weeks!

SH Okay, and you?

L I want to live a hundred and sixty…sixty seven weeks!

SH And you, learner?

L I want to live for a one hundred and a hundred and a fifteen weeks!

L [All together]

SH Okay, let me ask you one..let me ask you one question question about this picture….If

L I don't want to die, ma'am!

L Shhh!!

SH No…we don't want to die.

L I don't want to grow up!

University of Pretoria, etd - Human, S

L ..like a baby.
SH Yeah, we want to stay young.
L I want to be like a baby.
SH What is nice about being baby?
L [All together]
SH I'm asking…I'm asking L.
L Because, you see I don't like to be a mother…and then when you marry you fight with your husband, and your husband…[intelligible] …hit…and you have to have a baby…so you don't have to work.
SH Okay, and you L?
L …you work so hard, and after working very hard, you get money and you can go and buy a double storey, and you don't need to go to school everyday. School starts at seven o'clock.
SH Okay, so you would like to be a grown-up.
L Yes.
SH Okay, now it's your turn.
L …it's so nice, when you cry..the baby stop crying…and you…[intelligible, everyone laughing]
SH So would you like to be a grown up or would you like to stay a child?
L A grown up.
L I like to stay a baby…do everything for me…
SH Okay. And you L?
L I want to stay a kid. I don't want to buy groceries, I don't want to pay for electricity, I don't wanna do…I don't wanna work …I don't wanna work for long hours and make food…[intelligible]
SH So being a grown up sounds like a lot of hard work.
L I just like cooking!
SH You just like cooking, okay.
SH Let's..let's go back …just a second…let's go back to the picture again. Tell me – but I want you to talk among yourselves first, I want you to give me only one answer – who among you is going to be the leader. And it can't be L [one who said she was a captain the whole year].
L Me!
SH Okay, let all of you decide among yourselves who will be the leader.
L Okay! Okay! But L can't?
L She can't, because she is the worstest leader [said by the learner who perceives the one learner as his enemy].
L I've got a plan!
L [Talking together]
SH Okay, L's got a plan.
L [Talking together]…Ma'am I've got a good idea!
SH Let's hear Ls idea?
L ….make a vote!
SH That is a very good idea, we have to vote! Okay, so who will vote for L?
L Me!
L No, not me!
SH You vote for Ls, we've got one vote. Who votes for L?
L Me!
SH One vote. Who votes for…L? One vote. Who votes for L? Three votes! Three votes! So L is the leader!

L Ma'am can you believe that…
SH L will be the one who will give me the answer after all of you have decided about this question. And the question is: If you have to give a name to this picture, what name would you give it?
L [softly]I think we call it uh…the …market.
SH I want to hear…I want to hear what you say.
L We must call it the…the…the zoo.
L Let's call it the Pretoria zoo!
L No, but it doesn't… look here..it doesn't got anything that's there…
SH Do you think it doesn't have anything that they have in a zoo, Michael?
L No! I don't think that crabs..
SH Okay.
L [In disagreement pointing to various animals individually] This stays in a zoo! This stays in a zoo! This stays in a zoo!
L I think we must call it the Mpumalanga zoo!
L Yeah, Mpumalanga zoo!
L Yes! …it doesn't make sense…yes, there is that…the Mpumalanga zoo.
L The Mpumalanga zoo.
L Pretoria zoo makes sense!
SH Why does Pretoria zoo make sense?
L Because…
SH I want all of you to agree…if only one disagrees, then I don't want the answer. All of you must agree.
L Mpumalanga zoo.
SH So I think what must happen is…three of you think it's the Mpumalanga zoo, and one of you thinks it is the Pretoria zoo, so…
L No, but maybe we should…
SH You will have to…
L No but maybe we should not say what zoo…maybe we should just call it a zoo.
SH What do you think about that idea?
L It must have a name!
L Yes!
L It's a zoo, but what is the name of the zoo![exasperated]
L No!
L I do agree that it's a zoo, but the name, like..it's a…[intelligible]
L [Together] Yes!
L Yes, like when you call the cops, …and there's a fire at the zoo…you say, it's a zoo, now they don't know what zoo.
SH So its important to have a name for the zoo.
L …what street!
SH Okay, but do you all agree that this could be a zoo?
L [Together] Yes.
L But what's the name! [somewhat anxious]
L [determined] But that doesn't stay in a zoo!
SH Okay, so you are unhappy about these animals…you don't find them in a zoo.
L I found them in a zoo!
SH Do you think…do you think that we find MOST of these animals in a zoo?
L Yes.
SH Not ALL of them.

L It does not matter.
L …not ALL of them but SOME of them.
SH Okay, it sounds to me…
L [Talking together]
SH Who of you have been to Pretoria Zoo? Uh huh, and you Ayanda, and you Felile?
L …to Mamelodi zoo.
SH Did you go to Mamelodi zoo?
L I have!
SH I didn't know there is a zoo in Mamelodi?
L I can't remember. [going to the Pretoria Zoo]
SH I want to ask you something: I didn't know that Mamelodi had a zoo? What animals do you find there?
L Hippo's, lions, cheetah's…
SH Okay, so you'll put beans on all the animals that you find in the Mamelodi zoo.
L Yes…[talking all together]
L I have seen a lion.
SH A real live lion?
L [All talking together]…no lion, no cheetah, no tiger.
L No, maybe I have seen a…
SH …so there are lions…[learners talking together and increasingly vying for attention]…Okay, I can't listen to two people at once.
L …and they try to make me believe it's just gonna go away if you don't lie. Okay, so now you go…and my father says…[illegible, talking at length while the others are working on the Mamelodi zoo animals]
L Flowers, flowers too…
SH Okay L, let's see what they are doing over here.
L …to talk?
SH Yes, L, what did you want to say?
L [beginning to talk]
SH Just a second [stops learner interrupting] Phuleng?
L At the Pretoria zoo they put money in the water for fish, ma'am…want to take that money, you can't take it ma'am.
L [excited] They go so…they go like…they throw five rand!
L Ja!
SH It's a lot of money to throw away!
L Ma'am, look here! …My dad had a big operation…[talking illegibly]
SH Yes…come back to your chair, L. I have something else here, so as soon as we are finished with this, then I can show you what is over here…Okay, so these are all the animals that you find at the Mamelodi zoo?
L [Together] Yes ma'am!
SH Okay.
L [Ls talking about different experiences. Not focused on the task at hand any longer]]
L [unhappy] At the Pretoria zoo you have to pay to go in.
SH You have to pay to go in?
L Yeah!
SH Okay. I've got some play money here. I want you all in a group to tell me how much money there is. All of that together.
L I got fifty cents!
L I also got fifty cents!
L I got one Rand.

SH You can see…you can count, just tell me how much money there is. You can work it out on your own.
L Can I try?
SH All of you together, I want it to be a group effort. And L is the leader so he will give me the answer.
L …and this is fifty rand.
L …one rands, both of them…
L [starting to count together] …two rands!…three rands!…five rands!
SH Who will write?
L She will!
L You can do this…
L [All talking together].. we can use this?
SH You can use what you want. Come, come, learner.
L Ma'am can I please work it out?
SH You are a group you have to work together.
L Four rand…write four rand.
L Four rand.
SH I see only two people doing this, I want everybody to do it.
L So you guys have to count…
L Okay.
L Okay.
L That's five rands.
L …eleven rand.
L I've got to count to elevent rand.
L Five plus eleven rand is sixteen rand.
L It's five rand, or four rand or three rand.
SH Do you think it might help if you sort all the…if you group all the same money into little heaps?
L [pleased] Yeah!
L But…but…
L We must count…
L …we must have the coins…
L [A lot of talking] Let's do like this…put the fifty cents together like that…
L [sing-song] Ja, ja, ja, ja, jaaa…
L [guessing] A hundred rand, you'll see
L Hundred rand!
L There's another fifty cents!
L …together, fifty cents together.
SH [sees one learner losing interest and letting others complete the task] Come on, learner, group effort! Come one, you must come and help.
L It's five rands!
L It's a hundred.
SH Give Ayanda also something to work out.
L Is this…?
L One rand.
SH Okay. Whose going to count what?
L [starting to count by adding each individual piece]
SH Okay, before you add them all together, let's try something. Why don't you put them in a row, from the biggest to the smallest. The biggest to the smallest.
L [Doing this]
SH Okay, do all of you agree that it's from the lowest to the highest?
L [Together] Yes!
SH Where's the lowest end?

L	[All point to twenty cent piece]
SH	Okay, so where are you going to start if you want to count all the money?
L	[Some pointing to the twenty cent piece] Here!
SH	Are you going to start with the biggest or the smallest?
L	The biggest!
L	Smallest!
L	Biggest!
L	I think the biggest!
L	[Talking together]
SH	So you think you're gonna get forty something rand, learner? Just a second! Take a guess, how much money do you think there is? L says…
L	I think about fifty five rand.
SH	L thinks fifty five. What do you think, learner?
L	Sixty five rands.
SH	Sixty five. What do you think, learner?
L	Eighty five. L says eighty five.
L	I think it's ninety seven rand.
SH	Okay, you think its ninety seven rand. Okay, you can count it, you can now add everything together and we'll see who was the closest.
L	Thirty! thirty rands!
L	Thirty rands.
SH	Okay, so you count all the ten rands first.
L	Thirty…
SH	Okay and then? What do you do next?
L	And then we're counting five…
L	Thirty-five…
L	Thirty-five, forty!
L	[upset]…give me that!
SH	L, come on!
L	Forty, plus five rands, forty five!
L	No, but…
L	Forty! Forty!
L	It's forty.
SH	Okay, learner says its fifty, [other] Phuleng will check it. Okay?
L	It's fifty.
SH	Okay, so its fifty, now we can…
L	Okay, now come the two rands!
SH	Okay, let Michael [one who has been losing interest] count it.
L	Fifty-four rands, fifty eight rands…sixty rands…sixty-one rands, sixty two rands, sixty three rands…sixty four rands…sixty five rands…she's the closest!
SH	How much is there?
L	Ma'am who said sixty something?
L	[in a row] Not me! Not me! Not me!
L	You were closest because its around sixty, now look…
L	How much is that?
SH	Work with them, work with them learner.
L	[Together]…sixty three rand sixty.
SH	Okay, you're right…you're right, sixty three rand sixty. Okay? Okay?
L	I said sixty five rand!
SH	Did you say sixty five rand?
L	Yes!
SH	So you were the closest! Very nice! Very, very nice! And you were the second closest. That's very good. Okay, we're

University of Pretoria, etd - Human, S

finished for today, thank you so much for helping me.

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P10: SSGR1JUNE9.txt [C:\phd\SSGR1JUNE9.txt]

Group : Grade 1
Date : 9 June 2000
Time : 11:00 – 11:40

Learners begin by singing a song and each saying their names.[Seifo, Kagiso, Tshepo, Tshediso, Relobihile.]

SH Turn the picture around. Okay, maybe you want to sit over there so that it's easy for you so that you don't see the picture upside down. You don't have to, but maybe it will just make it a bit easier for you. If we want to say what the title of this picture is, if we want to give it a name, what can we say? What is this picture all about? What do you think? Refilwe? Look at all the things you can find on this picture and tell me what it is all about? Does anybody have an idea? She has an idea! What do you think it is all about?
L It's like it's at the zoo.
SH It's like it's at the zoo, do you agree?
L Yeah.
SH Does it look like it's at the zoo, Tumi?
L Yeah.
SH What makes it look like it's at the zoo, Tumi? [unresponsive] What is a zoo, what do we find at a zoo? Let's hear what Tumi wants to say. What do we find at a zoo?
L The animals.
SH Yes! We find animals, we find lots and lots of animals. What else do we find at the zoo, Kagiso?
L There's lot of animals here.
SH Yes, yes…and what else do we find? The most important thing is that we find animals at the zoo, but what else can you see here that we also see at the zoo. Yes?
L Zebra's, and some…
L Butterflies.
L …butterflies, and lions and …
SH What is this called? What is this? Do you know what it is? Can somebody tell him what this is?
L I saw this on TV but I forget what it is.
SH It's called an….octopus! Do you know what this is called?
L No.
SH I just said its name.
L I know! I know!

SH Did you listen?
L I did listen, an octopus.
SH No, I want to hear from him.
L An octopus.
SH An octopus…okay. Who can tell me what this is?
L [together] Lion!
SH Very good! It's a lion. Okay, I want everybody to choose…wait before you do that…choose their favourite animal, or the animal that they like on this picture and then I'm going to start with Tshediso and I'm going to ask each one of you what their favourite animal is and what you call that animal in your own home language. Okay? Tshediso, what animal do you like to choose? [silence] Of all the animals, what animal do you like to choose?
L [points to an animal on the poster]
SH That animal…what do we call that animal?
L Giraffe.
SH Yes, a giraffe. What language do you speak at home?
L Sotho.
SH Sotho. Do you know what one calls that in Sotho? Can you tell us?
L Mala.
SH Mala? I'm not sure that is right? Who else here speaks Sotho? Do you know what we call that in Sotho?
L Yes, I do. It's still the same word, it's still giraffe.
SH Is it still giraffe? Okay. Good Tshediso, do you like giraffes?
L [nodding head]
SH Why do you like them? [silence] Because…? [silence] Who can help him?
L [indecipherable]
SH Because…
L Ma'am I do know!
SH Let me just hear what he says, because?
L They are climbing.
SH Because they are climbing?
L They can climb.
SH Okay.
L I feel like a pere.
SH Like a?
L A pere.
L What is that?
L A horse!
SH Like a horse? Okay, a pere is…
L …they sit at the top of…
SH Children sit at the top of a horse and they ride a horse? A pere. This giraffe, do you think we also can ride on them?
L No.
SH No, we can't.
L Giraffe….giraffe has big neck!
SH Yes, a long neck. Why are their necks so long you think?
L Cos their legs are long.
SH Yes…their legs are long, but look at this picture? What do you think why are the giraffe's necks so long? What do they do with a neck that is so long?
L Eat the leaves!
SH They eat the leaves of trees. If it had a short neck, do you think it would be able to reach to the trees and eat the leaves?
L No.

University of Pretoria, etd - Human, S

SH	No, so that's why it has a long neck, so it can eat the leaves of the trees. Very good. What animal do you want to choose?
L	A lion.
SH	A lion! And in Sotho that is called…Tau!
L	Tau.
SH	Tau…is it right? Okay, why do you like the lion?
L	Because I like the skin of the…it's very nice and soft.
SH	Very nice and soft…
L	I don't know what the lion is in Sotho.
L	Don't say tau. You must say ke lione.
L	It's not! It's tau!
SH	Is it Pedi that you are speaking?
L	Yes.
L	I speak Sotho.
L	You speak Sotho. And you?
SH	Sepedi and Sotho. Okay…and English?
L	I have the combi.
SH	What do you have to go and do?
L	I have a car. The toys car.
L	I think he has a car.
SH	Do you have a car?
L	Yeah.
SH	Okay, where do you have a car?
L	In my room.
SH	Okay. Let's ask her. She's the next one.
L	I have two cars.
SH	That's good, but let's see if we can talk about what's on the picture. Let's hear what she says, what animal does she want to choose?
L	Lion
SH	Which animal do you like?
L	[points to picture]
SH	You like that one? What is it called?
L	Cheetah.
SH	Yes, you're right. It's a cheetah. You're very, very right. How do we know it's a cheetah and not a leopard?
L	Leop…this thing he can kick your head!
SH	I just want to know about the cheetah. Yeah?
L	Because it don't looks [sic] like a leopard, but its…like all the animals but it doesn't look like a leopard. It doesn't look like a leopard.
SH	Does it have spots like a leopard? [silence] Does a leopard also have spots?
L	Yes.
SH	Yes, he thinks the leopard also has spots and he's right. But, does a leopard have a little black line on it's face there on its eyes? Does a leopard have a line like that?
L	[together] No. No.
SH	No! So that's how we know when it is a cheetah and not a leopard? What is your home language?
L	English.
SH	English? Don't you speak another language? Which language do you speak at home?
L	English.
L	At your real home.
L	I only speak English.
SH	You only speak English, okay, that's fine, that's fine. Let's give Kagiso a chance. What animal is Kagiso going to choose?

University of Pretoria, etd - Human, S

L The lion.

SH Lion! Okay, we already know what is the lion called? In your home language? What do you speak at home?

L I speak Sotho and English.

SH Sotho and English, what is it called in Sotho again?

L A tau.

SH Tau. That's right, okay, and you?

L This one.

SH Which animal are you going to choose?

L Okay, what is it called?

L It's like a monkey but it's like a baboon.

SH It's like a monkey, but it looks like a baboon.

L Yes.

SH What do you think it is called? What is it's name?

L It looks like baboon.

SH It looks like a baboon. How do you think it will be….Okay.

L I know!

SH What do you think it will be?

L Gorilla.

L [indecipherable] It's not a gorilla, it's a monkey.

L It's a gorilla!

SH Okay…the two of them thinks it is a gorilla and you think it's a monkey. Tell me why you two think it's a gorilla?

L Because, because, this one is the monkey, this one is the baboon and this one is the lion. This is a gorilla because the gorilla is like this. And this is a monkey and this is a baboon and this is the gorilla.

SH Okay, so you say it's a gorilla because their faces look the same? And because they look different from the monkey?

L Yes.

SH If you see them…if you see an animal like this in the bush, how do you know if it's a monkey, or if it's a baboon?

L Ma'am I can see it!

SH How? How are they different? How is a monkey different from a gorilla?

L It's a monkey, Ma'am.

SH Are they different in their size?

L They are different.

L It's, it's not the same because he has red eyes, and it has black eyes.

SH Yes.

L And because they don't have the same skin, and it doesn't have the same skin, same like the monkey.

SH Okay. Is a monkey smaller or bigger than a baboon?

L [together] Smaller!

L There are some monkeys they are big! Some monkeys are big, some monkeys are small.

SH Okay, are they bigger or smaller than a gorilla?

