Pedagogic scaffolding practices of primary mathematics teachers

By

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature:____Date:______________________

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ABSTRACT

This study describes the pedagogical scaffolding practices of nine primary school teachers in 18 lessons in the foundation phase. These teachers were participants in an in-service training and research project called the Count One Count All project in South Africa.

On the basis of a critical review of relevant literature, the study proposes a definition of complex scaffolding pedagogy that differentiates between discrete scaffolding strategies and this complex scaffolding pedagogy. Complex scaffolding connects three sets of scaffolding strategies: those that orient pedagogy to a concept, those that 'open up' the concept through interactions between teacher and learners and those that structure learner activities to enable learners to internalise concepts. The notion of complex scaffolding recognises the interdependence between these categories of discrete scaffolding strategies within a lesson.

The analytical framework developed for this study generates 52 potential combinations of the three categories of scaffolding strategies. This is achieved by considering variations of these sets of scaffolding strategies that could possibly occur during a lesson. These variations do not constitute scaffolding and rather denote the absence of a specific scaffolding strategy. The combinations then represented either complex scaffolding or combinations of some of the scaffolding strategies. The analysis locates and describes the lessons in relation to these 52 potential scaffolding combinations.

The analysis indicates that the 18 lessons examined by this study, represent 13 types of scaffolding combinations. Only one lesson in the data constitutes complex scaffolding. The 13 types of lesson combinations highlight a lack of pedagogical practices that orient learners toward the concept and enable them to internalise concepts during the learner uptake part of the lesson. Even though the analysis indicates a presence of scaffolding strategies that open up the concept, the type of strategies utilised during the lessons, draws attention to the passive manner in which

learners engage with the concepts. The study concludes that in general teachers used a very limited range of discrete scaffolding strategies. In the context of the lesson as a whole, these discrete strategies were not combined to constitute a general complex scaffolding approach.

The development of a definition for scaffolding and a framework that describes scaffolding practices in the classroom, are the main contributions of this study. This study encompasses more than an analysis of scaffolding in terms of discrete strategies; it describes the combination of scaffolding strategies as they were utilised during the 18 classroom lessons. Even though the data set chosen for this study indicated a lack of complex scaffolding strategies, the framework was useful to describe those scaffolding practices that were present during the lessons.

CHAPTER 1: INTRODUCTION

This study examines the pedagogical scaffolding practices of a selected group of teachers in South Africa. At the outset, I establish the rationale for this study by referring to the crisis that classroom teaching in South Africa is currently facing and the response of some stakeholders to this crisis. This contextualisation is necessary to fully understand the relationship between the pedagogical practices of teachers and the crisis within which they teach. Arising from this discussion is a description of the purposes and pertinent research questions of this study, as well as a brief discussion on the significance of this research. To conclude this chapter, the various components of the study are briefly outlined.

CLASSROOM TEACHING IN CRISIS

The tumultuous history of South Africa's apartheid policies is well known as well as the detrimental effect they have had on education (Johnson, Monk & Hodges, 2000:179–180). After 14 years of reconstruction, South Africa is still struggling to overcome the legacy of the past. One of the manifestations of this legacy is the presence of two educational 'systems' that currently exist in South African education. According to Brahm Fleisch (2008:2), one system is well resourced and produces the majority of university entrants and graduates. The other system represents the majority of children in South Africa, namely poor and middle class learners who struggle to read, write and perform numeric operations at school (Fleisch, 2008:2).

The effect of the existence of these two educational systems has been to differentiate the performance of learners.

> While a small minority of primary school children attending privileged schools are achieving at curriculum benchmarked 'grade level', which is comparable to countries such as Germany and the United States, the vast majority of children attending disadvantaged schools do not acquire a basic level of mastery in reading, writing and mathematics (Fleisch, 2008:30).

Owing to this gap in achievement, stakeholders in education have turned their attention and resources towards the disadvantaged educational sector. In a bid to understand this disparity, they consider the context of the system, the causes of prevalent learner underachievement, how teaching takes place in the system and other related issues.

The data from this current study originates from schools which operate within this disadvantaged system and grapple with the difficulties particular to this context.

Over the last two decades data has been collected by various agencies ranging from the South African government to international initiatives concerned with quality education. These international, nation-wide and local school-improvement initiatives were undertaken to describe learner performance and the classroom practices of teachers. These initiatives and findings lay a foundation for discourse around the crisis that South African education is currently facing, and cannot be distanced from the influence of content and pedagogical knowledge, and the effect of the curriculum changes on the classroom.

Learner performance in crisis

From 2001, the National Department of Education embarked on systemic evaluations of Grade 6 and Grade 3 learners. The purpose of these evaluations was "to measure the extent to which the education system achieves set social, economic and transformational goals" (South Africa, Department of Education, 2003:2). These evaluations provided information regarding learner performance and the context in which teaching and learning took place.

The Grade 6 evaluation assessed 1 677 learners in 2004, and 679 learners in 2005 according to their achievement of the five learning outcomes of the National Curriculum Statement. The results indicated that in numeracy, 70% of the learners performed at a 'not achieved' level in 2004 and that an even higher percentage of learners (82%) did not achieve the mathematical learning outcomes set for the Intermediate Phase in 2005. Between 30% and 50% of learners could also not achieve the outcomes for Natural Sciences and Literacy (South Africa, Department of Education, 2005:3).

The national Grade 3 systemic evaluations in 2001 and 2007 indicated the same dismal findings. These evaluations included a far greater sample of learners than the Grade 6 systemic evaluations, as 5% of all Grade 3 learners from all the districts or regions in the country were tested (South Africa, Department of Education, 2003:9), thus making these findings more representative. The systemic evaluations indicated that in 2001 the numeracy mean score was 30%. This increased to 35% in 2007. The literacy score also improved from 30% to 36%. Although an improvement in scores was achieved, the general level of performance in numeracy and literacy was poor (Pandor, 2008a).

Systemic research studies done in 2002, 2004 and 2006 by the Western Cape Educational Department (WCED) indicated the same trend of poor learner performance. According to the 2006 study, more than 60% of Grade 3 learners were performing below the expected level for literacy and numeracy in Grade 3, and "the vast majority of learners in Grade 3 were performing two to three years below expectation" (WCED, 2006:2). The study also indicated that between 2002 and 2006 the numeracy level dropped from 36.6% in 2002 (and 37.3% in 2004) to 32% in 2006. However, there was a consistent, yet small increase in literacy scores over those years (WCED, 2005; WCED, 2007). According to the WCED the classroom practices of teachers was one of the reasons for these poor results (WCED, 2006:2).

Over the last decade, three prominent international studies to test learner performance were administered in South African schools, namely the *Trends in Mathematics and Science Studies* (TIMSS), *Monitoring Learner Assessment (*MLA) and SACMEQ II. Although concerns were raised regarding the validity and reliability of these tests (Taylor, Muller & Vinjevold, 2003:35), the results still create a consistent picture of learner performance in South Africa.

The TIMMS research report in 1999 (which included 38 countries) and in 2003 (which included 45 countries) indicated that South Africa's eighth grade students had the lowest mathematical scores of all the nations tested. In both cases, the mathematics scores were nearly half the international average (TIMMS, 2000; TIMMS, 2004).

The MLA study was conducted in 1999. As part of UNESCO/UNICEF's 'Education For All' campaign, the MLA compared South African numeracy, literacy and life skills scores with those of 11 other African countries, including Zambia, Madagascar and Senegal. More than 10 000 Grade 4 learners in South Africa participated. The results indicated that South African learners scored an average of 30% for numeracy tests. This was the lowest score for all the participating African countries (of which Tunisia had the highest score of 60.4%). The literacy (48.1%) and life skills (47.1%) scores were also low in comparison with the other participating countries (Fleisch, 2008:10-12).

In 14 Southern and Eastern African countries, *SACMEQ II* placed South Africa's Grade 6 learners ninth in both reading and mathematics. *SACMEQ II* concurs with TIMSS, the MLA report and the national Grade 3 and 6 systemic evaluations, by demonstrating that the learners in the South African sample performed better in reading than in mathematics. The scores of learners from the Western Cape and Gauteng were the highest (Moloi & Strauss, 2005:11-109). The reading scores indicated that of the eight levels of reading, the modal competence of South African children is at basic reading level three. In mathematics, the learners were only able to achieve an emergent level of numeracy, namely a level two competency out of a possible eight (Moloi & Strauss, 2005:179-181).

The TIMMS report, MLA and SACMEQ II unambiguously indicated that South African learners perform poorly when compared to other impoverished nations in Africa, and extremely poorly when compared to first world countries. According to Taylor, Fleisch and Schindler (2008:39) the results of especially the TIMMS were not a true reflection of the state of education since nearly a 100% of children in South Africa are enrolled in primary education, whilst in other African countries it is mainly the elite who have this privilege. An alignment between the quality of teaching and the enrollment ratios of countries participating in the TIMMS 1999, indicated that most countries had a balance between access to school and quality of education. South Africa did not have this balance, but rather indicated high access and low quality (Taylor, Fleisch & Schindler, 2008:40).

The studies discussed so far indicate that South African learners performed poorly in both literacy and numeracy, especially when compared against international benchmarks. These results are especially prevalent in the disadvantaged education system of South Africa. According to Brahm Fleisch (2008) the poor achievement levels of learners are the reason why education in South Africa is in crisis. This presents a significant challenge to teachers, since learners do not necessarily perform at grade level. Teachers in South Africa need specific skills and knowledge to overcome this crisis.

Factors affecting poor learner performance

The poor performance of learners in especially literacy and numeracy has sparked discussion regarding the causes of these poor results. The literature arising from this discussion, points towards, amongst other causes, the teachers' *subject matter content knowledge* and *pedagogical content knowledge*, (Shulman, 1986:9-10), the use of time and the influence of curriculum changes.

A teacher's *subject matter content knowledge* refers to a teacher's knowledge of a specific subject area, the ability to move beyond concepts and to understand the underlying structures of the subject domain (Shulman, 1986:9-10). In South Africa, no large scale studies have been done to measure the extent of teachers' subject matter content knowledge. A recent opportunity provided by SACMEQ II to conduct such a study was unfortunately not utilised as teachers refused to participate. Most studies related to teacher content knowledge, conducted their analysis using small samples of data, as can be seen in the following studies.

Carol Bertram (2006) studied the reading competence of 153 teachers that were registered for an honours degree at the University of KwaZulu-Natal. The study found that more than a third of the teachers read an academic paper at a frustration level, meaning that the text is too difficult to cope with even when assistance was offered (Bertram, 2006:9-12). Brahm Fleisch comments on this study as follows:

> If a substantial portion of teachers enrolled in an honours level programme are not proficient or fluent readers, that is, struggled to read to learn, we may well assume that many teachers with lower qualifications are similarly reading at a frustration level (Fleisch, 2008:123).

The President's Education Initiative (PEI) (Taylor & Vinjevold, 1999:143) commented as follows on teacher content knowledge:

> One of the most consistent findings of a number of the PEI projects pointed to teachers' low levels of conceptual knowledge, their poor grasp of their subjects and the range of errors made in the content and concepts presented in their lessons (Taylor & Vinjevold, 1999:139).

These results were also confirmed by studies from the *Khanyisa* project. This project found that most of the Grade 3 teachers in their study could answer less than 50% of a Grade 6 reading test correctly (Taylor, Fleisch & Shindler, 2008:49).

These studies, of course, cannot be generalized to indicate that all teachers in South Africa have a poor content knowledge. A significant conclusion of all these studies is that more should be done to improve teachers' content knowledge. When teachers do not adequately understand the concepts that they are teaching, then learners are misinformed about content knowledge. This then negatively affects the learners' understanding and their consequent performance in tasks related to the concept.

Pedagogical content knowledge refers to the ways in which subject knowledge can be represented and framed so that it is understandable to learners (Shulman, 1986:9-10). Wagner, Speer and Rossa (2007:249) also define this as the knowledge that teachers have about teaching and learning. In the late 1990s, a series of studies was undertaken under the name of the PEI to examine the quality of education in South Africa (Diphofa, 1999:3) whilst Curriculum 2005 was being implemented. The results of these studies suggested that the following practices regularly occurred in the classroom: dominant teacher-talk was accompanied by low-level questions; lessons lacked structure; limited activities to enhance higher order thinking skills; superficial use of real world examples; and few observable interactions between learners (Taylor & Vinjevold, 1999:143). PEI reported that Reeves and Long's study on mathematics teaching and learning in Grade 4 concluded that the teachers in their study used low level tasks pitched towards the weakest learners and that teachers had low expectations of learners (Reeves & Long, 1999:323-324). Another PEI study undertaken by Pile and Smyth indicated a disparity between teachers' perceived ideas of how children learn and the actual practices they pursue during the lesson. They drew the conclusion that what teachers say they do in the classroom, differs from what they actually do in the classroom (Pile & Smyth, 1999:314-317).

An interesting observation can be made when the PEI findings (Taylor and Vinjevold, 1999) are compared with the SACMEQ II report (Moloi & Strauss, 2005:109,115). According to the SACMEQ II report, an overwhelming majority of mathematics educators used *everyday* *problems* to teach mathematics, in addition, strategies like *explaining mathematical processes* and *giving positive feedback* were employed. A small number of teachers (21,7%) taught learners individually. SACMEQ II delivered the following comment:

> On the whole, it was heartening to observe that Grade 6 educators most frequently used teaching strategies that, if used properly and in keeping with a learner-centred and activity-based pedagogy, had the potential to promote effective learning (Moloi & Strauss, 2005:115).

According to the PEI report, though, teachers use real world examples superficially and the use of this strategy will therefore not necessarily promote effective teaching.

Taylor, Muller and Vinjevold (2003:89) conducted a study of 20 schools in Siyathuthuka and Phalaborwa, and produced similar findings to the PEI report. They reported a lack of learner interaction and activities to develop higher cognitive thinking skills. In addition, the following prevalent pedagogic actions in classrooms, of which only one was positive, were indicated:

- Although learners in the classroom are organized in smaller groups, the teachers' top-down teaching style did not allow dynamic group work to take place.
- Evidence of pupil initiative and learner interaction is largely missing in the classroom lessons.
- Teachers pay little attention to planning at the macro or micro (daily lesson planning) level.
- Teachers neglected to monitor their progress in covering all aspects of the curriculum.
- Daily learning activities are paced to ensure that the learners stay on track.
- There is an insufficient focus on making conceptual principles explicit.

Studies that are linked to small scale interventions, though, report positive shifts in teachers' pedagogic content knowledge. Two examples are the UNIVEMALASHI project in the Limpopo Province and the READ programme in the Eastern Cape. The UNIVEMALASHI teacher training project is aimed at teachers in the Foundation Phase. As a result of this project, teachers worked more closely with pupils, questioning techniques improved and investigations were employed as a teaching strategy in the classroom (Onwu & Mogari, 2004: 170). The whole-school teacher training programme called READ focuses primarily on

English language development in the Eastern Cape. This programme reported results such as increased methodological consistency amongst teachers, increased evidence of teacher-made materials and improved use of group and project work in the classroom (Schollar, 2001:211-212). However, the depth of effectiveness of the above mentioned inputs can only be determined over time.

From these studies it is clear that, like subject matter content knowledge, much work still needs to be done to improve teachers' pedagogic content knowledge. Taylor, Muller & Vinjevold (2003:104) indicates that there might be an alignment between 'classroom-level factors' and learner performance. Stevens (1997:4) agrees and states that "what teachers do in their classrooms when they are teaching students" has an influence on students' academic performance. Teachers' pedagogic content knowledge thus contributes to the crisis in classroom teaching. Training programmes, though, can influence and shift this knowledge significantly. More longitudinal studies in this regard need to be conducted in South African schools.

The crisis in education is endemic in classrooms where *time* is mismanaged. The National Grade 3 systemic evaluation (South Africa, Department of Education, 2003:53-54) in 2001 and the SACMEQ II report (Moloi & Strauss, 2005:109) indicated that teachers misuse their allocated teaching times. The systemic evaluation reported that only one-third of the Grade 3 teachers in the study started their lessons on time and that teaching periods were not used for teaching purposes. The SACMEQ II report indicated that on average, the Grade 6 teachers in the study taught less than the official time of 26 hours and 30 minutes per week. Furthermore, the study also reported a high occurrence of teacher absenteeism. Hoadley's study (2003:265-274) indicated similar findings. This study found that in two contrasting Grade 3 classrooms, the children from the disadvantaged school only had three-and-a-half hours of instruction time. This compared to six hours and 15 minutes in a middle-class school. Children in the former school spent much time waiting for teaching to begin.

As a final point, when little instruction takes place, fewer opportunities are provided for learning. The ineffective use of time in the classroom therefore contributes to the crisis in the classroom.

Education in South Africa has undergone various reforms since 1994 of which *curriculum reform* is certainly predominant. Curriculum 2005 (C2005) was developed and implemented from 1994 as a response to the newly established democracy in South Africa. This curriculum introduced an outcomes-based philosophy to education "based on the principle of providing equal opportunities for all children to develop the knowledge best suited to building a peaceful and prosperous society" (Taylor & Vinjevold, 1999:16).

According to Chisholm (2003:272), the intention of the new curriculum was to establish effective teaching strategies in the classroom in two particular ways: firstly, to shift the focus of teaching towards the processes of learning which generates learner participation in the classroom. Secondly, the aim was to facilitate learning in the classroom according to the pace and interest of the learners (Chisholm, 2003:272).

The interpretation and implementation of C2005, however, proved difficult (Chisholm, 2003:272). Teachers were unfamiliar with the complex terminologies and concepts used by the curriculum. Teacher training (or the lack thereof) of the new curriculum also progressed in a hasty manner and teachers were given insufficient time to adapt to the vast ideological and methodological shifts implied by C2005. Teachers therefore found it difficult to interpret the curriculum.

To implement the curriculum, teachers needed skills to develop learning programmes, to assess and to teach effectively. Knowledge and understanding regarding the concepts of specific subject areas were also necessary. A lack of training in these skills and deficient subject knowledge made the execution of C2005 difficult.

By 1999 research findings were mounting that:

> South Africa's learner achievement remained poor despite curriculum changes … Muller and Taylor linked poor educational results to approaches advocated through C2005, which emphasised process and everyday knowledge at the expense of conceptual and content knowledge (Chisholm, 2003:274-276).

Mashwahle Diphofa, Penny Vinjevold and Nick Taylor made the following statement:

> There are important practical questions which query whether Curriculum 2005, as presently constructed, will provide the best vehicle for achieving these aims (building a peaceful and prosperous society) in the majority of South African schools (Taylor & Vinjevold, 1999:16).

Since learner performance remained poor, it is also doubtful that C2005 caused significant changes to classroom practices.

Owing to mounting criticism of C2005, Kader Asmal, then the Minister of Education, established a controversial *C2005 Review Committee* in 2000 to develop a revised *National Curriculum Statement* (RNCS). The curriculum was based on the same outcomes-based principles as C2005. One of the significant differences between C2005 and the RNCS is the addition of specific requirements (assessment standards guided by skills, knowledge, attitude and values) for the teaching of various Learning Areas in the RNCS. This brought a renewed emphasis on subject knowledge into the sphere of classroom teaching.

Reforming the national curriculum twice in a decade brought about much uncertainty amongst teachers. Teachers were debating the value of 'old ways of teaching' and were not necessarily convinced that the practices promoted by the new curriculum would be effective in South African classrooms. Teachers were also unfamiliar with the new philosophy of teaching and how to practically implement it in daily teaching. As a result, teachers seemed to resist the changes. However, longitudinal studies are still needed to empirically verify the impact of the new curriculum on the classroom.

What are the responses to this crisis in education?

A speech delivered by the Deputy Minister of Education at the Torch of Peace Handover in Limpopo (Gaum, 2009:1) indicated that the National Department of Education is committed to improving teaching and learning in South Africa. Literacy and numeracy in the primary schools were also prioritized as the platform from which to develop quality education for all learners in South Africa.

On 11th of August 2008, the African National Congress indicated its support for quality education by stating that health and education will be at the centre of the government's social transformation programme for the next five years. A 'Code for Quality Education' campaign was also launched at that same meeting. This code comprises various commitments that the departmental official, the teacher, the learner and the community will be called upon to make. This campaign would be spearheaded by various stakeholders in 2009.

Besides stating a commitment to quality education, the Department of Education also implemented various actions to facilitate change. These include (Pandor, 2008a; Pandor, 2008b):

- systemic evaluations of learner performance;
- creating opportunities to address challenges in education in partnership with key stakeholders;
- the implementation of programmes for various purposes, for examples the *Foundations for Learning campaign* that focuses on improving the reading, writing and numeracy abilities of South African children, the *National Strategy for Mathematics, Science and Technology Education* (NSMSTE) and the *Adopt-A-School project;*
- school improvement initiatives, for example, the *Education Action Zone programme* of the Gauteng Department of Education;
- supporting and encouraging conferences where teachers can share their practices (for example the Foundation Phase Conference).

According to Naledi Pandor (2008a:5), the Department of Education:

> recognize(s) that we still have a long way to go, and also that we must have the support of other role-players in the sector if we are to make more significant inroads into the challenges we face.

Examples of these stakeholders that also play a role in education in South Africa are:

- the financial sector that provides funding for various projects;
- academic institutions like the *Institute of Mathematics and Science Teaching at the University of Stellenbosch* and non-governmental organizations like the *Primary Science Programme* in the Western Cape that manage various school improvement programmes;
- independent associations like *Education Africa* that addresses accessibility to quality education;
- businesses that develop and sell various teaching products.

Some of these stakeholders deal directly with the teacher and the current crisis in the classroom by providing comprehensive in-service training and development at no charge. "There is a general agreement that, without an explicit focus on schools and classrooms, improved learning is very difficult if not impossible to achieve" (Taylor, Muller & Vinjevold, 2003:5).

Evidence-informed conversations between the various stakeholders in education need to formulate a response to the crisis reflected in current research. Brahm Fleisch (2008:145) indicates that education research communities are needed that can produce descriptive findings based on small-scale research studies and even case studies, which can inform policy change. This current study was developed as a response to the crisis in the classroom and to contribute to the education research communities mentioned by Brahm Fleisch.

The response to the crisis in education has been significant and encompasses far more than can be detailed in this study. Change, though, is an arduous process and the road to reconstruct education in South Africa is both challenging and complex.

THE PURPOSE OF THIS STUDY

Strategies that have been employed in an effort to address the shortcomings of pedagogical content knowledge include teaching concepts with representations like manipulatives (Rasmussen & Marrongelle, 2006; Schorr, Firestone & Monfils, 2001), the use of tasks for problem solving (Van den Heuvel Panhuizen, 2001; Doerr, 2006), scaffolding and the use of sociomathematical norms like encouraging learners to find their own solutions to problems (Pang, 2003). Scaffolding stands out as an all encompassing method of transference which can impact on the quality of teaching in this crisis in education. Scaffolding refers to the verbal and non-verbal actions of the teacher in the classroom that assist the learner to acquire the concept that was taught. This is evident when the learner can perform a related task which he initially could not do on his own. Since the pedagogic practices of teachers influence poor learner performance, this study can produce findings that can contribute to current evidence-informed conversations as alluded to by Brahm Fleisch (2008:145).

This study is undertaken to expand the current description of the concept of scaffolding (as it is applied to the classroom) to include the notion that teaching is focused on the concepts that are prescribed by the subject. These concepts should be taught in such a way that learners can acquire them. Furthermore, this study also describes specific scaffolding strategies that are employed by teachers to engage learners. An analytical framework is developed that generates descriptions of the ways in which these scaffolding strategies work together to describe the pedagogical actions of teachers. In this study, this framework is utilised to analyse how a selected group of teachers that work in disadvantaged schools, engage their learners with numeracy concepts. The analysis describes pedagogic practices of these teachers and indicates the extent to which scaffolding takes place during their lessons.

There are three specific purposes for this study:

Purpose 1: To produce a definition of scaffolding that recognizes the interdependence of discrete scaffolding strategies in relation to orienting learners to concepts, opening up new concepts and structuring learner activities that enable learners to internalize these concepts.

Purpose 2: To examine the pedagogic practices evident in selected foundation phase mathematics lessons in order to identify those interactions that can be described as scaffolding.

Purpose 3: To describe lessons in relation to combinations of scaffolding strategies, in order to generate more general descriptions of pedagogic scaffolding practice.

Related to these purposes, this study then aims to answer the following research questions:

Question 1: What scaffolding strategies are evident in selected foundation phase Mathematics lessons?

Question 2: What are the scaffolding features of these lessons in relation to combinations of scaffolding strategies that orient learners to concepts, open up these concepts and structure activities in which learners can work with these concepts?

This study is does not examine the scaffolding practices of teachers only in terms of discrete scaffolding strategies. Instead it recognizes the interdependence between these strategies and examines how these strategies work together to constitute scaffolding during a lesson. Furthermore, due to the way in which this study relates scaffolding to the teaching of concepts, this study also provides a descriptive language to describe how teachers engage learners with concepts.

THE CONTEXT FOR THIS STUDY

The main data texts for this study were transcripts of eighteen classroom lessons that had been videoed by the Count One Count All (COCA) project. As will be explained more fully later in this dissertation, this project provided developmental support for a group of teachers from the West Coast Winelands district of the Western Cape Education Department. The lessons had been planned and taught by the teachers in 2004 and 2006. The COCA project had provided a lesson plan format that guided teachers in the planning of the 2006 lessons.

While these lesson texts did form part of the data for both the COCA study and this study, the analysis for this project was separate and independent from the analysis for the COCA project.

OUTLINE OF THE STUDY

The premise on which this study rests is that education is in crisis as evident in the poor performance of learners in national and international tests. The quality of pedagogic practice is a key contributory factor and scaffolding is a component of good pedagogic practice. This first chapter describes the rationale for this specific study and introduces its purpose and pertinent research questions.

Chapter 2 reviews literature that discusses the concept of scaffolding by referring to the two contexts in which this concept has emerged, namely, the context of tutor interactions with a child (or mother/child interactions) and the context of teacher interactions with learners in the classroom. The influences of the notion of a *zone of proximal development* and the notion of *mediation,* and their relation to the concept of scaffolding, are discussed. Finally the operationalisation of scaffolding in the classroom is reviewed.

In the third chapter, the analytic framework for this study is presented and developed, based on a critical evaluation of relevant literature. The chapter describes three key features of scaffolding, based on the notion that scaffolding is focused on the teaching of concepts, and presents a definition of scaffolding. These scaffolding features are then further developed to indicate how they are empirically evident in the classroom. Lastly, a framework is presented that combines these key features of scaffolding to generate a more complex notion of scaffolding as a basis for describing the pedagogical scaffolding practices of teachers.

Chapter 4 addresses the research design of the study by describing how this study was designed, the type of data collected for this study and how this data was analysed. Relevant validity issues and the limitations of the study are also highlighted.

In Chapter 5 several case studies are presented. These case studies indicate how classroom lessons were analysed according to the analytical framework of this study. The trends that were observed regarding the classroom practices of teachers are further discussed.

The last chapter provides an overview of this dissertation and draws conclusions from the study.

CHAPTER 2: LITERATURE REVIEW

In the previous chapter it was noted that scaffolding refers to the interactions between the teacher and the learner in the classroom. The classroom, though, has not been the only context for studying the concept of scaffolding. Over the last three decades, scaffolding studies have investigated the adult's function in mother-child, tutor-child and teacher-learner interactions in various contexts of learning and development. As the concept of scaffolding has transversed many borders over the years, various meanings and usages for the metaphor have emerged. It is especially in the context of teaching and learning in the classroom, that the concept of scaffolding has acquired numerous interpretations. It seems as though currently the rich conceptual features of scaffolding have been diluted by simply equating scaffolding to any type of teaching strategy or intervention.

