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.
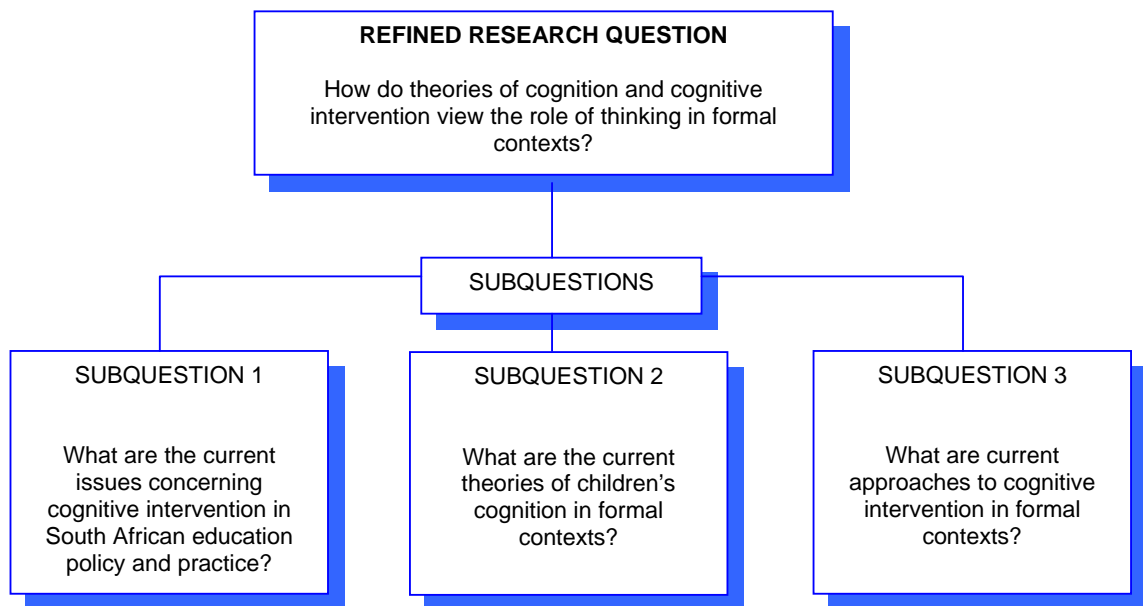
The process of reflecting the emergent nature of the research will be continued in the current chapter. As the research is summarised, conclusions that were drawn throughout the study will be revisited, selected findings will be presented and where necessary, limitations will also be addressed. Finally, 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.
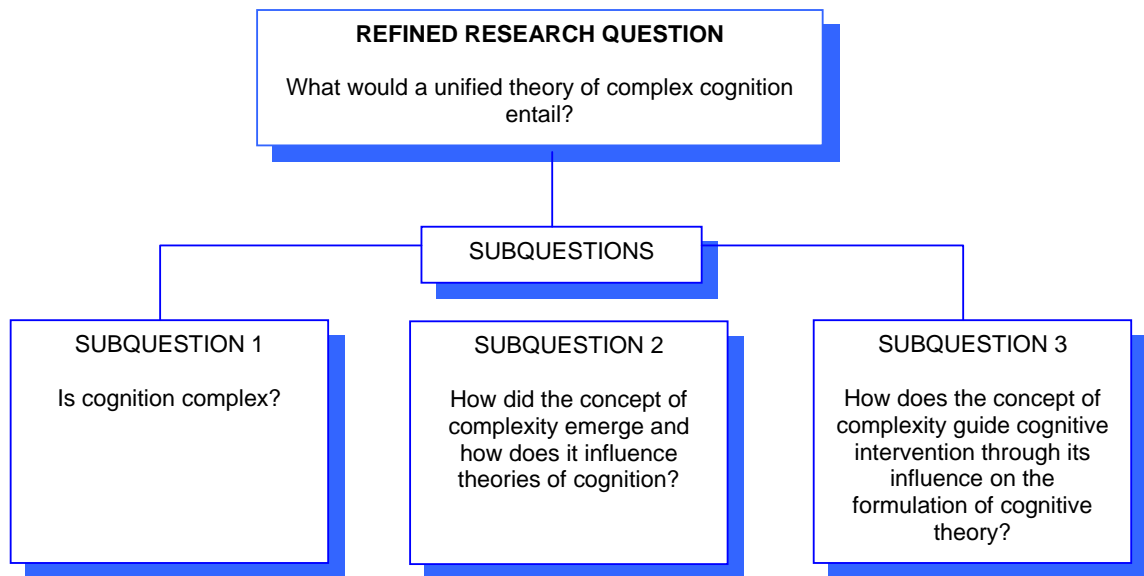
In *Chapter One*, the research question was formulated as follows:

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│          REFINED RESEARCH QUESTION        │
│                                           │
│   How do theories of cognition and        │
│   cognitive intervention view the role    │
│   of thinking in formal contexts?         │
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           ┌─────────────────────┐
           │    SUBQUESTIONS      │
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SUBQUESTION 1	SUBQUESTION 2	SUBQUESTION 3
What are the current issues concerning cognitive intervention in South African education policy and practice?	What are the current theories of children's cognition in formal contexts?	What are current approaches to cognitive intervention in formal contexts?