L Some…some gorillas are small and some are big. And like, some are bigger, some gorillas are, they are mighty.

SH Okay, are ALL gorillas bigger than monkeys?

L Some are, some are not.

SH Okay, which gorillas are not? Is a gorilla large? Or is it small?

L Some are large.

SH ALL gorillas are large. Gorillas are only large. Okay? So they are always bigger than monkeys. Gorillas are always bigger than monkeys, okay?

L Yes.

SH Okay, I'm gonna show you a few cards. I'm going to put them down. When I put them out I want you to tell me if you can see what the name is. What animal is that? Tshediso? Sit a bit up and lean over the table so you can see. Lean over the table, what animal is this?
L Lion.
SH What is it?
L Cheetah.
SH Okay, what animal is this?
L Leopard.
SH Which one is the leopard and which one is the cheetah?
L This one is the…this one is the cheetah, this one is the leopard.
L THIS one is the leopard, this one is the cheetah!
SH Ah, why do you say that one is the leopard and that one is the cheetah? How do you know the difference? I want her to tell me quickly, how do you know which one is the cheetah, and which one is the leopard?
L Because the leopard is lying on the tree and the cheetah is running.
SH And a cheetah is very fast. There's another difference. We cannot see it very easily on these cards, but the head of a cheetah is normally smaller…
L Yeah.
SH …than the head of a leopard. Okay? What is this?
L I know.
L Fox!
SH It's a fox.
L Fox.
SH What is this?
L Ah! It's again!
SH What is it?
L Leopard.
SH Leopard. Does the leopard have the big or the small head?
L Small.
SH Tshediso? Is it's head big or small?
L Big.
SH It's big! What is this?
L Elephant!
L Tlou.
SH Tlou, yes. What is…this!
L A rhino!
L Rhino!
L That looks like a leopard, I don't know.
L I like it when it goes and goes fast and run and eat some animal…
L [indecipherable, making noises and interrupting learner]
L A rhino is very fast.
SH Yeah, a rhino is fast. Okay, what is this?
L Leopard.
L Leopard.
L Cheetah.
L Cheetah.
SH Why is it a cheetah?
L I can see it running.
L Yeah
L Because it has some…
L A cheetah can't climb very high.

University of Pretoria, etd - Human, S

L …it has this black thing on its head…but it doesn't, it doesn't…
SH Okay. What do we have here, Tshediso?
L Baboon.
SH Okay, I want to ask Tshediso, the others musn't say. What is this?
L I don't know, ma'am.
SH Okay, let's help him?
L Sparrow!
L Squirrel!
L Rabbit!
L Squirrel!
SH Squirrel! Yes. Why is it not a rabbit?
L Because a rabbit has, has a …
L …also like…
L ..it doesn't have it.
SH Okay, a rabbit has long ears.
L …it can hear the other rabbits…
SH Yes! What do we have here?
L Monkey.
SH Monkey. Okay, and there?
L [together] Hippopotamus!
L He's in the water!
L Lion!
SH Tshediso? What's that?
L I know.
L Let me think, wait.
SH Can somebody help him?
L I know!
L It comes from the sand!
SH Yes, it comes from the sand. It comes to the…?
L Moo…
SH Does it make that sound?
L Yes.
L It's..it's..
SH What do we call it? It's a…? It's a camel!
L Oh, yes!
SH Camel! It's a camel. Okay, we already had that one…And this one?
L Tiger!
SH That's right, you were very fast and quick with that one. How do we know the difference between a tiger and a leopard and a cheetah?
L Elephant is…
SH You tell me, I want you to tell me. How do we know the difference? How do we know this one is a tiger and this one is a leopard? How are they different?
L This one sleep in the tree.
SH Okay, but in the way that they look? No, no, no, I want to hear from him…in the way that they look, their appearance, how do they look different? How is the tiger different from the leopard? [silence] What does the tiger have that the leopard doesn't have? [silence] If you look at the way that they look, what sort of marks does a tiger have on it's body? Does it have dots?
L Big lines.
SH It has big lines.
L This one has dots.

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SH Yes, the one has stripes, and the other one has spots! Okay, what do we have there?
L [together, indecipherable]
SH Okay, I'm going to put them down, look at those that are already there and put all the ones…come on! Come and sit here!…you must come and sit up here, no, we're not going to sleep in this class. We're not going to sleep, you must concentrate. Did you not have enough sleep last night?
L Me too, I never had enough sleep. Everyday my brother wakes me up at night. I go to bath and I go to sleep, my mother wakes me up…
L My brother…
SH So you are being woken up many times?
L At night I sleep at twelve.
SH You sleep only at twelve? You need enough sleep so that you are not tired the next day.
L Ma'am yesterday I went to my brother…
SH Uh-huh, and you wanted to say…?
L My mother always wakes me up. When my mother wakes me up, my brother comes…my baby brother come and play with me, and I don't wanna play. He always wakes me up.
SH Then you can't sleep and that's why you are tired.
L [together indecipherable]
SH And you, Tshediso, do you sleep enough?
L No.
SH Why not?
L I didn't sleep, I watch TV.
SH You watch TV?
L My mother…waking me up.
SH Okay. Okay, look at all the pictures that we have there and then you put all the ones that are the same…but not all together, we're going to ask him first…you take two that are the same and you put them together. You can take any two and put those two together that are the same. Okay. And yes….now we have turns. Kagiso? Which ones are the same? Which ones are you going to put together?
L [working together]
SH Now, I'm going to put an animal down, or I'm going to give it to you and then you see if you can put it together with some of the others. [hands one down] Is it the same as some of the animals that are on the board? Is it the same?
L [nodding]
SH Okay, then you put it together with the ones where it belongs.
L [working and talking together, indecipherable]
SH Okay, let's give it to Kagiso. What is that? Yes…
L It's not the same!
SH Okay, then if it's not the same, then you just put it down. It's friend will come later on. Let's give her a chance….ah! and there's the friend. Okay, just put it down again, so that everybody can see it.
L …this one has a friend…
SH Does it have a friend, that one that you have?
L Yes, yes.
SH Where are you going to put it?
L There!
SH What is it?
L [talking together, indecipherable]
L Tshediso, here!

SH Tshediso? Tshediso, wait, before Tshediso can put it there he must tell me what it is.

L Lion.

SH Okay, it's a lion. That's right, very good! [handing out a new card] Does it have a friend on the board?

L No.

SH Okay, then we put it down. It's friend will come. Does this one have a friend?

L No.

SH Okay, then you can just put it down. Does this one have a friend, what is it called?

L Springbok.

SH Yes, springbok.

L Springbok, he runs fast, nê?

SH Yes, they do. And they jump very high.

L And they can jump up in the air.

SH What do we call this again?

L Baboon.

SH Baboon, okay. And this one I have…good, Tshediso, baboon. Does this one have a friend?

L [together] Yes! Oh, yes!

SH Where is it? What do we call it? Tell them what do we call it?

L [laughing and joking]

SH Okay, what is it? What do we call it, Tshediso? Rrrr….

L Rat!

SH Rhino! Do you know what that is?

L [indecipherable]

SH Good. Does it have a friend?

L No.

SH Okay, I want you to hold the card so that nobody can see it, and then tell them what it is. And then they must tell you if it has a friend on the board. No, tell them what it is. It is a…? What's the name of the animal you have in your hand? [silence] It is a leopard. Does it have a friend on the board?

L Yes! Yes!

SH Ah! Okay, so now we can put it there.

L Yeah.

SH Good! Now you hold it and tell them what animal do you have.

L Fox.

SH Ah! There…it has a friend. Okay…

L [laughing and giggling]

SH Tell us what that is…Tshediso, have a look at that card, what does it look like? It's a wild dog.

L Oh!

SH A wild dog! Hold the card and tell them what it is.

L Oh, it's a police dog.

SH Tell them what it is?

L I know!

L I know!

SH Do you know what it is? [silence] Can somebody help him?

L Wolf!

L Wolf!

L Wolf!

SH What do you have there? He has a…? Did you tell them? Tell them what you have.

L A bird.

SH Okay, what do you have?

L	Monkey [talking together, indecipherable]
L	[singing] Three little monkeys, jumping on the bed…
L	[all together singing now] five little monkey, jumping on the bed, one falls down and bumps his head!
SH	Okay, next one!
L	[shouting together]
SH	Not all together.
L	[singing while others laugh] One little monkey, jumping on the bed…
SH	That's good, okay, what animal do you have? Tshepo, the monkey…does it have a friend?
L	Yes!
L	Don't have friend…he have?
L	Yes! He have!
L	He have friend, he have friend.
SH	Okay. Yeah, tell them loud enough so they can hear. Before you put it down, tell them what you have?
L	[laughing] Uhmm….
SH	Now…we have to think!
L	Let me think.
SH	…the one that lives in the desert, where there is sand…? We call it a….c-a-m…
L	Camel!
L	Camel!
SH	Ah, very good! Good for you two! It's a camel.
L	It's a camel.
SH	Okay, what do you have?
L	Camel!
SH	Also a camel? So we can put it there. What do you have?
L	Kangaroo.
SH	Okay, does it have a friend?
L	[together with SH] Yes…
SH	What do you have?
L	Lion.
SH	The one with the stripes?
L	Yes, it's a lion.
SH	I'm not sure….ask them if they also think it's a lion?
L	Tiger!
SH	What's the difference between a tiger and a lion?
L	I know, I know, I know, I know!
SH	I want him to tell me. Does a lion also have stripes like that?
L	No.
SH	No, so that's how we know the difference. Okay, does it have a friend on the table? Okay you can put it down.
L	[indecipherable]
SH	What is it called?
L	Wolf!
SH	It's a wolf! Does it have a friend…yes! Ah, let's see if Tshepo can remember what we called this one?
L	[laughing and shouting]…dog!
SH	A…?
L	…bad dog.
SH	It's called a dog, but it's not a bad dog it's a…? Wild dog! So it is a dog, does it have a friend?
L	Yes.
SH	Okay, which one do we have there?
L	Cheetah!
SH	That's good, you're beginning to know what the difference is

between a cheetah and a leopard. What do you have? What do you call it?
L [laughing]
SH What do you call it, the one in the desert, you just had one.
L I know! I know!
SH Can you tell us?
L Camel.
SH It's a camel. What do we call it, Tshediso?
L A camel.
SH Camel! How are you going to remember it? How will you remember? Shall we take a picture of it?
L Yes.
SH Let's take a picture of it. Each one take a camera…There's your camera…okay. Where's the camel, where's the camel?
L Here, this one.
SH Ah, this is a camera. Okay, we put the camel there…and we…click! Take a picture! And we remember it is a…? Camel!
L [together] Click!
L I'll remember!
SH Will you remember? Yes, click your camel! Take a picture of the camel.
L Click!
SH No, do it like this, so you can see it.
L Click!
SH Through the circle. What do we call it? We call it a…?
L Camel.
SH We call it a camel. Okay…Okay, let's take one more picture. Okay? Uhm…who must have the next one? You must have the next one, because he had the camel. What do you have there?
L Uhm…kangaroo.
SH Kangaroo! Does it have a friend?
L Yes!
L Yebo, yes!
SH Yebo, yes! Okay, what do you have?
L [indecipherable because of noise outside]
SH It's a dog…what sort of dog is it? A…?
L Wild dog!
SH Good for you! It's a wild dog! We must listen to the others, what do we call that one? Tshediso? Did you listen to what she said? [to another learner] Just a second. No, you didn't listen because what were you doing? You were singing a song?
L [laughing in response]
L Ma'am, I know.
SH No, he's going to first try to remember. Show us the picture? What do you think that is?
L A dog!
SH What sort of dog, you're right, it's a…?
L Wild dog.
SH Wild dog. Wild dog. [to all learners]Take a picture of the wild dog?
L [making clicking noises]
SH And remember it's a wild dog.
L Okay, wild dog.
L Wild dog.
L Let me! Let me! Let me see the picture.
SH It's a wild dog. It's a wild dog. He's got a picture of a wild dog. Okay?

L	It's a wild dog!
L	I've got a picture of a wild dog!
SH	Okay, put the wild dog back again. Put the wild dog back again where they belong. Okay, I'm going to show one more, I'm going to show one more…
L	[talking together]
SH	Who can tell me what this is!
L	[together] Lion!
L	Okay!
L	No, it's not lion!
L	I know!
L	It's different!
L	Tiger
L	Tiger!
SH	Ah, it's a tiger! Take a picture of a tiger quickly. No, no, no, there's only one and I'm going to show it to you. So take a picture with your camera?
L	[together] Click! Click!
SH	So you'll remember this is a tiger?
L	Ma'am can we go for break?
SH	Yes, you have to go out for break now. Let me take all the cards, and you can keep your camera cards if you want.

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Data subset 5 (DS5) **EXHIBIT K**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 03:00:48 PM

P11: SSGR2JUNE9.txt [C:\phd\SSGR2JUNE9.txt]

Group : Grade 2
Date : 9 June 2000
Time : 10:20 – 11:00

Learners introducing themselves. [Ofentse, Tshaofaso, Kevin, Thabang, Agi, Mandisi, Kefilwe, Fumi]

SH Who of you wants to guess what is on this picture before we turn it over?
L Calendar!
SH What did you say?
L A calendar.
SH A calendar. She thinks it's a calendar.
L Clothes!
SH You think its clothes.
L A photo.
SH What do you think?
L A photo.
SH A photo? Okay…what do you think?
L Clowns.
SH Clowns…
L A…I think it's people.
SH Yes…what do you think?
L I don't know.
SH Take a guess.
L Animals.
L Animals.
SH You think there are animals on it.
L A birthday child.
SH A birthday child…okay, well, let's see…what we have.
L He was right! He was right!
SH He was right!
L And people…
SH Yes, and he was right because there were people.
L Clothes! I was right, clothes!
SH Yeah!
L Animals.
L Animals, he was right, who said animals?
L Ofentse!
L Oh, he was right also….let me see, animals…
SH So in a certain way, all of you were right.
L Ah!
SH All of you were right. There were clothes…I think somebody said a birthday child.
L And a clown.

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SH Hmmmm…we can't find a birthday child. But that's okay…maybe there's somebody on the picture who is having his birthday. If we have to say what the title of this picture is…what this picture is all about…what would you say?
L It's about a circus.
SH Okay, she thinks it's about circus. What do you think?
L I think it's about animals and people.
SH You think it's about animals and people.
L Ma'am? I think it's at the zoo.
L Ah…!
SH Ah, you wanted to say that too!
L And me!
SH And you too! Who thinks its about the zoo?
L Me! Me! Me!
SH Uh-huh? All of you? All of you thinks its about the zoo? Well, all of you are right! It is about the zoo. Tell me, if you can see…what sort of animals do you see on here? What…
L Ma'am I see a lion!
L A lioness!
L Elephant!
L And a elephant!
SH Just a second….
L And a seal!
SH Ah, ah, ah!
L Shhhh!
SH I know you're excited and there are lots of things
L Yes.
SH …but let me point to the animals, and then you tell me what they are.
L Lion!
SH What is it called in Sotho?
L Uh….tao!
L [together]Tao!
L [laughing]
SH Good, what's this?
L [together] A giraffe.
SH Giraffe. Does anybody…who speaks Xhosa?
L Me.
SH Do you know what giraffe is in Xhosa?
L [laughing]
L I speak French!
SH Do you speak French? Parlez vous Francais?
L Oui!
SH [laughing] That's all I know, I don't know more French.
L I know Bonjour!
SH Bonjour?
L Yeah.
SH That's very nice!
L Bonjourno.
SH Okay…what do we call a giraffe in French?
L [saying giraffe with a French accent]
SH Giraffe? That's good, and a lion? Can you remember what a lion is?
L No.
SH You must ask your parents.
L …it's my language! I know what's it!

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SH Ah! Ah!
L N'est ce pas.
SH N'est ce pas…you don't know?
L I know!
L [All talking together]
SH Okay…one, one at a time. Who speaks Xhosa?
L Me.
SH Okay, what's a snake in Xhosa.
L Inyoka.
SH Inyoka. Okay, who speaks Zulu?
L No one.
L Me.
L You, you!
L I don't speak Zulu! I only speak English, that's all.
L I know…copycat!
L [fight ensues among some learners]
SH Hey! [whistles]
L [laughing but quiet]
SH Only one person at a time. One person at a time and I want you to put up your hand. If you want to say something…you have to use…put them there…as soon as you want to say something, you pick up a card…I'm only going to listen to you if you pick up a card. What did you want to say?
L Give it back!
L A zebra.
SH This one over here?
L Zebra.
L Zebra!
SH I'm not listening to anybody who hasn't a green card. It's a zebra…what is it called in French?
L [says something undecipherable]
SH Okay…okay…okay…you cant…
L Put them down!
SH Put them down. Okay…so it's one, two and three…what do you want to say?
L I want to say…a grasshopper.
SH Okay, where do you see the grasshopper? Over there…very good. Okay, so put your card down so somebody else can take it. Yes?
L Yes, I wanted to say a elephant.
SH Elephant…tlou? Is it called in Sotho tlou?
L Yes.
SH Okay…yes?
L I wanted to say uh…springbok!
L Ah!
SH Where do you see the springbok?
L [points]
SH Does everybody agree that's a springbok?
L No!
L No!
L [talking]
SH Wait…wait…wait…I'm first asking this question?
L It looks like to me.
SH Does it look like a springbok.
L A bok!
SH It is a buck. What do you think it is?
L A buck.