This chapter reviews literature related to the concept of scaffolding in two ways. Firstly, the concept of scaffolding is discussed, based on its journey since 1976 from the context of parent/child or tutor/child interactions to the context of teacher/learner interactions. This is followed by a discussion of how scaffolding has been operationalised in the classroom; that is how it can be observed in the classroom.

THE CONCEPT OF SCAFFOLDING

Scaffolding in the context of mother/child or tutor/child interactions

Origin of the term

The term scaffolding was first coined by David Wood, Jerry Bruner and Gail Ross in an article entitled *The role of tutoring in problem solving*, published in 1976. The term emerged from a study regarding the tutorial process between an "adult or expert (who) helps somebody who is less adult or less expert" (Wood, Bruner & Ross, 1976:89). Their study was situated in the context of interactions between a tutor and a child, and Wood, Bruner and Ross referred to the child as the tutee.

This initial study introduced five basic notions regarding the idea of tutoring, also called scaffolding. (Wood, Bruner and Ross, 1976:90-97). The first notion is that assisting learners to solve problems and acquire skills involves more than instances of modelling and imitation

(Wood, Bruner & Ross, 1976:90). It is a much more involved process comprising six strategies and functions. The six functions that Wood, Bruner and Ross identified will be discussed later in this review.

The second notion relates to Wood, Bruner and Ross's (1976:90) famous definition of scaffolding which states that scaffolding is a "*process that enables a child or novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts*" (Wood, Bruner & Ross, 1976:90). According to this definition scaffolding implies that the adult assists the child with a task (problem) that he cannot perform or solve on his own as the task/goal is beyond his current abilities. Once the assistance is removed, the child can perform the task, solve the problem or achieve the goal on his own. Wood, Bruner and Ross's definition is referenced in most literature to describe scaffolding. This definition also connects with the Vygotskian constructs of mediation and the zone of proximal development which will be briefly explored later in this chapter.

The process that enables the child to complete tasks beyond his initial ability is controlled by the adult. The adult focuses the child's concentration towards the parts of the task that he can perform and thus leads him to successfully complete those aspects of the task first. The measures of *adult control* introduce Wood, Bruner and Ross's (1976) third idea relating to scaffolding (Wood, Bruner & Ross, 1976:90).

Wood, Bruner and Ross emphasize that to merely perform a task is not the only goal of scaffolding. The fourth notion of scaffolding is thus, that to *understand the task and to acquire the knowledge to accomplish the task* (the specific steps that need to be taken) is crucial (Stone, 1998: 345; Wood, Bruner & Ross, 1976:90).

The fifth notion proposed is that "*comprehension of the solution must precede production*" (Wood, Bruner & Ross, 1976:90). A child firstly needs to recognize the solution to the problem (which requires the support of the tutor/expert) before he can produce the steps to solve the problem without assistance. When the child has made the connection between the means of how to solve the problem and the actual solution at the end, feedback regarding the end-result will be useful and the child can benefit from his own "knowledge of the results" (Wood, Bruner & Ross, 1976:90; Stone, 1998:345). Wood, Bruner and Ross (1976:90), did, however, acknowledge the role of discovery by accident (trial-and-error) during learning. This support of the tutor is required to lead the child to the objective. There is a parallel between this fifth notion and Bernstein's (1996) rules of recognition and realization, where individuals recognize the special features of the context or problem they have (recognition) and then construct the appropriate action (realization) to solve the problem (Bernstein, 1996:107).

Wood, Bruner and Ross's final conceptualization for the term scaffolding is that it is task and tutee dependent. Scaffolding is task dependent in two ways. Firstly, scaffolding cannot take place without a task or a problem that needs to be solved (where the learner also cannot perform the task without assistance). And secondly, the tutor needs to understand the task and know how to solve the problem or perform the task, before he can plan his assistance. In addition the assistance is influenced by the tutee's reaction to that assistance (hence it is tutee dependent). This assistance needs to be appropriate for the tutee at that specific point in the task mastery. In this way, according to Wood, Bruner and Ross (1976:97) "the requirements of the tutorial (are) being generated by the interaction of the tutor's two theories" (Wood, Bruner & Ross, 1976:97). These two theories also relate to Bernstein's (1996) idea of instructional and regulative discourse where the presentation of the knowledge taught (instructional discourse) is dominated by theory of learning (regulative discourse) (Bernstein, 1996:27-28).

The scaffolding study performed by Wood, Bruner and Ross (1976) involved three to five year old children putting together 21 interlocking blocks to form a pyramid with the help of a tutor. In this tutoring situation, the tutor knew how to build the pyramid and the child could not perform the task without assistance, since it required a "degree of skill from the child that was initially beyond them" (Wood, Bruner & Ross, 1976:89). The task of building the pyramid was designed to be entertaining and challenging, so that the learner was motivated to do the task and also compelled to change his behavior in order to complete the task. This activity, though, was not so difficult as to lie completely beyond the child's ability. The role of the tutor in this task was to plan instruction according to the needs of the individual child and also to allow the child to work on his own as much as was possible. Consequently verbal instructions were given before the tutor intervened directly and the level and direction of instruction were geared towards the failures or successes that occurred when the child worked on his own. The ultimate purpose of this study under discussion was to examine how children react to various forms of assistance and then to identify those tutor interactions that lead the child to acquire the skill and to solve the problem (Wood, Bruner & Ross, 1976:89-92).

The results of the study were significant. Firstly, it showed that the role of the tutor interactions change as the child develops their abilities to perform the task. Initially the child is dependent on the tutor's assistance. As the child's ability and confidence develops, this assistance is less important and finally becomes redundant. Secondly, there is a gap between the child's ability to *recognize* the relevance/use of a puzzle piece or series of actions required to build the toy and his ability to actually *produce* a series of actions necessary to build the toy. Thirdly, the study shows that effective instruction in this gap consists of setting goals that the child can recognize as appropriate to mastering the task. These goals, though, must still lie just beyond the child's performance so that he cannot reach them alone (Wood, Wood & Middleton, 1978:131-132). Wood, Bruner and Ross used the term scaffolding to describe the tutor's functions in the above gap between *recognizing* and *producing*.

To support the above study David Wood, Heather Wood and David Middleton (1978) did a similar study of a mother and her child (instead of a child and a tutor), using the same toy building activity. Their study confirmed two aspects of adult based instruction. Firstly, it was found that the "patterns of instruction per se do have causal influences on the child's range of learning" (Wood , Wood & Middleton, 1978:143). This means that the strategies employed by the adult can influence the quality of learning. Secondly, the nature of instruction is to present the child with problems of "controlled complexity" (Wood, Wood & Middleton 1978:143). This demands that the instructor (mother or tutor) initially increases her control in the learning situation until the child is successful. The same control is then decreased until the child can work independently.

To summarise, initially scaffolding was placed in the context of effective instruction between a mother/tutor and the child. The concept of scaffolding was designed to "explore the nature of the support that an adult provides in helping a child to learn how to perform a task that, alone, the child could not master" (Wood & Wood, 1996a:5). Lastly, Wood, Bruner and Ross (1976) also placed scaffolding in the hand of the tutor/mother who balances control until the child can perform independently.

At this juncture more studies in the context of mother/tutor and child interactions need to be discussed to highlight other or similar features implicit in the concept of scaffolding than those discussed above.

Other scaffolding studies in the context of mother/tutor and child interactions

According to Roy Pea (2004:425) scaffolding emerged during a time when psychologists were particularly interested in the language development of children and how they acquire meaning in parent-child interactions. Although not all these language studies related their work to the metaphor of scaffolding, their connection with the concept of scaffolding is evident.

These links can be found in the popular use of the term *formats* in these early studies. In this context, formats refer to "habitual exchanges that provide a basis for interpreting concretely the intent of the communications of a child and of the mother" (Bruner, 1975:265). An example of such a format is when the mother and child are playing the game peek-a-boo. The formats or habitual exchanges between the mother and child are signified by the mother who is continually covering and uncovering herself with a blanket and shouting peek-a-boo (Bruner, 1975:265). During these scaffolding interactions between the mother and the child, the child makes meaning of the parent's actions and the objects that they are playing with. This process also develops the child's use of language. Jerome Bruner (1978:254) explained this well with the following comment,

> I have used the expression scaffolding to characterize what the mother provides on her side of the dyad in one of the regularized formats – she reduces the degrees of freedom with which the child has to cope, concentrates his attention into a manageable domain, and provides models of the expected dialogue from which he can extract selectively what he needs for filling his role in discourse (Bruner, 1978:254).

Over the past three decades, scaffolding studies have also focused on the development of theory and empirical studies on adult-child interactions (Stone, 1988:345). An example of this was a parental scaffolding study done by Greenfield (1984) in southern Mexico. Greenfield studied how mothers taught their daughters to weave. The study confirmed Wood, Bruner and Ross's idea that during scaffolding the mother calibrates her assistance according to the child's need. The study also indicated that, as the child's experience develops, the mother uses fewer combinations of verbal and nonverbal modelling to guide the child. The mother rather uses verbal guiding more frequently (Greenfield, 1984:117-138).

The scaffolding studies discussed so far were based on one of two contexts:

- One-on-one learning situations between the mother and child as would occur naturally in the home (Greenfield, 1984:117-138)
- One-on-one learning situations between the tutor and a child in a research setting (Hodapp, Goldfield & Boyatzis, 1984:772-781)

In these contexts, the assistance is personal and geared towards one child. Scaffolds are adjusted according to the needs of the individual child and immediate feedback on the child's progress is also available. According to Bliss and Askew (1996:40) the focus is on:

> how the adults negotiate with children the goals of activities at home, or how children learn their mother tongue from their parents. In adult situations, people have been observed learning to weave, tailor, throw pots, ski, et cetera. In many of these situations the teaching strategies are not necessarily deliberately employed.

These features differentiate the abovementioned studies significantly from those related to the classroom. In the classroom the teacher does not only deal with one child, but rather a small group or a whole class of learners. The assistance and feedback is therefore not geared towards the individual child, but rather towards the collective 'child' that represents the whole group of learners. In the school context, scaffolding also refers to the acquisition of specialised school knowledge rather than everyday knowledge in the informal setting. Later in the chapter this transfer of the concept into the classroom will be discussed, as well as the changes that consequently occurred to the concept of scaffolding.

Since the concept of scaffolding emerged from the West and the concepts of the *zone of proximal development* and *mediation* originated from the East (more specifically Russia), these terms cannot simply be equated with one another. The theoretical connection between scaffolding and the Vygotskian notions of the *zone of proximal development* and *mediation* need to be discussed. This discussion encompasses the similarities and differences between these notions, as well as providing an indication as to how the concept of scaffolding was enriched by these theoretical notions.

Vygotskian influence on scaffolding

The zone of proximal development (ZPD)

Wood, Bruner and Ross's (1976) initial description of the term scaffolding was largely "atheoretical and pragmatic" (Puntambekar & Hubscher, 2005; Palincsar, 1998; Stone, 1998). Over the last three decades, though, as more scaffolding studies emerged, the concept has become associated with the Vygotksian construct of the zone of proximal development.

The term *zone of proximal development* is derived from Vygotsky's Russian term *Zona blizhaishego razvitiya* (literally translated as the *zone of closest or nearest development*) (Daniels, 2001:57-58). The ZPD proposes two developmental levels of psychological functioning, namely the actual development level and the potential development level (Hedegaard, 1996:172). The *actual development level* indicates the child's current individual functioning and the *potential development level* indicates the potential level at which the child can function as a result of social interaction (Vygotsky, 1978:85). According to Wertsch and Rogoff (1984:68) these two levels form the boundaries of the ZPD.

According to Vygotsky (1978:86) the ZPD:

> is the distance between the actual development 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." This distance defines psychological functions that are still maturing today, but might be fully developed tomorrow through the aid of a competent other (Vygotsky, 1978:86).

The link between scaffolding and the ZPD was not made explicit by Wood, Bruner and Ross's (1976) article that described the concept of scaffolding for the first time. Stone (1998:345) argues that three events influenced the conceptual link between scaffolding and the ZPD:

- In 1962 Jerome Bruner (part of the trio that initiated the term scaffolding) wrote the introduction to the first translation of Vygotsky's book *Thought and Language.* He was clearly aware of and possibly influenced by the notion of the ZPD when the term scaffolding was developed (Vygotsky, 1962).

- Cazden's (1979) paper, entitled *Peekaboo as an instructional model: discourse development at home and at school* explicitly linked the two concepts for the first time.
- Jerome Bruner (1986) and David Wood (1988) also explicitly acknowledged the link between scaffolding and the ZPD. According to Bruner (1997, quoted by Daniels, 2001:107), pedagogy and intersubjectivity (shared meaning between teacher and learner) meet in the ZPD. Pedagogy then works "through shielding a learner from distraction, by fore fronting crucial features of the problem, by sequencing the steps to understanding, by promoting negotiation, or by some other forms of 'scaffolding' the task at hand" (Bruner, 1997, quoted by Daniels, 2001:107).

Many scholars have accepted that the zone of proximal development is at the heart of scaffolding (Daniels, 2001; Maybin et al, 1992; Palincsar, 1998; Puntambekar & Hubscher, 2005; Stone, 1998; Wong, 1998). Scaffolding can either be viewed as the provision of assistance (instruction) in the ZPD (Puntambekar & Hubscher, 2005:2; Seng, 2000:5), which can be interpreted as scaffolding the learning task so that external knowledge can be internalised or be used to describe the specific structure and function of that instruction in the ZPD (Goos, 1993:2; Wood & Wood, 1996a:5). This instruction has the goal of enabling the child to perform a task or solve a problem that he could not do previously (Puntambekar & Hubscher, 2005:2). Palincar (1998) also extends the notion of scaffolded instruction to "reflect the learner's current understanding and activity in the ZPD". Scaffolding should take cognizance of the child's current state and intervention should be framed accordingly.

The way in which the ZPD underpins scaffolding, though, is a contentious issue in the literature. Reid (1998:388) suggests that scaffolding cannot be reduced to describing it as "*any* intervention that occurs within a learner's ZPD … (we) have drawn too close a parallel between scaffolding and operating within the ZPD." According to Reid (1998:388) scaffolding should rather be seen as one of many possibilities for instruction in the ZPD. He agrees though that through scaffolding a learner is enabled to perform tasks and to extend their upper ZPD level, thus indicating the important role of scaffolding in the ZPD.

I agree with Daniels (2001), Palincsar (1998) and Stone (1998) that scaffolding describes the nature of adult guidance or peer collaboration in the zone of proximal development. It is not my intention, however, to equate scaffolding with the ZPD or to claim that every action that occurs in the ZPD is necessarily scaffolding. My reasons for this are twofold. Firstly, actions in the ZPD can only be labeled as scaffolding once they have been assessed against the meaning of the concept, as is described later in this chapter. Secondly, the ZPD is also a very rich notion that refers to child development through teaching and learning, whereas scaffolding primarily refers to teaching. In essence, the theoretical notion of the ZPD incorporates much more than the concept of scaffolding.

It is my opinion that there are two reasons for the claim that the ZPD incorporates much more than scaffolding:

- During scaffolding the teacher interacts in the child's ZPD with the purpose of assisting the learner until he can solve the problem or perform the task on his own. The purpose of the ZPD is not only pedagogical. It aims to move the child onwards between various age-periods through the development of new formations. While transferring to a new age-period, the child is confronted with contradictions between his current capabilities, needs and desires and the demands of the environment (Chaiklin, 2003:39-64).
- Chaiklin's (2003:48-50) distinction between the *objective* and *subjective* ZPD further emphasises the richness of the ZPD. Scaffolding seems to play a greater role in the *subjective* part of the ZPD, specifically regarding the development of higher cognitive functions of the individual child and to move the child (with assistance) from his actual level of development to his potential level of development regarding specific scientific concepts and skills. The *objective* ZPD focuses on the generic psychological processes that are formed during each age-period. These psychological processes are not formed through scaffolding, but rather through other processes of development.

In this review I have identified three major links between the concepts of the ZPD and scaffolding. Firstly, earlier in this section it was mentioned that scaffolding was initially described in an atheoretical manner. Embedding the concept in a Vygotskian theoretical framework, though, can elaborate the concept theoretically. An example of this is to use the Vygotskian concepts of internalization and intersubjectivity to explain how scaffolding leads to understanding (Stone, 1998; Puntambekar & Hubscher, 2005). However, the concept of scaffolding is not well developed in relation to a theoretical framework in the literature. This is an aspect of scaffolding which needs further development.

Secondly, one of the features of the ZPD is that when a child starts to move from his actual developmental level towards his potential level, his cognitive systems are changed according to the type of interactions happening in the ZPD. These interactions are characterized by an asymmetry between the adult and the child, meaning that the teacher is more able than the child. The teacher then holds the responsibility to give the child access to that knowledge (Newman, Griffin and Gole, 1989:152-154). During scaffolding, the same asymmetrical relationship and responsibility exists.

Lastly, scaffolding plays a role in developing the learner's higher cognitive functions in the ZPD. Through adult/peer assistance the child progresses from his actual level of development to his potential level of performing skills and understanding scientific concepts. The scaffolding task should therefore be designed to move the learner forward into his potential development.

Mediation

Mediation is a Vygotskian concept that originated in Russia in the early 1900s and it explains the process of instruction in the ZPD. This term has been in use for many years. The term scaffolding only emerged in the West in 1976 and the concept seemed to share some of the same features as mediation.

During joint activity between the teacher and the learner, the adult or a capable peer teach psychological tools, for example language, to the child. These tools are then internalised to "function as mediators of the child's more advanced psychological processes" (Karpov & Haywood, 1998:27). This process of internalization transforms the child's mental functions (Karpov & Bransford, 1995:61). Vygotsky explains this process by means of his *general genetic law* whereby "every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level" (Vygotsky, 1978:57). Scaffolding also adheres to these two levels of the *general genetic law*. During scaffolding the subject concepts first appear socially during the joint activity between an adult and the child. These concepts are then internalized so that the child can independently perform a related task or solve a problem.

Unlike scaffolding, mediation is not only limited to the joint activity between people. According to Michael Cole (1996:119) the human being interacts with his environment by means of culturally available artefacts. These artefacts can include technical tools (which bring about changes in other objects), psychological tools (which influence the mind and behaviour) and other human beings (Daniel, 2001:15-17). Kozulin, (2003:18) agrees that mediation has two faces, namely human and symbolic, and that there is "an important distinction between experiences produced by the immediate contact of the individual with environmental stimuli and experiences shaped by interactions mediated by symbolic tools" (Kozulin, 2003:23).

Another distinction between scaffolding and mediation lies in what is being taught. Literature has equated scaffolding to parent/child interactions where skills, for example weaving, were taught (Greenfield, 1984). The first scaffolding study undertaken by Wood, Bruner and Ross (1976) also related to the skill of building a puzzle. Vygotsky, though, denied that technical skills can be mediated, since mediation rather develops higher cognitive functions (Vygotsky, 1978:134).

According to Karpov and Haywood (1998:27) cognitive mediation occurs when learners go to school and acquire scientific concepts. According to Karpov and Bransford (1995:62) scientific concepts "represent the essence of some class of phenomena that is fixed in science. These concepts must be acquired consciously and in a certain system". Once the scientific concept has been acquired, it becomes part of and changes the child's everyday knowledge (Hedegaard, 1996; Karpov, 2003). Scientific concepts are distinct from spontaneous concepts. Karpov describes spontaneous concepts as "the results of everyday experiences in the absence of systematic instruction" (Karpov, 2003:65).

According to Van der Veer and Valsiner concepts must be "introduced in a systematic and explicit fashion" to lead the child to independent mental operations (Van der Veer & Valsiner, 1991:277). Karpov and Haywood (1998:29) state, though, that if the child is to acquire knowledge that is meaningful, the processes that undergird these concepts also need to be taught. Karpov (2003:68) provides an example of this: Teaching children the definition of perpendicular lines will not necessarily enable them to distinguish between perpendicular lines and other types of lines (Karpov, 2003:68). To truly understand the concept of perpendicular lines, students must also understand both the notions of an angle and a gradient and its relation to perpendicular lines. Furthermore, learners should also be able to do calculations that will indicate the attributes of a perpendicular line.

The notion of acquiring scientific concepts through mediation is also a significant contribution to scaffolding. According to Bliss and Askew (1996:58) scaffolding is difficult since some concepts seem to be more understandable to children than others. When scientific concepts are scaffolded, teachers should recognise that these are not spontaneous concepts which learners know from everyday life. Scientific concepts are theoretical and the teacher needs to grasp the whole system of concepts if she is to assist the learner. It is my view that scaffolding in the classroom should be directed towards the learner's acquisition of scientific concepts and its underlying processes. This view point will be elaborated in Chapter 3.

Scaffolding in the classroom

Significant early scaffolding studies

In the late 1970s Cazden became interested in the parallels between the dynamics of parent-child exchanges and teacher-learner interactions in the classroom. This study was the first to apply the concept of scaffolding to the classroom and to indicate that scaffolding can be useful for analysing and designing classroom instruction for large groups of learners. It was only in the mid-eighties, though, that a significant stream of scaffolding studies relating to teacher-learner interactions in the classroom emerged (Fleer, 1992; Palincsar & Brown, 1984; Palincsar, 1986; Paris & Brynes, 1989; Stone, 1998).

The first significant scaffolding studies to be published in the 1980s were undertaken by Langer and Applebee (1983) and Palincsar and Brown (1984). Applebee and Langer (1983:169) examined teacher-learner interactions and coined the term 'instructional scaffolding'. By examining classroom dialogues Applebee and Langer identified five components for effective instructional scaffolding, namely learners' ownership of activity, appropriateness of task, structure of interactions (for example sequence of thought), collaboration between teacher and student and internalization of concepts through transfer of responsibility for learning to the learner (Applebee & Langer, 1983:169).

Palincsar and Brown (1984) developed the term 'reciprocal teaching' as a specific scaffolding strategy to improve the text comprehension of learners in language teaching. This format entails a reciprocal exchange between the learner and teacher where the one party acts and responds in reaction to the other. The goal of reciprocal teaching is to transfer responsibility to the learner to independently execute strategies like summarizing, questioning and clarifying with regard to text comprehension (Palincsar, 1986:77).

Alternative terms for scaffolding

Literature provides various alternative terms to describe the concept of adult or peer assistance. Examples of such alternative phrases are 'assisted performance' (Tharp and Gallimore, 1988), 'guided participation' (Rogoff, 1989) and 'contingent instruction' (Wood, 1996b). These terms describe different aspects of assistance, which are either similar to the original concept of scaffolding or provide an extension to the concept itself. The three terms, their link with scaffolding and my reasons for choosing to use the term scaffolding rather than other alternatives mentioned above, will be discussed below.

Assisted performance

The term assisted performance was developed by Tharp and Gallimore (1988:30) to describe the teacher's assistance in the ZPD. It was defined as "what a child can do with help, with the support of the environment, of other, and of the self" (Tharp and Gallimore, 1988:30). This theory of assisted performance constitutes three key elements. Firstly, through assisted performance the child progresses from other-assistance to self-assistance in the ZPD. Secondly, the child's performance and specific need influence the type of assistance that is provided. Lastly, Tharp and Gallimore (1988:72-92) emphasize that teaching occurs in *activity settings*. This assistance takes cognizance of who participates in the activity, what is being done in the activity, when and where the activity happens and the goal of the activity. This last key element brought a new addition to the concept of scaffolding. The teacher's scaffolding actions are influenced not only by the learner, but also by the specific activity setting.

The above theory of assisted performance bears a close resemblance to the concept of scaffolding discussed so far (Hobsbaum, Peters & Sylva, 1996; Anghileri, 2006). Tharp and Gallimore (1988:30) believed that scaffolding suggests that support is not modified during instruction; the same kind of support is offered regardless of the need of the child. I disagree with this opinion and rather concur with Maybin, Mercer and Stierer (1992:187) that scaffolding indicates joint participation. During assistance both the teacher and learner are participating in the learning process. The teacher reacts to the learner's success or failure to solve the problem or to perform the task. The teacher's scaffold is then changed accordingly (Wong, 1998:340).

Guided participation

Barbara Rogoff (1989) developed the term guided participation to indicate "a collaborative process involving joint structuring of activities with participation by both partners in the thinking process, either with symmetrical or asymmetrical sharing in decision making" (Radziszewska & Rogoff, 1991:381). This process thus ranges from equal collaboration between peers or the teacher and the learner, to demonstration by the teacher and active observation by the learner.

Guided participation is used especially during problem solving. Through active collaboration (between teacher and learner or peers) the bridge between the child's current skills and those needed to solve the problem, is crossed. Guided participation also implies structuring the activity to suit the child's needs and to arrange manageable sub-goals to ensure child participation. In this way, the child is motivated to engage with the problem. Another imperative aspect of guided participation is the gradual transference of responsibility for problem solving to the child (Rogoff, 1989:62-71).

In 1991, Barbara Rogoff and Barbara Radziszewska examined the nature of the scaffolder and the child's role in scaffolding. The focus was on the role of guided participation on children's learning when they collaborate with an adult or a peer in planning an activity. The activity was an imaginary errand to find the shortest route on a map and to collect all the prescribed items from stores on the route. This study found that guided participation in collaboration with more skilled partners successfully develops children's skills and that interaction with an expert (in this case a parent) is more effective than with novice peers (Radziszewska & Rogoff, 1991:388).

With regard to the child's role during collaboration, the study indicated that when children were involved in symmetrical decision making (collaboration) or actively followed the adult/trained peer; their post test performance in a similar errand activity (as mentioned above) increased (Radziszewska & Rogoff, 1991:381). This underlined the importance of the child's active participation during the scaffolding process.

Barbara Rogoff's unique contribution to the concept of scaffolding is twofold. Firstly, it recognizes the mutual participation of both the teacher and the student in the joint cultural activity of learning and teaching. Scaffolding is not a mere one-sided and rigid form of instruction, but an active collaboration by both parties. The teacher, as scaffolder, also has the responsibility to arrange the teaching situation so that the learner is motivated to participate. Secondly, the scaffolder can be either a peer or an adult. This insight aligns with the idea of a ZPD.

Contingent instruction

Contingent instruction relates to task responsibility and the *contingent control* of learning (Wood & Wood, 1996a). It is the:

> seeking to identify aspects of tutorial activity which lead to the progressive acquisition of task competence by the child and to the 'hand over' of task responsibility from tutor to learner (Wood & Wood, 1996a:5).

Contingent control entails two fundamental features: an increase in help/control when a child fails and a decrease in help after the child experiences success (Wood & Wood, 1996a:5). Responding contingently to students requires judging the need and current understanding of the learner and the quality of assistance required to meet this need. This demands great skill and sensitivity.

Contingent control describes the scaffolding process well. Through contingent control, the demands placed on the child (through scaffolding) will not be burdensome, create boredom or cause defeat. It will rather lead the child safely through and beyond his specific point of need. When the point of need then passes, the support is withdrawn so that the learner can perform the task or a related activity independently. The withdrawing of support is also called *fading of the scaffold* (Anghileri, 2006; Pea, 2004; Puntambekar and Hubscher, 2005; Stone, 1998). According to Holton and Clark (2006:129) children do not remember the mechanisms by which they gained knowledge. "However, the 'memory' of the scaffolding may still remain" (Holton & Clark, 2006:129).