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.*

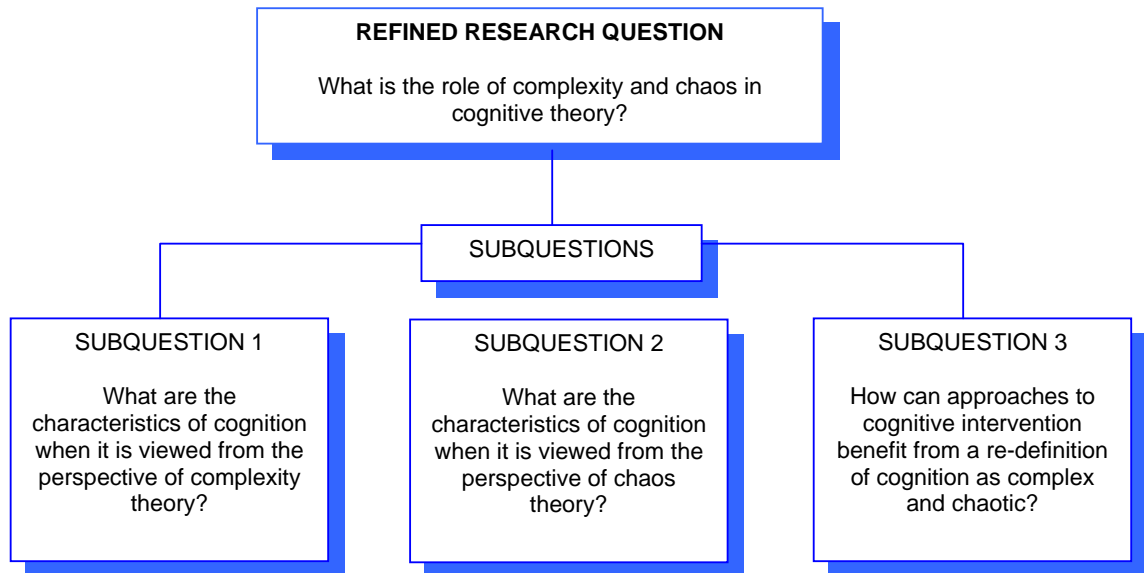In *Chapter Two* the research question was formulated as follows:

REFINED RESEARCH QUESTION

What would a unified theory of complex cognition entail?

SUBQUESTIONS

SUBQUESTION 1	SUBQUESTION 2	SUBQUESTION 3
Is cognition complex?	How did the concept of complexity emerge and how does it influence theories of cognition?	How does the concept of complexity guide cognitive intervention through its influence on the formulation of cognitive theory?

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

the complexity inherent in cognition, an observation which led to the formulation of the research question that was addressed in *Chapter Three*.
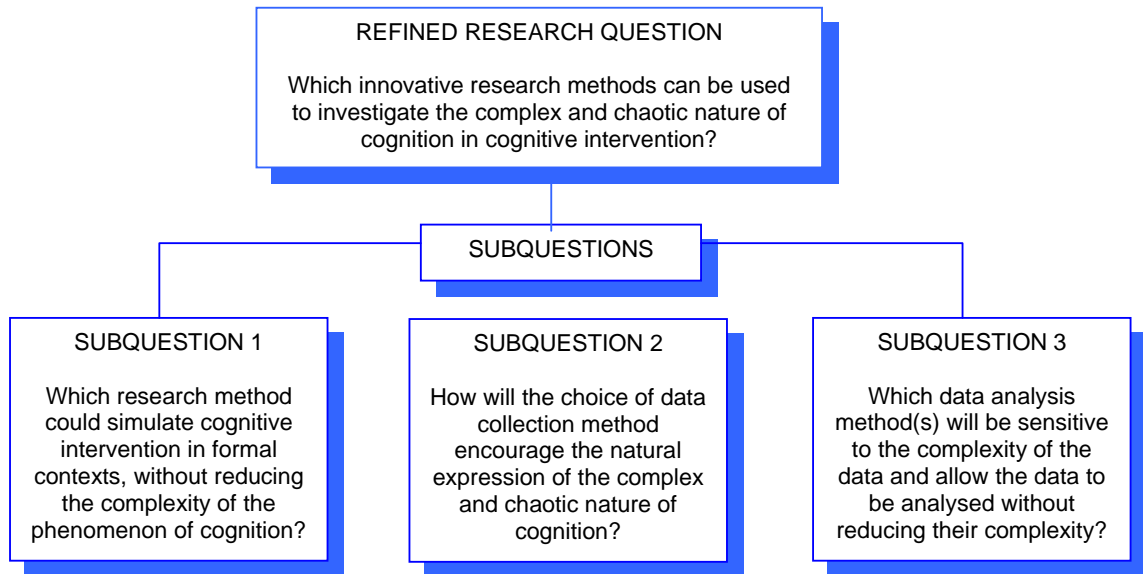
In *Chapter Three* the research question was formulated as follows:

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┌─────────────────────────────────────────┐
│       REFINED RESEARCH QUESTION          │
│                                          │
│   What is the role of complexity and     │
│      chaos in cognitive theory?          │
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           ┌─────────────────────┐
           │    SUBQUESTIONS      │
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      │              │                │
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│ SUBQUESTION 1│ │ SUBQUESTION 2│ │ SUBQUESTION 3│
│              │ │              │ │              │
│ What are the │ │ What are the │ │ How can      │
│ characterist-│ │ characterist-│ │ approaches to│
│ ics of       │ │ ics of       │ │ cognitive    │
│ cognition    │ │ cognition    │ │ intervention │
│ when it is   │ │ when it is   │ │ benefit from │
│ viewed from  │ │ viewed from  │ │ a re-        │
│ the          │ │ the          │ │ definition   │
│ perspective  │ │ perspective  │ │ of cognition │
│ of complexity│ │ of chaos     │ │ as complex   │
│ theory?      │ │ theory?      │ │ and chaotic? │
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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.*

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	SUBQUESTION 2	SUBQUESTION 3
Which research method could simulate cognitive intervention in formal contexts, without reducing the complexity of the phenomenon of cognition?	How will the choice of data collection method encourage the natural expression of the complex and chaotic nature of cognition?	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).

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:
o Guidance in the way learners execute tasks
o Closed questions
o Attempts to engage learners in group discussions
o Modelling or requiring learners to explore tasks systematically
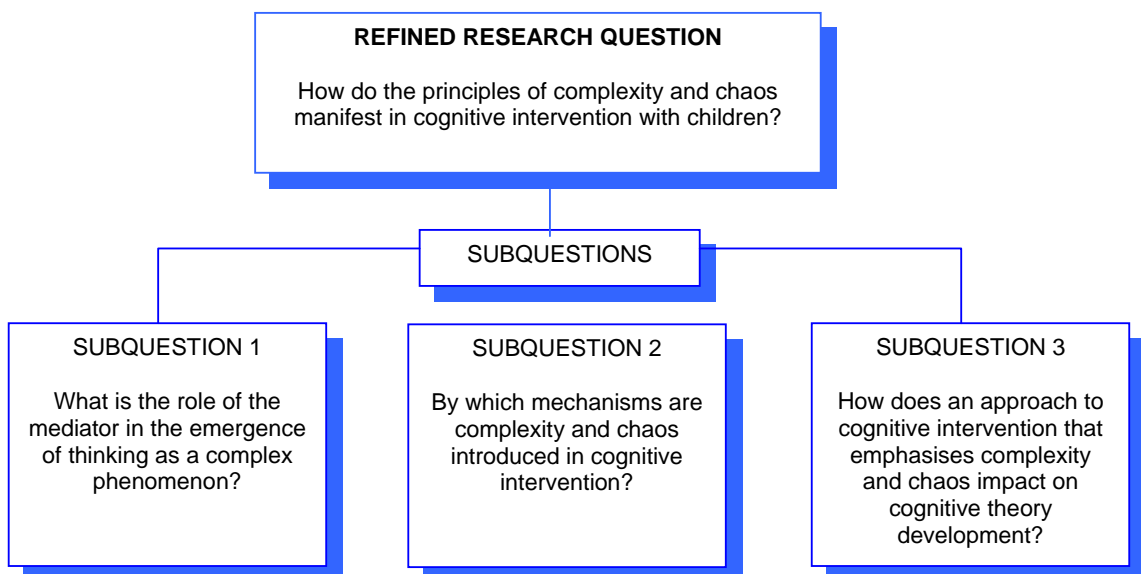o Positive interactions such as acknowledging responses or praising learners

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:

REFINED RESEARCH QUESTION

How do the principles of complexity and chaos manifest in cognitive intervention with children?

SUBQUESTIONS

SUBQUESTION 1	SUBQUESTION 2	SUBQUESTION 3
What is the role of the mediator in the emergence of thinking as a complex phenomenon?	By which mechanisms are complexity and chaos introduced in cognitive intervention?	How does an approach to cognitive intervention that emphasises complexity and chaos impact on cognitive theory development?

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.

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

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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

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.