SH	Yes, it is a buck. But what kind of buck….? A gemsbuck.
L	Yes.
SH	Anybody ever hear of a gemsbuck?
L	No!
SH	In Afrikaans it's a gemsbok.
L	I know gemsbok!
SH	Do you know gemsbok?
L	In French is…..le…[unintelligible]
SH	Ah…okay, that's very good!
L	I know my language!
L	You don't!
SH	Okay…
L	[arguing]
SH	Who picked up the green card…
L	[fighting]
L	Put it down! Kevin!
SH	Okay
L	[fighting and shouting]
SH	Hey. Hey. If you said something then you can put it down so somebody else…
L	Caterpillar.
SH	Ah, that's a caterpillar, very nice. Okay…
L	The lion.
SH	Where do you see the lion? Over there…very good. Okay, you can put your card down.
L	A bicycle.
SH	Where do you see the bicycle?
L	There.
SH	[exclaim] That's nice! You are one of the first learners to tell me that they see a bicycle. Everybody talks about the animals, and nobody talks about the people.
L	Butterfly.
SH	A butterfly, very nice!
L	I can see a child.
SH	Where do you see the child?Yes…a little baby child. Tell me…I'm going to say…the name of an animal, and then I want you all…you don't have to say anything…you can just put your finger where you see the animal. Okay? Can you tell me where…the hippo is. Very good!
L	[unintelligible]
SH	Oh. Well the important thing…I think the important thing is if everybody can see the animal that I say. Who can show me where the spider is?
L	I got it first!
SH	Very nice. Who can show me where the seahorse is?
L	There! I got it first!
SH	Okay…right. Who can show me where the vulture is?
L	What's a vulture?
SH	Ah, do you know what a vulture is?
L	Yes, that is that.
SH	Just a second? Just a second.
L	A vulture.
SH	That is not a vulture. So that tells me that…
L	It's a penguin! It's a penguin!
SH	That's right, it's a penguin.
L	This is a vulture.
L	It's a bird.
SH	Who can tell me what a vulture is?

L It's a…
SH No, that is not a vulture. Let me give you a clue. A vulture is a bird. So you must look where the birds are. Ah…who's got his finger over there? You've got your finger over there. We call that bird a vulture. Do you know why we call it a vulture?
L Because it's go like…[imitates scream of vulture]
L [Laughing]
SH Yes, it does that. It flies very, very high and it waits to see where dead animals are…so that it can go down and hop to those animals…
L I know! First the lion eats it, then after that the hyenas come, then the birds, then the vultures!
SH That's right, that's right. Do you know why the vulture…
L Hyena!
SH …Do you know why the vulture's beak is round and sharp like that?
L For cut…
SH Can you guess?
L For cutting.
L For cutting.
SH For cutting and eating, yes. All of you are right. If you wanted…if he wants to tear the flesh from the lion then he must have a very sharp and rounded beak. Okay. I'm going to ask you…to take some of these beads. It doesn't matter what colour beads you take…no, no, wait a second! Don't take it right away. But, I'm going to say the names of some animals, and then I want you to put a bead on each of the animals that I say. So I want you to find me all the birds on this picture.
L [laughing and working]
L Ma'am…it's mine…it's mine.
L Don't take mine!
L Hey, ma'am!
SH Okay…once you've..
L [talking and working]
L There's a bird!
SH Once you've put…just a second…once you've put the bead on the bird, you can take your hand away, so we can see if there are…others. Do all the birds have beads?
L Here's a flamingo!
L What is it?
L Flamingo.
SH Put your finger back.
L Flamingo..
SH Okay…what did I ask you to do? Just a second. What did I ask you to do now after you put the bead on the bird?
L Take off your hand.
SH Okay, so he's the only one who is listening. Do all the birds have beads on them?
L [together] Yes!
L Someone said this one.
L No, no!
L Yeah! I saw you…
SH Okay…do all the birds have beads on them?
L Yes.
L Not all…not all of them.
SH But you must find ALL of them…and ALL of them must

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have beads on.
L That's not a bird!
SH ALL the birds…
L [Talking among themselves]
SH How do we know when something is a bird?
L I think this one must have a bead.
L No, that one cannot fly.
SH Okay…so you think something can only be a bird if it can fly?
L Yes.
SH Well, it is important. Birds must be able to fly, but do you think that an ostrich is a bird?
L No.
L No.
L No.
SH Not?
L It is.
SH It is! Why is it a bird? Why do we call it a bird? There are two other things that are important. Apart from the fact that a bird must be able to fly, there are two other things that…
L Wings!
SH Yes, wings…what else?
L It's got a beak!
SH Yes, okay…it's got a beak. And how do birds get their babies?
L They just lay eggs.
SH Yes! They lay eggs! That's important! So there are three important things that a bird must have…it must have wings, it must have FEATHERS on the wings, it will have a beak, and if it lays eggs, then you can say it's a bird.
L It must have wings because it must fly to look for food for the baby.
SH That's right, so if you know all those things…do you still think that all the birds on this picture have beads on them? Have we covered all the birds?
L Yes.
L No.
L No.
L Put her back…the bead back.
SH Which bead? On which animal?
L [exclaiming]
SH Okay…so the vulture must also have a bead. The vulture must also have a bead…there we go! So we've got a ….
L …butterfly!
SH Okay, put your hands back so we can see, no, no, put your hands back so we can see where the beads are.
L Leave…!
SH Leave the beads on the picture and put your hands back. Okay.
L [to another learner – exasperated] Put your hands back!
SH Come a bit closer, come a bit closer, okay…and I'll put the picture also closer. Okay, I'll show with my finger…I'll show with my finger. Here we've got a vulture…is that a bird?
L Yes!
SH [noticing one learner] Are you unhappy about something, Kevin?

University of Pretoria, etd - Human, S

L	Ma'am, he's pushing me!
L	He's hurting me!
SH	Is he pushing you off the chair?
L	Yes, Ma'am.
SH	Okay…you must sort that out between the two of you. Okay? Is the vulture a bird?
L	[together] Yes, ma'am!
SH	Is the owl a bird?
L	Yes!
SH	Is that a bird?
L	Yes!
SH	Do we know what we call it?
L	No!
SH	An eagle.
L	Oh yeah!
L	I know it!
SH	An eagle, can you say it?
L	Ma'am, ma'am, we call it mokgobe!
SH	Mokgobe?
L	And it can pick you up! It's big!
L	Uh! Uh! It can only pick up fishes!
SH	I believe him! I don't know if an eagle is strong enough to pick up a person?
L	No! Not a person!
L	Ma'am, the chickens….
SH	Yes…yes….
L	…and it can scratch you…
SH	And it can scratch you because it's got very sharp….?
L	Legs!
SH	We call those bird nails, we call them talons.
L	Ma'am then why do they…?
SH	Can you say the word?
L	Talons.
L	Talons.
L	Talons.
L	Talons.
L	Talons.
L	Talons.
L	Talons!
SH	Okay, is that a bird?
L	Yes!
SH	Is that a bird?
L	Yes!
SH	Hmmm…
L	No.
L	Yes.
L	No, it's not a bird.
SH	Why is it not a bird?
L	Because it looks like..
SH	Okay.
L	It can, wena!
L	Ma'am it's a ostrich!
SH	It can…it can fly.
L	It's an ostrich.
L	It's ostrich.
L	No, it's a flamingo!
SH	You're right, it's a flamingo. Flamingo's are pink. What colour is an ostrich?

L Brown.
L Brown…and black…
L White!
L No, it doesn't fly.
SH You're right. Do you know what? Do you know what? A bird is a bird even if it can't fly. It is more important to know that a bird has feathers…
L [doing something]
SH It's more important…just a second..wait, wait, wait…did you see the moment I…no, no, no…hey! Listen to me…okay, one at a time. Did you see when I said that a bird is a bird even if it can't fly, then he…put the bead on the penguin because he realised that a penguin is also a bird. If a bird has feathers, and if it lays eggs, then it's a bird…even if it can't fly.
L Can, can, can penguins lie eggs?
SH Hmm?
L Can penguins lay eggs?
SH Penguins lay eggs, yes they do. They lay eggs. [pointing to the bat] Would you say…would you say that this is a bird?
L No!
L No!
SH It can fly!
L What is it?
L No, it can't lay eggs.
SH It doesn't lay eggs…it doesn't lay eggs…that is why it's not a bird.
L Because the…
L Ma'am, it licks blood, ma'am.
SH [amid squeals and laughter] Yes it licks blood…it does, it licks blood, but it's babies come out alive. Okay…it's like people, it doesn't lay eggs.
L Ma'am! Babies…babies, babies are wet!
SH Yes, babies are wet. That's why, even if this animal can fly, we don't call it a bird…because it doesn't lay eggs and it also doesn't have feathers.
L Just like a vampire.
L Yes…it looks like a ….what is the other name, what do we call it?
L A bat!
SH Yes, we call it a bat. So we have beads on all the penguins…they are birds. We've got beads on the flamingoes…they are birds, and we've got beads on all these animals over here.
L Ma'am, in our language we call this ….
L Yeah!
SH What is your language? Sotho?
L Yes.
L [everyone including the researcher repeating the word]
SH Right, now I'm going to ask you…to put beads on…and let's see if you can…ah! Wait! Wait! Wait, No! Put them back? Put them back! Before we do something…we always have to listen very carefully…before we act. Think before you act! Okay? Think before you do something. I want you to put beads on all the animals that live in water.
L [laughing and arguing while doing the task]
SH Okay, stop! Stop!

L [screaming]

SH Stop! Right away. Stop right away. Go back to your chair….stop and go back to your chair. Stop, put your fingers back and go back to your chair. Go back…go back..

L Ma'am but I never get anything.

SH Okay, but this is why. This is why. Okay…put everything back, yes. Can you see that when we fight and we try to do everything all at once, that nobody gets a chance? Can you see…

L There's a bead.

SH Just a second? 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?

L To give turns.

SH Yes, that's right…to give turns. Okay?

L It's fair.

SH It's fair…that's right. So now you have to put it in action. You know what you have to do…so now you only have to do it. How are we going to take turns?

L You must try something like this, like this, like this..

L We can start with like…

L No!

SH Okay, how are we going to decide? How are we going to decide which side? How will the group decide and agree which side we're going to start? How can we do this? Who said we must start on this side? On this side?

L Ma'am…

SH No, I want to first know who said we must start on this side? One, two, three…

L Four!

SH One, two, three…Who says we must start on this side?

L Me, ma'am!

SH Okay, that's the most…so we start on this side. So we have to vote…and that is how we decide. Okay. You take one and put the bead on an animal that lives in water. Then you take your turn…you take your turn…once you put it down, then you just leave it and you let the other learner decide…where they want to put their bead. There you go…he's waiting very, very patiently. That's very good. Okay…ah! Put it back, put it back…stop! You're not playing according to the rules…the rule is…just a second…the rule is…yes, wait a minute…the rule is…we go around…you will get a chance again, you are not allowed to change anybody else's beads. Okay…okay you have a chance again. Okay…in this way we all work together. Okay, you have a chance again, Trevor.

L No!

L A frog?

L Yes, there's the frog here…

SH Ah, no! You're not allowed to do that. Okay…

L I just want to put this on the fish, ma'am.

SH Okay. Put it down.

L I never got a chance, ma'am.

SH You're going to get your chance now. …has had her chance…and now you get your chance.

L A flamingo.

L A flamingo.

SH	All the animals that live in water.
L	Water. [arguing ensues] No!
SH	Ah! It's his chance, and he will have to…
L	Two!
L	This is mine.
L	A shark.
L	Yeah, it's mine.
L	Elephant!
L	But I didn't get my second chance.
SH	Because we are waiting for them to finish. Okay, you can have your chance. Okay…
L	…under water this.
L	It eats people.
L	No I think it doesn't eat people.
L	Can a octopus eat people?
SH	No, an octopus doesn't eat people. Wait a second…you just had your chance, you just had your chance. Where did you get this bead?
L	Here
SH	Yes, but you've already had your chance…we're going down the row…you're finished now, so now its his chance. Okay? We take turns.
L	Can I put it down?
SH	Okay, but you must put it down quickly.
L	[learners laughing]
SH	Do we have ALL the animals that live in water?
L	No!
L	Yes!
L	Here's one, there's one, there's one…!
L	No!
L	No, ma'am…!
SH	Okay, now, look at all the animals…look at all the animals…look at all the animals…
L	…a snake…
L	Yeah, I think that!
SH	Does a snake sometimes live in water?
L	Yeah!
L	No!
SH	You can put a bead on the snake.
L	And I said a starfish!
L	Ma'am, I want to play ma'am.
SH	Do you want to put one on that snake. We'll give him a chance to put one on the snake. Who can see something else that still lives in water? Who has the green card?
L	Ma'am, this!
SH	Does it live in water?
L	No!
SH	I'm waiting for the one who has the green card…Yes? Did you want to say something?
L	Ma'am…a lizard?
SH	A lizard doesn't live in water…it's an animal that lives in a
dry place.	Yes, Kevin?
L	Ma'am, what is that?
SH	That's fish, okay, you can put a bead on. Okay, yes? Which animal? What kind of animal is that?
L	A ladybird!
SH	A ladybird…do you ever see it in water?
L	No!

SH No. It flies and it sits on flowers.

L He grabs the card, ma'am!

L No!

L He grabs the card!

L Why don't you put it down?

SH Okay. These animals, what do we call them?

L I don't know.

L Jellyfish!

SH Ah…do the others agree with her? Do you agree with her?

L Yes, ma'am.

SH Yes, you're right. It's called a jellyfish. What do we call this?

L [together] A shark!

SH Yes, and that?

L Octopus!

L [together] Octopus!

SH Uh-huh…and this?

L A crab!

L [together]

SH What's this?

L A crab!

SH Okay…so they look different. So both of them can't be crabs. Do you think this is something different?

L Yes.

SH Uh-huh? Do you know it's name?

L No.

SH It's called…I want to know what this is.

L Ma'am…

SH It's called a…crayfish.

L Crayfish.

SH Crayfish! You can also eat it.

L [talking together] ….Ma'am I see them on TV!

L Yeah!

L And they look a little…

SH Not all together! What do you want…do you want to know it's name?

L Yes.

SH Can somebody help him and tell him what the name is?

L Two are monkeys…

SH Don't tell me, tell him.

L Tortoise!

SH Did you hear what they said?

L Tortoise.

SH That's right, what do we call the one that lives in the water?

L Turtle!

SH A turtle, that's right.

L Frog!

SH A frog is an animal that can live in water and on land.

L It can jump, ma'am.

SH And it can jump. If we want to know how many animals there are here that live in the water, how can we find out? How can we find out? If we want to know how many animals there are here that live in the water?

L Ma'am…..a shark, ma'am.

L No, give me.

SH Okay…did you hear my question? I said…if we want to

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know how many animals here are that live in water, how will we know? What do we have to do? Can somebody tell him?

[recording interrupted]

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HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 03:01:20 PM

P12: SSGR3JUNE9.txt [C:\phd\SSGR3JUNE9.txt]

Group : Grade 3
Date : 9 June 2000
Time : 09:00 – 09:40

Learners begin by saying their names [Tshepo, Kyle, Onkopotse, Oratilwe, Amo, Tumi]

SH Okay, the way that we're going to do it, is…I have a set of cards here, and maybe you have seen them before.
L Oh, yeah.
SH Have you seen them before?
L Uh-uh.
SH Have you used the cards before?
L Uh-uh.
SH Okay, what do we have there?
L [together] Four!
SH And there?
L [together] Two!
SH And there?
L [together] Go!
SH Good! And there?
L [together] Three!
SH There you go, we're only going to use one set. Can you see that these three cards are different from this one?
L Yes.
SH Okay. It's like a little game that we're going to play. The person who has this card, can say something. Only the one who has the green card. Okay, so it's a way to help us to take turns. It seems like you know…you've played this game before.
L No, but are we going to cover them and mix them?
SH No, what we're going to do is: we're going to put them down, like this. Okay? Who wants to say something, wants to ask something? Okay, then you take the green card, Tshepo. Take the green card. Is there anybody else that wants to say something? The next person must take the number two, because that means you have the second chance to say something. And then somebody can take the number three…and somebody can take the number four! Okay, but now you see, we have two people, and they don't have any cards. So what are we going to do…to help them to also have a chance? What do you think?
L We take turns.
SH Yes. How are we going to get the green card to all of

you?
L She have to speak, Ma'am.
L Then I go like this and he goes like that.
SH Yes, you've got the right idea! Except, the green card always goes to number two. So if you can give the green card to number two once you have finished…she gives the number two card to number…?
L Three.
L Three.
SH You're right, Tumi. You give your number two card to number three.
L Number three goes to number four.
SH That's right, Tshepo. Number three goes to number…?
L Four.
L Four.
SH And number four…puts it down. And so then any of the other two learners can take a number four card. And then that way, everybody is going to have a turn. Okay? Shall we try it?
L [nodding and one learner attempting to look at upside down picture]
SH Okay. I think you are curious to know what is on that picture.
L Which picture?
SH Which picture? There's a picture on the table. Can you see it?
L No.
SH That's because it's upside down.
L Yeah, it's upside down.
SH So…shall we turn it around and see what it has?
L It's a garden!
SH A garden? Sipho thinks it's a garden. Okay…
L It's a zoo.
SH It's a zoo, that's right. Tell me your name again, it takes me a while to remember everybody's names.
L Amo.
SH Amo. Amo thinks it's a zoo. What do the rest of you think?
L Circus!
SH Okay.
L I think it's a zoo.
L Also.
SH Okay, so Tumi and Amo thinks it's a zoo…Kyle and Tshepo thinks it's a circus…what do the two of you think?
L I think it's a play place.
SH A play place? Okay…and you?
L Zoo.
SH You also think…So we've got three people who thinks it's a zoo…
L And I think it's a circus.
SH Okay, what makes you say that it's a circus, Kyle? What…
L Seals!
SH Okay, because of the seals?
L No, no, no! I do not think it's a circus, Ma'am, because I cannot see any circus people.
SH Can't see any circus people…so do you think you are going to change your mind?
L Yeah, ma'am, zoo.
SH You also think it's a zoo. Now we have FOUR people