I decided to use the term scaffolding to describe the teacher's assistance in the classroom rather than the phrases *assisted performance*, *guided participation* or *contingent instruction* for two reasons:

- The term scaffolding is a metaphor that can open up various avenues of interpreting, connecting and developing ideas related to teacher-learner interactions. The term can also continually produce fresh ideas. The notions of assisted performance, guided participation and contingent instruction do not leave room for much interpretation. These phrases are not metaphors and the meaning of the term is embedded in the phrases themselves. This curbs further development of the term.
- Scaffolding has become a popular metaphor in literature to describe teacher assistance in student learning (Daniels, 2001:107-110). I think that Maybin, Mercer and Stierer (1992:187) have captured the reason for this enthusiasm well by indicating that scaffolding seems to resonate with teacher's ideas regarding successful intervention in student learning. The abovementioned phrases have not achieved the same level of popularity in recent literature.

Contentious issues

There are two contentious issues that relate to scaffolding in the classroom: the broadness of the meaning of the term and the type of teacher interaction suggested by the term.

In the introduction to this chapter, it was suggested that scaffolding seems to currently suggest any type of teaching strategy. Courtney Cazden (1979) argued that scaffolding has a "wide utility and can be used to describe many everyday classroom interactional procedures designed to operate within and simultaneously advance students' ZPD" (Cazden, 1979 in Reid, 1998:391). This wide utility of scaffolding is a point of concern for Roy Pea. According to Pea (2004, 423) "scaffolding has become a proxy for any cultural practices associated with advancing performance, knowledge and skills". Since the term has become so broad in its meaning, Pea stated that it is first necessary to clarify the use of the concept for individual learning before it can be extended into the classroom (Pea, 2004:423). I agree with Roy Pea's concern but believe that if the concept of scaffolding is defined and described, according to its essential features, a mechanism will be produced to scrutinize teaching strategies closely in the classroom in terms of scaffolding. I will suggest, though, that not all teaching strategies are scaffolding. In Chapter 3 this study provides a robust description of scaffolding in the classroom.

Maybin, Mercer and Stierer (1992:187) suggest that scaffolding acknowledges the active role of both the teacher and the learner in the learning process and that scaffolding is a "conceptual escape from the tired debate about 'traditional versus progressive' pedagogies. Anghileri (2006:50) disputes this point by indicating that the term scaffolding can suggest the idea that classroom interactions are one-sided, rigid and teacher-dominated. She provides a relevant example of this in the field of mathematics teaching. According to Anghileri (2006:50) scaffolding can suggest that mathematics is taught with routine/standardized approaches and that learning is built level by level on a firm foundation. This contrasts to the idea that various elements of understanding already exist within the child and that learning is a manner of making connections for understanding.

I believe, like Maybin , Mercer and Stierer (1992:187), that the concept of scaffolding should not be part of the traditional versus progressive debate in the classroom. The original context for studying scaffolding was the interactive and spontaneous actions between the tutor/mother and the child. The purpose of these studies was to identify those strategies that successfully lead learners/children to perform a task or solve a problem. No distinction was made between 'old/ archaic' methods and new strategies; the focus was simply on the effective strategies that parents/tutors use naturally. Scaffolding in the classroom has a similar purpose, although this context is not as formal.

Furthermore, the traditional versus progressive debate does not refer to natural interactions between a parent/tutor and a child; it rather emerged from years of developments in teaching practices in the classroom. When the concept of scaffolding was taken into the classroom, it invariably became entangled in this debate. Since teachers' actions in the classroom always seem to be classified according to this debate, the strategies implied by scaffolding were discussed in a similar manner. This discussion was further fueled by the way in which teachers used scaffolding strategies and whether their approach caused the interactions in the classroom to be traditional or progressive. I believe that even if literature labels a strategy as scaffolding, the teacher can still implement the strategy in a way that does not suggest scaffolding. This is evident when the scaffold is removed and the learner still cannot perform the task or solve the problem.

If scaffolding is purely connected to the literal meaning of a scaffold, teaching seems to be traditional and similar to what Anghileri (2006:50) described previously. The literal meaning is "bolted together tiers of boards upon which human workers stand to construct a building" (Rogoff & Wertsch, 1984:47). These bolted tiers of boards are placed outside new buildings and used as a tool to construct or repair buildings. These structures give workers access to each new level of the emerging structure and make it possible to reach previously inaccessible places. When the construction or repair is done, the scaffold is removed (Rogoff & Wertsch, 1984:47; Holton & Clark, 2006:129). However, when scaffolding is viewed by considering its development since 1979, and the main features of the concept are maintained, then the concept suggests a less rigid approach.

The challenge posed by scaffolding in classrooms

Strides have been made to examine scaffolding in whole classroom situations (Anghileri, 2006; Bliss & Askew, 1996; Coltman, Petyaeva & Anghileri, 2002; Murphy & Messer, 200) and some of these studies affirmed the effective impact of scaffolding in the classroom (Coltman, Petyaeva & Anghileri, 2002; Murphy & Messer, 2000). Extending the concept of scaffolding, though, from one-to-one tutoring to the complex system of the classroom is challenging (Reid, 1998:391; Davis & Miyake, 2004:265; Maybin, Mercer & Stierer, 1992:187; Freedman & Delp, 2007:260). Tharp and Gallimore (1988:27) argue that while it is natural for adults to assist children during everyday interactions, in classrooms teachers need help with this assistance. Three possible reasons are mentioned: in a classroom setting the teachers do not know every learner's needs and abilities and the teacher needs guidance in how to scaffold under such circumstances. Secondly, the social practices are also different at school than at home since schooling is much more formal and rigid. Teachers need to learn which social practices contribute to assistance. Lastly, the teacher interacts differently with learners at school than with their own children at home, since the context differs and the teacher is not as familiar with the children in their class. Tharp and Gallimore (1988:27) agree that the principles of informal teaching are relevant to the classroom in that,

> they (schools) have much to learn by examining the informal pedagogy of everyday life. The principles of good teaching are not different for school than for home and community. When true teaching is found in schools it observes the same principles that teaching exhibits in informal settings (Tharp and Gallimore, 1988:27)

In 1996 Joan Bliss and Mike Askew studied whether the model of using scaffolding to acquire everyday knowledge could be transferred to the acquisition of specialised school knowledge. They published despondent results that highlighted the difficulty that teachers experience with the application of scaffolding in the classroom. According to their study in 12 primary school classes "situations in which conditions for scaffolding are neglected, or scaffolds misfire, constitute nearly a quarter of instances" (Bliss & Askew, 1996:58). Teachers in the study either avoided scaffolding practices or used them unsuccessfully, especially when teaching abstract subject knowledge.

An interesting addition to Bliss and Askew's (1996:47) study was an exploration of failed scaffolding attempts (called misfired scaffolds) and/or when scaffolding happened by chance (unintended scaffolds). The study found that some teachers intended to scaffold, but that the learners' interpretation of the scaffold were different than what was expected. When the teacher then neglected to make these misinterpretations and their unintended consequences explicit, the scaffold misfired. Regarding unintended scaffolds, Bliss and Askew found that the teacher's actions or words sometimes assisted the learners in an unexpected manner, and that the teacher was not always aware that the learner's answers were derived from the unintended scaffold. The existence of misfired and unintended scaffolds indicates two interesting phenomena regarding scaffolding. Firstly, even though the teacher intended to scaffold, the results of her actions may be unsuccessful (for example the learners may still not understand the concept). In such cases the teacher's actions cannot necessarily be classified as scaffolding. Secondly, scaffolding during dialogue can also happen unintentionally (Bliss & Askew, 1996:47).

Bliss and Askew's (1996) alarming findings of a lack of scaffolding in the classroom were in direct contrast to the successful scaffolding instances found between mothers and their daughters in rural Mexico where mothers taught their daughters to weave (Greenfield, 1984). The disparity of results between learning at home and learning at school compelled Alex Kozulin (2003:21) to study the scaffolding differences between these two contexts. Kozulin (2003:21) found that home situations do not provide structured learning environments and parents feel the need to provide extra mediation to clarify situations. At school situations/tasks are very structured and "many teachers apparently believe that the meaning embedded in these materials is sufficiently transparent to students and that the situation therefore does not warrant intensive mediation"
(Kozulin, 2003:23). As a result the teacher abandons the idea of using scaffolding in the class and does not develop his/her skills in this regard.

The nature of school subjects poses the next challenge for scaffolding. School knowledge is abstract and it takes skill to scaffold. Teachers need to be trained in this skill. To effectively scaffold abstract concepts is also time consuming (Bliss & Askew, 1996:58). As teachers need to deliver the curriculum in a limited time, it might seem more favorable to use teacher-dominated interactions that miss the input of the learners. In this way, the teacher can move at a quicker pace through the concepts that need to be taught.

A prominent feature of scaffolding is the continual assessment of individual learning. In a classroom setting this can be problematic for two reasons: "teachers are trained to keep lessons moving and pupils active" and diagnosis, a time-consuming process, slows down the movement of the lesson (Bliss & Askew, 1996:58). It is my view that the teacher needs the skill to make assessment part of the process of teaching and not to distinguish between the two. Assessment should also not break the movement of the lesson, but rather enhance the quality of the teaching since the teacher reacts according to the need of the learner. Secondly, assessment during whole class teaching is geared toward the class as a whole (and not the individual learner) and therefore support is calibrated not towards the individual need, but the need of the collective child that represents the class as a whole (Davis & Miyake, 2004:265). It is therefore difficult to ascertain, during assistance, if the chosen scaffold is effective for each learner in the class. The teacher's ability to observe and to skillfully ask questions is imperative under such circumstances. It is then only during the final phase of scaffolding, when the learner has to independently do a task, that the effectiveness of the scaffold can be established.

Lastly, scaffolding assumes teachers have a good understanding of the domain/subject knowledge and are aware of the misconceptions that learners already have or can develop regarding the knowledge that is being taught. Bliss and Askew (1996:57) noted that due to a lack of subject knowledge, teachers who do not have these insights found it difficult to understand learners' questions and to appropriately respond to them.

Scaffolding and whole-class teaching

Applebee and Langer (1983:169) use the term instructional scaffolding and suggest two types of interaction in the classroom: "direct interaction with individual learners" and "group-oriented instruction" (Applebee & Langer, 1983:169). Whole class teaching is done through the lesson structure, teaching materials and the teacher's dialogue with the class which includes specific comments and discussions. Instructional scaffolding to the whole class also entails anticipating possible learner difficulties and structuring lessons to overcome these difficulties (Applebee & Langer, 1983:169).

Scaffolding learning for the whole class, though, is a very contentious issue. Since scaffolding is described as one of the processes of the ZPD, whole class scaffolding can only take place once the idea of a collective ZPD is agreed upon. Guk and Kellogg (2007) argue though that Vygotsky indeed refers to the possibility of whole group zones of proximal development. The following quote from Vygotsky seems to confirm Guk and Kellogg's (2007) opinion:

> Since teaching depends on immature, but maturing processes and the whole area of these processes is encompassed by the ZPD of the child, the optimum time for teaching *both the group* and each individual is established at each age by the zone of their proximal development" (Vygotsky quoted in Guk & Kellogg, 2007:283).

Nyikos and Hashimoto (1997:506-507) debated the possibility that the potential growth for the group as a whole can be pointed to where the individual ZPDs intersect and that through the social mediation of the group's interrelated ideas, the group ZPD can grow exponentially. Goos, Galbraith and Renshaw (2002:195) agree and argue that each learner requires the contribution of another's skill and knowledge to reach greater learning potential. Collaborative interaction characterized by a "shared activity, a common goal, continuous communication and co-construction of understanding" (Goos, Galbraith & Renshaw, 2002:196) is thus needed to make learning possible in the group ZPD. Freedman & Delp (2007:262) also reasoned that when individuals 'latch' onto the whole-group activity (and group ZPD) in their own way and the adult gives support in such a way that the learners can challenge themselves to move beyond what they could not do on their own, learners can work within their own ZPD.

Synoptic view of the concept of scaffolding

The various contexts for studying the concept of scaffolding (parent/tutor and child and teacher and learner interactions) chart an interesting conceptual map for the metaphor of scaffolding. Although some scaffolding features have been maintained, (for example Wood, Bruner and Ross's original definition of scaffolding, the fading of the scaffold and contingent instruction) conceptual shifts were inevitable. These shifts are partly due to the specific context related to scaffolding studies and the theoretical framework (mediation and the zone of proximal development) which have been linked to the metaphor over the years.

OPERATIONALISING THE CONCEPT OF SCAFFOLDING IN THE CLASSROOM

At this juncture I will examine literature that describes how scaffolding can be identified empirically in the classroom. In this case, the focus is on the teacher's interaction with the learner and not the actions of the learner.

Wood, Bruner and Ross's process of scaffolding

Wood, Bruner and Ross (1976) were the first to report a variety of scaffolding strategies that parents or tutors use when interacting with children. Although these strategies were not classroom-based, they were still related to learning and therefore provided key indicators for future studies. Wood, Bruner and Ross (1976:98) identified the following functions that a tutor has during the process of scaffolding.

- *Recruitment,* which implies gaining the child's interest and keeping him on goal for the task.

- *Reduction in degrees of freedom,* which implies simplifying the task so that the tutor's feedback can establish whether the learner "achieved a fit with the task requirement" (Wood, Bruner & Ross, 1976:98).
- *Direction maintenance,* that verbally keeps the child in pursuit of the task.
- *Marking critical features* relevant to the task, which will indicate to the tutor the discrepancies between "what the child had produced and what he would recognize as a correct production" (Wood, Bruner & Ross, 1976:98).
- *Frustration control,* which involves managing the child's emotional state and not creating too much of a dependency on the tutor.
- *Demonstration of the task.*

In a further study by Wood, Wood and Middleton (1978:132-134), the mothers' strategies to lead their children in building a pyramid were rather classified by five levels (L1 – L5) of intervention:

- *General verbal encouragement* using words like "Good, do something else now" (L1)
- *Specific verbal information* on how to build the pyramid (L2)
- The mother became involved in *selecting* the correct blocks for building (L3)
- The mother *prepared the materials* in such a way that the child could simply assemble the blocks (L4)
- The mother *demonstrated* the process of assembling the blocks (L5)

Wood, Wood and Middleton (1978:132-134) also employed these levels to name four strategies that the mothers used to assist their children, namely de*monstration* (level 5), *verbal communication* instead of any physical intervention (when level 1 and level 2 interactions took place), *swing* (when level 1 and level 5 occurred simultaneously) and *contingent* (when all five levels occurred when the mother assisted her child).

The common elements between the above two studies seem to be: a description of the teachers' non-verbal actions (*demonstration*, *selecting* and *preparing materials),* the use of verbal comments to assist the child (*direction maintenance/ marking critical features* and *general verbal encouragement/specific verbal information*) and a cognizance of the child's emotional state (*frustration control* and *general verbal encouragement*).

Tharp and Gallimore's means for assisting performance

The next significant contribution that describes teachers' actions in the classroom, was research undertaken by Tharp and Gallimore (1988). They identified the following six means of assisted performance in the zone of proximal development:

- *Modelling* is the process of imitation originally used to teach culture specific activities like fishing and preparing food (Tharp & Gallimore, 1988:47-51). Vygotsky also viewed imitation as an effective method of instruction. He stated that imitation can only occur, though, when the person already has the ability for the task, hence his quote "a person can imitate only that which is within" (Vygotsky, 1978:88).
- *Contingency management* is the arrangement of rewards and punishments as a result of the nature of the child's behavior. Even though contingent management does not "originate new behaviors", it is "like props or buttresses that strengthen each point of advance through the ZPD, preventing loss of ground" (Tharp & Gallimore, 1988:53).
- *Feeding-back* can be described as providing feedback (sometimes instantaneously) on the child's performance in what is called responsive teaching (Tharp & Gallimore, 1988:54-56).
- *Instructing* is a linguistic form of assistance that requires specific action of the learner. It can only occur "when teachers assume responsibility for assisting performance, rather than expecting students to learn on their own" (Tharp & Gallimore, 1988:57). Instruction can be used as a point of departure for the lesson (to start of the lesson) or when explaining or assigning tasks to learners. An important aspect of teacher-instructing is its meta-cognitive aspect. The teacher's voice is transferred to the self-regulatory voice of the learner (Tharp & Gallimore, 1988:56-57).
- *Questioning* is also a linguistic form of communication that activates learners mentally to elicit a verbal response. Tharp and Gallimore mention two kinds of questions, namely assess and assist questions. *Assess* questions discover the learners' ability to perform, for example: "how did you get your answer?" This will indicate how learners were thinking about a mathematics question. A*ssist* questions lead the learner to produce what he could not on his own, for example: "What if you rather take this step first? Will that make it easier to find the answer?" (Tharp & Gallimore, 1988:58-62)
- *Cognitive restructuring* differs from questioning in that no action is elicited. The teacher rather provides a structure in which different concepts can be organized and related to one

another. During teacher/learner interactions the learner invents new cognitive structures and the teacher's assistance is necessary to identify and correct the unreliable structures (Tharp & Gallimore, 1988:67).

Tharp & Gallimore's (1988) label of *modelling* resonates with Wood, Bruner and Ross's (1976) idea of *demonstration*; whilst *contingency management*, especially through rewards, is a way to *control* the child's *frustration* level during assistance (Hardman, 2008:7). *Instruction*, *feeding-back* and *questioning* were used by Tharp and Gallimore to describe the verbal actions of teachers. It is my opinion that these types of verbal communication can also be used to operationalise the following elements of Wood, Bruner and Ross's process of scaffolding:

- Recruiting the child's attention to the task by, for example, asking the child pertinent questions that will keep him on track with the goal of the task or by providing feedback on his previous success and simultaneously indicating how the steps that were taken previously can be used to solve the current task.
- Reducing the degrees of freedom of the task by, for example, instructing the learner to do a specific aspect of the task first.
- Keeping the child in pursuit of a particular objective (direction maintenance) by asking relevant questions or to instruct the learner to do a next step.
- Marking the critical features of the task by asking pertinent questions or to provide feedback on what was done so far and to relate that to the features of the task.

Tharp and Gallimore's (1988) theory, though, did not necessarily describe how feedback, questioning or instruction can lead to cognitive restructuring as a purpose for teaching. The theory aimed to describe the various elements of assisted performance, rather than the process of assistance.

Tharp and Gallimore's strategies can also be classified as verbal and non-verbal teaching strategies. Modelling and contingent management can take place through non-verbal actions like arranging rewards, whilst the rest of the strategies are communicated verbally.

Bliss and Askew's description of various types of scaffolds

A scaffolding study that illustrated scaffolding in science, mathematics and design and technology classrooms was undertaken by Bliss and Askew (1996). This study focused more closely on the dialogic nature of teacher-learner interactions in the classroom than the work done by Tharp and Gallimore (1988). Bliss and Askew (1996:47-48) also used a novel vocabulary to describe these interactions, namely:

- *Props scaffolds* entail a teacher's suggestion that provides help in completing a task (Bliss and Askew, 1996:47).
- *Localised scaffolding* occurs when the concept to be taught is complex. The "teacher scaffolds one part of it which could put the pupil on the foot of the ladder to the more general concept" (Bliss and Askew, 1996:47).
- *Foothold scaffolds* are used when the teacher leads an argument/explanation in a step-by-step way, where each step in the argument is turned into a question. The learner's answer then leads to the next question (Bliss and Askew, 1996:47). Bliss and Askew only described foothold scaffolds in terms of questions and did not elaborate on other ways for leading an argument in a step-by-step way. An explanation can also be made by demonstrating each step.
- *Hints and slots scaffolds* are questions that are designed to have only one specific answer. The answer operates like a filler for a slot. This kind of scaffold takes place when open-ended questions are not relevant. It is my opinion that this kind of scaffold can also be used during foothold scaffolds (Bliss and Askew, 1996:47).

Bliss and Askew (1996:47) also acknowledged other non-verbal forms of scaffolding and instances of emotional input from the teacher. These were generically labeled as *actual scaffolds* and included approval, encouragement, structuring work and organizing people (Bliss and Askew, 1996:47).

Siemon and Virgona's communicative acts

A more recent contribution to scaffolding in the mathematics classroom relates to the communicative acts of teachers. Siemon and Virgona (2003) identified and described 12 such acts that could be classified as scaffolding. The uniqueness of their study lies in the fact that it was conducted in an 'ideal' teaching situation where teachers taught only a small group of children. This context provided multiple opportunities for the teacher to use a variety of scaffolds according to individual learners' needs, comments and questions. Siemon and Virgona's study first labeled the communicative practices that teachers used to assist learning in mathematics and then arranged these labels according to 12 categories (Siemon and Virgona, 2003:9). These categories were then called *scaffolding practices*. The 12 scaffolding strategies (Australian Government Department of Education, Science and Training, 2004:vi) identified by the study were:

- *Excavating* (other labels: drawing out, digging, uncovering what is known, making it transparent) to find out what students know and to make that knowledge explicit.
- *Modelling* (other labels: demonstrating, directing, instructing, showing, telling, funneling, naming, labeling, explaining) to show students what to do and how to do a mathematical task.
- *Collaborating* (other labels: acting as an accomplice, co-learner/problem-solver, co-conspirator, negotiating) with learners to solve a problem.
- *Guiding* (other labels: cueing, prompting, hinting, navigating, shepherding, encouraging, nudging) to observe, listen and monitor learners as they work.
- *Convince me* (other labels: seeking explanation, justification, evidence, proving). The teacher expects learners to give evidence of their thinking and to be more specific in their explanation.
- *Noticing* (other labels: highlighting, pointing to, attention to, drawing, valuing). The teacher points to concepts without telling the learners what to see or notice.
- *Focusing* (other labels: coaching, tutoring, mentoring, flagging, redirecting, re-voicing, filtering) on a learner's gap, whether it is a skill or a concept, that needs to be bridged so that the learner can progress.
- *Probing* (other labels: clarifying, monitoring, checking) to evaluate the learner's understanding.
- *Orienting* (other labels: setting the scene, contextualizing, reminding, alerting, recalling) learners to establish a context and to set the scene for learning.
- *Reflecting/reviewing* (other labels: sharing, reflecting, recounting, summarizing, capturing, reinforcing, reflecting, rehearsing) on what learning took place during the lesson.
- *Extending* (other labels: challenging, spring-boarding, linking, connecting) learner's understanding through strategies like open-ended questions.
- *Apprenticing* (other labels: inviting peer assistance, peer teaching, peer mentoring) where knowledgeable peers act as the teacher.

I have identified particular connections between Siemon and Virgona's (2003) scaffolding practices and the studies discussed so far. The notion of modelling/demonstration (where learners then imitate the teacher's action) was used by Wood, Wood and Middleton (1978), Tharp and Gallimore (1988) and Siemon and Virgona (2003). Siemon and Virgona's idea of *noticing* and *focusing* can be used to implement Wood, Bruner and Ross's notion of marking the critical features of a task, where *focusing* points the learner's attention towards the gap between what the learner produced and what he recognizes as a correct production, and *noticing* is used to point to the critical features of the task. *Probing*, *collaborating* and *guiding* can be linked to Tharp and Gallimore's (1988) notion of assessing and assisting questions. Through the use of probing questions the teacher can assess the learner's understanding and ability, whilst during collaboration the teacher works with the learner and asks relevant questions that assist the learner to solve the problem. When the teacher observes, listens or monitors learners as they work, assisting questions can be used to guide the learner in the task/problem. Siemon et al's range of scaffolding practices seem to contribute to the second and third level of Anghileri's (2006) hierarchy. The hierarchy will be elaborated on in the discussion below.

Julia Anghileri's hierarchy

Up until the 1990s scaffolding in the classroom has been labeled and described in terms of various specific strategies. None of these studies discussed the qualitative nature of the support implied by each strategy. In 2006, Julia Anghileri proposed a comprehensive three-leveled hierarchy that demonstrated the qualitative differences between the various interaction patterns that occur during scaffolding. This hierarchy included all the verbal and non-verbal teacher actions in the classroom that can scaffold student learning, namely the learning environment, the interactions between the learner and teacher and the development of conceptual thinking.

The *first level* of Anghileri's hierarchy focuses on the prompts and the stimuli that the environment provides for learning to take place. This is called *environmental provisions*. At this level the teacher organizes the learning environment (through various non-verbal actions) so that learning can take place "without the direct intervention of the teacher" (Anghileri, 2006:38). Environmental provisions that are used as scaffolding are (Anghileri, 2006:40):

- artefacts (for example wall displays, puzzles, manipulatives and appropriate tools);

- classroom organization (for example seating arrangements, sequencing and pacing of events);
- structured tasks (for example worksheets);
- self-correcting tasks (the structure of the activity provides feedback and opportunities for reflection);
- peer collaboration;
- emotive feedback (remarks to gain attention, to praise).

Some of these environmental provisions are in agreement with Bliss and Askew's (1996) idea of the *actual scaffold*.

The *second level* "involve (s) direct interactions between teacher and students related specifically to the mathematics being considered" (Anghileri, 2006:41). Three types of scaffolding can be observed at this level, namely *explaining/telling/showing, reviewing and restructuring*.

Showing and telling have been the predominant tradition of classroom practice for centuries. This practice holds the teacher in dominant control of the classroom events. *Explaining* is also a teacher action that can control classroom communication, especially when the communication is one-sided and does not consider the learners' thinking or ideas. Explaining can also confine the child's thinking to pre-determined procedures and thinking patterns that are not necessarily in line with their current maturation processes (Anghileri, 2006:41). Explaining, though, can effectively lead to greater levels of understanding, especially when learners deal with complex concepts.

Reviewing and restructuring, relating to Wood's focusing pattern of interaction, are specific scaffolding practices to support the development of the learner's own understanding. *Reviewing* relates to refocusing the student's attention to "those aspects most pertinent to the implicit mathematical ideas or problem to be solved … to encourage reflection, clarifying but not altering students' existing understanding" (Anghileri, 2006:41, 44). Anghileri (2006:41-44) suggests the following interactions to achieve *reviewing*:

- Students are encouraged to *look at* and *touch* manipulatives and to *reflect and verbalize* their observations (Anghileri, 2006:42). This differs from telling and explaining since here the learner is given the opportunity to actively engage with the task by using all four of their senses. During telling and explaining the learner passively observes and does not engage with the task to form his/her own opinions.

- Students are challenged to *explain and justify their solutions*, either to peers in small groups or to the teacher. In this way the teacher can also monitor learner understanding (Anghileri, 2006:44).
- The teacher *interprets the student's actions and talk* by highlighting the key characteristics to solutions. According to Wood, Bruner and Ross (1976:90) a learner should first "*recognize* a solution to a particular class of problems before" he can solve it. The teacher's role is to expand the child's understanding of this solution and to make the knowledge explicit. (Anghileri, 2006:43)
- The teacher uses *prompting questions* (that lead students to a predetermined solution) and *probing questions* (expanding student's thinking) to facilitate learning (Anghileri, 2006:43). These questions relate to the IRF interaction (Sinclair & Coulthard, 1975), funnel pattern of interaction (Bauersfeld, 1988) and Tharp and Gallimore's (1988) explanation of questioning.
- The teacher engages in *parallel modelling*, i.e. the learners observe the teacher solving a similar task carrying some of the same characteristics as their task (Anghileri, 2006:43).

Restructuring as a scaffold means to make ideas more accessible to learners by connecting with their current knowledge. Once this has been achieved, these ideas are then further developed. This involves interactions like:

- The teacher provides *meaningful contexts* for solving abstract concepts.
- The mathematical *problems are simplified* "so that understanding can be built in progressive steps towards the larger problem" (Anghileri, 2006:45). This relates to Wood, Bruner and Ross's (1976) notion of reduction in degrees of freedom.
- The teacher *re-phrases* the *students' talk* to clarify the students' ideas and to extend their use of a formal mathematical language (Anghileri, 2006:46).
- The teacher and learners co-operatively *negotiate* mathematical *meanings* to determine what is understood by both parties. Learner errors and misconceptions are also exposed and discussed (Anghileri, 2006:46).

The third level of Anghileri's hierarchy deals with the development of *conceptual thinking,* which coincides with Tharp and Gallimore's (1988) assistance through cognitive structuring. Interactions to accomplish this are:

- *Developing representational tools* through example mathematical language, visual imagery, making meaning of graphs and making notes of student's thinking and solutions for the purpose of communication and reflection (Anghileri, 2006:48).
- *Making connections* between different ideas in Mathematics (Anghileri, 2006:48).
- *Generating conceptual discourse by* establishing acceptable norms and standards for mathematical explanation (Anghileri, 2006:49).

Anghileri's (2006) hierarchy has contributed significantly to the current understanding of scaffolding in the classroom. Although some of the scaffolding strategies that are discussed in the hierarchy have been suggested in previous literature, Anghileri's (2006) hierarchy is the first to combine these strategies into different levels of teacher-learner interaction. The hierarchy extends scaffolding from interactions between the teacher and the learner, towards the role of the classroom environment and the development of conceptual thinking.
The hierarchy also indicates that scaffolding progresses from the environment, to learner-teacher interactions and then finally towards conceptual thinking. The one level influences and can lead to the next. Anghileri's (2006) discussion on the hierarchy, though, is based on a description of the various scaffolding strategies that occur at each level and the discussion does not present scaffolding as a process that necessitates movement from the first to the third level. Scaffolding can occur even though all three levels of scaffolding are not present during a lesson. For example, when a student is doing a puzzle at level one of scaffolding, levels two and three will not be evident since there is no interaction between the teacher and the learner. Teaching that engages learners in answering step-by-step questions (level two scaffolding) can also take place without developing conceptual thinking (the third level of the hierarchy).

Another novel implication of this hierarchy is that the learner's need to acquire conceptual thinking is the ultimate purpose of scaffolding. Although Anghileri wasn't the first to mention conceptual thinking (Tharpe and Gallimore entertained this discussion) in relation to scaffolding. Anghileri's work was the first to indicate that conceptual thinking wasn't merely a scaffolding strategy, but the highest level of scaffolding. Anghileri's hierarchy, though, did not relate *all* scaffolding strategies to the notion of concepts and only discussed concepts when they appear at an abstract level.

The final contribution of the hierarchy is that the distinction between level two and three of Anghileri's model also highlights the qualitative differences between various teacher interaction patterns in the classroom. These levels "offer another, possibly more useful, way of talking about the nature of the teacher's role in shaping classroom communication and culture" (Siemon & Virgona, 2003:3).

CONCLUSION

According to the literature reviewed, scaffolding has specific purposes, the learner and the teacher fulfill distinct roles during the process of scaffolding and scaffolding is evident in the classroom through a variety of teaching strategies

The purpose of scaffolding

The scaffolding definition provided by Wood, Bruner and Ross (1976:90) suggests that the purpose of scaffolding is a tripartite entity, namely to *enable*, to *accomplish* and move *beyond unassisted efforts*.

The purpose of scaffolding is to enable the child to accomplish that task or skill that he could not do before. This accomplishment is indeed novel since the child now performs the task independently. This goal of independence is also achieved through assistance provided by an adult or a competent peer. Previously, in the absence of assistance, autonomous performance could not be achieved.

These ideas of accomplishing tasks through assistance also linked with Vygotsky's notion of the *zone of proximal development* (Vygotsky, 1978:85). According to this notion the child, during teacher-learner interactions, moves from his actual developmental level of understanding to his potential level of understanding. The latter refers to the level beyond the child's current ability. Another goal of scaffolding is therefore that the child reaches this potential level of understanding with the assistance of an adult.

To achieve the purpose of scaffolding, a transfer of knowledge should take place from the child's interaction with the teacher (also called the interpsychological or social plane) to the child's intrapsychological plane (Vygotsky, 1978:57). During this process of transfer, the learner internalises the knowledge so that he can eventually perform a task without assistance.

Another purpose for scaffolding is taken from Anghileri's (2006) hierarchy. As discussed previously, the goal of scaffolding is that it should lead the learner to an abstract level of conceptual thinking (on the third level of the hierarchy).

The role of the scaffolder

The scaffolder can have the identity of an *adult* (for example a teacher) or a *competent peer* (Wood, Bruner & Ross, 1976:90). During assistance, an asymetrical (Radziszewska & Rogoff, 1991:381) situation exists between the scaffolder and the learner which implies that the teacher is more knowledgeable than the learner. The teacher then transfers knowledge and skill to the learner in such a way so that the learner will not only grasp the concept, but also perform the task (or a similar task) independently.

In the context of schooling, the scaffolder is an *expert* in his subject domain and understands the difference between scientific and spontaneous concepts. The scaffolder also teaches the scientific concept in connection with its underlying processes so that the learner can acquire the concept and use it to perform related tasks or to solve problems.

Scaffolding is a purposeful intervention or act by the teacher or competent peer and is arranged to produce independent learners. During informal learning situations, the mother does not necessarily pre-plan the intervention, but is guided by the responses or needs of the child during scaffolding. In the context of whole-class teaching, the scaffolder's intervention, though, is pre-planned and then adapted according to the emerging needs of the learners during learning.

During teacher and learner interactions, three key features of scaffolding are evident: contingent control, fading of the scaffold and the focus on the potential level of the child's development. C*ontingent control* is an intuitive balance between increasing help (when the learner experiences failure) and decreasing help (during success). Scaffolding provides a range of measured support according to the needs of the learner (Hobsbaum, Peters & Sylva, 1996:18; Stone, 1998:349; Pea, 2004:430). These needs are ascertained through continuous cycles of learner assessment (Pea, 2004:431) so that the learner support can be calibrated and tailored accordingly (Puntambekar & Hubscher, 2005:3).

The scaffolding support is also temporary and at the right time the scaffold is *faded out* or taken away to allow the learner to independently demonstrate the attained skill and ability. The fading of the scaffold thus ensures a gradual transfer of responsibility from the teacher to the learner; until the learner has the responsibility to perform the task without the teacher's assistance.

Another feature of scaffolding is that assistance is not aimed at the current actual developmental level of the learner, but rather towards that which the learner cannot currently achieve without assistance. This potential level of development cannot necessarily be pre-determined by the scaffolder. It only becomes visible during the scaffolding process.

The distinction between scaffolding and mediation, points to other significant features of the scaffolder. Mediation can take place through various tools. Scaffolding can only occur when a person intentionally organises the learning environment; whether through his actions, or by using resources such as computers. The focus during scaffolding is on the intentional actions of the teacher, whereas mediation also explores other media (for example a toy without the intervention of the mother). Lastly, a significant difference between mediation and scaffolding is that the latter focuses on pedagogic intent (for example how the human influences the toy), whereas mediation concentrates on the effects of mediation through a toy.

The role of the learner

Although Wood, Bruner and Ross's (1979) definition of scaffolding primarily equates scaffolding with teacher's actions, this definition implies that the success of the scaffold is ultimately measured according to the learner's ability to perform a task or to solve a problem. The learner therefore has an essential role during scaffolding.

Barbara Rogoff's notion of *guided participation* (Rogoff, 1989) indicates that during collaboration, the learner is actively involved in the teaching/learning process. When the learner actively responds to the teachers' actions, the teacher is guided to assess the effectiveness of the scaffold and to contingently control the intervention.

How scaffolding is applied to the classroom

Scaffolding strategies can be arranged in three major categories, namely *verbal* and *non-verbal actions* of teachers and possible *combinations of verbal and non-verbal actions*. The *verbal actions* include specific forms of communication or dialogue as undertaken by the teacher. The *non-verbal actions* include all other aspects of teaching, including the organization of the classroom (for example seating arrangements), the use of artifacts, punishment and reward systems, the structure of the lessons, et cetera. Possible *combinations of verbal and non-verbal actions* are when a teacher demonstrates a task to the learner and simultaneously explains the different steps that need to be taken.

Of all the studies described, Anghileri's model provides the most comprehensive external description of scaffolding in the classroom. Although the hierarchy does not provide an exhaustive description of all possible scaffolding strategies, it does provide a framework for organising such strategies. The key contribution of Anghileri work, though, is the notion that scaffolding is geared towards the highest level of thinking, namely conceptual thinking.

The elements discussed above paint a picture of the potential of scaffolding in the classroom. In my forthcoming discussion, I will provide a specific critique of some of the literature reviewed and then consequently propose a definition for scaffolding and show how it is empirically evident in the classroom. This also encompasses a discussion detailing how the analytical framework of this study was developed in order to achieve the purposes of this current study.

CHAPTER 3: THE ANALYTICAL FRAMEWORK

In this chapter a definition of scaffolding is presented that will provide a point of reference for the development of an analytical framework for this study. This definition must take into account the relationship between scaffolding and the scientific concept. The analytical framework must act as a lens that identifies empirical instances of scaffolding that are evident in the classroom. This framework is developed by combining and relating three sets of scaffolding strategies. The significance of combining these features of scaffolding and the impact of this on the design of the analytical framework is discussed in this chapter. The ways in which the framework is brought to bear on the data are illustrated by means of excerpts taken from lesson transcripts that constitute the data for this study.

WHAT IS SCAFFOLDING?

The starting point for defining scaffolding, as used in the classroom context, is provided by Wood, Bruner and Ross who in 1976, established that: scaffolding is the "process that enables a child or novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts" (Wood, Bruner & Ross, 1976:90). This definition, though, is not suitable for this current study because it was developed in the context of tutor/parent and child interactions, which is a different context to the one used in the current study, being teaching in the classroom. A significant difference between these two contexts is that tutor/parent and child interactions are informal and mainly based on the acquisition of skills and making meaning of language, whilst teacher/learner interactions in the classroom are based on purposefully assisting learners to acquire the scientific concepts of the various subjects that are taught. As previously discussed, this idea that learners acquire scientific concepts at school informs the notion of mediation. The abovementioned difference in context therefore makes it necessary to further develop Wood, Bruner and Ross's definition when this is applied to the classroom.

According to Wood, Bruner and Ross the purpose of scaffolding is to solve a problem, carry out a task, or achieve a goal. In the classroom, though, the purpose of scaffolding is that the learner acquires a scientific concept. Acquisition of a concept is evident when the learner solves a problem, carries out a task or achieves a goal that is related to the concept that was taught. The concept that is scaffolded should therefore be a *new* concept so that the teacher's assistance is necessary for the acquisition of the concept. Although assistance in the classroom can also focus on the teaching of skills (for example how to weave in the subject area of technology), the present study is about assistance that leads to the acquisition of new scientific concepts.

The term scientific concept can be used to represent all types of concepts from the different subject areas that are taught at school, and does not solely relate to the subject area of science. A concept is thus understood as an idea that has a fixed meaning, which can be expressed with a definition. This idea is also related to a system of other ideas. Since the data for this current study relates to the subject domain of mathematics (specifically numeracy), the phrase mathematical concepts will be used to describe ideas that have a fixed meaning in mathematics. Karpov and Bransford (1998:27) suggest that concepts are linked to specific underlying processes. Learners can only understand a concept once the underlying processes that undergird the concept are learned. Understanding a concept therefore involves more than knowing its definition. For example, in order to understand the concept of the number seven, learners need to carry out the underlying processes of representing seven in various ways, counting seven objects and ordering the numbers one to seven.

The literature on scaffolding (reviewed earlier) does not sufficiently explore the notion of the scientific concept in relation to scaffolding. Tharp and Gallimore (1988) and Anghileri (2006) touched on the notion of the concept in relation to the context of teaching. Both these scholars discussed concepts on the abstract level of conceptual thinking or cognitive restructuring. Tharp and Gallimore (1988) explained that during teacher assistance the learner forms cognitive structures into which the concepts taught are organised. According to Anghileri's hierarchy, developing learners' conceptual thinking is the highest level of scaffolding. The work of both these scholars identified and described discrete scaffolding strategies, including strategies that lead learners to conceptual thinking or cognitive restructuring. The use of these strategies in a lesson was then utilised to identify the measure in which scaffolding takes place during a lesson. Their work did not assert that in order for the teaching strategy to be labeled as scaffolding, the learner should be assisted to acquire the concepts of the subject. Only when concepts have been acquired, can the learner function on the abstract level of conceptual thinking and cognitive restructuring. This insight has been a significant motivation for exploring the relationship between the concept of scaffolding and the acquisition of mathematical concepts in this study.

Scaffolding in the classroom can thus be defined as *the actions of the teacher that assist the learner to acquire scientific concepts. This assistance occurs when the lesson is focused on or oriented to a particular concept, the concept is opened up and learner activities are structured in a way that enable the learner to internalise the concept. The success of scaffolding is evident when a learner can perform a task or solve a problem aligned with the concept(s) taught once assistance has been removed.*

Both Wood et al's definition and the one stated above suggest that scaffolding consists of two distinct parts, namely:

- The interactions between the learners and the teacher, which are described according to various scaffolding strategies, form the first part. Wood et al delineates this as the 'process that enables' a child and I refer to this as 'assistance'.
- The second part is the task that the learners can, and do perform relevant tasks, once the scaffold is removed. The structuring of such a task during a lesson is a fundamental part of the scaffolding process, since the learners' performance in this task indicates whether the scaffold was successful or not.

The literature reviewed in Chapter 2 suggests that scholars examine scaffolding predominantly according to the interactions between the teacher and the learner (except Anghileri who also discusses environmental provisions as scaffolding strategies), whilst the importance of structuring the independent learner task is ignored. This study encompasses scaffolding strategies that consider both parts of the scaffolding process and also indicates how these strategies engage the learner with the concept.

The definition, developed in this study, indicates the inter-dependence between the three features of scaffolding. In order for *complex scaffolding* to take place, orienting, opening up and structuring of the learner activity need to occur jointly in a lesson. Thus the definition does not view scaffolding as discrete strategies. Although the various strategies that assist learners are called scaffolding strategies, the discrete use of these strategies does not constitute complex scaffolding. Furthermore, the definition also implies that scaffolding strategies should focus on a new scientific concept that the learner has to acquire. If the strategy does not focus on a new concept, it cannot be labeled as a scaffolding strategy. Activities that relate to knowledge that has previously been acquired, can be described as practicing or revising.

For the purposes of this study, three key features for the concept of scaffolding (as it is applied to the classroom) have been identified. These features refer to categories of scaffolding strategies. Although the literature reviewed earlier places the scaffolder as either a teacher or a competent peer, this study examines the actions of the teacher rather than that of the peer. Therefore, the three key features of scaffolding have been described in terms of the actions of the teacher. The three features of scaffolding are:

- *Feature 1*: The teacher orients or focuses the lesson on one or more mathematical concepts.
- *Feature 2*: The teacher strategies open up the main mathematical concept.
- *Feature 3:* The teacher structures the learner task in a way that enables to learner to internalise the concept.

The first two features are evident during teaching, when the teacher engages with the learners through various questions, activities and other forms of interactions that can be labeled as *teacher input*. The third feature takes place when the teacher assistance is withdrawn and the learners are given the opportunity to perform a task on their own, which will be referred to as *learner uptake.*

The next section of this chapter describes the three features of scaffolding, using extracts from transcripts of lessons that comprise data texts for the study. The lessons had been videoed as part of research for the Count One Count All project. In this study lessons have been labeled so as to identify the particular teacher, grade and lesson. For example, teacher 8.13 represents teacher number 8 who taught Grade 1 in 2004 and Grade 3 in 2006. This numbering system is explained in greater detail in the next chapter.

Feature 1: The teacher orients or focuses the lesson on one or more mathematical concepts.

I have identified three ways in which the teacher's actions can introduce mathematical concepts or their underlying processes during teacher input. These are to *practice* and *revise* previously learnt mathematical concepts and/or to *teach the main mathematical concept* of the lesson. Of these, only the focus on the main (new) mathematical concept is described as a scaffolding strategy.

The analysis differentiates between introducing new concepts and practicing processes associated with previously acquired concepts. The following extract taken from one of the lessons of teacher 8.13 illustrates instances of practice:

Extract 1: Teacher 8.13

Time	Line	Dialogue	Non-verbal actions
		EXTRACT 1:	
	1	T: Would you please count for me from where you are sitting	
	2	in 3s.	
	3	T: You are going to count for me in what?	
	4	LS: In 3s.	
	5	T: Count in 3s starting from 33 to 120.	
	6	T: 33	Some learners are using
	7	LS: Counting forward in 3s from 33 to 120.	the number chart that's on
	8	T: Ok, some of you are not counting at all. Ok, I want you to	the board.
	9	count in 5s starting from 32 to 97. You add on 5s, you add on	
	10	5s.	
	11	LS: Count forward in 5s from 32 to 97.	
		EXTRACT 2:	Bongani comes to the
	36	T: Which number comes before 106?	board and places a sticker
	37	L: Bongani puts the sticker on 105.	on the board.
	38	T: Is he correct?	
	39	LS: Yes, Miss.	
	40	T: Ok, I want one person to put a sticker on the number that	
	41	comes before 177.	
	42	T: Xolisile, come and put your sticker on the number that	
	43	comes before 177.	
	44	T: Xolela on one hundred and seventy seven.	Xolela comes to the board
	45	L: Xolela puts the sticker on 176.	and puts the sticker on
	46	T: Is he correct?	176.
	47	LS: Yes, Miss.	
	48	T: Ok, now I want the number that comes after – which	
	49	number?	
	50	LS: The number that comes after…	Neziswa comes to the
	51	T: I want the number that comes after 152.	board and puts the sticker
	52	T: Neziswa, I want the number that comes after 152.	on number 153.

In this extract, the learners are practising acoustic counting, by counting in 3s and 5s in a chorus. In the second part of the extract, the teacher asked the learners to identify a number on a chart and to indicate what comes after the number. Counting, identifying numbers and indicating the next number are underlying processes used to establish the concept of a number. These activities take place for a short time in nearly all the lessons in the data, but are not the main focus of those lessons. They are therefore seen as practising the underlying processes.

A second way in which previously acquired concepts are revisited, is revision. Revision can also be used to excavate (bring to the surface) the learner's prior understanding or knowledge of the new mathematical concept that is going to be taught.

An example of this was found in one of the lessons taught by teacher 7.13. For about four minutes the teacher revised the different forms of money, namely notes, bronze and shiny coins. The learners answered the teacher's questions easily and they could provide examples of notes and coins. The teacher also wrote the various amounts of money that were mentioned by learners on the board. In this way the teacher revised how amounts are written in *rands* and *cents*.

The last way to introduce mathematical concepts is to teach a new mathematical concept, also called the main concept, which the learners have not previously required. The notion of scaffolding only applies when the teacher introduces a concept that the learners have not yet acquired. Scaffolding is not the revision of old concepts and/or their underlying processes that learners have already acquired. The first feature of scaffolding, therefore refers to the actions of the teacher that introduce a concept which the learners have not yet acquired and orients the lesson to this concept. At this point in the lesson the learners would not be able to perform a task that is related to the concept, without teacher assistance.

Typically, the introduction of a new concept and the orientation of the lesson, including learner activities, to this concept would result in a substantial portion of lesson time being allocated to this concept. Thus the mathematical concept would be sustained.

To conclude, the first feature of scaffolding indicates that a main mathematical concept (one which the learners have not yet acquired) is the object of scaffolding. Teacher input and learner activity should be oriented to this concept for a substantial portion of lesson time.

Feature 2: The teacher strategies open up the main mathematical concept..

Scaffolding refers to the pedagogic practices of a teacher that assist the student in acquiring a concept. The implication of this is that the scaffolding strategies ‘open up’ the concept so that the learner can acquire the concept.

While the first feature of scaffolding indicates that a main mathematical concept should be present and sustained for a sufficient amount of time during teacher input, the second feature emphasizes *engagement* with the main mathematical concepts.

Chapter 2 indicated that the scaffolding actions of teachers can be both verbal and non-verbal. The following extract illustrates how the teacher employs a non-verbal scaffolding strategy to engage the learners with or ‘open up’ a mathematical concept. This extract was taken from a lesson taught by teacher 9.33.

Extract 2: Teacher 9.33

Time	Line	Dialogue	Non-verbal actions
	181	T: Mandla has 30 candles and ties them into 3 bundles. Now	Teacher takes the beads
	182	how many candles will be in each bundle?	and shows the learners
	183	T: He has 30 candles and 6 bundles. Now how many candles	how to count 30 candles
34.39	184	will be in each bundle?	and how to separate the
	185	T: There are 30, so put your beads aside. Now how many	candles into three
	186	candles will be in each bundle? Yes.	bundles.
	187	L: 4	
	188	T: No.	
	189	LS: 6 bundles.	
	190	T: h	
	191	How many candles in one bundle?	
	192	L: 6	
	193	T: No.	
	194	L: 4	
	195	T: No.	
	196	T: How many are they? Here is your 30. Count off 30 and separate 6. Now how many are they?	

In this extract the mathematical concept was division and the learners had beads which they could manipulate in order to answer the question. When the learners could not solve the candle problem, the teacher *demonstrated* to the class how to use a string of beads to calculate the answer. In this way the learners were engaged with the concept by observing how the teacher paired off the beads into three groups. Although this engagement was more passive than when learners divided the beads into three groups themselves (instead of observing the teacher), the concept of division (as pairing off 30 beads into three groups) was opened up so that the learners could acquire the concept.

The following extract was taken from a lesson by teacher 1.11 and it illustrates how the learner was engaged with the concept through a verbal scaffolding strategy.

Extract 3: Teacher 1.11

Time	Line	Dialogue	Non-verbal actions
Before this extract two learners told the class how many family members they have. The teacher then asked the class to calculate how many more family members the one child has than the other. When the correct answer was given, the teacher proceeded with the following conversation.			
	122	T: How did we find the answer? What did we do to get the	
	123	answer?	
	124	T: Who can tell us what we did to get the answer?	
	125	T: Stand up, Sabelo.	
	126	L: It's 1.	
	127	T: It's 1 – what about 1? Because Bongani is your family.	
	128	T: Whose family is this?	
	129	LS: It's Nondumiso.	
	130	T: It's Nondumiso. What did we do to get 2?	
	131	L: We counted.	
	132	T: What did we count?	
	133	L: We started with 9 and then 2.	

In this extract, the concept was subtraction, and the teacher was *probing* the learners' understanding of the mathematical problem by asking the learners to explain how they calculated the answer to the problem. This scaffolding strategy challenged the learners to think about how they solved the problem and to formulate their thinking into words. In this way, the learners were actively engaged with the concept of subtraction by explaining how they, for example, counted forwards to solve the subtraction problem, thus opening up the concept.

To conclude, verbal and non-verbal scaffolding strategies engage learners with the concept. These strategies then open up the mathematical concept.

Feature 3: The teacher structures the learner task in a way that enables to learner to internalise the concept.

During a lesson, when the teacher assistance is removed (which is also called *fading of the scaffold*), the teacher creates the opportunity for independent learner activity to occur. The independent learner activity can be described as the learner's attempt to perform a task or solve a problem without the direct assistance of the teacher. The teacher creates an opportunity for this learner uptake activity by, for example, providing an appropriate task, setting up the group work activity and providing the resources to complete the task.

The rationale for choosing this as a key feature of scaffolding is as follows:

- As was discussed before, both Wood et al's (1976) definition and the one employed by this current study indicate that the end result of scaffolding is that the learner is enabled to independently solve a problem, perform a task or achieve a goal related to the assistance. The teacher, therefore, needs to provide such an opportunity.
- The learner uptake activity is instrumental in providing the scaffolder with two distinct results. Firstly, if the learner task aligns with the concept that was taught, the learners' success or failure in attempting the task will indicate whether the teachers' scaffolded actions were successful or not in opening up the concept. In addition, the learner's success or failure will also point toward the type of assistance that is further needed.

To ensure that the opportunity created by the teacher for learner uptake successfully completes the scaffolding process, the third feature of scaffolding is identified by the following scaffolding strategies:

- The learner uptake activity that the teacher designs or selects focuses on the same mathematical concept that was taught. There should therefore be an alignment between the concept of the learner uptake activity and the concept that was taught during teacher input.
- The teacher organizes the lesson in such a way that there is a sufficient amount of time for the learners to perform the learner uptake task. If the learner cannot complete the task due to time constraints, the learner's performance does not indicate the level at which the concept was acquired.

- The teacher structures the learner uptake activity in such a way that each learner in the class has the opportunity to perform the task.

A summary of the concept of scaffolding

When scaffolding is applied to the classroom, the notion of the scientific concept becomes a relevant focus of this process. On the next page, figure 1 provides a descriptive summary of the three key features of the concept of scaffolding.

Figure 1: A description of the three features of scaffolding.

	Key features	Description of the key features
These features take place during **teacher input.**	Feature 1: ◆⟶ The teacher orients or focuses the lesson on one or more mathematical concepts.	▪ The teacher focuses on a new mathematical concept which the learner has not yet acquired. ▪ The main mathematical concept is sustained throughout the teacher input.
	Feature 2: ◆⟶ The actions of the teacher open up the main mathematical concept.	▪ The teacher uses verbal and non-verbal strategies to allow learners to engage with the concept. These strategies then open up the concept.
This feature takes place during **learner uptake.**	Feature 3: ◆⟶ The teacher structures the learner task in a way that enables to learner to internalise the concept. .	▪ The teacher creates an opportunity during the lesson for a learner uptake activity. During this activity the learner can demonstrate the level at which he/she acquired the mathematical concept that was taught. ▪ The concept of the learner uptake task aligns with the mathematical concept that was taught during teacher input. ▪ The learner has the opportunity to spend a sufficient amount of time on this task. ▪ Each learner in the class has the opportunity to perform the task.

HOW IS SCAFFOLDING EMPIRICALLY EVIDENT IN THE CLASSROOM?

The next step in achieving the purposes of this study is to describe how the abovementioned features of scaffolding are empirically evident in the classroom. These features are also illustrated with extracts from various lessons transcripts.

Feature 1: The teacher orients or focuses the lesson on one or more mathematical concepts.

To indicate that the first feature of scaffolding is evident in the classroom, the researcher has to determine if there is a main mathematical concept in the lesson and if this concept is sustained during the teacher input. To achieve this, the researcher has to answer the following two questions:

- What is the main mathematical concept of the lesson?
- Is the main mathematical concept sustained during teacher input?

What is the main mathematical concept of the lesson?

Four factors are significant in identifying the main mathematical concept of a lesson:
Firstly, the observable acts and verbal communication of the teacher are used to identify the main mathematical concept of the lesson. In this study this is called the *purposefulness* in teaching. The mathematical concept that is taught (which is the purpose of the lesson) is not determined from the teacher's description of the lesson, in a lesson plan, nor from a discussion with the teacher before or after the lesson. Even though the lesson plan and the discussion with the teacher reveal the purpose of the lesson, this study is interested in the actual acts of the teacher during teaching and what these actions indicate. For this reason the *purposefulness in teaching,* as evidenced in practice, indicates the main mathematical concept of the lesson.