agreeing that it's a zoo. Okay? You think it's a playing place, why do you say it's a playing place?
L Because there is fishes and…
L Ma'am, can you play with a snake? [everyone laughs]
SH Tshepo wants to know if you can play with a snake?
L Only if it's kind.
SH Only if it's kind.
L Can you play with a gorilla?
L No! Because the gorilla will kick you!
L It will kick you!
L …to Mexico!
SH Will it kick you to Mexico, Tshepo?
L Isidingo.
SH [amused] Will it kick you to Isidingo?
L Yeah!
L What is that?
SH Yes…who can tell Tumi what this is?
L Me!
SH Did you want to know what is this?
L Yes.
SH Oh…okay.
L These are flamingoes.
SH You're right, that's flamingoes. Is there anything here on the poster that you don't know…what it is?
L Yes, this.
L Jellyfish.
SH Ah, where have you seen a jellyfish before, Tumi?
L The sea. In Cape Town.
SH In Cape Town! Okay, anything else that you don't know?
L This…monkey?
SH You're right, that's a monkey…
L [indignant] It doesn't look like a monkey!
SH It's a gorilla monkey.
L No, this is a monkey, this is a gorilla.
SH That looks like a funny monkey to you, Kyle?
L It looks like a baby gorilla.
SH Yeah, perhaps it's a baby gorilla.
L I don't know this…prawns?
SH Does anybody know what this is?
L Scorpion!
L Prawn!
SH But you know what? Somebody thinks it's a prawn, and do you also think it's a scorpion?
L Yes, ma'am.
SH You know, it actually does look like a scorpion, but it's in this tank of water together with the other fish, and do we find scorpions in water?
L No!
SH Do they live in water? No! So… it is…?
L Crab!
L Crab.
SH Crab. Okay…what is this, over here?
L Crab.
SH Okay, so we've got one here and one here and both of them could be a crab.
L What's this?
L A seahorse.
SH A seahorse. Do you know what we call this? We call this

a crayfish.
L What?
L [together with researcher] Crayfish!
L Yeah.
SH You can also eat it.
L But that one they are red…they are nice, they are red.
L Yeah!
SH Have you eaten crayfish before, Tumi?
L No.
L Ma'am, I want to eat it but I can't.
SH Why not?
L Because my …
L …dangerous! Ma'am do you think they are dangerous, ma'am?
SH Are they dangerous, Kyle?
L [nodding]
L Porcupine!
SH You're right, what do porcupines do?
L Ma'am, but are you going to rub us off, ma'am?
SH Do you want to know when I'm going to rub you off the tape? After I've listened to it and after I have put everything down on paper.
L Ma'am it doesn't look like a bat.
SH Uh…but you can see that it is a bat?
L Yes, but it doesn't look like.
SH Why…what's wrong there with the bat?
L [interrupting] Ma'am! A bat doesn't really have hair! It's head, is like…smooth!
L Bats can't see, they are like blind.
SH …and this one has an eye, so you think it's not like a bat.
L Bats are dangerous.
L Ma'am, how can they put this thing…what you call them again?
SH What do we call them?
L Leopard!
L It's not a leopard, that's a a cheetah.
L Ma'am, a cheetah can jump a wall, ma'am!
SH Ah! Okay…how do we know if those are cheetahs or leopards?
L Ma'am…
L [interrupting] Ma'am, a cheetah has spots and a leopard is just black!
L [disbelief] A leopard's just black?
L [talking together, indecipherable]
L A leopard is like…it has spots and on the insides, it doesn't have…it's like, almost like white. And they don't look like…mmm, they don't look like orange, orange, orange, orange, orange. They are light colour.
SH Mm-hm…is there something else on that picture there that tells us that it's a cheetah, and not a leopard? Look for something there that tells us that that picture is about a cheetah and not a leopard? No, you can just look at them…just look at them. There's something on their bodies that tells us that it's a cheetah.
L [together] Spots!
L The spots. They are coloured in…because they are coloured in, and a leopard's ones are just round…
SH Okay, there's something else, that little stripe there, on

their eyes. Okay? Cheetahs always have a stripe, it goes down from their eyes…to their mouth. Next time you see one, you must remember.
L I know what, ma'am, leopards just stay in trees.
L Also on land!
SH Uhm…I think cheetahs can also go into trees. Sometimes they drag their prey, the animal that they have killed, they drag up to a tree. Okay? Who can tell me where the hippos are?
L Here, ma'am.
L And they open their mouths so wide…
L [talking together, indecipherable]
L It opens it's mouth, jo,jo,jo!
L …at the TV…[referring to an advertisement on TV: Pick and Pay hypermarkets are open!]
SH Okay, who can tell me what this is?
L I know!
SH What do you think this is?
L A …eagle, ma'am.
L It'a a eagle!
SH An eagle? [pointing to vulture] Okay…what is this?
L A peacock!
L I think, uh-uh…
L Ostrich!
SH Why is this not an ostrich?
L Ma'am, ostrich has long legs!
SH And can an ostrich fly to sit all the way up here?
L [together] No!
SH No. An ostrich can't fly.
L That's an eagle! That's got a eagle head.
SH This is an eagle, but do you see these two birds?
L Vulture!
SH Do you see their beaks are the same?
L Vulture!
L Vulture!
SH That's right! Do you see their beaks? They go round and down like this. Do you know why their beaks are shaped like that?
L [talking together, indecipherable]
SH Wait, wait, wait…let's hear what Tshepo says.
L Maybe they can knock on the tree.
SH Like woodpeckers?
L Yes.
SH No…woodpeckers have long, straight beaks so that that they can pick…
L I know!
SH Okay, let's hear…
L ..animals, that …[demonstrate]
SH Yes!
L Ah, that's what I wanted to say.
SH That's what you wanted to say?
L They go like this and then they kill the animal, like a zebra, they…the lion or whatever, catches the zebra or anything, and then after they open it, they go like this with their beaks, and..
SH That's right…let me just say…they use their beaks to tear the meat, to hook their beaks into the meat and tear it off. That's why their beaks are like this. Do you know what we

call all the animals that have beaks like this and that hunt for their prey? Do you know what we call them? We call them raptors. Raptors.

L Hm, you mean like poison?

SH No, that's just a name that we call all the animals who hunt for their meat.

L Like lion and cheetah…

SH No, but only birds. Only birds. All the birds. Sorry, I said animals, and I was wrong. All the birds who hunt for their meat, we call raptors. So an eagle is a raptor. What else is a raptor?

L Vulture!

L A woodpecker.

SH Does a woodpecker eat meat?

L No.

SH Okay, so a woodpecker is not a raptor. Who can think of another bird that hunts for its meat?

L Somewhere here?

SH Yes!

L A lion?

L A cheetah.

SH A bird. Let's think, we're talking about birds. We want to know which are raptors. There's another…in here there is a another bird…

L Owl!

L A owl!

SH An owl…what does an owl hunt?

L Mice! Rats! Hamsters!

SH Maybe even hamsters, yes.

L And this mouse, ma'am.

SH Yes, I don't think they are very safe with that owl sitting up there.

L Ma'am, I saw this owl hunting a mouse…

SH Mm-hmm…so he had just caught a mouse. When do owls hunt? Do they hunt at…?

L Night!

SH Yes…they hunt at night!

L But in the morning they sleep ma'am.

SH Yes.

L And some of them, ma'am…some of them they hunt in the morning ma'am, but, but we'll not see them. …snakes are very dangerous.

L Yeah!

SH Let me now tell you something…we say that this…who hunt for their prey are called…?

L Raptors.

L Raptors.

SH Raptors! Can you say that word?

L [together with researcher] Raptors!

SH Raptors, yes. Okay.

L Ma'am this thing…

SH Animals, animals like lions and cheetahs, that hunt for their meat…

L And elephants?

SH No, not elephants,we're only talking about animals that hunt for their meat like lions and cheetahs, we call them…

L Leopards.

SH …and leopards, we call them…predators.

L Oh!
L Yes, ma'am, I know it!
SH Who can say that word?
L Predators.
L The big five, ma'am. I know which are the big five.
SH Predators.
L I know this animal, ma'am!
SH Just before you show me where the rhino is…tell me what do we call the animals that hunt for their meat, like lions and cheetah.
L Pred…
L Pre..
L Predors.
SH Pre-da-tors.
L Predators.
L Ma'am…
SH Say quickly.
L [together with researcher] Pre-da-tors!
SH Predators. And the birds? We call them…?
L Raptors.
L Raptors.
SH Raptors! I think your teacher is going to be very impressed if you tell her about this.
L Ma'am, but some of this animals, ma'am, they are dangerous, they can kill the…something like a giraffe.
SH But a gemsbuck that can kill a giraffe? Do you really believe that?
L No, a giraffe is so high ma'am.
L It will kick it.
L It will kick it and it will fall.
SH It's got very, very strong legs, hey? Which of the animals on this picture do you like the most?
L I like the shark.
SH Tumi likes the shark. We're going to give everybody a chance.
L I like the leopard!
SH Just a second, let's go down the row. Why do you like the shark, Tumi?
L Because, uh…sharks I always draw in my class.
SH Do you always draw sharks? Just a second, I'm talking to Tumi.
L I like sharks and whales and stuff like that.
SH Okay. Amo, which animal do you like? You can turn it so you can see properly. Which animal do you like?
L The lion.
SH The lion?
L [talking together]
SH Why do you like the lion?
L [softly] I like the lion because…
SH Let me hear, let me hear what she says?
L I like the lion…
SH Yes?
L I like the fur.
SH You like the colour and the fur of the lion?
L Ma'am, a lion will…
SH Yeah, a lion is dangerous but they are still beautiful. Okay,
L I like the snake.

SH	The snake…why do you like the snake?
L	Because….people are holding the snakes, and I like snakes but…
L	[Interrupting] Ma'am!
L	…I draw them in class…
L	[saying something , indecipherable]
SH	[ignoring learner who interrupts, but encouraging one who is responding] Yes?
L	…and I like the colour of it. That's why I draw the snake.
SH	You like their colours. Okay, tell me what animal do you like?
L	The lion.
SH	Do you like the lion? Okay, why do you like the lion?
L	[softly] It's eats people.
SH	[incredulous] It eats people? Do you like the fact that it eats people?
L	[bearly audible] Yes.
L	What if it eats you?
L	[bearly audible] I don't care.
SH	You don't care if it eats you? ….Okay, Kyle which animal do you like? Now you've got a chance to say what you would like to say.
L	Ma'am, octoplus [sic]!
SH	An octoplus?
L	[laughing]
SH	How do we say…can somebody help him to say…
L	Octopus.
L	Octopus.
SH	Did you hear what they said?
L	Yes, octopus.
SH	Okay…
L	[interrupting] But, ma'am!
SH	Why do you like…let's hear what Kyle has to say…why do you like the octopus?
L	Ma'am, so you can see…[indecipherable]
L	The elephant!
SH	Uh-huh?
L	Elephant.
SH	Why do you like the elephant?
L	Ma'am that's because…even when you have a …like an elephant…when you can climb on the elephant…
SH	Okay…
L	[learners laughing]…the elephant can go fast…[indecipherable]
SH	So you would like to ride on an elephant?Okay, all the animals that you chose…I want you quickly to tell me, what you call that animal in your own home language. What's your home language, Tumi? What do you speak at home?
L	Sotho.
SH	Sotho? And you chose the shark, can you tell us what it is called in Sotho?
L	Shaka!
L	Shaka, yeah!
SH	Is it really called shaka?
L	Yeah.
SH	Okay.What did you choose…
L	We call this tau.

L Tau.
SH Yes…tau. Yes, some of the other children also told me yesterday. The snake?
L Nocha.
L Nocha.
SH Nocha. Okay, and you?
L Tau.
SH Tau. That's right. And you are English speaking?
L Yes, ma'am.
SH Yes, so what do we call your animal?
L Octopus.
SH Octopus. That's it. And you had the elephant?
L Elefente.
SH What is it called?
L Elefente.
SH Uhm…is there is a word such as tlou?
L What?
L Tlou!
L Tlou! Yeah, that's a tlou, Ma'am, it's a tlou.
SH Is that what it is, because I think somebody told me once it's a tlou.
L It's a tlou, ma'am.
L [talking in their own language]
SH Okay, okay, let's see. Uhm…I have a set of cards here, and we're going to play a game. Not yet, not yet. Okay, let's see, I'm going to put an animal down and I want you to tell me what animal it is.
L [together] Lion!
L [together] Fox!
L [together] Elephant!
L [together] Tiger!
SH What's the difference between a tiger and a leopard?
L Because a tiger can lie like this.
L Strong!
L Stripes!
SH Stripes, okay.
L Some of them have stripes like this.
SH Yes…so a tiger…wait a second…a tiger has stripes and a leopard has…?
L Spots!
SH Spots….okay, what's this?
L A buffalo.
L Buffalo.
L Uhm …dog!
L Fox!
SH Not quite, it's a wild animal.
L That's a wild dog!
SH Yes, you could say it's a wild dog, but actually, that one…is, yes, a wild dog.
L A leopard!
L A leopard, a leopard!
SH A leopard? I'm….not too…sure.
L It's a cheetah!
L That's a cheetah.
SH Why do you say it's a cheetah?
L [interrupting] Ma'am cos it's got spots!
SH Let's hear what she wants to say?
L Ma'am, it doesn't have that line that the…

SH It's too small to see the line, but you know what? A cheetah normally has a smaller head than a leopard.
L Cheetahs are bigger than…cheetahs are bigger than…
SH What's this?
L [together] Kangaroo!
SH And this?
L [together] Camel!
SH And this?
L [together] Squirrel!
SH And this?
L [together] Bear!
L [together] Buck!
SH What sort of buck is it? Can somebody say?
L Hier kom die bokke!
L Baby buck!
SH It could be a baby buck…
L Kudu!
SH No…let me show you how a kudu looks. Let me turn it around…this is a kudu and this is a gemsbuck. And this is a….? What did we use to call the people who represent South Africa in sport?
L Springbok!
SH Yes! We call them them springbucks.
L I know it in Afrikaans, ma'am! It's [singing tune] Hier kom die bokke!
SH Yeah, that's nice! Hier kom die bokke! That's springbucks they are talking about.
L …for Stormers.
SH Is it? Okay, what's this?
L A baboon!
L A baboon
SH Yes, you're right, it's a baboon. And what is this?
L Zebra!
L Zebra!
SH No, no,no! [laughing] That one over there!
L Hippo!
SH Okay. What's this?
L A wolf!
L A snow wolf!
SH [impressed] A snow wolf?
L A snow buck!
L A fish!
SH No, no, no…you're guessing now, you're guessing now….I don't want you to guess. A wolf is right…it's just very interesting that you say a snow wolf. It's very nice for you to say that. And this?
L [indecipherable]
SH And we have had this one already?
L Yes.
SH Okay. Now what we are going to do…have anyone of you ever played snap?
L Yes, ma'am I have!
L I have.
SH So you know how to play snap?
L Yes, ma'am!
SH Who hasn't played it before? You haven't played it before…
L [talking all together]

SH Wait….wait, wait,wait, wait…
L [arguing about how to play the game]…then you get a card…no, you don't…no…
SH Tell me how you play the game?
L Ma'am, isn't it…
SH Oh no, that's not the snap game.
L Ma'am, …you put the card, and if somebody has the same card, you go snap!
SH That's right, she's got the right idea! Okay…so I'm going to distribute all these cards, I want you to put away the other things that you have. I'm going to give you all the cards and you must keep it…you musn't show the other children your cards. Throw it down…as soon as somebody puts down a card that is the same as the one that is already lying there…you say snap!
L And then you take…
SH ..and then you take…the person who said snap…may take all the cards. Okay, and the one who ends up with the most cards, that's the one who has won. Okay? And remember you're not allowed to look at your own cards either.
L Huh?
L Yeah!
SH I'm also going to play. [After some playing and after a learner looks at his cards] The one who cheats in this game, has to give his cards to the other learners, okay? We're not going to tolerate cheating.
L Ma'am…stop being naughty!
L …and cheating!
L Yeah…so we could win money.
SH Why do you think rules are important?
L Some people play for money.
SH Let me just hear what she wants to say?
L So you must not do wrong things and stuff like that.
SH That's right, it helps us to do the right thing. Okay. No looking at the cards, okay? We are going to start with….
L Onkopotse!
SH Onkopotse… and then we go clockwise…always clockwise. So we must look carefully…if you feel that your arms are not going to be long enough…you can stand up and lean over the table…but not too much. Okay? So…you can put down the first card. You can take the first one…from up here…and you throw it down like that. Okay, and the next one? No, no, no…you must just put it down…if it's not the same, then you leave it here. You only have to wait until there is one that is the same.
L Ah, this is what we call a leopard, ma'am!
SH That's right, there's the leopard. If we put down a card we don't do this [demonstrate]…okay, we put it down quickly. Okay…now it's your turn.
L I put camel.
SH Okay, you must put it down so we can see it. Tiger…
L Ma'am, there's already a tiger!
SH Yes, but it has to be…it has to be…
L …on top of it!
SH On top of it…that's right!
L Fox.
SH Baboon… Hippo…

University of Pretoria, etd - Human, S

L [laughing]

SH No, no, no..

L He cheated!

SH Okay, you must now hand all your cards to the other learners.

L [laughing]

SH Okay, so give me your cards…no,no,no, give me the cards….I'll distribute them between the other learners. You are out for this round…you cannot play.

L Oh, ma'am can I have a little bit?

SH No, I'm not going to…

L [upset] Now I'm bored.

SH I'm not going to. Okay, you are the next one.

L Okay.

SH Remember…keep it like this, you are not allowed to look at it. Okay…and you, Tumi? Hey…Tumi!

L [laughing and talking]

SH You know what the rules are, Tumi…so give us your cards.

L [indecipherable]

SH No, no,no…give us your cards.

L She's a liar ma'am.

SH No, you must give us your cards, because we took her cards away…

L I'm a he, not a she!

SH Yes…sorry…there you go…so you can have a card again. [to learner whose cards were taken away] It's not nice when this happens, hey?

L No.

SH Okay. I'm the next one, I've got the hippo…camel!

L It was you.