The following extract illustrates how the observable acts of the teacher indicate the main mathematical concept of the lesson

Extract 4: Teacher 6.11

Time	Dialogue	Non-verbal actions
Before this extract, the teacher reads the following word problem to the learners: A blue tin has 45 litres of paraffin and the green tin has 48 litres of paraffin. How many litres are in these tins? The rest of the dialogue focuses on this word problem.		
32.35	T: Here they are asking us: How many litres of paraffin do they have all together? We have a green tin and a blue tin. We have to know: How many litres do they have all together? Who can come and do the sum for us?	
	T: Yes, Ntombi, come quickly.	Learner writes on board: 40+ 5 (T erases this incorrect method)
	T: There are 45 litres and 48 litres. Some of you should be calculating so that, if she makes a mistake we can rectify it.	
	T: Can someone else come?	Another L writes on the board: 40 + 40 = 80 8 – 5=
	LS: Yes, Miss.	
	T: Do your own way, live the way she was calculating. Are we subtracting here? Are they asking us to do subtraction? How many litres do we have?	
	LS: No, Miss!	
	T: All right. Yes, there we are! He says we take 40 + 40 is equal to 80 and 8 + 5 is equal to 13and 80 + 13 is equal to 93. So it's equal to 93. Because we are running out of time we were going to do more on these examples. Now let's look at the second one. Let's read.	Learner writes on the board: 8 + 5 = 13 80 + 13 = 93

In this extract the teacher's actions were: to explain the meaning of the word problem and to ask two learners to demonstrate, on the blackboard, how to solve the word problem. The teacher's actions indicated that the purpose of this interaction was to teach the concept of addition by using the familiar example of paraffin. The teacher's actions were focused on the concept of addition.

The second factor in depicting the main mathematical concept of each lesson is that the main mathematical concept is identified from the teacher input, and not from the learner uptake activity. The reasons for this are:

- In this study each lesson that was examined included teacher input. Some lessons, though, had no opportunity for learner uptake. In such cases the main mathematical concept of the lesson could still be derived from the teacher input.
- The specific interest of this study was to examine what the teacher taught and how the teachers arranged opportunities for the learners to engage with these concepts. The purpose was therefore to examine how the concepts were taught during *teacher input* and how these concepts were employed in the learner uptake activity.

Thirdly, as was discussed in the previous section, the teacher's actions can require learners to practise or revise processes associated with a concept, or the teacher's actions can teach the new concept for the lesson. In this study, only concepts that were taught, were classified as the main mathematical concepts of the lesson. However, since no tests were done to assess the learner's prior knowledge of the concept that was taught, it was not possible to imply that the main mathematical concept that was identified for each lesson was necessarily a new concept. The study differentiated between teaching, on the one hand, and structuring practice or revision on the other.

Lastly, a teacher may teach and/or practise or revise more than one concept and its associated processes in a lesson.

The following example from one of the lessons of teacher 7.13 illustrates this. During teacher input this teacher initiated various activities to *practise* the underlying processes of acoustic counting and mental calculations and to *revise* the units of measurement. The teacher then proceeded to a range of activities that related to the conversion of units of measurements (capacity), comparing capacities, division (how many cups can go into a litre), addition and fractions in the context of measurement. The variety of concepts taught during teacher input made it difficult to determine what the *one* main mathematical concept of the lesson was, especially since no more than one to seven minutes were spent on each concept or process. It was then decided to exclude those concepts that were practised and revised. The *remaining* concepts taught during teacher input were then classified as the main mathematical concepts of the lesson. In this lesson the main mathematical concepts and underlying processes were therefore: capacity (conversion of units, comparing capacities), division, addition and fractions.

To summarise, the main mathematical concept(s) of each lesson was determined according to:

- The observable acts of the teacher.
- The concepts evident in the teacher input.
- The main mathematical concept, which is a concept that is taught, rather than revised or practised.

Is the main mathematical concept sustained during teacher input?

To determine whether the main mathematical concept is sustained during teacher input, a time mechanism is used. The duration of the activities or teacher actions, during teacher input, that relate to the *main* mathematical concept or its underlying processes, is recorded.

In this current study a mathematical concept is only sustained when a minimum of 60% of the teacher input time is spent on *one* of its mathematical concepts or *one* of the underlying processes. This percentage was chosen since 60% of the teacher input time was deemed to be a sufficient amount of time for the teacher to teach the new mathematical concept(s). The percentage was taken from the lesson plan format provided by the Count One Count All project. The teachers in this current study participated in the project and were encouraged to plan their lessons according to these formats.

A portion of one of the lessons taught by teacher 6.11 is discussed below to illustrate the process of determining whether a concept was sustained. The teacher spent a total of 50 minutes on teacher input. Of the 50 minutes, 30 minutes were spent on practice activities (acoustic counting, number recognition, estimation, etc.) and the rest of the time on the main mathematical concepts. 16 minutes were spent on addition (that is 32% of teacher input time) and four minutes on money (that is 8% of teacher input time). This is illustrated in table 1 on the next page:

Table 1: An illustration of the percentage of time that was spent on the main mathematical sub-concepts of the lesson. (Teacher 6.11)

Focus of teacher actions during teacher input	Time	Percentage of teacher input
Practice activities	30 minutes	
Main mathematical concepts	20 minutes	
Addition	16 minutes	32% (16 minutes out of 50 minutes)
Money	4 minutes	8% (4 minutes out of 50 minutes)
TOTAL teacher input time	50 minutes	

Since the mathematical concepts were taught for less than 60% of the teacher input time, the main mathematical concept in this lesson was *not* sustained.

Feature 2: The teacher strategies open up the main mathematical concept..

As was discussed in the previous section, specific verbal and non-verbal scaffolding strategies can open up the main mathematical concept of the lesson. To determine if the concept is opened up, it is first necessary to examine the *type of strategy* that is used by the teacher to teach the concept. Next, it is necessary to examine *how* this strategy is used to teach the concept. From the literature that was reviewed in Chapter 2, I found that Siemon and Virgona's 12 communicative scaffolding strategies were the most useful. It was possible to use their list of generic strategies to describe the types of strategies that were employed by the teachers in this study. The reason for selecting Siemon and Virgona's strategies is two fold. Firstly, these strategies were a further development of Anghileri's work and also supported the idea of assisting "students to make conceptual connections and understand their own learning processes" (Siemon and Virgona, 2003:18). Siemon and Virgona's strategies were therefore mindful of conceptual thinking. Secondly, Siemon and Virgona's strategies were developed in the context of numeracy teaching. This correlated with the data of this study, which also related to numeracy teaching.

Figure 2 provides an explanation of Siemon and Virgona's strategies. Of these strategies, only the definition of modelling has been extended to suit the data for this study. The data indicated that in some instances teachers did not model a problem or a task in front of the class, but rather instructed a learner from the class to model the problem or task. This strategy is called *delegated modelling*.

Figure 2: Siemon and Virgona's 12 scaffolding strategies

Definitions in brackets are provided as adaptations for this study.	
Modelling	This occurs when the teacher shows the learner what to do and how to do it. The teacher communicates through voice and actions. Modelling does not happen, though, simply through a serious of questions; it is also accompanied by the teacher's demonstrative actions. (The teacher can also use *delegated modelling* when a learner is asked to demonstrate to the class how to solve a problem or perform a task.)
Instructing	This occurs when the teacher instructs the learners to do a specific action or task (that displays the features of the concept.)
Telling	This occurs when the teacher tells the students the concept or how the concept works. Telling seldom involves the questioning-answering technique and mostly includes a monologue.
Excavating	The teacher systematically questions to find out what students know or to make the known explicit. The teacher explores the children's understanding in a systematic way.
Collaborating	The teacher works interactively and in-the-moment with the children to achieve a solution. The role of the teacher is to provide ideas, to respond to suggestions of others and to use props scaffolds (provides a suggestion that will help students to do the task).
Guiding (cueing)	The teacher observes, listens and monitors students **as they work**, asks questions designed to help them see connections and/or articulate generalizations, guiding/leading the student to the to the correct answer through comments and questions and answers.
Convince me (justify/prove)	The learners have to prove or convince the teacher (e.g. by providing evidence) of their mathematical solutions, for example the teacher can act as if she does not understand what the student is saying.
Noticing	The teacher draws the learner's attention through questioning, rephrasing and gestures to a particular aspect of the concept which has been taught. The teacher does not tell the student what to see or notice or how the concept works. However, the teacher engages the learners by encouraging them to explain and verbalize their thinking.
Focussing (noticing/coaching)	The teacher focuses on a specific gap (in skills or knowledge) that the learner has. This gap needs to be bridged so that the learner can proceed. The teacher provides opportunities for the learners to bridge the gap for themselves.
Probing	Probing occurs when the teacher evaluates the student's understanding using a specific question/task designed to elicit a range of strategies, presses for clarification and/or identifies possible areas of need.
Orienting	The teacher positions the lesson and sets the scene (e.g. by establishing a context or posing a context) or the teacher invokes direction to the lesson (e.g. invoking relevant prior knowledge and providing a rationale for the lesson).
Reflecting (reviewing)	The teacher recounts what was learned or the learners share ideas and strategies. This can also be the share time at the end of the lesson when learning is made explicit.

Siemon and Virgona's list has one shortfall. It does not adequately address a specific strategy that was observed in many of the lessons in the data. This strategy was to teach a concept by asking learners a series of questions. These questions had specific predetermined answers. In this study, this technique will be referred to as *closed questioning*. This strategy was used in two ways:

- The questions lead the learner in a step-by-step way to the mathematical concept. Correct and incorrect learners' answers are discussed. The use of this strategy opens up the concept.
- The answers to the questions that the teacher asked were never discussed. Incorrect learner answers were ignored and questions were repeated until the correct answer was provided. There was no explanation of *why* answers were correct or not. This strategy does not open up the concept.

Previously in this section it was stated that to determine if the concept was opened up, it was first necessary to identify the type of strategy that was used and then to examine *how* this strategy was used. When a teacher used a scaffolding technique, it does not necessarily mean that the concept was opened up. The strategy should engage the learners (whether actively or passively) with the concept. An example of this is illustrated in one of the lessons of teacher 9.33.

Extract 5: Teacher 9.33

Time	Dialogue	Non-verbal actions
	T: Now, let's move on to something else. I want you to look at the board. Please, let's look at the board. I have written something there.	
	T: Will you pass on the beads. We are going to use the beads. If you brought pegs from your home let's use them. Can we listen now?	
	T: What we are about to do is for example: your mother sends you to the shop and gives you R10 to buy something. The things you are going to buy, let's say, it will cost you R6.00. Now how much will be your change.	
	LS: R4	
26.00	T: What?	
	LS: R4	
	T: Please, let's lift up our hands when we want to give an answer. Do not shout. Now, if your mother gives you R20 and what you buy costs you R13, how much is your change? Lift up your hand.	
	T: How much? You had R20 and you paid R13. How much is your change?	Only some learners attempt to answer the question.

28.55	140 141 142 143 144 145	L: R7 T: Your change will be R7. Yes, that's right. T: Now, if your mother gives you R30 and you spend R22, how much do you have? L: R 8, Miss. T: All right, very good. Now, I want us to look at the board. Read together.	

In this extract the teacher asked a variety of questions. When a question was answered correctly, the teacher continued with the next question. At no point did the teacher enquire how the correct answer was calculated nor did the teacher demonstrate or explain the answer, by for example using beads that were available during this specific lesson. In this lesson the strategy of closed questioning was not used in such a way that it opened up the concept.

Another example is the use of the strategy of probing. When a teacher asks a probing question, this question should elicit a range of strategies from the learners. If the teacher asks a probing question and then immediately provides her own answer/strategy then this strategy was not deemed to be used in a probing way.

A quick survey of the data (before the official analysis took place) indicated that few teachers employed more than one scaffolding strategy during teaching. Since one of the purposes of this study is to examine the extent to which scaffolding is evident across a lesson, I decided to follow minimal approach: if a teacher used a *minimum of one scaffolding* strategy to teach *each* mathematical concept or *each* underlying process, it was established that the concept was opened up. This does not necessarily imply that the concept remained "open" during the lesson and that the learner acquired the concept in such a way that he/she could perform a related task on his/her own. The purpose in describing this feature of scaffolding is rather to establish whether the teacher used a strategy that could possibly open up the concept. The following two examples illustrate this point.

Example 1: If a teacher taught one main mathematical concept or underlying process, the concept was opened up when *one* scaffolding strategy was employed to teach the concept. An example of this was found in one of the lessons of teacher 2.11.

Extract 6: Teacher 2.11

Time	Line	Dialogue	Non-verbal actions
25:47	425	TS: Here is 7 (pasting a number card on the board). Here is 7	Teacher instructs
	426	(pasting another number card on the board). Can we all see?	learner
	427	LS: Yes, Miss.	
	428	T: Let's count with our fingers from 1 to 7.	
	429	LS: Counting their fingers from 1 to 7.	
	430	T: Again.	
	431	LS: Counting their fingers from 1 to 7.	
	432	T: Show me 7 with your fingers.	
	433	LS: Lifting 7 fingers.	
	434	T: Is there 7 here in this thing? (Meaning the number chart)	
	435	LS: Yes, miss. (Pointing to the number).	
	436	T: Where is 7?	
	437	LS: Pointing to the number 7 on the number chart.	
	438	T: Where is the number 7? Show me here (pointing to the	
	439	number chart).	Learners have their
	440	LS: Points to the number 7. (Teacher going around helping	own number charts
	441	them to share the number charts).	
	442	T: I didn't see your number 7. Where is your 7? Yes, write.	
	443	(Clapping) Let's count.	
	444	T: Phamela, look at Miss Ndevu. Let's write 7 in the air.	
	445	L: Writing the number 7 in the air.	
	446	T: Amanda look at the board. We are writing 7 in the air.	

The main mathematical concept of this lesson was the number *seven* and its underlying process was to represent the whole number seven in various ways. To teach this main concept and process, the teacher instructed the learners to: count up till seven with their fingers, to show the number seven with their fingers, to point to the number seven on a number chart and to write the number in the air. After the event depicted in the extract, the teacher continued with similar activities. In this extract the teacher *instructed* the learners to perform various actions that displayed the concept. According to Siemon and Virgona's list, instructing is a scaffolding strategy. Since the teacher used a *minimum* of *one* scaffolding strategy to teach the main concept, the concept was opened up.

Example 2: If the teacher taught more than one concept, *all* the concepts had to be opened up before the lesson was labeled as *opening up the concept*. An example is taken from one of the lessons of teacher 9.33. The teacher structured a variety of activities that related to different concepts. Firstly, the learners in the class were asked to order the weights of items that were brought from home from heaviest to the lightest. The teacher also reminded the learners that scales are used to measure weight. Next, the learners had to estimate and compare the weight of the teacher and another learner in the class. The teacher asked the learners several questions regarding their comparison. Following this discussion, a graph was pasted on the blackboard and the learners had to answer several questions regarding the various weights of people that were presented on the graph. The learners were also asked to total the weights of several learners. Finally, the teacher read through two pages in a textbook with the learners. During this reading the learners were told about various kinds of scales and asked to arrange pictures according to the different weights of the objects.

During this lesson the teacher taught the main mathematical concepts of measurement, number and data. The following table represents the various scaffolding strategies that were employed in this lesson.

Table 2: The main mathematical concepts taught by teacher 9.33

	Scaffolding strategy	The actions of the teacher	Concepts and underlying processes determined from the teacher's actions
		Main mathematical concept of *weight*	
1.	Instruction (scaffolding strategy)	The teacher instructed the class to order the weight of items and also the weight of some class mates.	Ordering weights according to its size (underlying processes)
2.	Closed questioning: (not used as a scaffolding strategy)	The teacher asked numerous questions relating to estimation.	Estimation of weight (underlying processes)
3.	Closed questioning: (not used as a scaffolding strategy)	The teacher asked numerous questions relating to the comparison of learners' weight.	Comparison of weight (underlying processes)
		Main mathematical concept of *a scale*	
4.	Telling (scaffolding strategy)	The teacher discussed various scales.	The concept of a scale
		Main mathematical concept of *addition*	
5.	Closed questioning: (not used as a scaffolding strategy)	The teacher asked numerous questions relating to addition.	The concept of addition
		Main mathematical concept of *data*	
6.	Closed questioning: (not used as a scaffolding strategy)	The teacher asked numerous questions relating to a graph that was pasted on the wall.	Reading a graph (underlying process)

To indicate whether the main mathematical concepts of this lesson were opened up, the following questions were answered:

- Was a minimum of one scaffolding strategy used to teach *each* underlying process of the concept of weight? The answer is no, only the processes of ordering weights were taught with one scaffolding strategy. The teacher used no scaffolding strategies for the other processes.
- Was a minimum of one scaffolding strategy used to teach the concept of scales? The answer is yes.
- Was a minimum of one scaffolding strategy used to teach each concept of addition? The answer is no.
- Was a minimum of one scaffolding strategy used to teach the concept of data? The answer is no.

Conclusion: Since the answer was *no* for three of the four concepts, the main mathematical concepts were *not opened up*. If the answer for *all* the concepts had been yes, then the main mathematical concepts would have been opened up. This was not the case though for this example.

An exception to the rule to determine if a concept was opened up, was when more than one main mathematical concept was taught during teacher input and one of the concepts was taught for 50% or more of the teacher input time. In such cases, the other main concepts were taught for a very short period of time and it was evident that the main concept of the lesson was the one taught for more than 50% of the teacher input time. If *one* scaffolding strategy was used to teach this main concept (regardless of whether scaffolding strategies were used to teach the other concepts identified in the lesson) then the lesson was classified as: opening up the concept. An example of this is illustrated in Chapter 5 when the first case study is discussed.

This study did not examine the degree to which the mathematical concept was opened up, since it would make the analysis too complex. In the analysis 'opening up' strategies were described as being either present or absent. An example of this again relates to probing. A teacher might ask one probing question, but then not follow through on it. As discussed before, probing does not only imply that the teacher merely asked a probing question. It also entails drawing out the learners' understanding of the concept and then using that knowledge to explain the concept. A probing question might open the concept up, but if the teacher does not follow through with the strategy, the concept thus becomes closed again. This was one of the limitations of the study. In this study, when a probing question was not followed through, the strategy was described as: not opening up the concept.

To conclude, in this study the concept was categorized as having been 'opened up' when:

- A *scaffolding strategy* was used to engage the learners in the concept. Siemon and Virgona's list defined possible strategies.
- *One* scaffolding strategy was used to teach *each* main concept and *each* of its underlying processes.
- The exception to the rule was when one main concept was taught for 50% or more of the teacher input time. If one scaffolding strategy was used to teach this concept, the lesson was classified as: opening up the concept.

Feature 3: The teacher structures the learner task in a way that enables to learner to internalise the concept.

An important aim of scaffolding is that the learner should be able to perform a task or solve a problem on his own once the scaffold has been removed. This task or problem should be connected to the main mathematical concept that the teacher taught during teacher input. For the purpose of this study *learner uptake* was seen as the opportunity provided by the teacher for a learner to perform a task or solve a problem on his own.

To discuss how this feature of scaffolding is evident in the classroom, it is necessary to answer the following questions:

- How does the researcher differentiate between learner uptake and teacher input?
- What are the different forms of learner uptake? This means, what does learner uptake entail?
- How is the structuring of the learner uptake activity evident in the data?

How did this study differentiate between a learner uptake activity and teacher input?

Learner uptake takes place when a learner performs a task, does an activity or solves a problem on his/her own or in collaboration with peers (where the role of the peers is not to scaffold, but to do the task). During learner uptake the teacher acts as a facilitator. In a real classroom, though, the teacher might provide scaffolding to either individual learners or a group of students during learner uptake. This only takes place upon request or when the teacher observes that a learner is struggling. During such instances scaffolding is directed towards the learners in need and not the whole class.

Forms of learner uptake activities

Learner uptake can consist of the following two elements:

- The opportunity provided by the teacher for learner uptake can be in the form of group work, an individual activity (when the learner works on his own) or pair work.
- The data analysed by this study included some instances of reflection sessions (after group work or working in pairs). During these sessions learners were sometimes given the opportunity to reflect on the correctness of their work and to discuss their own understanding so that the knowledge that was learned could be made more explicit. In this study, these instances were classified as part of learner uptake.

The aim of this study is not to show the level at which the learner acquired the mathematical concept that formed part of the learner uptake. Nor is it within the scope of this study to indicate whether learners could perform tasks or solve problems correctly. The data for this study was collected to analyse the teacher's actions during teaching and not those of the learner. For this reason, no learner interviews or tests relating to the concepts taught during the lesson were undertaken. Only one camera recorded lessons of 30 or more children in each class. Each learner's actions and conversations during the lesson were not recorded. For this reason no claims can be made regarding learner acquisition of the main mathematical concept(s).

How was the opportunity provided by the teacher for learner uptake analysed?

The opportunity that the teacher provides for learners to perform a task without teacher assistance, is described in relation to the following scaffolding strategies:

- The teacher aligns the mathematical concept that is taught during teacher input with the mathematical concept of the learner uptake task.
- The teacher provides an opportunity for the learners to spend a sufficient amount of time on the learner uptake task.

- The teacher structures the learner uptake task so that each learner in the class can participate in the task.

To identify that these strategies are evident in the data, I formulated and answered the following questions for each lesson:

Question 1: Does the teacher provide an opportunity for learner uptake in this task?

The first task for the researcher is to identify the learner uptake task. If there is no such task then the abovementioned Questions 2 to 5 cannot be answered. As was discussed before, a task was identified as learner uptake when the learners in the class (on their own, in pairs or groups) were performing a task or solving a problem independently, without the continual assistance of the teacher. If support was provided by the teacher, it was only for a short amount of time, relative to the activity, and then the support was withdrawn again.

Question 2: What are the mathematical concepts and the underlying processes addressed in the learner uptake task?

To determine the mathematical concepts and underlying processes of the learner uptake task(s), the actual task(s) that the learners performed, was examined. This task was either shown on the video recording (and could be observed through teacher and learner actions) or written in the transcription of the lesson. An example of this was found in one of the lessons of teacher 4.22.

Extract 7: Teacher 4.22

Time	Dialogue	Non-verbal actions
	T: Now, I am going to give each of you your own pigs. You are going to build a pigsty. I am going to lift a number. You know who counts small numbers and big numbers. I am going to lift a number and you are going to put your pigs in the sty.	Teacher moves to the next group.
	T: You are going to write your name and today's date. What is today's date?	
	L: 1st of August, Miss.	
	T: Here is the date for every one.	
	T: You will get your own pigs. I will give you 8. If you get more than 8 bring the extra ones back.	
	T: You in the middle, come and get 12 and that group must have 16. Each person must take 16. Any extras must be brought back.	
	T: Thuliswa! Thuliswa, you must only have 16.	
	L: He is taking from my pigs, Miss.	
	T: Each person has her/his own pigs please.	
	T: How many pigs do you have? You must take only 12 in this middle group.	Learners are talking while the teacher is explaining. the task.
	T: How many do you have?	

	L: 12	
	T: You are short with how many?	She wants them to open the book where they can have one blank page on the left and one on the right.
28:00	L: I have 6.	
	T: How many do you need to make 12?	
	L: No response.	
	T: Take these.	
	L: Miss, Miss, sorry Miss.	
	T: Gives them more, why are yours--	
	T Now listen, if you have your pigs, make your 2 pigsties.	
	T: You must open your book like this so that you can make one sty on each page. Share your pigs. I said your pigs must be put in 2 sties and I want to see how many pigs you are going to put in each sty.	The teacher walks around the class to check learner work.
	L: Learners are working.	

From the extract and the learner work that was observed in the video recording, it was clear that the learner uptake task is the following: each learner has to divide a certain number of cut out images of pigs into circles representing two pigsties. This is done in the learner's workbook. In this activity the main mathematical concept is division (and the underlying process is equal sharing).

Question 3: What is the alignment between the main mathematical concept of teacher input and the main mathematical concept of learner uptake?

To analyse the alignment between the mathematical concepts and underlying processes of the learner uptake task(s) and the ones that were taught during teacher input, the following rule was taken as a guideline: the main mathematical concept taught during teacher input formed the *main* concept of the lesson. The mathematical concepts of the learner uptake were evaluated against this main concept of the lesson.

To examine the ways in which the mathematical concept that was taught, and the ways in which the mathematical concept of the learner uptake task aligned with each other, the following criteria were established: the alignment can be good, partial or there can be no alignment. Another category was also created for lessons that had no learner uptake task. For scaffolding to occur, though, the alignment needs to be good. Next, I will discuss how these criteria were evident in the data.

Good alignment

Good alignment was deemed to be present when the main mathematical concept of *every* learner uptake task that is performed during the lesson was the same as the one taught during teacher input. An example of this is found in one of the lessons of teacher 2.11. During teacher input, the teacher taught the process of representing the number seven in different ways (showing it with fingers, drawing the number in the air, et cetera). For learner uptake, each learner completed a worksheet that also dealt with representing the number seven in different ways. During teacher input and learner uptake the same concept and its underlying process was employed and therefore this was an example of a good alignment.

The exception to this rule is: when one of the main concepts of the lesson was taught for 50% or longer of the teacher input time, then the concept of the learner uptake task was only compared with this one main concept. If the concept of the learner uptake task was the same as the concept that was taught for more than 50% of the teacher input time, then the learner uptake task had a good alignment.

Partial alignment

Partial alignment occurs when some but not all concepts addressed in the task align with the main concepts taught, or where there are multiple learner activities, only some of which align with the concepts and processes taught. In some lessons, learners did more than one task for learner uptake, for example learners would first do a group work activity and then complete a worksheet on their own. The data also indicated instances where groups of learners performed different, differentiated tasks. An example of differentiated tasks was found in one of the lessons of teacher 3.11.

Extract 8: Teacher 3.11

Time	Line	Dialogue	Non-verbal actions
23:52		TASK 1:	
	451	T: You here, can you see this page? You are going to	
	452	choose the one with a lot of water, the one that can	
	453	carry a lot of water into e…e…e…no…. the one that	
	454	can be filled with a lot. Isn't it? When you are done you	
	455	are …. are going to colour it with a red (ebomvu)	
	456	crayon and when you finish you will write its name on	
	457	the side.	
	458	T: If the name is Nomsa, you are going to write the	
	459	name; if it is dog, you will write dog. Do you	
	460	understand? There is an example. Which can carry a lot	
	461	of water from these? Which carries a lot of water?	
	462	Good, when you finish you colour it and where do you	
		write it? You write it next to its name, next to name at	
		the bottom here.	
		TASK 2:	
	478	T: Here, we said we are here; you are going to start	
	479	here. Start now, start here in the middle. You are going	

	480	to explain if this 300 ml bottle can fill up 21 cups with	
	481	water. How many cups can it fill up? This 500 ml milk,	
	482	can it fill up 21 cups with water. How many cups can it	
	483	fill up?	
	484	T: This litre of milk, how many cups of water can be	
	485	filled with it? This litre bottle, how many cups of water	
	486	can be filled with it? You will write here how many	
	487	cups isn't it?	
	488	T: Right, after that we are going to come back to - to	
	489	check if you are right. Put here now. Yes, the first one	
	490	is your name. Here is the right one. The first thing is	
	491	your name isn't it? Shh- I'm going to beat you, I'm	
	492	going to embarrass you, I'm…. right you – you have a problem here, come – come and join us here all of you come here.	

The learners in the class performed either Task 1 or 2. In Task 1 the learner compared the capacity of various quantities. These quantities were represented by pictures. In Task 2 the learners had to indicate how many of one quantity can fit into another quantity. Both these tasks also represented different concepts. Task 1 was the concept of capacity and Task 2 was the concept of division.

Regardless of whether the learners did the same learner uptake task(s) or differentiated task(s), a partial alignment is evident in the following way:

- If only *one* of the concepts or *one* of the underlying processes of any of the learner uptake tasks was the same as *one* of the concepts or *one* of the processes that was taught.

The following extract illustrates a *partial* alignment. The example was taken from one of the lessons of teacher 8.13. For learner uptake the learners in the class performed the following three tasks.