SH Yes, but I put down the camel. Zebra….kangaroo…buffalo…tiger. Bear…Ah!!

L [all laughing]…like me, ma'am, that other time! Before you said…

SH Where did Tumi disappear to?

L [all laughing]

SH Come one…Tumi!

L [all laughing]

SH Come on! Tumi? Back to your chair. We're having fun, but it doesn't mean that we can do what we want.

L Shhhh!

SH Go back to your chair. Okay…[playing out of turn]

L But Ma'am, you cheated!

SH Ooh…I cheated! [disappointed] So I have to give my cards out…Sorry!

L [happily laughing]

L He was out…and he has cards!

SH I didn't see him. If I didn't see somebody cheating, then I don't want to hear from the others. Wait, wait, just a second, I'm speaking. Tumi? Stay on your chair.

L His name's not Tumi, his name is Tumelo!

SH He said earlier to me that his name is Tumi.

L They call me Tumi, ma'am.

SH Okay. Tumi, or Tumelo, whatever it is. Who has to play?

L Look at me! Look at me!

L [laughing and playing cards]

SH Okay…it is twenty to ten, which means that it is almost

University of Pretoria, etd - Human, S

breaktime. Okay?

University of Pretoria, etd - Human, S

Data subset 7 (DS7) **EXHIBIT M**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 03:01:48 PM

P13: SSGR1JUNE12.txt [C:\phd\SSGR1JUNE12.txt]

Group : Grade 1
Date : 12 June 2000
Time : 11:40 – 12:20:

SH Okay, I want you to tell me what your name is…
L My name is Sitjaba.
SH Your name is Sitjaba?
L My name is…Shimon.
SH What's your name?
L Shimon
SH Shimon?
L Yes, ma'am.
SH Good!
L My name is Adi.
SH Adi.
L My name is Zintle..
L My name is Banga.
SH Banga? Okay! Who can tell me what this picture is all about?
L A zoo!
L / It's all about a zoo!
L Ma'am…?
L Yes?
L Animals!
SH It's a picture with animals. You say it's about a zoo, and it's about fun…What do you think, Zintle? What is this picture all about? [Silence] If you have to give it a title, if you have to give it a name…what name would you give it? It's about the….?
L Zoo!
L / Zoo!
SH / Zoo! And you? What do you think, do you agree with them?
L Yes.
SH Okay, it's about a zoo. What do we get at a zoo?
L You get…
L / You get a lion, and…
SH / Lion, and what else, Adi?
L And sharks!
SH Sharks! A zebra…let's hear what Shimon says…

L Zebras, ma'am.
SH / and zebras
L / and snakes!
SH / Snakes! Zindle?
L Baboons, ma'am.
L / Baboons.
SH Baboons. Will we get a dog at the zoo?
L [incredulous] No, ma'am!
SH Why not? Who knows why not? Why don't they have dogs at the zoo?
L Ma'am!
SH Let's hear what he wants to say.
L I think…I think it's like a dog, but its not a dog…
L / hyena!
L / ..it's a wild dog.
L It's a hyena!
SH Hyena, it's like a wild dog, yes. Adi, why don't you think we get a dog at a zoo? Why don't they have dogs there?
L Because its not like a zoo with puppies and that thing…only at the pet shop there's dogs and animals…
L /…and cats and mice and hamsters…
SH / …Okay, will we get pets at a zoo?
L Pets?
L /No!
SH Yeah. [Silence] Give me names of pets. What are pets? Give me a name of a pet?
L Snoopy?
SH Okay, maybe I asked the question wrong. What sort of pets do we get? What sort of animals could be pets? [Silence] What sort of animals could be pets? Dogs and ….? [Silence] Dogs can be pets. And…?
L Mice, ma'am!
SH Mice can also be pets.
L And my cat.
SH Yes, cats can be a pet. Zindle? What else can people keep as pets?
L Uhm…rats.
SH Rats? Yeah…people may keep rats also as mice…what else?
L Hamster.
SH Yes! A hamster can also be a pet. Do you think a parrot could be a pet?
L Yes! Yes! Yes! And a cat, ma'am!
SH Yes, and a cat could be a pet. Okay…so we
L /…and fish
SH /…yes and fish can also be pets. We don't get animals at the zoo that we find a lot. These animals that we have at the zoo are animals that are endangered. They are animals that people hunt, and they are animals that people…
L /….kill.
SH /….kill. Okay…so if we..
L /…Ma'am if they kept them [noise]
SH /…Just a second, just a second, only one person, only one person at a time. You wanted to know why people kill animals. And Adi wants to tell us why. So why do people

kill animals?

L Because when they are hunting animals…animals are having fun…playing…behind the house or somewhere next to the house. Then people get angry, then some of the people…kind human beings come and take them, then they take them to the zoo, then those kind people take care of them at the zoo.

SH Yes…Why do we kill animals?

L Because, animals they doesn't have food.

SH Do we kill animals because they don't have food?

L Yes!

L /No!

SH No…why do we kill animals, Zindle? Why do we kill a buck? What do we do with animals that we kill? Yes?

L When they kill the…hmmmm, the….animals, they…they eat them…

SH Yes, we kill animals because we eat them!

L / Because they're hungry, ma'am!

SH Who's hungry? The people that eat them?

L Yes, ma'am.

SH Where do we get the meat that we eat, in the shop? Its animals that were…? killed!

L /killed!

SH Okay…Some people also kill animals for fun. Did you know that?

L Yes, ma'am.

SH Okay, they just hunt the animals. So you can kill animals because you…

L /…some people kill them….[unclear]

SH That's right, so they kill them because they want to defend themselves. Okay, they are scared the animal is going to kill them, and…if you see a lion, and the lion is coming at you. Will you try to kill him, or not?

L No.

SH No?

L I will be kind to him.

SH Do you think he will be kind to you? He will eat you.

L Huh?

SH Yes, animals… lions are wild, and lions are dangerous.

L Yes, if you see like a lion, don't run away…but just stand still and call somebody else. If somebody can't hear you, you must just stand, and then you run away.

L It…it wil run…

L /…looking at you!

SH Okay, what do you want to say?

L When the lion looks at you, and then the people calls the cowboys, then the cowboys come and kill them…the lions.

SH Okay, good. I'm going to ask you the names of some of these animals and then I want you to put your finger on the animal that I say. Who can show me…all of you put your finger you don't have to say anything, you can just put your finger. It doesn't matter if you are fast, you can think before you put your finger down. Show me where…the ele…

L / [learner points]

SH /…ah, you are a bit fast. Wait to hear what I am asking. Show me where the elephants are.

University of Pretoria, etd - Human, S

L [all pointing]

SH Good, right, this time you waited before you put your finger down. That's good, always wait before you do something. Show me where…the zebra is.

L [pointing]

SH Okay, why did you think this is a zebra? [pointing at the giraffe]

L [laughter]

SH Why did you think the giraffe is a zebra? I want to ask him first…wait, I want to ask him. Why did you think the giraffe is a zebra?

L They look the same.

SH They look sort of the same…okay, are their colours the same?

L No!

L / No!

SH And the shapes on their bodies, is that the same?

L No!

SH This one has blocks and this one has…

L Stripes.

L / Stripes.

SH Stripes! That's right. This one is black and white and this one is green and yellow…

L No, ma'am! Green and yellow? No, ma'am!

SH [laughter] Ah, brown and yellow! Okay, you see anyone can make a mistake! Show me where the seals are.

L [pointing]

L Here.

SH How many seals are there?

L Three.

L / One…two

L / Three

SH Yes, there are three seals. Show me where…the frog is.

L [pointing]

L Frog.

SH Good, there's the frog. Show me where the snake is…

L Where…where's it?

L There?

L No!

L Where's it?

L [noise]Here's a snake!

SH Okay, the two of them think that is a snake. Do all of you agree?

L No, ma'am.

SH What is it?

L Snail.

SH It's a snail.

L This is a snake!

SH / I'm looking for the snake. Ah…two of them over there got a snake. Show me where the other snake is. There are two snakes.

L There's another one.

SH Adi has a snake. Is this a snake?

L [laughter] No!

SH What's your name again?

L Banga.

SH Banga, why did you put your finger there? [laughter] Hmmm, is this one a snake?

L uh-uh.

L Two snakes, ma'am!
SH Okay, there are two snakes. Now…who can tell me where the seahorse is…the seahorse.
L [repeating the word]
L There's the crab!
SH No, it's a crab. I want the seahorse, so where is the seahorse? There they've got their fingers…that is a seahorse. Why do you think we call it a seahorse?
L Because…its..its
SH /Adi! Adi!
L /…it looks like a horse but it is not a horse.
SH Yes, it looks like a horse. Bhanga?
L The kids go on it…
SH Can you ride on a seahorse?
L No!
SH How big do you think a seahorse is?
L It's big, ma'am.
SH How big? Show me with your hands.
L It's not really very big.
L It's this high, ma'am.
SH Okay, some of you think it is very big. Adi, how big do you think it is? Show me with your hands.
L I think it's big like this.
SH Okay…
L / No!
L / Uh-uh, uh-uh!
SH Do you know how big it is? Do you want me to show you? Yes?
L I think it's big like this.
SH You think it's big like this. It's like this.
L [exclaiming] Oh! Oh!
SH Its small…Some of them are even as small as this…[demonstrating with fingers] You can even not see them.
L Why, ma'am?
SH That's how small they are.
L Where's the daddy seahorse, ma'am?
SH The daddy seahorse?
L Is it this big ma'am?
SH Its that big.
L And the mother?
SH The mother and the father, the adults, are this big. The babies can be as small as that.
L [exclaiming] Sho!
SH Very, very small.
L [unclear]
SH Okay, you know what this is, don't you?
L I know!
L A cheetah!
L A leopard!
L A cheetah!
L Its a leopard!
SH Okay, stop a second. You think it's a…?
L Cheetah, ma'am.
SH You think it's a…?
L Leopard.
SH Leopard, leopard, you think it's a tiger. Tell me why you think it's a cheetah?

L I think it…
L /..a lion ma'am!
SH No, I'm waiting for him, why do you think this is a cheetah? Tell us why you think it's a cheetah?
L Because…they are the same.
SH How are they the same? How do they look that makes you think it's a cheetah?
L Ma'am…a cheetah is thin!
SH I'm asking him…Yes. but you're right, a cheetah is thin. Okay?
L Ma'am a cheetah doesn't have spots on. But it doesn't have hair like that, that's a lion.
SH Okay. A cheetah has spots…but a cheetah also has this black line…that goes down its face.
L This is a cheetah, here ma'am!
SH Yes! These are the cheetahs, you're right. Why is it not a leopard? The two of you thought it was a leopard, why is it not a leopard? [silence] What made you think it was a leopard? Why did you say it was a leopard?
L A cheetah…
L / Uh…because it looks like a leopard…a leopard has…it looks like…a leopard looks like it has spots on its legs.
SH That's right. A leopard has spots on its legs. There's something wrong with this picture. It's supposed to be a cheetah, but the spots were not..are not correct. So it could be a leopard or it could be a cheetah. Why is it not a tiger? Why is it not a tiger? How does a tiger look? [silence] Does a tiger have spots?
L No, ma'am!
SH No!
L Wild, ma'am!
L / A tiger is not there.
SH A tiger is not there, you're right. But how does a tiger look? Does it have spots?
L No.
SH Does it not have spots? I'm going to show you a picture of a leopard…wait a second…sit on your chair, sit on your chair…I'm going to show you a picture of a leopard, a cheetah and a tiger. And you tell me which is which. [puts cards down]
L [talking to themselves]
SH Okay, here I have three pictures.
L Sho!
SH Okay…
L Where's the leopard, ma'am?
SH One of these three…one is a tiger, one is a leopard, and one is a cheetah. Tell me which one is the leopard?
L [pointing]
SH Wow! I have news for you…that one is the cheetah!
L Oh!
SH That one is the cheetah! Which one of these two is the leopard?
L [pointing]
SH That's right, that's the leopard. Okay, we cannot see it very easily on this picture but, the difference between the leopard and the cheetah…
L [talking together]…it's round, and in the middle of the spots, they all colour them in!
SH That's right, Adi! Can you see the spots are different? The

spots of the cheetah is black, the spots of the leopard, looks
like there's a little yellow thing in the side, it looks like a …
L
[learning asks something – unclear]
SH Yes. Okay, so we know already which is
the leopard, and we know already which one is the…
L cheetah!
SH cheetah. So which one is the…
L
…Ma'am?
SH
Wait a second, which one is the tiger?
L [pointing] The tiger.
SH Okay…
L Ma'am?
SH How is the tiger different from the leopard
and the cheetah? Zindle? How…look carefully at these three
pictures. How is the leopard different from these two.
L Cause they have stripes.
SH Yes! Yes! Can you see that? What's the difference between the
tiger…
L [statement
unclear]
SH
No, not yet. What's the difference between the tiger
and the two leopards? Ag, the leopard and the cheetah,
what's the difference between them. She just said it. What
does he have that the others don't have.
L These two…
SH Yes?
L Ma'am?
L Help her.
L [in the background] Ma'am, I know!
L Because…
SH What do they have? They have…?
L Spots!
SH Yes, and this one has…?
L Stripes
L Stripes.
SH That's right. So a tiger, very good Zindle, always has stripes.
L Yes, ma'am.
SH And a leopard and a cheetah always have…?
L Spots!
L Spots!
SH Spots! There's another difference between a leopard
and a cheetah. And it's more difficult to see. Can you think
what it is?
L Ma'am, I cannot.
SH Yes, Adi?
L It's like…and there's still something that they like…
SH Come
back! Come back! Come back! Listen to what she is saying.
What did she say just now?
L Like the…[unclear] of the mouth.
SH Okay. A cheetah runs very very fast. Okay, what were you
going to say?
L A tiger runs fast but a…
L [whispering] lion…

University of Pretoria, etd - Human, S

SH Yes, a tiger runs fast but a …?
L Than a lion, ma'am.
L A leopard doesn't run fast.
SH Okay, the cheetah's head is normally smaller…than the leopard's head. Okay? If you look at a cheetah it's head is a bit smaller. It has a small head.
L Ma'am, ma'am, but if you touch the head of a cheetah…the cheetah going to bite you.
SH Oh it will! If it's wild, it will bite you. It won't even wait for you to touch its head. If you are just five metres away from it, it will bite you.
L And then it's just going to chase you, then its going to eat you.
SH That's right. Okay, we're going to play a game. I'm going to describe what I have on this card and you must guess. You must take a guess what it is. Okay?
L Ma'am, what is this, ma'am?
SH It's a camera, I'll show you in a second. I have an animal here, on this card, it eats meat. It's wild, and it eats meat. [silence] It looks like…a wolf or a jackal, but it's not a wolf or a jackal. It has a long tail, it has lots of hair.
L Lion!
L It's a lion, ma'am!
SH Not a lion, no.
L Tiger?
SH No.
L Snake.
SH No…does a snake have hair?
L No!
SH It has lots of hair, okay, so its not a snake. It is a …? What is this? [showing]
L Cheetah!
L Wild dog!
SH Yes, you're right, it's a wild dog. And this is where I'am going to give each of you a camera so you can take a picture of this wild dog so that you can remember what it is! So…you take a picture quickly.

[Recording interrupted]

SH Okay, let's see, this is the last animal that I'm going to show you today at the zoo. This animal is big. It's as big as a hippopotamus. But..it doesn't live in water like a hippopotamus. It lives on land. And it has two funny horns on its nose…its grey and its got two funny horns on its nose.
L A bull! A bull! A bull!
SH No, its not a bull.
L Buffalo!
L Rhino!
SH Right! You're right! It's a rhino!
L [clapping hands and shouting]
L Rhino!
SH A buffalo…
L [shouting]
SH Just a second…a buffalo has horns on its head. A rhino has horns on its nose. Yes! So take a picture!
L [shouting click! and rhino!]
SH Very, very good.
L I took a picture of the spider.

SH Hmmm…
L A spider…where is the spider, where?
SH Okay…
L [noise] Spider!
SH Okay I'm going to show you. These are beads that we have…don't' fight…smell them and you'll smell that they don't smell very nice
L [Giggling]
SH Don't put them too close to your nose.
L Ma'am…
SH It's the paint, so don't put them too close to your nose. Okay…I am…
L Did you paint them, ma'am?
SH Hmmm?
L Who paint them like that?
SH I painted them.
L For how long, ma'am?
SH No, just for a short while. Just painted them.. and then they were…you let them dry…
L Ma'am..
SH Okay…this is…what colour is this?
L [chorus] Green!
SH This colour is…?
L [chorus] Blue!
SH And this colour is…
L Red!
SH Red. First of all, we're…what's your name again?
L Sitjaba.
SH Sitjaba. First of all we're going to give Sichaba a chance. I'm going to make a pattern in a row. And I want you to complete the pattern for me when I am finished. Okay… Okay, I've got a green one, a blue one, a red one, a green one…
L ..red one, a green one!
SH Okay, don't tell him yet. Let him try first. Which one must come next?
L Uh…
SH Which one do you think comes next?
L I think….blue!
SH Okay…and after the blue one?
L The red.
SH Okay. Do all of you agree?
L Yes!
SH Yes. Okay. I'll put another one, a green one, a blue one…and a red one. Okay, who can count in two's!
L [chorus] Me, ma'am!
SH Let him try. Count these for me, but count them in twos.
L Two….four…six…eight…ten
L [others] four….six…eight…ten
SH Ten, very good. Very, very good. Now I'm going to make another pattern and I'm going to ask…? What's your name?
L [unclear. One learner is whistling loudly in the background]
L Shimon
SH Shimon. Shimon which language do you speak at home?
L Sotho!
SH Sotho.
L Sotho! [noise alltogether]

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SH Okay, Shimon. I've got two blue,
two green…
L
…one red!
SH Which one must come next?
L Red, ma'am…
Red!
SH Okay, and then which one must come next?
L The blue.
SH And which one after the blue?
L [whisper answer] Green.
L Green.
L No, don't tell me! [laughter]
SH Ah…so he's telling you but you know! I know you know.
Which one comes after the blue?
L The red.
SH Okay…so he can make the pattern. Adi, can you count for us
in fours?
L [unclear]
SH Have you learnt how to count in fours?
L Yes, ma'am.
SH Four…
L Eight…
SH Four, eight. Okay…but are there eight? Four, eight…
L Nine!
SH Ten. Okay. Okay, but I don't think the teacher has taught you
how to count in fours yet.
L Yes, ma'am.
SH Okay…Just one pattern. Just one more pattern
L [noise] I'll make a pattern.
L Ma'am! Ma'am, is this your office, ma'am?
SH No, this is Mrs Nidri's office.
L [unclear due to noise from outside]
SH Yes, this is going to be…let's see. Adi? What do we have
there? Blue…
L Green
SH Blue, green, blue, green, blue
L ….blue, green, blue
SH Okay, which one must come next?
L Red.
L [laughter]
SH Uh-uh!
L Red!
SH No!…Can you see a red one here?
L No!
SH We don't have a red one here.
L Green! Green! Green! Green!
SH Look at it…Green, you're right, green! Okay…
L [noise]
SH How many green ones are you going to put?
L Four!
SH 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?
L I thought that …I'm gonna make one, then two, then one,
then three, then one.
SH You're right! So there's always one blue one. Which one must
come next? Zindle? Which one must you put there?

L Blue!

SH Okay, put the blue one..

L Red…

SH You're right! Very good, Zindle. So we always have one blue one, and the green one…

L Red, ma'am!

SH …and the green one…No, we're not using red… the green one is one more each time. Here are two…three…four! So if we put green ones there, how many green ones must we put there?

L Five!

L Four!

L Five!

L Five

SH Five! Okay...and we can carry on like that. Okay, I think we can stop there. Do you know what? I have finally finished. We are finished for today.

L Finished?

SH Yes. We are finished.

L [unclear]

SH Sorry, what did you say Adi?

L [unclear]

[End of recording]

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Data subset 8 (DS8) **EXHIBIT N**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 03:02:14 PM

P14: SSGR2JUNE12.txt [C:\phd\SSGR2JUNE12.txt]

Group : Grade 2
Date : 12 June 2000
Time : 10:00 – 10:40

L My name is Nasser
L My name is Mohammed
L My name is Khanyisa
L My name is Kirsty
L My name is Dineo.
L My name is Amal
SH You had the opportunity to quickly look..did you see what is on this picture?
L Yeah!
SH Who didn't see? Okay. Do you want to guess what's on there?
L [chorus] Yes!
SH Okay, let's go in a row. Nasser?
L A zoo!
SH He thinks there's a zoo.
L Uh…a bird.
SH A bird. Khanyisa?
L A bee.
SH A bee.
L A whole lot of bees!
L There's a zoo!
SH A zoo! Okay. And you Amal?
L [unclear]
SH Okay, let's see what we have over there…
L The zoo!
SH That's right, the zoo! This is what this picture is all about, It's about a zoo, can you see? We can turn the picture around a little bit so that everybody can see. So when you want to say something, then we can do that. Okay, I'm going to say a word and then you quickly…all of you, you put your finger on the animal that I say. Okay? Uhmm…you don't have to worry about being quick, so you can take your time to think. Okay? I don't want to see who can see it first, I want to see if all of you can say it. So take your time to think. Okay, who can tell me where the lions are?
L [Silently put their fingers on the animal.]
SH Okay, very good! Who can show me where the elephants are?
L Silently…
SH Very nice! Who can show me where the frog is?
L [exclaim…takes some time to find it]

SH Okay, you got the frog.
Okay who can show me where the seahorse is?
L I knew it!
SH Okay, what are you showing me there?
L Uhh! The seahorse.
L [in disagreement] No!
L That's not a seahorse!
SH What is it?
L [together] There! It's a seahorse!
SH Very good! Okay, let me just ask you a question. When you
pointed to these animals, what do we call them?
L Uhm…seals.
L Elephant seals.
SH That's right!
L Like on the news
there was a huge one jumping on everybody's cars…
SH Yes, I saw that! I saw that.
These are seals and you can also get a type of seal like Kirsty
says, which is an elephant seal. Do you think, that when I said
seahorse, that some of you heard the wrong word maybe?
You thought I said seals?
L Yeah, I didn't know it was that one.
Okay, so you guessed and you didn't know it was that one?
L Look at the bee.
Khanyisa said it was a bee, ma'am.
SH Yes, she's right there was a bee. All of you were
right in some respects. Okay. Right. This time I want you to
listen clearly and to think carefully before you show me the
animal. Okay. Don't show me too quickly. Don't show me too
impulsively. Right, show me where the rhino is.
L Rhino.
SH Yes!
That's good. Who can show me where the porcupine is?
L Porcupine?
L What's that?
SH
Okay, Dineo is not sure what a porcupine is.
L [Arguing.]
SH Okay, just a
second…just a second…just a second.
L Me, ma'am!
SH Just a second…Let's go in a row.
Amal, do you know what a porcupine is?
L No, ma'am!
SH Do you know what a
porcupine is?
L
Yes!
SH What?
L It's a thing that has horns out like that, and when
you touch the thing…
SH Okay…who of you don't know what a porcupine is? You
don't know what a porcupine is? Explain to Dineo quickly..
L A porcupine is
that little animal…[others are interrupting] it's very nice but it's
got that stuff that you…on the back, the stuff…cause when
you go outside…
SH Listen…listen…

…because the things are short.
SH Okay…Yes, Kirsty?
L [together, unclear]
SH [Whistling] Not all together.
L I was thinking it was this one, and it was right, ma'am.
SH But you didn't say because you were not sure?
L Yes, ma'am.
SH Okay. You must take a chance, it's okay to be wrong. There's nothing bad about being wrong.
L Yes, ma'am.
SH So next time you think you know something, you take a chance.
L Yes, ma'am.
SH Okay? Right! Who can tell me where the giraffes are! Okay! Very good, Nasser! I think maybe you must lean over the table so that you can also have enough space.
L …cos its not there!
L There…there…there…there…there…
SH Hmm…how many ants do you think are there on this poster?
L One…two.. .three…four…five…six….seven….eight…
L Ten!
L Ten!
L It is ten!
L Let's have a vote!
SH Okay…I have another idea. To make sure how many ants there are on this picture what we can do is we can take a bead…
L …and put it on!
SH That's right! We put it on. But we're not going to do it all at once, we're going to give each one a chance to put a bead on an ant. So let's start with Amal.
L [Puts a bead on]
SH Okay, you take one?
L [Takes one]
SH Okay, Kirsty?
L Very colourful!
L Take a red one!
L Okay. Uhmm….
L There! There!
L There!
SH Okay, Khanyisa? Nasser? Okay!
L [shouting together after bead fell of the poster]
SH Okay, let's start over again. Lean on the table or I'll bring the poster closer. Okay. Okay, can anybody still see…
L Me! Ma'am!

SH Okay, put one on. Can anybody still see an ant…
L [Together] / Yes! Yes!
Yes, ma'am!

[Learners put another bead on an ant on the poster]

SH Okay, can anybody still see an ant that doesn't have…
L
[noise] There was an ant here but now it's gone!
SH Nasser, can you see one?
L No.
SH No? Okay…Are all the ants covered with beads?
L [chorus] Yes!
SH Okay…now…
L Ma'am let us count them! One…
SH I think
it's a good idea! Let's count them. But you know what? It's still
difficult to count all the beads because we're not sure where
everything is. So…what plan can we make to make sure…
L
[noise]
SH Let's hear what Dineo wants to say?
L Uhmm…Ma'am we can do this…we can all look and we can
all count and when it's right and we can't find anymore and
Ma'am first you must look around for more and if you find
them you must put them on so that we know how many is
actually there.
SH Okay. What plan does Mohammed have, let's hear what
Mohammed says.
L Ma'am, ma'am, if you wanna count you must count one, then
you must take them out, Ma'am!
SH Ah! What do you think of that idea?
L [chorus] Yes!
SH Okay…let's do that. Each one of you take…
L One! [Noise] No!
She's got two, I got three….one! six!
SH Okay, listen to Kirsty and Khanyisa's plan,
what do you say what do we have to do, Kirsty?
L [noise together]
SH I'm asking Kirsty?
L You must go one, and two, … and I go three, and then she
goes four, she goes five, she goes six…
SH Okay, I also have a plan…What if we just
take all the bead off [demonstrate] and we count them?
L and we count them!
SH Yes!
L [counting together] One…two…three…four…
L there's ten!
L One…four…six…eight…and then you have two, that's ten!
L
Eleven!
L No! Twelve! [arguing] Five…two…
SH Okay, stop! Stop, stop, stop, stop, stop! Stop immediately,
stop!
L
One…
SH
STOP. Okay, can you see we can't count all

together. We get confused and we get nowhere.
L Ten, ma'am!
SH Okay, just a second. We can't count all together. If you count, and she counts, and he counts and she counts, then we're going to get confused, okay?
L Ma'am, I know! We can…
L Ma'am, I count!
SH Just a second, she's listening, uh talking.
L Ma'am you can hide it..then it somebody get it right…He…he's clever, ma'am!
L Ja!
SH But I'm not going to hide it, I'm not going to hide it. All I want you to know…is you, as a group, must tell me how many beads there are! So…each one of you can count on your own…and tell me how many beads there are.
L Ten!
L Ten!
SH Ten? Okay, let's ask Nasser to count them, just to check!
L [silently counting]
SH Very good! Very good! You were right! Let's ask Dineo…can you count in three's? Count them for me in three's.
L Three…six….nine….and a one! That makes ten!
SH That's great, Dineo! Very good! Can you count in three's? Let's try!
L Three…six…nine….ten!
SH Very good…so how many ants are there on the…
L [together] Ten!
SH There are ten ants on this board. Okay. Each one of you is going to choose me their favourite animal and not all together. In your head, decide which animals you want…
L …Oh no! [noise]
SH and…I'm going to ask each of you what's your favourite animal. Okay. Nasser, can I start with you?
L Yes.
SH Okay, let's turn the poster so that Nasser can see….which of all these animals is your favourite animal?
L Uhh….[pointing] Giraffe!
SH Okay, the giraffe! Okay. And you, Mohammed?
L A dog, ma'am…A dog!
SH Show me an animal on the picture…tell me what its name is and choose one that you like. Choose your animal that you like.
L [speaks softly] This, ma'am!
SH What do you call that?
L [another one answering] Seals!
L [speaks softly] Seals, ma'am!
SH Seals..you call them seals…
L Or elephant seals!
SH Or elephant seals. Okay Khanyisa, show me which animal is your favourite animal.
L [pointing] A ladybird.
SH Do you like a ladybird? Good! Kirsty show me your favourite animal.
L Ma'am, I like lions cause Ma'am I've got cats and they're like big cats.
SH Okay, you like lions.
L Lions are part of cats!

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SH That's right, they're part of the cat family. Good!
L My favourite animal is…
L …a pig!
L [all exclaiming]
SH You wait, you wait, we asked Dineo.
L My favourite animal…[silence]…animal is a ….
SH If you don't know the name of the animal you like, then it's okay, then we can ask someone…
L I know, I know…the name of the animal. I think the animal is a …
L She's gonna wait…
L Cause I have to take a card and say this and that and this and that…
SH Okay. So we'll ask Amal while you think?
L Yes, ma'am.
SH Okay. Amal, which is your favourite animal?
L Ma'am it's a elephant.
L Yes!
SH Your favourite animal is an elephant? Okay…now its Dineo!
L Okay. My favourite animal is a turtle!
SH It's a turtle! Okay, do you know what the difference between a turtle and a tortoise is?
L [chorus] Yes!
L Ma'am, a tortoise, ma'am…I forgot!
SH It's a tortoise!
L [noise]
SH What did you say?
L A tortoise is brown and a turtle is green!
SH Okay, maybe there's a difference in colour. But there is a more important difference. Where do they live? Nasser?
L A tortoise…a turtle ma'am…live at the water.
SH Yes, a turtle lives in water and a tortoise…Mohammed! A turtle lives in water and a tortoise lives on…?
L Ground!
L Ground, ma'am!
SH Yes, it lives on ground. Okay, very good! Very good. Right. Okay, I'm going to ask each of you to take a bead…one at a time…we're going to take turns…uhm…I want you to put a bead, Nasser…put a bead on any…put a bead on any…let's see…put a bead on any insect that you see. See if you can find an insect…Ah! Do you know the name of that insect?
L Praying mantis! Uh…no, a grasshopper.
SH It's a grasshopper, very good! Mohammed, you choose an insect.
L [talking softly to himself]
SH Let me put it a little closer.
L Ma'am what's an insect?
SH What is an insect?
L It's a….
SH No, let's just first hear if Mohammed can tell us? What is an insect, Mohammed, do you know?
L A grasshopper, ma'am.
SH Yes, how do you know if something is an insect? How do we

know if it's an insect, Mohammed? How do we know this is not an insect? Would you say a leopard is an insect?
L [chorus – laughterly] No!
SH No, it's not! Would you say an elephant is an insect?
L No!
SH No. Would you say….a penguin is an insect?
L [incredulously and laughter] No!
SH No. So how do we know when something is an insect?
L Ma'am…
SH Yes?
L Ma'am…I…
SH Is an insect big or is it small?
L [chorus] It's small! [One learner pointing to an insect and saying its name – unclear]
SH That's right, it's an insect.
L Ma'am…
SH Okay, let me just finish here and say: an insect…how many pairs of legs..yes, how many pairs of legs…
L Four! Four, ma'am.
L Four, ma'am! [noise]
SH An insect always has…listen to this: an insect always has three pairs of legs.
L Ma'am….Ma'am…
SH Three on the one side, and three on the other side!
L Ma'am…ma'am…
L And a spider?
SH Yes, that's right so this is also an insect.
L A spider?
SH A spider, how many legs does a spider have?
L Four
L Four, each
SH So is a spider an insect?
L [chorus] No, ma'am!
SH No, it's not an insect.
L It's a goggo!
SH Sometimes people say it's an insect, but it's really not!
L Ma'am, it's a goggo!
L Goggos and bees are insects, ma'am.
SH Okay. Let's give somebody else a chance. Khanyisa? You are next.
L Don't tell me, Amal!
SH You had your turn, Amal. Okay? Okay, Khanyisa, what did you choose?
L I chose a butterfly.
SH You chose a butterfly. Is a butterfly an insect?
L Yes, ma'am!
SH Okay, why do you say a butterfly is an insect? Because it's small and…
L and…
L and ma'am…
SH No, it's not your turn, it's not your turn, I first want

to know, wait, wait wait…put something over your mouth. You must not say anything now. Okay, Khanyisa, its small and what else? What else did we say is always true of insects? What about their legs?…..Who can help Khanyisa?

L Ma'am…

SH Okay…Okay, Amal. You wanted to say. What about the legs of insects?

L Three. Three on the side and three on the other side.

L Three in the other side…other side…

SH Okay, so how many legs do they have in total?

L Six

SH Six. Insects always have three pairs of legs. Okay? So a butterfly is an insect because it has three pairs of legs! Okay? Kirsty, your turn.

L [pointing]

SH Kirsty chose the big….

L [another learner] Butterfly.

SH …what over there?

L Butterfly!

SH Butterfly.

L It's an insect.

SH Yes, it's an insect. Choose another insect, Dineo.

L [Unclear]

SH Dineo? Let's turn it so Dineo can see. [silence] Do you see an insect, Dineo?

L Yes, ma'am.

SH Okay, put it on.

L And I think this insect…a bee or a butterfly.

L What?

SH Don't worry about what you like best, just choose an insect. Okay, so you chose the butterfly. Okay, Amal its you turn. Just put a bead on any insect that you can find.

L That's an insect.

L No!

SH Does it have three pairs of legs?

L [noise]

SH So do you think it's an insect?

L No.

SH No. Okay, Amal.

L A bee.

SH Okay you want to choose a bee. How many legs does a bee have?

L Six!

L Three!

L Three pairs

SH Three pairs! There's a difference between three pairs and three. Okay. Three pairs is the same as…? six legs. Okay, so each one of us chose an insect. Now tell me, if I want to divide you into two groups, how could I do that? Dineo?

L …that makes six altogether. Three here and three there. So that makes…three.

L Ma'am…

L Uhm…two times three equals six!

SH That's right! Okay, what do you have over there, Nasser?

L ….fit in my bag.

SH Okay. Right, now do you think all of you are the same?
L [chorus] No!
SH Are you different?
L [chorus] Yes!
SH How are you different? Khanyisa? How are all of you different?
L Ma'am…?
SH Yes?
L …your blood.
SH Okay, yes your blood. Yes, what else? Amal?
L Your fingerprints are not the same.
L Your face and your brain.
SH Yes, okay. Tell me, what are you? Are you a boy or a girl?
L A girl!
SH And what are you?
L I'm a girl…
L …girl
L girl
L boy
L boy
SH Okay..so do you think the two of them are the same as you?
L [girls] No!
SH No! So if we wanted to make two groups, which two groups could we make? We could make a group with…?
L Boys
SH Boys, or we could make a group with…?
L Girls!
SH Okay, we could also make a group on who has long hair and who has…short hair!
L [chorus] short hair!
L I've got short hair! [shouting ensues]
SH He's got short hair, and he's got short hair and you've got…?
L …a little bit of short hair
L …A little bit long.
SH A little bit long, so do you want to be in the long group or in the short group.
L In the long group.
SH Okay…
L ...I want to be in the short group.
SH Okay, so we've got four within the short group with short hair and we've got four in the group with long hair. How else can we make you into groups. What else can we use to divide you into groups. Nasser? What else can we do to divide you into groups? We can divide you into boys and girls or we can divide you into who has short hair and who has long hair…What else can we do?
L Who has the longest legs!
SH Yes!
L …laughter
SH Just a second, we can divide you into who has long legs and who has ….? short legs!
L short legs!
SH How else can we divide you?
L Who has uhm…who has long elbows and who has the shortest elbows.