Extract 9: Teacher 8.13

Time	Line	Dialogue	Non-verbal actions
		TASK 1:	
	213	Ok, listen now, nhe. We are going to work as a group	
	214	LS: Yes, miss.	
	215	T: I am going to give each group pages, nhe, and then	
	216	give you numbers, nhe.	
			Teacher hands out A3 pages with patterns to each group. Pointing to the flower on the worksheet.
	217	T: We are going to look at this first flower.	
	218	T: What are we going to put here?	
	219	LS: 1	
	220	T: What are we going to put next to the first flower?	

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236</td><td>LS: 1
T: 1.The last one has 10 flowers. What are we going to write?
LS: 10
T: 10. You have different patterns in those pages. This group has flowers, this one has washing and this one has a millipede and you also have a millipede and you have a flower. You also have a flower
L: It’s for all of us.
T: Ok, ok, don’t fight. Keep quiet.
T: Take out the numbers. Take them out of the holder. Which number are we going to put first?
LS: 1
T: 1. Ok, take out the numbers. Look if you are pasting it correctly. Ok, this is the head and where are you going to put 1.</td><td>Learners do not respond.

Teacher hands out number cards.</td></tr>
<tr><td>30:00</td><td>308
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330</td><td>TASK 2
T: Ok, ok, listen. Listen first before we do this work. Turn your pages facing down, turn your pages, turn your pages. In that home, in that family - Kibi’s family - the mother went to town, nhe.
LS: Yes, Miss.
T: She bought 4 apples. Do you understand?
LS: Yes, Miss.
T: And the father went to the supermarket. He bought apples, nhe. Father bought 5 apples, nhe.
T: How many apples did the mother buy?
LS: 4
T: And how many apples did the father buy?
LS: 5
T: 5 There in your page. Let’s write how many apples. Do not tell me. I will see in your paper. How many apples you have all together. When we add the ones that mother bought with the ones that father bought and write your name so that you don’t lose your paper.
T: You take here.
L: Are we adding on?
T: We are adding, Zanele. We are adding the apples that mother bought with the apples that father bought.
T: First write your name.</td><td>Teacher is handing out pencils.</td></tr>
<tr><td>40:00</td><td>380
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382
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384</td><td>TASK 3:
T: What we are to do this side? We are going to fill in the missing numbers>
Worksheet:
<table><tr><td>1</td><td>2</td><td></td><td>4</td><td></td><td></td><td>7</td><td>8</td><td></td><td></td></tr></table>T: Here, you are going to fill in the numbers in the empty boxes.
When you complete this you fill in the missing numbers.</td><td></td></tr>
</table>

One group of learners had to paste the numbers one to ten, in sequence, on a row of flowers, millipedes, et cetera. The mathematical concept here was number and its underlying process was *to order numbers.* A second group of learners had to perform a calculation. Learners did this by drawing four apples and then five apples on their pages. The mathematical concept here was *addition*. A third group of learners had to fill in the missing numbers on a number line. The mathematical concept here was number, and its underlying process was to complete a number line.

During *teacher input* this teacher taught the concept of number and the following underlying processes, namely:

- Ordering whole numbers
- Representing whole numbers
- Recognizing whole number symbols

When the concepts and underlying processes of the three learner uptake tasks were compared with the main concept and underlying processes that were taught, the following emerged:

Table 3: The alignment between concepts taught and concepts of learner uptake tasks for teacher 8.13

Learner uptake task	Type of alignment between concept of task and the main concept that was taught.
Task1	Alignment with *one* of the underlying processes that were taught, namely ordering whole numbers.
Task 2	No alignment. The concept of addition was not taught.
Task 2	No alignment. The skill of completing a number line was not taught.

Since one of the underlying processes of the learner uptake task aligned with one of the main mathematical processes that was taught, this lesson is an example of a *partial alignment.*

No alignment

When the learner uptake task(s) introduced a different mathematical concept or underlying process than the one that had been taught, the lesson was categorized as exhibiting no alignment.

No opportunity for learner uptake

When the teacher did not structure any opportunity for learners to perform tasks independently (on their own, in groups or in pairs), there was no opportunity for learner uptake.

Question 4: How much time is spent on the learner uptake activity in comparison with the rest of the lesson?

Learners required sufficient time to complete structured activities. A rule of thumb was adopted that one third of lesson time would be deemed to be sufficient. The quantity of a third of a lesson time was taken from the lesson plan format given to teachers by the COCA project. This format stated that 20 minutes of a lesson of 60 minutes should be spent on differentiated group tasks.

To analyse the amount of time spent on learner uptake tasks in the lessons of this study, I decided to classify the time allocation as either high or low. High and low time were evident in a lesson in the following ways:

- If the learner uptake (including possible teacher reflection) was a third, or more than a third, of the total lesson time, the learner uptake time was classified as *high*.
- When less than a third of the total lesson time was spent on learner uptake, the time allocation was deemed to be low.

Question 5: Does the teacher structure the learner uptake task(s) in such a way that each learner can participate?

Learner participation was described according to whether the activity is *structured* in such a way that all learners could participate. Examples of situations where learners chose not to participate, even though there was an opportunity for participation, were not considered.

Opportunity for learner participation during learner uptake was taken to be evident when the following occurred:

- When each learner in the class had the opportunity to actively participate in activities.
- When concrete objects were manipulated during group work activities, and *each* child had the opportunity to manipulate these objects. This could happen in the following two ways: either each child was given his/her own concrete objects, or the teacher explicitly stated that *eac*h child had to have a turn to handle the concrete objects given to the group.
- During group work activities each child had the opportunity to work out the problem set by the teacher. If only one paper and pencil was provided to a group of three or more learners, this was not possible.

- When a task was given to a group of learners, each learner had the opportunity to do the *whole* task and not just a part there of. In this study, learners that watched while others worked, were not actively participating in the task.
- During group work, each learner in the group had a role and knew what was expected of him/her. This role was explicitly stated by the teacher.

THE ANALYTICAL FRAMEWORK OF THIS STUDY

The analytical framework of this study has differentiated three features of scaffolding or sets of scaffolding strategies. The study recognizes the interdependence of these sets of scaffolding strategies. This interdependence is evident when a new (main) concept is introduced, sustained and opened up during teacher input and a learner activity is then structured which enables learners to work with and internalize the concepts that were taught. This interdependence suggests that the purpose of scaffolding can only be achieved when these three categories of scaffolding strategies jointly occur in a lesson. This combination of different strategies will be referred to as *complex scaffolding practice*.

The analysis generated a description of each lesson with regard to:

a) whether orientation of the lesson to a concept was sustained or not sustained,

b) whether or not main concepts that were taught together were 'opened up' and

c) whether learner activities

- manifest good, partial or no alignment to the concepts taught,
- were allocated sufficient time,
- were structured for participation .

When the first two sets of scaffolding strategies are combined, four possible combinations are produced. These describe teacher input as is illustrated in figure 3.

Figure 3: Description of the various types of pedagogical actions of teachers during teacher input

	Mathematical concept sustained	**Mathematical concept not sustained**
Mathematical concept opened up	Type 1: Mathematical concept sustained and opened up.	Type 3: Mathematical concept not sustained but opened up.
Mathematical concept not opened up	Type 2: Mathematical concept sustained and not opened up.	Type 4: Mathematical concept not sustained and not opened up.

The next step in developing the analytical framework is to combine descriptions of teacher input with the following descriptions of learner uptake:

- The alignment between the mathematical concept of the learner uptake and teacher input was good, partial or there was no alignment. Another variation is that the teacher gave no opportunity for learner uptake activity.
- The amount of time that was spent on learner uptake, in relation to the rest of the lesson, was either high or low.
- The learner uptake task(s) was either structured so that each learner could participate or it was *not* structured so that each learner could participate.

Before the above combination can take place, the various descriptions of learner uptake activities need to be joined. The above three aspects of learner activities are combined to generate 13 potential descriptions of teachers' pedagogical actions during learner uptake. These types are numbered 'a' to 'm' and are represented in the following figure:

Figure 4: The various ways in which learner uptake activities are structured

Explanation of various types of learner uptake			Various types
Good alignment between mathematical concept for teacher input and for learner uptake	High quantity of time	Opportunity structured for individual learner participation	Type a
		Opportunity not structured for individual learner participation	Type b
	Low quantity of time	Opportunity structured for individual learner participation	Type c
		Opportunity not structured for individual learner participation	Type d
Partial alignment between mathematical concept for teacher input and for learner uptake	High quantity of time	Opportunity structured for individual learner participation	Type e
		Opportunity not structured for individual learner participation	Type f
	Low quantity of time	Opportunity structured for individual learner participation	Type g
		Opportunity not structured for individual learner participation	Type h
No alignment	High quantity of time	Opportunity structured for individual learner participation	Type i
		Opportunity not structured for individual learner participation	Type j
	Low quantity of time	Opportunity structured for individual learner participation	Type k
		Opportunity not structured for individual learner participation	Type l
No opportunity for learner uptake			Type m

The final step in developing the analytical framework for this study was to combine the descriptions of both teacher input and learner activity. The combinations that were formed in this way describe 52 potential types of lessons with regard to the general scaffolding approach. This is shown in Figure 5. To condense the size of the table, the following abbreviations were used: *MC* represents *Mathematical concept, TI* represents *Teacher input* and *LU* represents *Learner uptake.* In this table *Combination type 1(a)* means type 1 of teacher input (see Figure 3) and type (a) of learner uptake (see Figure 4).

According to Figure 5 combination type 1(a) represents rich complex scaffolding practice since it combines all the scaffolding strategies. The other combination types represent a weaker general scaffolding approach. Figure 5 is presented on the next three pages.

Figure 5: A description of the various types of lessons that can be formed when the types of teacher input and learner uptake are combined

TYPES of LU			VARIOUS TYPES OF TEACHER INPUT			
			MC sustained and opened up	**MC sustained and not opened up**	**MC not sustained but opened up**	**MC not sustained and not opened up**
Good alignment between mathematical concept for TI and for LU	**High time spent on tasks**	**All participate**	Combination type 1(a) ▪ MC sustained and opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 2(a) ▪ MC sustained and not opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 3(a) ▪ MC not sustained but opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 4(a) ▪ MC not sustained and not opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks structured for participation
		Some participate	Combination type 1(b) ▪ MC not sustained but opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 2(b) ▪ MC sustained and not opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 3(b) ▪ MC not sustained but opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 4(b) ▪ MC not sustained and not opened up ▪ Good alignment ▪ High time spent on LU task ▪ Tasks not structured for participation
	Low time spent on tasks	**All participate**	Combination type 1(c) ▪ MC sustained and opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 2(c) ▪ MC sustained and not opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 3(c) ▪ MC not sustained but opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 4(c) ▪ MC not sustained and not opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks structured for participation
	Low time spent on tasks	**Some participate**	Combination type 1(d) ▪ MC sustained and opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 2(d) ▪ MC sustained and not opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 3(d) ▪ MC not sustained but opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 4(d) ▪ MC not sustained and not opened up ▪ Good alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation

TYPES of LU			VARIOUS TYPES OF TEACHER INPUT			
			MC sustained and opened up	**MC sustained and not opened up**	**MC not sustained but opened up**	**MC not sustained and not opened up**
Partial alignment between mathematical concept for TI and for LU	**High time spent on tasks**	**All participate**	Combination type 1(e) ▪ MC sustained and opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 2(e) ▪ MC sustained and not opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 3(e) ▪ MC not sustained but opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 4(e) ▪ MC not sustained and not opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks structured for participation
		Some participate	Combination type 1(f) ▪ MC sustained and opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 2(f) ▪ MC sustained and not opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 3(f) ▪ MC not sustained but opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 4(f) ▪ MC not sustained and not opened up ▪ Partial alignment ▪ High time spent on LU task ▪ Tasks not structured for participation
	Low time spent on tasks	**All participate**	Combination type 1(g) ▪ MC sustained and opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 2(g) ▪ MC sustained and not opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 3(g) ▪ MC not sustained but opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 4(g) ▪ MC not sustained and not opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks structured so that each learner can participate
		Some participate	Combination type 1(h) ▪ MC sustained and opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 2(h) ▪ MC sustained and not opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 3(h) ▪ MC not sustained but opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 4(h) ▪ MC not sustained and not opened up ▪ Partial alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation

TYPES of LU			VARIOUS TYPES OF TEACHER INPUT			
			MC sustained and opened up	**MC sustained and not opened up**	**MC not sustained but opened up**	**MC not sustained and not opened up**
No alignment between mathematical concept for TI and for LU	**High time spent on tasks**	**All participate**	Combination type 1(i) ▪ MC sustained and opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 2(i) ▪ MC sustained and not opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 3(i) ▪ MC not sustained but opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks structured for participation	Combination type 4(i) ▪ MC not sustained and not opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks structured for participation
		Some participate	Combination type 1(j) ▪ MC sustained and opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 2(j) ▪ MC sustained and not opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 3(j) ▪ MC not sustained but opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks not structured for participation	Combination type 4(j) ▪ MC not sustained and not opened up ▪ No alignment ▪ High time spent on LU task ▪ Tasks not structured for participation
	Low time spent on tasks	**All participate**	Combination type 1(k) ▪ MC sustained and opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 2(k) ▪ MC sustained and not opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 3(k) ▪ MC not sustained but opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks structured for participation	Combination type 4(k) ▪ MC not sustained and not opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks structured for participation
		Some participate	Combination type 1(l) ▪ MC sustained and opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 2(l) ▪ MC sustained and not opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 3(l) ▪ MC not sustained but opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation	Combination type 4(l) ▪ MC not sustained and not opened up ▪ No alignment ▪ Low time spent on LU task ▪ Tasks not structured for participation
No opportunit y for LU			Combination type 1(m) ▪ MC sustained and opened up	Combination type 2(m) ▪ MC sustained and not opened up	Combination type 3(m) ▪ MC not sustained but opened up	Combination type 4(m) ▪ MC not sustained and not opened up

CONCLUSION

This chapter developed a definition of scaffolding that focuses on the pedagogic strategies that enable learners to acquire domain specific concepts. This chapter then presented an analytic frame that achieves the following two purposes:

- Purpose one: To identify discrete strategies that can be described as scaffolding. The framework differentiates three categories of scaffolding strategies.
- Purpose two: To describe the general or complex scaffolding approach evident in a lesson in terms of combinations of categories or discrete scaffolding strategies.

CHAPTER 4: RESEARCH DESIGN

This chapter outlines the logic behind the design of this study. The purposes of the study are used as a basis for the selection of data and the development of an analytical framework, and this framework in turn determines the analysis of the data. The conclusion describes the various relevant validity issues surrounding this discussion and highlights the limitations of this study.

THE DESIGN OF THIS STUDY

The first purpose of this study was to produce a definition of scaffolding. To achieve this, a literature review was conducted which discusses the concept of scaffolding and how it is operationalised in the classroom. A critical analysis of this review indicated that the current definition of scaffolding is insufficient to describe how scaffolding is operationalised in the context of the classroom. The definition was originally developed to describe parent/tutor interactions with a child during informal learning whereas scaffolding in the classroom rather focuses on strategies that assist learners to acquire a new concept.

Since the second purpose of this study was to examine the pedagogical practices of teachers and to identify those interactions that can be described as scaffolding, this study then identified and described scaffolding strategies that focus on the concept. These strategies were discussed according to three features of scaffolding, namely introducing the concept, opening up the concept and the structuring of the learner uptake activity. Next, the data was utilised to formulate descriptions that indicate how these features of scaffolding are evident in the classroom.

The selection of the three features of the scaffolding process also implied that a requirement for learner acquisition of the concept is that these features jointly occur during a lesson. The third purpose of this study, namely to describe lessons in relation to combinations of scaffolding strategies and to generate a more general description of the pedagogic scaffolding practices of teachers, was then achieved by developing an analytical framework that indicated the interdependence of these discrete scaffolding strategies. This framework combined the three features of scaffolding in various ways and presented 52 possible descriptions of the pedagogic scaffolding practices of teachers in a lesson.

Since this study set out to analyse the pedagogical practices of teachers, relevant data also had to be selected. This data was provided by the *Count One Count All* (COCA) project.

The COCA Project

The COCA project, implemented from January 2004 to December 2006, was funded by the South Africa Netherlands Research Program in Alternatives in Developments (SANPAD) and was a collaborative effort between the Western Cape Education Department (WCED), Schools Development Unit (SDU) based at the University of Cape Town, Cape Peninsula University of Technology (CPUT), the University of Cape Town (UCT) and the Freudenthal Institute of the Utrecht University.

The objectives of the COCA research and development project were threefold (Cranfield et al, 2005:5):

- to produce a *Learning Pathway for Number* (LPN) in the Foundation Phase in South Africa that aims to "offer teachers a conceptual map which provides an overview of the learning 'route' that children pass through in order to master number in the early primary grades",
- to provide evidence of the effectiveness of the LPN on teacher development and learner performance,
- to develop a model for *In-Service Education and Training* (INSET) for teachers working in disadvantaged communities.

To achieve the abovementioned objectives, three rural primary schools were chosen from the West Coast Winelands district of the WCED. These schools were chosen for the following reasons (Cranfield et al, 2005:15):

- The schools were situated in areas that have historically received little intervention from service providers.
- The three primary schools in the area could form and be developed into a collaborative cluster that could lead to greater sustainability of classroom reform initiatives.

- The Education Management Development Centre (EMDC) provides school management support in these three schools.
- These schools have mathematics teachers that have completed or are registered for an Advanced Certificate in Education (ACE). These educators were then chosen for classroom-based support for the purposes of the project.

The teachers who were the subjects for this study participated in the COCA project. They attended several COCA workshops on teaching numeracy and were regularly assisted in the classroom by COCA facilitators. They were isiXhosa home language speaking women and were all older than 30 years of age. Their teaching experiences ranged from five to 25 years. All the teachers were qualified to teach at the foundation phase level.
Two of the teachers had Bachelors degrees, whilst the lowest level of qualification was grade twelve (or standard ten) and a three year diploma in teaching.

The classrooms in which these lessons were taught can be described as well resourced. Many posters were visible on their walls and apparatus and materials were available and were used during teaching. On average, the class sizes were large. Only two of the nine classes were the national norm of 1:40. The largest class had 57 learners.

The learners in this project were from schools located in very poor townships in the Western Cape. Learners were assessed several times throughout the duration of the COCA project and the results indicated a consistently low level of performance in the area of number concept and number operations (Hoadley, 2008:1).

The data selected for this study

The COCA project video recorded several teacher lessons and selected 18 of these recordings and transcripts as data for this current study. The use of this data brought several benefits. Firstly, the WCED gave the project permission to undertake various research initiatives in the three abovementioned schools. No further authorization was needed for this study. Secondly, the COCA project wanted to contribute towards a Master's degree study that would use some of the data generated by the project. The project therefore freely provided 18 recorded classroom lessons for this study. Thirdly, this study also aims to contribute towards the findings of the COCA project.

Using recordings and transcriptions as data for this study had several advantages. As Erickson (2006:177) states, video recordings are useful when researching phenomena that imply sometimes complex and nuanced moment-by-moment actions. Since such finer-grained information was essential to analyse the actions of the teachers, video recordings seemed an appropriate form of data for this study.

Another advantage to the use of video recordings is that it provides a holistic view of the classroom teaching event. Smaller scenes can also be replayed frequently so that the actions of the teacher can be accurately recorded and analysed. In this way the human interactions that were recorded can be studied in detail (Ratcliff, 1996: 2-3). The video recording, therefore, firstly enables the researcher to have a macro view of how the various teacher/learner interactions progressed during the lesson and secondly to scrutinize these interactions.

For this study, I chose to use 18 recorded numeracy lessons that were taught by nine teachers. The original intention was to select three teachers per grade. Unfortunately, since some teachers moved between grades, not all the selected teachers taught two video recorded lessons from the same grade. For all the selected teachers, though, a lesson that was recorded in 2004 and another lesson that was recorded in 2006.

The recorded classroom lessons were numeracy lessons that were taught to home language Xhosa speaking children from Grade 1 to Grade 3. For the lesson in 2004 each teacher was asked to teach a number lesson for video recording purposes. No guidelines were given. The instructions for the second video lesson in 2006 were different in some respects, as teachers were asked to plan a numeracy lesson according to a set format and then to teach this lesson using the knowledge, skills and ideas imparted by the project over the years. The lesson plans that were prepared for the recording in 2006 were also collected by the project for future research purposes.

The next table indicates the number of lessons that were recorded from Grade 1 to Grade 3. Six of these nine teachers taught in the same grade in 2004 and 2006.

Table 4: Number of classroom lessons chosen per grade

		Grade 1		Grade 2		Grade 3	
		2004	2006	2004	2006	2004	2006
Amount of lessons from selected teachers in the COCA project	Teacher 1.11	one	one				
	Teacher 2.11	one	one				
	Teacher 3.11	one	one				
	Teacher 4.22			one	one		
	Teacher 5.32				one	one	
	Teacher 6.11			one	one		
	Teacher 7.13	one					one
	Teacher 8.13	one					one
	Teacher 9.33					one	one
	Total number of lessons	**five**	**three**	**two**	**three**	**two**	**three**

In this table teacher 5.32 firstly indicates that this is teacher number five. The two digits after the point then denote that he/she taught a Grade 3 class in 2004 and a Grade 2 class in 2006.

The actual recording of the classroom lessons

The raw video footage of the 18 classroom lessons was predominantly taken as a continuous shot of the whole lesson as conducted by the teacher. The various types of shots (Nel, 2008:2) used during filming included:

- Very wide shots which placed the teacher in the classroom environment, but also showed the context of the wider classroom.
- Wide shots, where both the teacher and a part of the class, individual learner or a small group of learners took up the whole frame of the shot, were used to show full body movement (of the teacher), actions and various teacher-learner and learner-learner interactions. "To place the camera halfway along the side of the room, with the teacher

and some of the students shown together in profile view is to emphasize reciprocal relations between the teacher and the students" (Erickson, 2006:178).

- Close-ups and extreme close-ups showed what the teacher was writing on the blackboard and specific learner interactions at desks, for example what learners were writing down or manipulating with their hands.
- Cutaway shots were used to show other, seemingly unrelated, actions like one or more disobedient acts of learners.
- Cut-in shots were used to show e.g. only the hands of learners manipulating objects.

Most of the above shots gave the learners' perspective of the teacher's actions in the classroom. The video was operated from the back of the class, facing the teacher in the same way as were most of the learners.

Various types of etic and emic perspectives (Ratcliff, 1996:7) were used during the filming. Etic perspectives (which give a more uninvolved impression, like that of an observer) were gained when the camera was placed on a tri-pod and filming commenced without adjusting the camera. Less etic viewpoints were also created by turning the camera to follow the teacher performing actions like walking between learners as they work at their desks, walking to a cabinet to find materials and walking to a shelf to find manipulatives. During these shots adjustments were made to the camera lenses for the different types of shots. In the same way video footage of the whole classroom was taken so that the posters on the walls, the seating arrangement of learners and classroom artefacts could be observed. Emic perspectives were produced by carrying the camera around in the classroom to show group interactions and learner work.

During the video recording, a mother tongue Xhosa speaking COCA facilitator was also present in the classroom. The facilitator recorded the various classroom events and conversations that occurred during the lessons. These observations of the faciliator and the video footage were used for the following two purposes:

- to record all the teacher's public talk and actions, that is when the teacher is addressing the whole class, as well as the learners' responses to the teacher's actions.
- to record (as thoroughly as was possible) the teacher's interactions with individual learners or small groups of learners as well as the learners' responses to the teacher's actions.

Transcription of teacher lessons

A transcription for the teacher lessons was undertaken by a mother tongue Xhosa speaker. The recording of the dialogue from the video recording was initially done in Xhosa and then translated into English. This transcript indicated the verbal and non-verbal actions of the teacher and the learner, and the time span of various events in the lesson. The notes from the facilitator, taken during the lesson were also used to develop this transcript. Below is an example of this transcript:

Extract 10: Teacher 1.11

Time	Line	Dialogue	Non-verbal actions
05:00	63	T: I did say that our families are different. Bongani, how	
	64	members are in your family.	
	65	L: We are 9.	
	66	T: You are 9 in your family? Count them, Bongani,	Learner is counting his
	67	Melikhaya must also hear you, nhe.	family members on his
	68	T: I can't hear you and I don't think Melikhaya can also	fingers, but his voice is not
	69	hear you from where he is.	audible.

Since I am not a Xhosa speaker, it was difficult to verify whether the transcription was correct. I was confident though that the COCA project employed a competent translator and that her work represented the classroom lessons adequately. After viewing the classroom lessons and reading the transcripts, I did find some incidences in which it seemed as if some of the dialogue was missing. In these cases the transcript seemed to represent an abbreviated version of what was taking place on the video recording. This did have an impact on the analysis when the verbal interactions between the teacher and the learners were examined to identify instances of scaffolding. However, I can say with some confidence that these instances seemed to represent repetitions of interactions that were recorded in the transcript, and that these instances did not constitute the type of scaffolding strategies that I was looking for.

Even though the video recordings were in Xhosa, it was possible to follow the dialogue of the teacher for two reasons. Firstly, in many cases the actions of the teacher or those of the learners indicated which dialogue was taking place. Secondly, the use of student names or the English language to say number names allowed me to track the interactions on the recording.

The only changes that were made to the original translated transcript were: correction of English grammatical errors, insertions of teacher or learner actions that the transcriber failed to record and changes to the format of the transcript by adding line numbers.

Data analysis

The analytical framework that was developed for this study is presented in Chapter 3. As illustrated in that chapter, the type of data in this study as well as a knowledge of the features of scaffolding guided the development of generic descriptions for the framework. These descriptions determine the extent to which the various scaffolding features can be observed in lessons.

To answer the first research question of this study, *'What scaffolding strategies are evident in selected foundation phase mathematics lessons?*', a set of questions was formulated to identify the scaffolding strategies that are used in each lesson. Table 5 on the next page represents these questions and a summary of how these questions were answered. It must be noted again that this is merely a summary of the questions and answers described in Chapter 3.

Table 5: A summary of how the data of this study was analysed

	QUESTION	HOW THE QUESTION WAS ANSWERED
	Questions to analyse the scaffolding strategies of teachers during teacher input	
1	*What are the main mathematical concept(s) and their underlying processes in this lesson?*	The teacher's actions which *did not involve practicing or revising the mathematical concept*, were classified as the main mathematical concept(s) of the lesson.
2	*Is the main mathematical concept(s) sustained throughout the teacher input?*	If one of the main concepts or its underlying skills were taught for 60% or more of the teacher input time, the concept was considered to be sustained.
3	*Is the main mathematical concept(s) of the teacher input opened up?*	If one scaffolding strategy was used to teach each of the concepts or their underlying skills, the concept was opened up. The exception to this rule is discussed in chapter 3.
	Questions to analyse the scaffolding strategies of teachers during learner uptake	
1	*Does the teacher provide an opportunity for learner uptake in this task?*	If the learners were performing a task without the assistance of a teacher, then an opportunity for learner uptake was provided.
2	*What are the main mathematical concept(s) and their underlying processes of the learner uptake task?*	The actual task that the learner performed was examined to answer this question.
3	*What is the alignment between the main mathematical concept and underlying processes of the teacher input task and the mathematical concept and underlying processes of the learner uptake?*	▪ An alignment was *good* if all the concepts and its underlying processes that were taught were evident in the learner uptake task. The exception to the rule is discussed in Chapter 3. ▪ An alignment was *partial* if one of the concepts or underlying processes taught was the same as that which was evident in the learner uptake task. An alignment was also partial if a component of one of the concepts or underlying processes taught was the same as that which was evident in the learner uptake task. ▪ *No* alignment occurred when a different concept and its underlying process were taught as the one focused on during the learner uptake task.
4	*Was the lesson structured so that each learner could participate?*	If each learner had the opportunity to actively participate in all the learner uptake tasks, the lesson was structured for participation.
5	*How much time was spent on all the learner uptake tasks?*	If the teacher provided the opportunity for learners to spend a third or more of the lesson time on learner uptake tasks, a high amount of time was spent on learner uptake.