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SH Who has long elbows and who has short elbows. Yes, Mohammed?

L …big nose and small nose…

SH So we can divide the group into those who have big noses and those who have small noses.

L Noise]

SH Let's just ask Amal first, yes?

L …who have a long head and who have a small head!

SH Yes, who have long and small head…Yes, Kirsty?

L Uhm…you can divide people, uhm…who have…long socks and short socks!

SH That's good! That's good! We can also divide people into the groups where people have long socks and have …short socks!

L short socks!

SH Can we divide….can we divide the group into who wears dresses and who wears trousers?

L [noise]

SH What do you have on at the moment? Do you all have trousers on?

L No! No!

SH You have a dress. Okay, do you have a dress or trousers?

L Trousers.

SH Trousers…[noise] Okay, I have a set of cards over here, and…I'm going to describe what is on this card and I want you to guess what it is. If you get it right, you can take the card, and you can keep it. Not for always…but just while we are busy today. At the end, who has the most cards will be the winner.

L …not shout out!

SH Yes, don't shout out, that's right. Okay. Good…I have on this card…an insect. Okay, it can fly. Yes, Nasser?

L A butterfly.

SH No.

L Ma'am…a bee!

SH No.

L Ma'am, a fly!

SH No. Yes, Dineo?

L A dragonfly!

SH A dragonfly? Very good! Okay…

[End of recording]

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Data subset 9 (DS9) **EXHIBIT O**

HU: SSMBOS
File: [c:\phd\SSMBOS]
Edited by: Super
Date/Time: 02-08-27 03:02:42 PM

P15: SSGR3JUNE12.txt [C:\phd\SSGR3JUNE12.txt]

Group : Grade 3
Date : 12 June 2000
Time : 09:15 –10:00

L	My name is Nosipho
L	My name is Koketso
L	My name is Maselilo
L	My name is Silas
L	My name is Setule
L	My name is Seselo
L	LAUGHTER (chorus)
L	My name is (unclear due to laughter)
SH	Just say your name again?
L	My name is Pindi
SH	Pindi?
	LAUGHTER
SH	Okay, so Koketso likes making jokes. Well, it's okay to make jokes but there's just one very important thing that I would like us to try this morning, is that if somebody talks then the others must listen.
L	Yes, Miss
SH	Okay? I'm sure you've tried this many times in class and I'm sure your teacher has also asked you many times in class. Okay? I have three cards here. Can anybody tell me what it says?
L	(chorus): Go!
SH	Yes, it says "go". What we're going to do with these cards is we're going to use them to help us to know who is going to give an answer. Okay? We're going to put them on the table and when you have something to say or when I ask a question, and you want to give an answer, then you pick up the green disk and you can give your answer. Okay? I'm only going to listen to answers of people who have this in their hand. If you don't have this in your hand then I'm going to ignore you. Okay? If you don't have one and everybody has a disk, then you wait for them to put it down, because as soon as you've given your answer you put it down again so that somebody else can take it. Okay? Right. Let's try this with our names. kay, I'm going to ask, whose name is Silas? Then you pick up the card and you tell me.
L	My name is Silas.

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SH Okay. Whose name is Maselilo?

L My name is Maselilo.

SH Okay. Whose name is Itumeleng and Pindi?

L My name is Itumeleng

L My name is Pindi.

SH Okay. Whose name is Nosipho and Koketso?

Laughter

L My name is Nosipho.

SH And whose name is Koketso?

L My name is Koketso.

SH Good. Okay, very good. So you get the idea. Okay, sometimes we get a little bit excited and we may forget to pick up the card. But if you see I'm not listening to you, then you must know that's why. Okay? Who can tell me… What do you think? Have some of your friends told you what we were doing here today?

L [chorus] Yes, ma'am!

SH What have they told you?

L One of my friends told me that they were saying their names and they were ask…they were just… saying names and stuff like that.

SH OK, just saying names and stuff like that?

L Filile…

SH Hmm, Filile, what did she say?

L She said you were asking her name and they were laughing when they told you.

SH Yes, very much like you did, all of you did this morning. It's funny to hear your voice on a tape isn't it?

L [Together] Giggling in acknowledgement.

SH Okay, who wants to take a guess and remember you have to take a green card if you want to give an answer. Who wants to give a guess as to what is on this picture? Grab a card, grab a card. Ok, you think animals. Sipho? What do you think, Maselilo?

L People.

L Pets.

SH Pets? Ok, does anybody else think, what do you think Nosipho?

L [giggling] Grannies and water?

[Laughter]

SH What do you think?

L Water.

SH Water?

L Yes, ma'am.

SH And you, Koketso?

L Grannies and parents.

SH Grannies and parents?

L …Jesus.

SH You think Jesus. What do you think?

L Plants.

SH Plants? Okay. I think we must turn it around and see what we have on it.

L [Exclamations] All talking together.

L [Talking together]

L I said animals

L I said plants.

L Water, water, water.

L I said parents here. They're people.
L No Jesus
L Pets. Where are pets, pets, pets?
L A bird, a pet is a…[rest unclear] [laughter]
SH …Okay, remember if you're not using the green card you have to put it back. You can't keep it with you the whole time. So if you put it there in the middle, where everybody can get it. So each one of you was right. Actually you were right too because Jesus is invisible and who is to say that he's not there. He might even be there.
L He is here! Because wherever…unclear… and God is…[unclear.
L speaking together, mumble]
SH Okay. One person at a time, one person at a time. Okay, good, right. If you have to give this picture a title – if you have to say what it is about, what would you say? What would you say? Anybody wants to give me an answer can take a green disk and tell me what they think this picture is all about? Maselilo?
L I think it's about…animals.
SH You think it's about animals? Did you want to say that? Okay, so that's why you put your disk back. And you – Itumeleng – No! Pinde! Pinde! Pinde!
L I think it's about people getting together and animals.
SH It's about people getting together and animals. Does anybody else have an idea? How about you, Itumeleng?
L Learners speaking together - unclear
SH What do you think about Koketso's answer? He's asking us if it isn't a zoo.
L But it is…
L It is…
L It looks like it because people, people are going around looking at these animals and they're locked inside..
SH And what does one do at a zoo, Itumeleng?
L They look at animals
SH You look at animals. Would you…yes…and would you say that this is what the people are doing on this picture?
L [together] Yes, ma'am
SH So do we all agree that this is a zoo?
L [Together] Yes, ma'am!
SH Okay, that's good. Now I'm going to ask you, all of you, that you must have a look at this picture and you must tell me…how many birds – how many birds – you can find on this picture. And what you can do is you can use these beads and you can put a blue bead or a red or a green one on each bird you can see. Okay, I'll put the beads over here…
L But don't grab, ma'am.
SH Yes, listen to what Pindi says, don't grab.
L Everyone laughing and talking together
SH Put your beads on the poster…where there are animals

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L [Laughter] Talking among themselves: How many birds? How many birds? One – two – three – four .
L Ma'am, there's no birds here! [Laughter] There's no birds.
SH Okay, everybody put it down, back again.
L [Laughter, girl squealing]
SH Okay, everybody sit back on their chairs again.Yes, first just listen.
L [Shouting] What is this, miss!
SH It's beads. It was beans and then I painted them.
L Oh, they stink.
L [Laughter]
SH Is it not nice?
L Yes, ma'am.
SH Just a second, just a second, did you put it in your mouth?
L [screaming inappropriately] No ma'am.
SH Does it not smell nice?
L Yes, it smells like burnt food
L [Laughter]
SH Like burnt food?
L Yeah, not like….
L Burnt macaroni
SH Like burnt macaroni?
L [Laughter]
SH Okay, all right. Okay, let me have your attention quickly. Did you see when every one of us tried altogether to put beads on the poster that it didn't work that well.
L Yes, ma'am.
SH Okay, what would be a better way to do this? Where are the green cards? What would be a better way? [Learners talking to one another in the background] Okay?
L Ma'am, I think that better way is to just…a person takes one and put on one bird and the other takes and put on one bird. That can work easily, ma'am.
SH Okay, so you think it would be better that one person takes a bead and then the next one takes a bead and then the other one …
L / Yes ma'am!
L [starts talking together]
SH Hey! Maselilo?
L Ma'am, you take it around, start from Pindi, then Pindi…six beads there, and each one puts on the bird…
SH Okay, so we start with Pindi and each one puts a bead until we've got beads everywhere. Did you also want to say that Koketso?
L Yeah
SH Okay, what did you want to say Itumeleng?
L We each have a turn to put a bead on a bird.
SH Okay, it's much like what Maselile and Itumeleng said that we must give each one…Ag, Nosipho! Itumeleng is you! Okay, just give me a while I'll get all the names right. Yes, Pindi?
L We can do like two by two. It's me and her, then her…

SH /
Okay, so you also say that you can work with partners. That is one way to do it, but I would very much like us to work as one group today. It's not wrong that you can work with a partner but I would like us to work as a group today.
L Okay.
SH Okay? So let's go for the idea that everybody gets a turn. Okay, we start with Pindi. So we have to put a bead on each bird and … Lets take the red beads. Let's use the red beads to go for the birds.
L [another learners begins]
SH No, no, no, no Itumeleng, it's not your turn yet so you can put your bead down. Pindi is first going to put her bead on a bird that she sees.
L [exclamations]
SH What is the name of that bird?
L [Together laughter and noise]
SH No, it's Pindi, it's Pindi, let her try first.
L Um, what's its name
SH Do you know it's name?
L A peacock.
L [Together laughter]
SH Okay, I don't want you to guess. Do you know the name or not?
L [another learner] I do, ma'am, it's an ostrich.
L [another learner amid laughter] Ostrich!
L Okay, so you think it's an ostrich, I'm not listening to somebody whose turn it isn't. So you think it's an ostrich?
L Yes ma'am.
SH Okay, how many of you – put up your hands- who also thinks it's an ostrich? Itumeleng thinks it's an ostrich. Maselilo doesn't think – why [stopping others from interrupting] uh- uh - uh – Maselilo, why don't you think its an ostrich?
L [Unclear because noise others are making]
SH I'm talking, I'm talking to Maselilo. Only one person at a time and we're listening to what he says. Maselilo, do you say an ostrich doesn't look like that?
L Yes, ma'am.
SH How does an ostrich look? What colours does it have?
L Blue
L Black… [laughter]
SH Black and what else?
L Blue…pink [laughter]
SH Okay, it's definitely… an ostrich is definitely not pink.
L [Together] Yeah!
SH That bird is called a flamingo
L [Laughter] What about…? [Laughter]
SH Did you know that
[No one responding amid laughter] Did you know that?
L No, ma'am. …didn't know.
SH Okay, whose going to be next? What's your name again?
L Refilwe.

University of Pretoria, etd - Human, S

SH Refilwe? You take a red bead and put it on another bird and tell us what the name of the bird is, that you put it on.
L [amid noise] Owl.
SH Yes, it is called an owl. Okay..
L [laughter and shouting]
SH [Attempting to quiet them down while a learner is looking for a bird] Itumeleng, which one, which bird are you going to choose ? Okay, Itumeleng will tell us now what the name of that bird is?
L An eagle
SH An eagle, that's right, very good. Okay
L [Noise] It's a bird.
SH Why do you say it's a bird?
L A bat!
SH Oh, a bat! Do you think a bat is a bird?
L No.
SH So why do you put the bead there?
L [noise and laughter] Uh….it looks like a bird.
SH It maybe looks like a bird but is it a bird?
L No.
SH So why did you put the bead there?
L …because it looks like the other ones…
SH Okay, did you put the bead there because you don't know the names of the other birds?
L Yes, ma'am.
SH So you put it there because you don't know the names of the other birds? That's okay, just put it on a bird, if you don't know the name, then somebody will help you.
SH Okay, you don't know what the name of that bird is? [noise] Hmmm?
L [squealing and shouting] Ma'am its not easy!
SH Okay, it's definitely, yes you're right, it's not easy. Do you think it's a duck?
L Yes, ma'am.
SH Okay.
L No, it's not!
SH No, it's not? You're not sure?
L It's a …it's..a…a turtle. It's like a fish
L [noise and laughter] ...into the water!
SH Okay…
L It's a duck, ma'am!
SH No….does a duck have long legs like that and a long beak like that? No, it doesn't.
L Look at those…boys they are outside ma'am!
SH Hmm…remember its okay if you don't know an answer – you don't have to think of just anything to give an answer. Okay? It's quite all right if you don't know an answer. All of us, we can't know everything. The name of that bird is a heron.
L Heron.
L What's a heron?
SH Can you say that word, Refilwe?
L [interrupting in background] Ma'am! Ma'am! Ma'am, what's that?
L Heron.
SH Heron! Who can … there it is. [ignoring learners who

are interrupting] Koketso: what's the name of that bird?

L Which one, ma'am?

SH This one.

L [interrupting] Ma'am, I told you it's not easy ma'am!

SH Just…don't help him. Did you listen when I said the name of the word?

L No, ma'am.

SH Why not? Was it nicer to play games with Maselilo?

L No Ma'am I'm not playing with Maselilo. I'm looking at that book.

SH Who can tell Koketso what's the name of this bird? Listen to Refilwe.

L It's a heron, ma'am.

L [Other learners laughter]

SH [Asking another learner who was laughter] What name is it?

L A heron, You said it's a heron, ma'am.

SH It's a heron, that's good, it's a heron. Okay, who has to put the next bead on? Silas, have you, yes you …and now its Maselilo.

L A red one!

L A red one!

SH Pick a red one because you're going to use the blue for something else. Can you see any other birds?

L No!

SH Okay, what's the name of that bird?

L Flamingo!

SH Yes, it's the same as we had earlier. Okay, hat's all right for him if he wants to do that, if he wants to do that. Okay, now Koketso…Just a second…Ah!! Koketso put the bead on that bird over there – what is it called Koketso?

L A penguin.

SH A penguin, Okay.

L [laughter]

SH What is it called, Silas ?

L A penguin.

SH Yes. Have any of you ever seen a penguin.

L On TV!

SH Okay. Itumeleng, do you know if those birds can fly?

L No, ma'am, they can…

SH I'm asking Itumeleng.

L No, ma'am!

SH Can they not fly?

L I think so.

SH You think they can? Who thinks penguins can fly? Koketso, Maselilo, and Pindi, and Itumeleng.

L I agree with …

SH Do you think a penguin can fly? And you Silas?

L No, ma'am.

SH So everybody thinks a penguin can fly, except Silas?

L Yes, ma'am.

SH Well, I have to agree with Silas on this one. Penguins can't fly.

L [Exclamations in surprise]

SH They have such small wings that they cannot fly. But do you know what can they do very well?

L They can jump!

L Ma'am…

L Jump and…I think swim.

SH Yes, Koketso you were right they can swim very well. Do you know what else they can do very well?

L No!

SH They can dive [exclamations]…they can dive very well. Okay, uhm…it's now your turn to put a bead on a bird. [Noise] Ah…I know why no-one chooses…

L I know!

L It's a pirate.

SH What is it Itumeleng?

L It's a pirate.

SH A pirate?

L No!

SH No it's not, what do you say? It is a…?

L Unclear

SH No, not quite, but you're on the right track. That bird over there, let me put it, is called…a vulture.

L It's not easy!

L Vulture.

SH Hey, Koketso? Is it not easy? Take your camera and take a picture of it [laughter] Everybody take a picture of the vulture. So you can remember, so you can remember it's a vulture [laughter].

L Ma'am, the other birds are bothering me [laughter]

SH Are the other birds bothering you?

L Yeah, ma'am.

SH Okay, good, a picture of what bird did you take? [making clicking noises]

L A vulture [laughter].

SH That's good, that's good, you're right,Refilwe. You took a picture of a vulture. What picture did you take Koketso?

L Of a vulture, ma'am.

SH Of a vulture. And you Silas?

L A vulture also.

SH Maselilo?

L A penguin,ma'am.

SH Okay, that's good.Can you take a picture of the vulture too and tell us what it is.

L It's vulture

SH Yes, it is a vulture. Are you going to remember that?

L [together] Yes.

L A vulture.

SH Do you know what a vulture is?

L Yes, ma'am.

L It's a bird, ma'am.

SH Yes, you're right, it's a bird…

L No!

SH But it's a very special…huh?

L No, ma'am, it's a bird, ma'am! [laughter]

SH It's a very special bird because…unlike other birds - unlike the eagle - an eagle hunts for its food. Okay, it has a very strong, sharp beak and it hunts rats and mice and rabbits. But do you know what a vulture does? He waits for other animals to kill. He waits for a lion or a leopard to kill a buck and then when the lion and the leopard have finished eating…then the vulture circles up there in the air. And it circles and when the lions are gone they come down and they hop, hop, hop to the buck and then they eat the rest of it. So they don't catch their food, they wait for other animals to catch it and then they just eat…

L [Noise everyone talking]

SH Okay, lets hear what Koketso wants to say. Why are you scared of him, of the eagle?

L That one, ma'am!

SH All right, Koketso?

L [Unclear due to laughter]

L Ma'am, isn't there a kingfisher here?

SH Do you know how a kingfisher looks?

L Yes, ma'am.

SH [Hands out small cards] Show us which one of these…You can just sit, I'll put it on the table, just sit, keep quiet, let's give Nosipho a chance to see if she can find a kingfisher.

L Wo, wo, we. Is it this one?

SH No, that one is a sparrow. Ah! What does Itumeleng say? This one, that's the kingfisher. Okay.

L …two colours and the red, ma'am…

SH Hmmm? Okay, that's a kingfisher. That is how a kingfisher looks. Let's put this away for a moment. Okay, who can tell me – all of you have a look – who is going to be the leader of this group?

L You choose, ma'am!

SH No, no, no, you choose. The seven of you must choose and tell me who the leader is going to be.