The answers to these questions were utilised to classify each lesson as a specific *combination type* of lesson. The analytical framework presents a description of a total of 52 combination types of lesson. An example is combination type 1(k). This lesson type represents the following pedagogical practice of teachers in the classroom:

- The main mathematical concept is sustained and opened up.

- There is a partial alignment between the mathematical concept and underlying processes of the learner uptake task and the one taught.
- A low amount of time (less than a third of total lesson time) is spent on the learner uptake task.
- The teacher provides a structured opportunity for all learners to participate.

The classification of lessons into its associated combination types aided in answering the second research question of this study.

VALIDITY ISSUES

This section discusses the validity issues raised by this study and the measures taken to address these. A first validity concern of this study is the transparency of the analysis process. Kvale (1996:209) advises researchers to describe the different steps of the analysis process and to make it possible for readers to check the analysis process followed by the readers. The previous chapter included a detailed explanation of how the analytical framework was developed and explicitly described the various aspects of this framework. In the next chapter, case studies relating to the analytical framework are provided. These case studies explicitly explain how the lessons were classified according to the analytical framework.

The second concern for this study was to describe the data as completely and accurately as possible. Maxwell (1992:287) refers to this concern as descriptive validity. In this study video recordings were used to capture the teacher and learner actions in the classroom. As discussed previously, these recordings were transcribed to provide a close account of the actual event. Since these transcriptions had to be translated from Xhosa into English, there was a threat of losing some of the original verbal interactions. For this reason, a home language Xhosa speaker with a good command of the English language was appointed to translate the lesson dialogue.

To describe the data as completely as possible, the transcript of each lesson indicates: the amount of time spent on each lesson activity, the dialogue between the teacher and the learner dialogue and the description of the non-verbal actions of both the learner and the teacher. In this way I attempted to provide a picture of the interactions in the classroom.

There are two concerns that could be raised regarding the descriptive validity of the study:

- A small amount of data was lost during the translation and transcription process. As was discussed before, there were cases in which the transcript seemed to represent an abbreviated version of what was taking place on the video recording. This affected the analysis when verbal interactions between the teacher and the learners were analysed to identify scaffolding strategies. However, these instances seemed to represent repetitions of interactions that were already recorded in the transcript. In most cases, it was already evident from the recorded interactions whether the type of scaffolding strategies that I was looking for were present in the lesson. If a teacher, for example, was modelling a mathematical concept, and the transcript only provided an abbreviated version of this interaction, then it was still possible to identify modelling as the scaffolding strategy.
- Only one video recorder was used to capture the interactions in the classroom. It was therefore not possible to record every interaction that took place during the lesson. Since this study, though, focused mainly on the teacher's actions, the recording could depict these in an adequate way.

The final concern of this study related to the notion of interpretive validity. This type of validity is "concerned with what these objects, events and behaviours mean to the people engaged in and with them…the 'participants' perspective." (Maxwell, 1992:288) This validity concern was raised when the mathematical concepts of the teacher input and the learner uptake were identified. Since no interviews were done with individual teachers and teachers only provided a limited number of lesson plans, teachers' perspective on the concept taught was generally absent. During this study there was no opportunity to clarify whether the concepts that were identified by the researcher were the ones that the teacher intended to teach.

To overcome this concern, this study used the observable acts of the teacher to establish which mathematical concepts were being taught. The teacher's choice of questions or activities, the coherent sequencing of these and the step-by-step movement towards an idea, provided the evidence for the concepts of the lesson. In this kind of study, though, the participant's perspective can cause confusion when there is a discrepancy between what a teacher says she intended to do during the lesson and what was actually being done during the lesson. Hence the observable acts of the teacher provide a more valid indication of the concepts of the lesson than the teachers' account of her intentions.

LIMITATIONS OF THE STUDY

A limited number of scaffolding features were chosen to constitute the analytical framework of the study to ensure that it is manageable and not too complex in nature. As a result of this restriction five limitations emerged.

The first limitation is that specific key issues that relate to the concept of scaffolding are not addressed by this study. These are environmental provisions (Anghileri's first level of scaffolding), fading of the scaffold and contingent instruction. My analysis rather focused on the presence of particular communicative/interactional scaffolding strategies and on the way in which teachers structure the learner uptake activities.

Secondly, in Chapter 3 some of the criteria for the analytical framework were described as the opposite ends of a continuum. For example, concepts were either opened up or not opened up; concepts were either sustained or not sustained, and the time spent on learner uptake was either high or low. This analysis placed lessons at either end of these continua and did not produce a fine-grained account of partial opening, sustaining the concept or the amount of time that was spent on learner uptake.

The third limitation refers to the minimal way in which this current study explores the notion of opening up of the mathematical concept. This criterion can be studied in a more in-depth manner by, for example, exploring the use of various combinations of scaffolding strategies to open up the concept, as well as the manner in which strategies open up the concept. Depending on how a scaffolding strategy was used by the teacher, a strategy could sometimes initially open up the concept and then close it before the concept was acquired. In Chapter 3 the incorrect use of probing questions was used to illustrate this point.

Fourthly, the analytical framework of this study was developed to analyse the pedagogical actions of the teacher, and not the actions of the learners. The quality of the work that the learners produced during learner uptake was thus not examined. Such an analysis would require the development of a more complex framework.

Lastly, this analysis did not examine the appropriateness of the level of the concepts taught nor the quality of tasks or activities structured by the teacher. Rather, the study focused on the manner in which the concepts were taught and how the tasks were structured to enable learners to internalise concepts.

CONCLUSION

This chapter has outlined the manner in which this study was designed by describing the process for developing the analytical framework, the data used by this study and the analytical approach that was followed. Specific validity issues and the limitations of this study have also been raised. In the next chapter an analysis of data from this study is presented.

CHAPTER 5: DATA ANALYSIS

The analytical framework utilized in this study represents 52 possible types of lessons that describe the pedagogical scaffolding practices of teachers in the classroom. Apart from four lesson types, each of these groupings represents a partial combination of the three key features of scaffolding, namely, the concept introduced is sustained, the concept is opened up and the learner uptake activity is structured in a way that enables the learner to internalize the concept. One of the lesson types signifies complex scaffolding practice as it combines the three features of scaffolding, whilst the combination denoted by three other lesson types does not represent any of the scaffolding features.

In this study, 18 classroom lessons were analysed according to the combination of the three features of scaffolding that were evident in each lesson. This analysis indicated that these lessons exemplify 13 types of lessons. In this, chapter I illustrate how six lessons were analysed: firstly to determine the scaffolding features evident in each lesson, and secondly, to establish the lesson type of each lesson. The selection of these six lessons enables me to demonstrate how the analysis proceeded in terms of each of the features of scaffolding that occurred in both the teacher input and learner uptake components of the lesson.

Following these six case studies is a discussion of the trends that were noted regarding the scaffolding features observed in the lessons and the type of lessons represented by this study.

CASE STUDIES

Case study 1: Combination type 1(a)

Teacher input for this lesson

The next extract depicts a portion of the teacher input that was taught by teacher 4.22 in 2006.

Extract 11: Teacher 4.22 (lesson in 2006)

Time	Dialogue	Non-verbal actions
09:00	T: Listen now, listen. I want to put these pigs in a pigsty nhe?	
	LS: Yes miss	
	T: I want to put them in 2 pigsties. I have 10 pigs. How many am I going to put in each pigsty?	
	T: Here is the first one and here is the second one.	
	T: We said they are 10. How many are we going to put in each?	She draws 2 circles on the board
	T: We said they are 10. How many are we going to put in each	Teacher holds a card with number 10 on it.
10:00	T: Here are my pigs Esona, come and help me put them in each pigsty.	Learner is to short teacher brings a chair so
	T: Climb on the chair.	that he can stand on it to be able to reach the
	L: Puts 5 pigs in each circle.	pictures.
12:00	T: Let's clap for Esona.	Teacher helps the child so that he can reach the pictures
	T: How many pigs did we have?	
	LS: 10, Miss.	
	T: How many did we put in each circle?	
	LS: 5, Miss.	Too much noise coming from outside.
	T: Listen now listen how many pigs do we have	
	LS: 10 miss	
	T: How many did we put in a circle?	
	LS: 5 miss	Teacher holding the card with 10
	T: And how many did we put in this one?	
	LS: 5 miss	
	T: Listen, listen this means that if I have 10 pigs and I want to put them equally into 2 pigsties I will have to put 5 in this one and 5 in that one.	Teacher points to one of the circles
	T: I want us to add and then I want my pigs to be this much (Lifting up the number14). What is this number?	
	L: 14, Miss.	Holding up a card with 14 on it and pointing to the 2 circles
	T: I want to add on. How many will I add?	
	L: 7, Miss	
	L: 8, Miss	
	T: There are 10.	
13:00	T: Oh no, put up your hand if you want to answer. Vuyo?	
	L: 4, Miss	
	T: Here are my pigs I will add 4. Now listen. We want to divide them for 2 people. What are going to do? Nontando?	
	L: Give each person 2 each, Miss.	
	T: Go and do it.	
	L: Pastes 2 pigs in each circle.	Teacher pastes 4 pigs on the board.
	T: That's right. Let's clap for Nontando.	
	L: Clapping.	

The teacher proceeds in this manner to the number 16. Each time the teacher asks the learners how many pigs must be added on to make the next number of pigs that is to be divided.. Next, the teacher then asked the learners to share 12 sweets between two learners. Counters were used to solve this problem. All of this was done as a whole-class teaching event. In the next extract learners are asked to indicate how many bicycles 14 wheels can make.

19:00	T:	Now listen we know how many wheels a bicycle has and I have 14 wheels. Count them.	Teacher draws 13 wheels on the black board
	T:	Count the wheels.	
	T:	Oh no! How many bicycles will we get from these wheels?	
	L:	14, Miss.	
	T:	Oh no, Abongile?	
	L:	No response	
	T:	Let's count the wheels again.	
	L:	Learners count from 1 to 13.	
	T:	Count again.	
	L:	Count from 1 to 13.	
	T:	Ntsikelelo, how many wheels are short to make 14?	Teacher draws the last wheel
	L:	1, Miss.	
	T:	How many bicycles will we get from these wheels Anelisa?	
	L:	14 Miss.	
	T:	Are you saying14? How many Khaya?	
	L:	77 miss	
	T:	How many?	
	L:	7	
	T:	Very good. Let's clap hands.	
	L:	Clapping hands.	
21:00	T:	Why are we going to get 7 bicycles?	
	L:	I love people who listen.	
	T:	From 14 wheels we will get 7 bicycles. Why are we getting 7 bicycles? Why?	
	L:	Voice not audible.	
	T:	Why are we getting 7 bicycles?	
	L:	Voice not audible.	
	T:	Why are we getting 7 bicycles?	
	L:	Because (can't hear the rest voice fads away)	
	T:	What do the others say, Khaya? Why are getting 7 bicycles?	
	T:	What do the others say?	
	L:	I can't hear the response.	
	T:	What do the others say Vuyo?	
	L:	Sorry miss…(voice not audible.)	
	T:	I want to know why we are saying that we will get 7 bicycles?	
	L:	Voice not audible.	
	T:	What are you going to say?	
	L:	No response.	
	T:	Can any one of you give us an answer? What do you say	
	L:	Voice not audible.	
	T:	He is correct. Let's clap for him.	
	LS:	Clap hands	
	T:	He said we have 14 wheels, but I want to hear him say that a bicycle has 2 wheels.	
	T:	Yes he is saying we are counting in 2's like this group the	

23:00	wheels are in 2's.	Teacher writes on the board, she is joining 2 wheels together with a line.

Locating the extract in the lesson

Teacher input started with a variety of activities that practise processes which are associated with the number concept, namely acoustic counting, positioning of numbers (what comes before and after a number) and estimating (including the difference between the estimated number and the actual number). All these activities were undertaken in the whole-class context and the teacher used a series of closed questions. These questions were repeated until learners provided the correct answer. When the correct answer was given, the teacher proceeded to the next question. For the next activity the teacher pasted ten pictures of pigs on the black board. She also drew two circles that represented two pigsties. This is depicted in the above extract.

Main focus of teacher input

- *What are the main mathematical concepts and underlying processes of this lesson?* The main mathematical *concepts* are *division* (the underlying processes are equal sharing or division by two) and *addition.*
- *Are the main mathematical concepts sustained throughout the teacher input?*

Table 6: Division of time during teacher input for teacher 4.22 (lesson in 2006)

	Time	Percentages
Practice activities	7 min.	
Main mathematical concept of *division*	14 min.	61%
Main mathematical concept of *addition*	2 min.	9%
Total time spent on teacher input	**23 min.**	

The mathematical concept of division was sustained throughout the teacher input, since it was taught for more than the prescribed 60% of the teacher input time. The main mathematical concept of this lesson is therefore sustained.

- *Are the main mathematical concepts opened up?*

The teacher used the following scaffolding strategies to teach the main mathematical concept:

Table 7: Scaffolding strategies employed by teacher 4.22 (lesson in 2006)

Modelling	X	Collaborating		Probing	X
Delegated modelling	X	Guiding		Orienting	
Instructing		Convince me		Reflecting	X
Telling		Noticing		Excavating	
Focussing				Closed questioning (as scaffolding)	X

This lesson is an example of the exception to the rule that was discussed in Chapter 3. This rule occurs when more than one main mathematical concept was taught during teacher input and one of the concepts was taught for 50% or more of the teacher input time. In this lesson the concept of division was taught for more than 50% of lesson time, whilst the other concept of addition was taught for a very short period of time. It was therefore evident that the main (focus) concept of the lesson was rather division. According to the exception rule, only the scaffolding strategies that were employed to teach division will be considered in order to determine if the concept of the lesson was opened up. During the pigsty activity the teacher instructed a learner to model how to divide the pigs between two pigsties. This is called *delegated modelling.* After each division, the teacher *reflected* on what the learner did. The teacher also instructed the learners to use counters to divide 12 sweets between two people. For the bicycle activity, the teacher tried to *probe* the learners' understanding regarding the answer to the problem. When a learner finally gave a sufficient explanation, the teacher *modelled* the learner's answer on the black board. On the black board each bicycle was indicated by connecting two wheels with a line.

To teach the concept of division, the teacher employed more than one "opening up" strategy and the concept of the lesson was therefore opened up.

Opportunity provided by the teacher for learner uptake

The next extract depicts a portion of the learner uptake that was taught by teacher 4.22 in 2006.

Extract 12: Teacher 4.22 (Lesson in 2006)

Time	Line	Dialogue Mayeki 2006	Non-verbal actions
		T: Now I am going to give each of you your own pigs. You are going to build a pigsty. I am going to lift a number. You know who count small numbers and big numbers. I am going to lift a number and you are going to put your pigs in the sty.	Each learner opens their book.
		T: You are going to write your name and today's date. What is today's date?	
		L: 1st of August, Miss.	T writes 06 August 01 on black board.
		T: Here is the date for every one.	
		T: You will get your own pigs. I will give you 8 if you get more than 8 bring the extra ones back.	Teacher hands out paper cut out pigs toeach child.

- *What are the mathematical concepts and underlying processes of the learner uptake task?* The mathematical concept is division.
- *What is the alignment between the mathematical concept of the teacher input and the mathematical concept of the learner uptake task?* The learner uptake activity was to equally divide a specific number of pigs between two circles. The learners had pictures of pigs and used their workbooks to present this distribution. Since the analysis of this lesson adheres to the exception to the rule, only the one focus concept (namely division) is used to determine the alignment of the lesson. Since the concepts of the learner uptake task and the one that was taught are both division, this lesson has a good alignment.
- *Was the learner uptake task structured so that each learner could participate?* Each learner had a workbook, a pencil and a set of pictures. The activity was structured so that each learner had the opportunity to participate.
- *How much time was spent on all the learner uptake tasks?* 18 minutes of a total lesson time of 41 minutes was spent on learner uptake. Since this is more than a third of the total lesson time, a high amount of time was spent on learner uptake.

Conclusion

In this lesson, the mathematical concept was sustained and opened up. There was also good alignment between the main mathematical concepts of the teacher input and the mathematical concept of the learner uptake. The learner uptake activity was structured for all learners to participate and a high amount of lesson time was spent on the activity.

Case study 2: Combination type 4(f)

Teacher input for this lesson

The next extract depicts a portion of the teacher input that was taught by teacher 9.33 in 2006.

Extract 13: Teacher 9.33 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
11:00	150	LS are reading the following word problem:	The learners are reading a
	151	LS: A blue tin has 45 litres of paraffin and the green tin has 48	problem that is written on
	152	litre of paraffin. How many litres are in these tins?	a chart. The chart is
	153	T: Now I want one person to come and solve number one on	pasted on the black board.
	154	the board. Look who can come to read? Yes	
	155	L: A blue tin has 45 litres of paraffin and the green tin has 48	
	156	litre of paraffin. How many litres are in these tins?	
	157	T: Right, how many litres are there in the first tin?	
	158	LS: 45 litres	
	159	T: How many litres of paraffin are in the green tin?	Teacher closes the door
	160	LS: 48 litres	because there is too much
	161	T: How many litres of paraffin do we have all together?	noise coming form
	162	T: Right, you have to look carefully now, when we do problem	outside.
	163	solving you must know what they are talking about. Number	
	164	2: How many litres do they want? And what colors are they?	
	165	Number 3: Do they want colors or litres?	
	166	T: Here they are asking us how many litres of paraffin they	
	167	have all together. We have a green tin and a blue tin. We	
	168	have to know how many litres they have all together. Who	
	169	can come and do the sum for us?	
	170	T: Yes Ntombi come quickly.	The learner first writes
	171		40 + 40 + 5 and then
			erases it. Learner then
		T: There are 45 litres and 48 litres. Some of you should be	writes: 40 + 5 and
	172	calculating so that, if she makes a mistake we can rectify it.	and underneath it
	173		40 + 8.
	174	T: Can someone else come?	
		LS: Yes miss	
	175	T: Do your own way, look the way she was calculating.	
	176		Teacher erases incorrect
	177		answer on BB
			Another L write on the
			board:

		T: Are we subtracting here? Are they asking us to do subtraction? How many litres do we have?	40 + 40 = 80 8 – 5=
	178 179 180	LS: No miss!	Teacher erases 8 - 5 Learner correct it and writes 8 + 5 = 13 and then 80 + 13 = 93
17:00	181 182 183	T: All right. Yes, there we are! He says we take 40 + 40 is equal to 80 and 8 + 5 is equal to 13and 80 + 13 is equal to 93. So its equal to 93. Because we are running out of time we were going to do more on these examples. Now let's look at the second one. Let's read.	
	184 185	All: Mandla has 30 candles and ties them into 3 bundles. Now how many candles will be in each bundle?	Learners read the next problem on the chart
	186 187	T: He has 30 candles and 6 bundles. Now how many candles will be in each bundle?	Teacher writes 30 on the board.
	188 189	T: There are 30, so put your beads aside. Now how many candles will be in each bundle? Yes.	
	190	L: 4	
	191	T: no.	Learners lifting up their hands.
	192	LS: 6 bundles	
	193	T: How many candles in one bundle?	
	194	L: 6	
	195	T: No.	
	196	L: 4	
	197	T: No.	
	198 199 200	T: How many are they? Here is your 30. Count off 30 and separate 6. Now how many are they?	Teacher takes the 100-string beads and shows the learners how to count 30 candles and how to separate the bundles.
		LS: 5	
20:00	201 202 203	T: Yes, that's right. So there are 5 candles in each bundle. Count from 1 to 5 in each bundle, now if you add all of them how many are they?	Teacher writes on the board to demonstrate further:
	204 205	LS: 30	///// ///// ///// ///// /////
Following this extract the learners answered a multiplication word problem relating to the amount of wheels that five cars have. After this task, the learner uptake task proceeded.			

Locating the extract in the lesson

At the beginning of the lesson the class engaged in a variety of activities to practise the following processes: acoustic counting, positioning of numbers, rounding off and breaking down of the number 89 (for example the number is formed by 40 + 40 + 9). These activities were undertaken in a whole-class setting. Next, the teacher posed a verbal word problem that related to the context of money ("how much change?"). Learners were asked to solve this problem mentally. The activities depicted in the extract ensued next.

Main focus of teacher input

- *What are the main mathematical concepts and underlying processes of this lesson?* The main mathematical *concepts* are addition, subtraction, multiplication and division. The underlying processes for each concept are to solve and explain word problems.
- *Is the mathematical concept sustained throughout the teacher input?*

Table 8: Division of time during teacher input for teacher 9.33 (Lesson in 2006)

	Time	Percentages
Practice activities	11 min.	
Main mathematical concept of *addition*	6 min	24%
Main mathematical concept of *subtraction*	3 min.	12 %
Main mathematical concept of *division*	3 min.	12%
Main mathematical concept of *multiplication*	2 min.	8%
Total time spent on teacher input	**25 min.**	

Since each concept was taught for less than the prescribed 60% of teacher input time, the main mathematical concept of this lesson was not sustained.

- *Is the concept opened up?*

Table 9: Scaffolding strategies employed by teacher 9.33 (Lesson in 2006)

Modelling	X	Collaborating		Probing	
Delegated modelling	X	Guiding		Orienting	
Instructing		Convince me		Reflecting	
Telling		Noticing		Excavating	
Focussing		Closed questioning (as scaffolding)			

To teach addition, the teacher instructed a learner to model the solution to the litre problem (*delegated modelling*). Regarding the candle problem (division word problem), the teacher *modelled* the solution with a string of a 100 beads and by a drawing on the black board. The teacher also *modelled* the solution to the wheels problem (multiplication) with a drawing on the black board. To teach subtraction, the teacher used closed questioning. The purpose here was not to lead the learners in a step-by-step way, but rather to produce correct learner answers. Incorrect answers were ignored. To conclude, the teacher did not employ any scaffolding strategy to teach each concept. The mathematical concepts for this lesson were therefore not opened up.

Opportunity provided by the teacher for learner uptake

The extract below depicts a portion of the learner uptake that was taught by teacher 9.33 in 2006

Extract 14: Teacher 9.33 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
22:00	221 222 223	T: Now I am going to give a group of people a problem to read. Read what it says and work out the answer. Each group is going to tell us how they got the answer. Let's make quickly.	Teacher gives each group a word problem and a blank A4 paper.
	224	L: What must we write here miss?	
	225 226 227	T: You write the numbers. Each group is going to come in front and show us how they got their answer. Write the numbers big.	Learners are busy calculating in their groups.
		Learners are busy working in groups	The teacher walks around the class checking if there is any group that needs help.
	228 229 230	T: Is there a group that is finished already? Right, let's look at the board. The first group is going to read the problem sum and show us how they got the answer.	The first group lifts up their hands.
27:00	231 232 233	L: Reads from the chart on the board: Nomsa has 50 bottles of drinks, 26 got lost. How many bottles are left? We said 50 – 26 = 24	Group 1 goes to the front and the teacher gives them prestick to paste their chart on the board.
	234 235 236	T: Very good, they took 50 and subtracted 26 to know how many bottles were left from the 26 that were lost. So there are 24 bottles of drinks left.	Teacher helps the learners by pasting the chart on the board
	237	T: Second group come. Read aloud the problem	2nd group stands and goes to the front. Teacher pastes the chart on the board.
In like manner, each group in the class had the opportunity to share their answers (and methods) with the rest of the class. The lesson ended when the last group's answers were discussed.			

- *What are the mathematical concepts and underlying processes of the learner uptake task?* The concepts are addition, subtraction, multiplication and division. The underlying process for each operation is to solve and explain word problems.

- *What is the alignment between the mathematical concept of the teacher input and the mathematical concept of the learner uptake task?* There were four different tasks. Each learner solved only one of these tasks in a group setting.

Table 10*:* Division of time during teacher input for teacher 9.33 (Lesson in 2006)

Task	Concept of task	How may of the four main concepts of the lesson is represented in this task?	Type of alignment
Task 1	Concept of subtraction	One of the four main-concepts.	partial
Task 2	Concept of multiplication	One of the four main-concepts.	partial
Task 3	Concept of division	One of the four main-concepts.	partial
Task 4	Concept of addition	One of the four main-concepts.	partial

There were four main concepts in this lesson. Each task represented only one of these concepts. In these instances the alignment was therefore partial.

- *Was the learner uptake task structured so that each learner could participate?* The various word problems were done in groups of five learners. Each group had one A4 sheet of paper and one pencil. The teacher did not assign roles to each group member, nor was each group member explicitly asked to participate. In terms of collaborative learning, two roles were possible for this task, namely acting as the scribe for the group and conveying the group's answer to the rest of the class. The rest of the learners could either be observers or partial participants. Since no direction was given regarding this, the learners could choose their own role in this regard. Furthermore, each learner did not have paper or pencils to work out the problem for themselves and only one learner in the group could effectively work on the problem. This task was therefore not structured so that each learner in the class could participate.
- *How much time was spent on all the learner uptake tasks?* 18 minutes of a total lesson time of forty-three minutes were spent on learner uptake. This was more than a third of the total lesson time. A high amount of lesson time was therefore spent on learner uptake.

Conclusion

In this lesson the mathematical concepts were not sustained and opened up. The learner uptake correlated partially with the main mathematical concept of the teacher input, a high amount of time was spent on teacher input and the task was not structured so that all the learners in the class could participate successfully.

Case study 3: Combination type 3(f)

Teacher input for this lesson

The extract below depicts a portion of the teacher input that was taught by teacher 8.13 in 2006.

Extract 15: Teacher 8.13 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
	130	L: We can all see they are holding numbers in hands, nhe.	
	131	T: So you who are sitting, we are asking you to add all these	
	132	numbers together.	
	133	T: How are we going to add these numbers in the simplest	
	134	way?	
	135	T: How are we going to add these numbers in an easy way?	
	136	T: How are we going to add them, Lwando?	
	137	T: We are waiting for Lwando.	
	138	L: (Lwando) sorry miss, we are going to take 30 and add it	
	139	to 40. Then take 10 from 15 and add it there miss.	
	140	T: Go and show us what you are saying. Did you hear him?	
	141	L: Yes miss	
	142	T: Do it here on the board.	
	143	T: Stand like this	
	144	T: That's it. Do what you came to do.	
	145		
	146	L: Takes cards from one of the 4 learners	
	147	T: (takes the cards from the learner) That's it, ok wait here	
	148	now. Can you see this number 36? How did he built it?	
	149	LS: Yes miss.	Learner takes a 30 and a
	150	T: Which numbers will give us 36?	6.
	151	LS: 30	
	152	T: and what?	
	153	LS: 6	
	154	T: Holding one card with 30 and another with 6.	
	155	T: Which number do you add to 30?	.
	156	LS: 6.	
	157	T: With 6 nhe. Which numbers are we going to use to make	
	158	42?	
	159	L: It's 40 and 2 miss.	
	160	T: Show me with which number?	
	161	L: (show a card with 2)	

	162	T: Ok, which numbers will give us 15?	
	163	T: Which numbers will give us 15?	
	164	L: It's 10 and 5 miss	
	165	T: Ok, it's 10 and 5. Come Lwando.	
	166	L: *Lwando takes number cards from the 4 learners*	
	167		
	168		
	169		
	170		Lwando puts the tens in a row on the BB:
		T: Can you please go back to your places?	40, 30, 20, 10
		T: Can you now tell me Lwando, How did you add them?	Next to it he places the
		L: We are going to add 40 and 30.	units of 2,6,4,5
	171		Teacher speaks to 4
	172		learners with flard cards.
	173		Teacher draws a line
	174		connecting the 40 and 30
		T: What is your answer?	40 30
		L: 70	
		T: It's 70, you added 40 and 30 and your answer is 70 nhe. What else did you do?	70
	175	L: I added 20 and 10	
	176	T: What was your answer?	
	177	L: It's 30	Teacher draws a line from
	178		20 and another from 10
			40 30 20 10
	179		
	180		70 30
	181		

The teacher proceeds in like manner until all the tens and units are calculated. Another learner is then asked to finish the problem on the black board. After this activity the learner uptake tasks proceed.