L Ma'am, can you choose ma'am.

L Yeah, ma'am, because they choose friends to play…

SH Okay, just a second, there's a problem. You say that they just choose their friends, they don't choose the one…

L They don't chose the one…

SH Okay, do you think we can solve this problem by voting?

L [together] Yes!

SH We can do like this, a boy and a girl.

L Yeah!

L You choose ma'am, because we don't know who…

SH Okay, we have three boys here and we have four girls. Is that right?

L Yes, ma'am!

SH Okay, were going to choose a girl and boy. Okay, now, who votes for Nosipo to be a leader? We're first going to chose the girls. Who votes for Nosipo?

L No one, ma'am.

SH She votes for Nosipo so there's one. Who votes for Pindi? Two votes for Pindi. You boys can also vote. Who votes for Refilwe? [Laughter] Four. Four for Refilwe. Who votes for Itumeleng? Okay. Then I think Refilwe is going to be the leader…of the girls. Refilwe is very happy about that. Okay, Refilwe is going to be the leader [noise] What did we say about the rules in the beginning? If somebody speaks then the others…?

L
[chorus] …keep quiet.
SH Okay, who is choosing Koketso for a leader? [noise]
Okay, well I think Koketso will be the leader then
because that's the most. Okay. Yes, Itumeleng?
L Ma'am, can we take turns?
SH Yes, we can take turns. For this exercise Refilwe and
Koketso will be the leader. Okay, is everybody happy
about this?
L Yes!
SH Okay. Listen to this question. There are two lions in this
enclosure.
L Enclosure.
SH One lion, two lions. Okay, or cage…let's call it a cage.
There are two lions in this cage. If we put – if we take
the two leopards and we put them also in this cage,
how many animals will we have? And I want all of you
to work together and when everybody has agreed on
the answer then I want Refilwe to tell me what the
group's answer is. Okay, there are two lions in the cage
if we take the two leopards and we put them all in this
cage, how many animals will we have? I'm only going
to listen to Koketso. You must talk to her and you must
see if all of you agree on what the answer is.
L Four.
L Four!
L Four!
L I don't think so, ma'am.
SH Tell me what you think.
L Here, four animals.
L 1, 2, 3, 4, 5, and then 6, 7. 8. Ok, if we put 2 leopards
in this cage how many animals will it be
[Noise from outside makes recording unclear]
SH Okay, if we put two leopards in this cage, how many
animals will their be?
L Four.
L One, two three four five six..
L Four!
L Five!

[noise as all learners count on their own]

SH Okay, do you have an answer? Do all of you agree on
the answer, Refilwe? Okay, Refilwe, what's the answer?
L Eight.
SH Eight? Tell me how you worked that out? Tell me how
all of you worked that out?
L [speaking together – laughter]
SH Maselilo…Maselilo. Okay, how did you work that out?
L I counted.
SH Which animals did you count?
L I count these two ma'am, plus this..this…this…this..
SH /
And how many is that?
L One, two, three, four, five, six, seven, eight.
L But it's not inside, can you see?
L Yes, ma'am!
SH Is this ant inside that cage?

L	[chorus] - No, ma'am!
SH	We only want to know about the animals in this cage.
L	Five.
L	Five.
SH	And we put them in there.
L	Seven.
SH	Okay, do all of you agree it's seven?
L	[together] Yes!
SH	So you see sometimes when you have to work out an answer that it's very easy to shout the answer out very quickly and you think you have the right answer. And then in the end you don't. So what do you have to do when you work a problem out?
L	Think.
SH	What do you say Maselilo?
L	See properly.
SH	See properly? And you, Nosipho?
L	Ma'am, I think you have to think before you say the word.
SH	Okay.
L	That's why we like saying: think before you speak.
SH	Yes. Yes, Itumeleng?
L	You have to count the animals.
SH	You're right! You have to count the animals. Otherwise you can't calculate how many there are. Okay? Very good! Just one more and this is then Koketso's answer.
L	Oh!
SH	What will happen if we put the two leopards in the cage over here?
L	What is that, ma'am?
L	The two leopards in the cage, what will happen?
SH	Let me just ask Itumeleng and Silas what the question was? Can you repeat the question for me?
L	Yes, ma'am.
SH	What did I ask the learners?
L	Ummm…
L	Ah, you weren't listening.
L	[someone else] I was.
L	…and we have to tell you what's the number…
SH	Oh, but we are finished with that. I've asked another question. Okay, Refilwe, let Refilwe tell us what question did I ask?
L	What will happen when we put this two in here?
SH	What do we call these animals?
L	[chorus] Leopards!
SH	What will happen if you put the two leopards in this cage over here?
L	They will fight.
SH	No, I want to know… Listen carefully to the question. Its important to listen carefully to a question. What will happen, what will happen, if we put the two leopards in this cage over here? Yes, Nosipho?
L	Ma'am, I think if you take these two and put them in here…
SH	Which two?
L	They're going to fight. The leopards going to …
L	[interrupting] Ma'am, ma'am…

SH [addressing learner who interrupts] Okay, what did Nosipo say?
L I don't know.
SH Why not? What did we say about the rules?
L Ma'am…
SH Before you ask me…No, I'm not asking what the question was! I want you to tell me what Nosipo said. Can you tell me what she said?
L She said…this two…
SH Okay. How does it feel Nosipho, how does it feel when you say something and the others don't listen to what you say?
L Ma'am, I feel cross because I have to listen to them and they don't listen to me!
L [others] Ja, yes!
SH Okay, do you think they respect you?
L Yes
L (chorus) No, ma'am!
L Ma'am?
SH Yes, Itumeleng?
L [unclear because everyone talking together]
SH Okay, all right. Okay, we're finished for today. Thanks a lot for helping me with this picture.
L Ma'am, can we hear it?
SH I can't put it back because I have to use it for another group and then I don't know where the end is. That's why I let you listen to your names.
L Ma'am, what's in here?
SH Cards are in here.
L What kind of cards?
SH I can show you the cards but you have your break and you're missing your break at the moment.
L Ma'am, show us the cards
L I don't need to eat..
SH You don't need to eat?
L unclear…for the whole day
L Noise, speaking together, Play cards, ma'am.
SH Okay, I'm going to look at a card and I'm going to describe it. You must guess what it is that I have on this card.
SH No, no, no. You are guessing, you are all guessing. It's an insect – do you know what an insect is?
L Yes,ma'am.
SH Okay, it's an insect, it can fly.
L It's a bug.
SH No
L unclear
SH No. This insect doesn't bite. It can fly but it doesn't bite.
L It's a spider.
SH Right. It's a spider.You may have this one. No, not for always. You have to give it back but we're going to see who can get these cards.
SH Okay, I have another insect here.
L A grasshopper.
SH Ah, did you see it?
L Yes, ma'am.
SH I have an insect here. All of these cards are insects. This insect can fly.

L	A bee.
SH	No, It can sting.
L	chorus. It's a bee. It's a bee.
SH	No
L	A mosquito.
SH	Yes
SH	And this insect is very, very small. It can't fly but it can jump.
L	A Ant
SH	No, it can jump and can an ant jump?
L	No.
L	It's a small thing, ma'am! It can jump, I don't know, ma'am!
SH	You get it on dogs.
L	…ticks!
SH	Okay! Another insect that can fly.
L	A bee
SH	No. It can fly but it's not a bee. It's green.
L	A grasshopper
SH	No, not a grasshopper. It sometimes looks as if it can pray- as if it's praying
L	[incredulous] Ma'am. [laughter]
SH	It can jump, it can jump.
L	A frog!
SH	No, is a frog an insect? What is a frog? A frog's not an insect, it's a…? reptile.
L	A reptile.
SH	That's right, OK. It has big forearms.
L	Ma'am, it's like a grasshopper.
SH	Not totally.
L	It is a … (unclear)
SH	It's a praying mantis.
L	Oh
SH	Do you know the word? Do you know a praying mantis?
L	No, ma'am.
Laughter-	noise
SH	Okay I'll keep this one because you didn't know. This one is also an insect. It's very small. Yes?
L	It's a bee.
SH	No
L	Ma'am, a ladybird?
SH	No
L	An ant, ma'am!
SH	No.
L	Does it fly?
SH	No, it doesn't fly, it can only walk around and..
L	…dog, ma'am.
L	I forgot it's name, maam.
L	A ladybug.
SH	Ah, you saw it so it's not going to count. An insect and it's a flying insect.
L	A bee
SH	Maselilo is the winner!
L	Yes!
SH	And now we have to finish. So I'm going take the next class and I'll going to take you back to your class.

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L …it was fun

SH I'm glad it was fun for you. It was fun for me too and thank you for helping me with the tape. Can we keep this? Yes, you can keep it.

L Yes!

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Code frequencies **EXHIBIT P**

Table 1 : Inter-code consistency for DS1 : SSGR1JUNE8.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	26	33	78.78
CS3+	52	70	74.28
CS5+	8	15	53.53
CS6+	2	3	66.67
KS1+	14	15	93.33
KS1-	6	8	75.00
KS2+	44	47	93.61
KS2-	72	78	92.30
KS3+	0	1	00.00
KS3-	0	1	00.00
KS4+	4	5	80.00
KS4-	0	4	00.00
KS5+	6	11	54.54
KS5-	14	25	56.00
KS7+	16	30	53.33
LD1+	3	3	100.00
LD2+	36	59	61.01
LD3+	14	19	73.68
LD4+	6	9	66.67
LD5+	1	1	100.00
LD6+	6	7	85.71

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times codes were allocated on both occasions.

3 Total number of times codes were allocated.

Unshaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Shaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 71.51%. A sample of 79 quotations from a possible 162 were selected from the first, third, and fifth blocks of 100 quotations. The sample represents 48,76% of the total quotations for primary document 1 : SSGR1JUNE8.TXT.

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Table 2 : Inter-code consistency for DS2 : SSGR2JUNE8.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	30	35	85.71
CS2+	6	10	60.00
CS3+	44	56	78.57
CS5+	2	4	50.00
KS1+	10	11	90.90
KS1-	0	1	00.00
KS2+	28	31	90.32
KS2-	34	43	79.06
KS3+	4	4	100.0
KS3-	0	2	00.00
KS4+	0	1	00.00
KS5+	0	1	00.00
KS5-	0	1	00.00
KS6+	2	3	66.66
KS7+	14	16	87.50
LD1+	8	12	66.66
LD2+	36	44	81.81
LD3+	12	12	100.0
LD4+	12	17	70.58
LD5+	4	4	100.0
LD6+	2	9	22.22

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times codes were allocated on both occasions.

3 Total number of times codes were allocated.

Unshaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Shaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 73.39%. A sample of 60 quotations from a possible 113 were selected from the first and third block of 150 quotations. The sample represents 53.09% of the total quotations for primary document 2 : SSGR2JUNE8.TXT.

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Table 3 : Inter-code consistency for DS3 : SSGR3JUNE8.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	14	21	66.67
CS2+	0	2	00.00
CS3+	26	35	74.28
CS4+	0	1	00.00
CS5+	4	5	80.00
CS6+	0	2	00.00
KS1+	10	20	50.00
KS1-	2	4	50.00
KS2+	12	20	60.00
KS2-	46	53	86.79
KS3+	4	5	80.00
KS4+	2	2	100.0
KS4-	0	2	00.00
KS5+	2	3	67.00
KS6+	2	4	50.00
KS6-	0	1	00.00
KS7+	0	3	00.00
LD1+	20	23	86.95
LD2+	20	31	64.51
LD3+	12	14	85.71
LD4+	0	1	00.00
LD5+	0	2	00.00
LD6+	4	4	100.0

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Unshaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Shaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 70.40%. A sample of 62 quotations from a possible 184 were selected from the first and third section of the text. The sample represents 33.69% of the total quotations for primary document 2 : SSGR3JUNE8.TXT.

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Table 4 : Inter-code consistency for DS4: SSGR1JUNE9.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	0	6	00.00
CS3+	48	73	65.75
CS4+	0	1	00.00
CS5+	6	14	42.85
CS6+	2	4	50.00
KS1+	0	1	00.00
KS1-	4	8	50.00
KS2+	26	39	66.67
KS2-	84	98	85.71
KS3+	24	27	88.89
KS4+	2	4	50.00
KS4-	0	5	00.00
KS5+	2	7	28.57
KS6+	8	11	72.72
KS7+	14	24	58.33
LD1+	4	6	66.67
LD2+	44	73	60.27
LD3+	12	14	85.71
LD4+	4	8	50.00
LD5+	2	2	100.0
LD6+	0	1	00.00

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Shaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Unshaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 67.13%. A sample of 78 quotations from a possible 168 were selected from the first and third section of the text. The sample represents 46.42% of the text for primary document 2 : SSGR1JUNE9.TXT.

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Table 5 : Inter-code consistency for DS5: SSGR2JUNE9.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	50	53	94.33
CS2+	0	1	00.00
CS3+	80	104	76.92
CS3-	0	1	00.00
CS4+	4	4	100.00
CS5+	2	5	40.00
CS5-	0	2	00.00
KS1+	2	3	66.67
KS1-	6	12	50.00
KS2+	24	34	70.58
KS2-	66	78	84.61
KS3+	8	9	88.89
KS3-	0	1	00.00
KS4+	0	4	00.00
KS4-	0	7	00.00
KS5+	4	8	50.00
KS5-	2	3	66.67
KS6+	4	6	66.67
KS7+	9	15	60.00
LD1+	0	1	00.00
LD2+	16	31	51.61
LD2-	0	1	00.00
LD3+	28	31	90.32
LD4+	6	10	60.00
LD5+	4	4	100.0
LD6+	2	2	100.0

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Shaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Unshaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 74.44%. A sample of 83 quotations from a possible 159 were selected from the second and fourth sections of the text. The sample represents 52.20% of the text for primary document 2 : SSGR2JUNE9.TXT.

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Table 6 : Inter-code consistency for DS6: SSGR3JUNE9.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	22	26	84.61
CS2+	4	7	57.14
CS3+	31	64	48.43
CS3-	0	1	00.00
CS4+	0	1	00.00
CS5+	2	4	50.00
KS1+	4	6	66.67
KS1-	6	13	46.15
KS2+	18	25	72.00
KS2-	42	53	79.24
KS3+	8	16	50.00
KS4+	2	6	33.33
KS4-	0	2	00.00
KS5+	2	3	66.67
KS5-	2	3	66.67
KS6+	6	7	85.71
KS7+	11	16	68.75
LD1+	6	7	85.71
LD2+	14	26	53.84
LD3+	18	19	94.73
LD4+	4	8	50.00

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Shaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Unshaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 67.13%. A sample of 78 quotations from a possible 168 were selected from the first and third section of the text. The sample represents 46.42% of the text for primary document 2 : SSGR1JUNE9.TXT.

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Table 7 : Inter-code consistency for DS7 : SSGR1JUNE12.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	26	38	68.42
CS2+	0	2	00.00
CS3+	72	88	81.81
CS5+	4	8	50.00
CS6+	2	2	100.0
KS1+	2	3	66.67
KS1-	10	15	66.67
KS2+	26	29	89.65
KS2-	54	60	90.00
KS3+	8	10	80.00
KS3-	8	13	61.53
KS4+	0	2	00.00
KS4-	0	1	00.00
KS5+	6	11	54.54
KS5-	2	3	66.67
KS6+	12	14	85.71
KS7+	18	29	62.06
LD1+	4	4	100.0
LD2+	34	51	66.67
LD3+	24	24	100.0
LD4+	2	4	50.00
LD5+	4	5	80.00
LD6+	2	2	100.0

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Shaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Unshaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 74.42%. A sample of 69 quotations from a possible 132 were selected from the first and third section of the text. The sample represents 52.27% of the text for primary document 2 : SSGR1JUNE12.TXT.

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Table 8 : Inter-code consistency for DS8 : SSGR2JUNE12.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	18	23	78.26
CS3+	38	59	64.40
CS5+	6	9	66.67
CS6+	2	2	100.0
KS1+	0	3	00.00
KS1-	6	10	60.00
KS2+	12	18	66.67
KS2-	52	60	86.66
KS3+	14	17	82.35
KS3-	6	12	50.00
KS4+	0	6	00.00
KS4-	0	5	00.00
KS5+	2	7	28.57
KS5-	0	1	00.00
KS6+	0	3	00.00
KS7+	16	21	76.19
LD1+	2	4	50.00
LD2+	16	39	41.02
LD3+	24	25	96.00
LD4+	4	4	100.0
LD6+	6	6	100.0

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Shaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Unshaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 66.47%. A sample of 63 quotations from a possible 132 were selected from the first and third section of the text. The sample represents 47.72% of the text for primary document 2 : SSGR2JUNE12.TXT.

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1 Table9 : Inter-code consistency for DS9 : SSGR3JUNE12.TXT

Code	Consistency[1]		Percentage
	Correct[2]	Total[3]	
CS1+	30	45	66.67
CS3+	60	96	62.50
CS5+	2	2	100.0
CS6+	0	1	00.00
KS1+	4	10	40.00
KS1-	4	8	50.00
KS2+	28	34	82.35
KS2-	76	86	88.37
KS3+	16	22	72.72
KS4+	0	4	00.00
KS5+	2	3	66.67
KS5-	2	3	66.67
KS7+	6	9	66.67
LD1+	10	13	76.92
LD2+	36	53	67.92
LD3+	10	12	83.33
LD4+	10	16	62.5
LD6+	2	2	100.0

1 Consistency with which codes were allocated to a sample of sentences on two scoring occasions.

2 Number of times same code was allocated.

3 Total number of times code was allocated.

Shaded blocks indicate coding consistencies (> 70.00%) that were regarded as acceptable.

Unshaded blocks indicated coding consistencies (< 70.00%) that were regarded as too low.

Consistency with which sentences were coded was 68.68%. A sample of 82 quotations from a possible 184 were selected from the first and third section of the text. The sample represents 44.56% of the text for primary document 2 : SSGR3JUNE12.TXT.