Locating the extract in the lesson

The teacher input started with a variety of activities to practise the processes of acoustic counting and the positioning of numbers. These activities were also done in a whole-class setting. Next, the teacher posed an addition word problem to the learners. (Each of four children has a number of sweets, namely 36 sweets, 24 sweets, 42 sweets and 15 sweets. How many do they have altogether?) Four learners were then asked to represent a specific number of sweets with flard cards (for example the number 36 was represented with two cards and the numbers 30 and a 6). These combinations of cards were shown to the class. The extract above depicts the rest of this activity.

Main focus of teacher input

- *What are the main mathematical concepts and underlying processes of this lesson?* The main mathematical concept is addition and the underlying processes are to solve and explain a solution to a practical problem and to use the breaking-down calculation technique to add numbers. An example of the latter is to add the units and tens separately during addition.

- *Is the concept sustained throughout the teacher input?*

Table 11: Division of time during teacher input for teacher 8.13 (Lesson in 2006)

	Time	Percentages
Practice activities	10 min.	
Main mathematical concept of *addition*	10 min.	50%
Total time spent on teacher input	**20 min.**	

Since less than the prescribed 60% of the teacher input is spent on the concept, the concept was not sustained throughout the teacher input.

- *Is the concept opened up?*

Table 12: Scaffolding strategies employed by teacher 8.13 (Lesson in 2006)

Modelling		Collaborating		Probing	
Delegated modelling	x	Guiding		Orienting	
Instructing		Convince me		Reflecting	
Telling		Noticing		Excavating	
Focussing		Closed questioning (as scaffolding)			x

The teacher instructed two learners to model the solution of the word problem to the rest of the class (*delegated modelling*). Closed questions were also used to lead learners step-by-step through the various processes of the concept. To conclude, since the teacher used two scaffolding strategies to teach the concept, the main concept for this lesson was opened up.

Opportunity provided by the teacher for learner uptake

The extract below depicts a portion of the learner uptake task that was taught by teacher 8.13 in 2006.

Extract 16: Teacher 8.13 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
		Learner uptake task 1:	
20:00	211 212	T: I did not say what you are going to do with them I have just put them in front of you.	Teacher gives each group a container with counters
	213 214 215	T: Let's estimate as a group how many counters are in the container that is in front of you. You have to agree as a group about your estimated number.	Teacher gives each group a blank A3 page and a cocky pen
	216	T: Then you write down the estimated number.	
	217	T: You write down the estimated number, nhe.	
	218 219 220 221	T: Then after you have written the estimated number you have to count how many counters are in the container, and then share the counters amongst you without counting them. Each one of you must have her/ his own counters.	
	222 223	T: Share the counters while I am handing out the blank pages.	
	224 225 226	T: Then each one of you count his \ her counters. You then write all your numbers down. Then you add them all together. This you do as a group.	
	227	T: Don't touch Andisiwe, divide the counters for others.	Groups are dividing the counter amongst themselves without counting how many counters each member is getting
	228	T: Each one of you must have his \her counters.	
	229		
		T: Count how many beans you have all together.	
	230	T: You write how many they have down on that page.	
	231	T: Did you hear me?	
	232	LS: Yes miss.	
	233 234 235	T: You are now going to count how many things each of you got and write those numbers down on the page below the estimated number.	
	236	L: I have22	
	237	L: I have 20	
	238 239	T: Add them all together. If you add 22 to this and this add them together.	
	240 241 242	T: You are going to add this one's number and this one's. Then this one's, this one's and this 20. Add them all together and then write down the answer.	
		Learner uptake task 2:	
	384	T: Ok, now I did my word sum. There it is on the board.	
	385 386 387	T: I said Sipho has 36 sweet, Naledi has 24, Zina has 15 and you counted how many were in the packet. Now I want you to make your own word sum. Do you understand?	
	388	LS: Yes miss	
	389 390	T: As you have that sum in front of you, you are going to make a word sum out of it. Do it. I am going to call now.	Teacher moves between the different learners
	391	L: You are playing.	
	392	T: Ok lets us listen to this group what they are going to say.	
	393	T: Anele stand up and tell us what your group is saying	Teacher is talking to one group.
	394	T: Yes.	

	LS: Mother has 26 sweets, father has 16, sister has 56	
	T: What must we do with them? Must we add them up? Ok	
	L: Yes	
	T: Ok, what does this group say?	Group reads their word problem
	LS Usive has 6 - dozen of eggs.	
	T: Usive has 6- dozen of eggs. You are supposed to use the numbers you added as a group. Do you understand?	
	T: Stand up and tell us what your group wrote.	
	L: Mother has sweets	
	T: Yes	
	L: We have not finished.	
	T: Ok finish then, finish, Ok finish. (Teacher moves to the board)	
	Learner uptake task 3:	
	T: Ok, people are still busy with their sums; will do them later. Do you understand?	
	T: Ok, here is another problem you are going to do for me. On your own not as a group. Do you understand?	
	T: Here is the problem	Teacher pastes a chart with a word problem on the BB.
	T: Lets read it.	
	LS: Reading: Zama has 41 marbles. He picked up 38 and won 57 when they played with other boys. How many marbles does he have?	
	T: Reading: Zama has 41 marbles. He picked up 38 and won 57 when they played with other boys. How many marbles does he have?	
	T: Write your name and today's date	Teacher hands out blank A4 sheets of paper.
	T: Calculate on your own now. Do not copy the story just use the numbers	
	L: Siphelele is writing with a cocky pen	
	T: Who is using a cocky pen	
	LS: Siphelele	

- *What are the mathematical concepts and underlying processes of the learner uptake task?*

  There were three tasks for this learner uptake. Each learner in the class was involved in all these tasks.

  Task 1: The mathematical concepts were addition and estimation. The underlying processes involved were to solve and explain a solution to a practical problem and to use the breaking down calculation technique to add numbers. The underlying process for estimation was to compare the estimated number with the real number.

Task 2: The mathematical concept is addition and the underlying process is to write a word problem.

Task 3: The concept is addition of two-digit numbers and the underlying process is to solve and explain a solution to a practical problem. Learners could possibly use the *breaking down* calculation technique to add numbers (even though this was not explicitly asked by the teacher.)

- *What is the alignment between the mathematical concept of the teacher input and the mathematical concept of the learner uptake task?*

Table 13: Concepts embedded in the various learner uptake tasks

Task	**Concept of task**	**How many of the main concepts of the lesson are represented in this task?**	**Type of alignment**
Task 1	Concepts of addition and estimation	All, but estimation was added	partial
Task 2	Concept of addition and its underlying process is to write a word problem.	Concept the same, but a different underlying process was used.	partial
Task 3	Concept of addition and its underlying process is to solve and explain a solution to a practical problem.	All	good

Since one of the tasks had a good alignment and the rest had a partial alignment, the learner uptake tasks in this lesson had a *partial* alignment with the main mathematical concept of this lesson.

- *Were the learner uptake tasks structured so that each learner could participate?* In tasks 1 and 2, the learners worked in small groups. Each group only had one paper and pencil available for calculations or for recording purposes. Also, no roles were assigned to individual group members to ensure that each learner had an opportunity to participate. These two tasks were therefore not structured for learner participation. In task 3 each learner had a page to calculate the answer and all learners could therefore participate in the task. To conclude: given that only one of the three tasks was structured for all learners to participate, this learner uptake event was classified as *not structured* so that all learners could participate.

- *How much time was spent on all the learner uptake tasks?* 29 minutes of a total lesson time of 50 minutes was spent on learner uptake. Since this is more than a third of the lesson time, this learner uptake was labeled as high.

Conclusion

In this lesson the main mathematical concept was not sustained throughout the teacher input time. The teacher used a scaffolding teaching strategy to open up the mathematical concept. The learner uptake tasks had a partial alignment with the main mathematical concept and these tasks were not structured for learner uptake and covered a high amount of the lesson time.

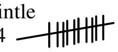
Case study 4: Combination type 3(l)

Teacher input for this lesson

The extract below depicts a portion of the teacher input that was taught by teacher 1.11 in 2006.

Extract 17: Teacher 1.11 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
34:00	225	T: Ok, I'm going to tell you a story. There was a mother who	
	226	had 2 daughters. Their names were Zimkhitha and Zintle.	
	227	What were their names?	
	228	L: Zimkhitha and Zintle, miss	
	229	T: Zimkhitha was a lazy girl. Zintle was very helpful. They	
	230	had no firewood at home. Their mother waited for them to	
	231	come back from school so that they could go and gather	
	232	firewood from the veld. So they went to gather wood,	
	233	each making her own bundle of wood. Mother collected	
	234	18 pieces, Zintle 14, Zimkhitha 8 because she was a lazy	
	235	girl. They had to carry their wood home. Zintle said,	
	236	"No, we must share wood equally". Zintle's friend,	
	237	Unathi, came to help them. Mother said that they must	
	238	divide their wood up for Unathi. How are going to do it?	
	239	L: Each will get 10.	
	240	T: How are you going to do it?	
	241	L: We are going to count.	
	242	T: Let's look at Zintle's mother' wood and Zintle's wood.	
	243	There is a relationship between those numbers. Identify	Teacher writes on the BB:
	244	the relationship.	Mama Zintle Zimk
	245	L: It's the 1's miss.	18 14 8
	246	T: What do the 1's mean in those numbers?	
	247	L: They mean for 10's.	
	248	T: What did you take away?	
	249	L: 4 and 8, miss.	
	250	T: Let's look at Zintle's mother's sticks. So that we can tie it	

	251	up and make a bundle.	
	252	L: Counting from 1 to 10.	The teacher makes a bundle of ten and write eight next to it: 8 
	253	T: How many are left from Zintle's mother's sticks?	
	254	L: 8, miss.	
	255		Teacher draws on BB:
		T: What are we going to do with Zinlte's sticks?	Zintle 14  4
	256	L: We are going to count 10 and tie them up.	
	257	T: How many are left from Zintle's sticks?	
	258	L: 4, miss.	Teacher draws on BB
	259	T: How many stick does Zimkhitha have?	Zimk
	260	L: 8, miss.	8 
	261	T: What are we going to do? We are not going to go get more	
	262	wood for her.	
	263	L: We are going to take from her mother's left over sticks.	
	264	T: How many?	
	265	L: 2, miss.	The teacher erases two
	266		of the mother's sticks
	267		and add it to Zim pile. Zim now has 10 sticks. Teacher writes 8 – 2 = 6
		T: How many will her mother be left with? What are we going to do about Unathi?	next to Mama's pile.
	268	L: We will give her Zinlte's left over 4.	Teacher erases four of
	269		Zin sticks and gives it to
	270		Unathi. Teacher write 4 – 4 = 0 next to Zintle's
		T: And then?	name
		L: Mother will give her left over 6.	
	271	T: How many sticks does Unathi now have?	
	272	L: 10, miss.	Teacher erases 6 of
	273	T: So each have 10 pieces of wood in their bundles.	mother's sticks and add
	274		it to Unathi's pile.
45:00	275		Teacher writes 6 – 6 = 0 next to mother's sticks

Locating the extract in the lesson

Teacher input started with a number of practice activities that focused on acoustic counting, bigger/smaller numbers, estimation and comparisons of estimated numbers with the real answer and lastly the friends of 13. For the latter activity two learners were asked to model the 'friends' of 13 on a number rack. These two learners completed this task easily. The extract above depicts the next activity.

Main focus of teacher input

- *What is the main mathematical concept and underlying process of this lesson?* The main mathematical concept is division. The underlying process is to solve and explain a solution to a practical problem.
- *Is the main mathematical concept sustained throughout the teacher input?*

Table 14: Division of time during teacher input for teacher 1.11 (Lesson in 2006)

	Time	Percentages
Practice activities	28 min.	
Main mathematical concept of division	14 min.	33%
Total time spent on teacher input	**42 min.**	

Less than 60% of teacher input time was spent on the main mathematical concept, therefore the main mathematical concept was not sustained.

- *Is the main mathematical concept opened up?* The teacher used the following scaffolding strategies to teach the main mathematical concept.

Table 15: Scaffolding strategies of teacher 1.11 (Lesson in 2006)

Modelling	x	Collaborating		Probing	
Delegated modelling		Guiding		Orienting	
Instructing		Convince me		Reflecting	
Telling		Noticing		Excavating	
Focussing				Closed questioning (as scaffolding)	x

The teacher used *closed questioning* to lead the learners in a step-by-step way to the solution. The teacher did not merely require correct answers. The teacher also *modelled* the various steps by using diagrams and number sentences on the black board. The teacher thus used more than one scaffolding strategy to teach the concept. To conclude, in this lesson the main mathematical concept was opened up.

Opportunity provided by the teacher for learner uptake

The extract below depicts a portion of the learner uptake that was taught by teacher 1.11 in 2006.

Extract 18: Teacher 1.11 (Lesson in 2006)

Time	Line		Dialogue	Non-verbal actions
	276	T:	You are now going to work in pairs. One person from the	T hands each pair of Ls a
	277		pair will come and get a card from me.	card and places a box of
	278	L:	Keep the number written on the card in your head and pass	crayons on each desk
	279		the card to those who did not get.	
	280	T:	Where must we keep our numbers?	
	281	L:	In our minds.	
	282	T:	Now you are going to take the number of crayons using the	The learners count out the
	283		number that was on your card.	crayons. The teacher
	284	L:	*(busy counting crayons)*	goes around checking if
	285	T:	How many must you have *(asking one group, they are*	each pair of learners took
	286		*grouped in pairs)*	the correct number of
	287	L:	13	crayons.
	288	T:	Count them. Are they 13?	
	289	L:	*(Counting)* They are 11	.
	290	T:	Add and make 11.	
	291	L:	They add 4	
	292	T:	Count them again to see if they are 13.	
	293	L:	*(Count 13 crayons and put back 2.)*	
	294	T:	How many are yours (asking the next group)? Count	
	295		together.	
	296	L:	*Counting*	
	297	T:	What was your number?	
	299	L:	15	
	300	T:	Count to make sure you have 15.	T collects excess crayons
	301	L:	Counting up to 15 and putting 1 back (they took 16)	and checks that each pair
	302	T:	Ok, all of you have crayons. Work as a group and stop	have correct number of
60:00	303		making noise.	crayons

- *What is the mathematical concept and underlying processes of the learner uptake task?* The mathematical *concept* is number knowledge. Its *underlying process* is to represent a number symbol with objects.
- *What is the alignment between the mathematical concept of the teacher input and the mathematical concept of the learner uptake?* The mathematical concept of the learner uptake is different than the one that was taught. The concept of *equal sharing* was the focus of teacher input, whilst *number knowledge* was the focus of the learner uptake activity. There was *no* alignment between the mathematical concept of the learner uptake and the main mathematical concept of the lesson.
- *Was the lesson structured so that each learner could participate?* The learners worked in pairs to pack out crayons that represented the number on a card. From the video recording it

was evident that the teacher structured the task in such a way that only one learner packed out the crayons, while the other one watched. The teacher did not explicitly ask both learners to handle the crayons. Furthermore, only one number was given to each pair to represent with crayons. Both learners therefore did not have the opportunity to do the task under the watchful eye of the other peer. The task was therefore not structured so that both learners could actively participate.

- *How much time was spent on all the learner uptake tasks?* Ten minutes of a total of 60 minutes of lesson time was spent on the task for learner uptake. This is below a third of the lesson time and was therefore classified as low.

Conclusion

In this lesson the main concept was not sustained throughout the teacher input. The use of scaffolding strategies, though, opened up the concept. There was no alignment between the main mathematical concept of the teacher input and that of the learner uptake. A low amount of lesson time was also used for the learner uptake task and the task was not structured so that each learner had the opportunity to participate.

Case study 5: Combination type 3(m)

Teacher input for this lesson

The extract below depicts a portion of the teacher input that was taught by teacher 2.11 in 2004.

Extract 19: Teacher 2.11 (Lesson in 2004)

Time	Line	Dialogue	Non-verbal actions
12:00	220	T: Heke, listen now. Now I want you to look at this 6. Are you	
	221	looking?	
	222	LS: Yes miss	
	223	T: Write 6 in the air.	
	224	LS: *Writing 6 in the air.*	
	225	T: Say six as you are writing.	
	226	LS: *Saying 6 in a chorus while writing in the air.*	
	227	T: Now write 6 on your desk.	
	228	LS: *Writing 6 on the desk.*	
	229	T: Now write on my back	
	230	L: Write 6 on teachers back	
	231	T: Write 6 on my back. Yha you don't want ok, ok.	
	232	LS: *making noise*	

	T: Hayi, wait. Don't make noise. Miss will not know what to do. But once you keep quiet I will know. Let's do this now. Amanda come! And you and you. I want 6 people to come here in front.	
13:00	LS: *move forward*	
	L: Get out; get out.	
	L: They are 7	
	T: Mpo, sit down	
	L: Goes back to her place.	
	T: How many are they now. How many?	
	LS: *count and say they are 6*	
	T: Look now, look at me. Can you see, do you know? Do you know what these are? These are counters. Each person is going to take 6 counters	
	LS: Taking 6 counters each.	
In the next teacher event, selected learners were asked to represent various numbers with circles on the black board. In the extract below, each learner has six counters. The teacher's instructions are based on these counters.		
	T: What you are going to do now; you are going to take all 6 and put them under your desk. Take all of them and hide them under your desk.	
	LS: *Putting counters under the desk.*	
33:00	T: How many are you left with?	
	LS: Zero	
	T: How many?	
	LS: Zero (joining the index finger and the thumb to form o)	
	T: Yes listen now. Take all your 6 counters and put them in front of you. Lets count them.	
	LS: counting from 1 to 6	
35:00	T: Heke; listen now; listen now. This thing says… I'm not going to write if you are making noise.	
	LS: *Counting* (putting 3 counters on one side and 3 on the other side)	
	T: Count them altogether.	
	LS: *Counting form 1 to 6*	The teacher writes on the BB:
	T: How many are they all together?	4 + 2 =
	LS: 6	
	T: Come, let's do this one. 4 + 2 =	The learners make groups of 4 counters and 2 counters.
	T: First put 4 counters together and then 2	
	T: How many are they all together?	
	LS: Lifting fingers and saying 6.	Teacher writes on the BB:
	T: This one now. 2 + 2 + 2 =	2 + 2 + 2 =
	T: Separate 2 three's	Learners make three
	LS: Separating	groups of two.

Locating the extract in the lesson

At the beginning of this teacher input, the learners did a number of practice tasks relating to the number concept, namely acoustic counting and counting pictures of animals or counters. These were done as whole-class activities. The extract above depicts the next two main activities done in the classroom.

Main focus of teacher input

- *What are the main mathematical concepts and underlying processes of this lesson?* The main mathematical concepts are number knowledge and addition.

  Regarding number knowledge: The underlying process is to represent a number in various ways (for example by writing the number in the air).

  Regarding addition: The underlying process is to use the calculation technique of building up numbers (for example 2 + 2 + 2 = 6).

- *Is the main mathematical concept sustained throughout the teacher input?*

Table 16: Division of time during teacher input for teacher 2.11 (Lesson in 2004)

	Time	Percentages
Practice activities	16 min.	
Main mathematical concept of number knowledge	21 min.	38%
Main mathematical concept of addition	10 min.	23%
Total time spent on teacher input	**42 min.**	

In this lesson the teacher did not introduce any concept for longer than 60% of the total teacher input time; the main mathematical concept of this lesson was therefore not sustained.

- *Is the main mathematical concept opened up?*

Table 17: Scaffolding strategies of teacher 2.11 (Lesson in 2004)

Modelling		Collaborating		Probing	
Delegated modelling		Guiding		Orienting	
Instructing	x	Convince me		Reflecting	
Telling		Noticing		Excavating	
Focussing		Closed questioning (as scaffolding)			

During the tasks relating to number knowledge, the teacher first *instructed* the learners to represent the number 6 in various ways. Selected learners were then instructed to represent other two-digit numbers with circles on the black board. For the concept of addition, the teacher also *instructed* the learners to manipulate counters to solve various addition problems (also called the bonds of 6). During all these activities closed questioning was used to elicit correct answers and not to scaffold. Since an effective teaching strategy was used to teach each concept, the mathematical concept was opened up.

Opportunity provided by the teacher for learner uptake

In this lesson no opportunity was provided for learner uptake.

Conclusion

In this lesson the main mathematical concept was not sustained, but opened up. This lesson provided no opportunity for learner uptake.

Case study 6: Combination type 1(b)

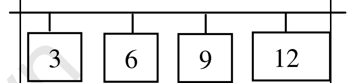
Teacher input for this lesson

The extract below depicts a portion of the teacher input that was taught by teacher 5.32 in 2006.

Extract 20: Teacher 5.32 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
In this excerpt the teacher asks individual learners to draw dots, in groups of three on the black board. Initially the teacher demonstrated how to draw the multiples. Individual learners are then asked to draw several sets of dots.			
	125	T: Everything was in three's nhe?	
	126	LS: Yes miss	
	127	T: So we were doing this story because we are going to do	
	128	multiplication. We are going to multiply. We are going to do	
	129	multiples of three do you understand?	
	130	LS: Yes miss	
	131	T: Isn't that so?	
	132	LS: Yes miss	
	133	T: Right, I have written an example here. I have written the first	
	134	three.	
	135	LS: yes miss	
	136	T: Lets count.	counting from the dots on
	137	LS: Counting form the dots on the board. 1, 2, 3	the board
09:00	138	T: do you understand that this is our first one?	T writes on black board:
	139	LS: Yes miss	1. •••
	140	T: I made the second one. Isn't that so?	2. ••• •••
	141	LS: Yes miss	

	T: How many three's are we going to have now?	
	LS: 2	
	T: 2.	
	T: How many are they going to be altogether?	
	LS: 6	
	T: Yes they are 6. Isn't it so?	
	LS: Yes miss	
	T: Don't you dare! Here is our first group of three's nhe? (Pointing to the groups)	Pointing as speaks.
	LS: Yes miss.	
	T: This one is our second group nhe?	
	LS: Yes miss	
	T: So what do we say? (Pointing to the groups)	
	LS: 3, 6	
	T: Heke! I am not going to do the rest nhe?	
	LS: Yes miss	
	T: Let me do the 3rd one nhe?	
	LS: Yes miss	
	T: This is the 3rd one. Teacher draws the 3rd group on the board.	
10:00	T: This is the first group, this the second group and the third group (Pointing to the groups)	
	T: Is there anyone who can draw the first group on the board for us?	
	T: Is there anyone who can draw the first group on the board for Us?	
	T: He! Who can come? Who can come? Who can come? Come Siphokazi.	Teacher writes on black board: 3. ●●● ●●● ●●●
11:00	L: stands up and goes to the board.	
	T: Make the fourth one for us. Be quickly sisi; be quick. Write under the 3rd one.	
	L: Writes on the board	
	T: Siphokazi is spoiling the whole thing. Siphokazi what is happing with you?	
	L: I am short.	
	T: What are trying to tell me. What do you want me to do? I won't do it. I'm not going to think for you. You have your own brain use it.	
	T: Siphokazi is telling me that she is short. What must she do? Must she stop writing because she short. You can't write here at the bottom Siphokazi.	
	T: what must she do?	
	LS: she must stand on the chair.	
	T: Go you are lazy to think. What must do?	
	LS: She must stand on the chair.	
	L: fetches the chair.	
12:00	T: Siphokazi doesn't know if cant reach she must use a chair.	Erasing what the learner wrote on the board.
	T: Write and be quick. Write next to that line and be quick.	
	L: Writes on the board.	
	T: Don't make the dots big; you are not going to have enough space to write.	
	T: You may get off the chair now.	Teacher shows learner where to write on the board.
	L: Takes the chair to her place and sits down.	
	T: Siphokazi is right nhe?	

13:00	195	LS: yes miss	Board work: (Learner work)
	196	T: Lets count.	4. ●●● ●●● ●●● ●●●
	197	LS: counting in three's. 3,6,9,12	Teacher colours the dots on the board
The teacher proceeds in the same way, until ten groups of threes are drawn on the black board. With each new drawing the teacher emphasizes the set number and asks learners to count the total number of dots in each row, by counting in multiples of threes (as was done in line 197). In the next excerpt the teacher has a number of cards on her table. Each card has a number (which is a multiple of three) written on it. The teacher asks learners to order these numbers on a number line on the black board. One learner gets the opportunity to paste one number at a time on the number line.			
	394	L: Goes to the board takes the prestick and a card from the table.	Learners form a number line like this:
	395	L: Pastes the card on the number line.	
	396	L: Miss	
	397	T: Look at the board don't talk.	
	398	T: What are you suppose to do there? What are you suppose to do	
	399	there?	
	400	L: Responds but the voice is not audible.	
	401	T: Heke!	
	402	T: Chooses another learner.	
	403	L: Goes to the board takes prestick and a card.	
	404	T: Be quick. Is that true.	
	405	LS: Yes miss	
	406	T: Ok, the next one.	
	407	LS: Miss, miss	
	408	T: No you will not! Simamkele? Make it quick make it quick.	
	409	L: Goes to the board takes the prestick and a card and pastes on the	
	410	number line.	
	411	T: Lets be quick, Nikelwa? No not in that way	
	412	T: Lets be quick, be quick sisi.	
25:00	413	L: Goes to the board takes prestick and a card and pastes the card	
	414	on the number line.	
	415	T: He! You are amazing me today. Is she right?	
	416	LS: Yes miss	
	417	T: Mmm, mmm, Thandokazi, Thandokazi?	
	418	T: Why am I calling only short people?	
	419	L: Goes to the board and the teacher gives the learner prestick and	
	420	the learner chooses a card.	
	421	LS: Laughing	
	422	T: Thandokazi, Thandokazi, my numbers are missing. My	
	423	numbers are disappointing me; they are missing.	
	424	L: Takes a card	
	425	T: No! Wait. Put back, put back I don't want you to see	
	426	L: Puts back the card.	
	427	T: I don't want you to see.	
	428	(T: Run.	One learner gets up and
	429	L: Runs out.)	asks to be excused.
	430	T: Be quick I did give you prestick.	
	431	L: takes the chair, but cannot reach the number line.	
	432	T: Ok, ok, the next one must come.	
	433	L: Gets up.	
	434	T: No, you won't. Come anyway; take. All of you are short you are	
	435	not going to reach either.	

	L: Fetches a chair T: Yho! Sorry. L: Pastes his card on the number line. (T: Only one learner went out nhe? Mmmm.)	A ruler falls from the board.

Locating the extract in the lesson

The teacher tells the story of Goldilocks and the three bears and emphasizes the number three in the story. The teacher sets the scene for the use of the number three. Next the teacher does an acoustic counting activity.

Main focus of teacher input

- *What are the main mathematical concepts and underlying process of this lesson?* The main mathematical concept is multiples and the underlying process is representing the multiples of threes in various ways.
- *Is the main mathematical concept sustained throughout the teacher input?*

Table 18: Division of time during teacher input for teacher 5.32 (Lesson in 2006)

	Time	Percentages
Practice activities	4 min.	
Main mathematical concept of *multiples*	26 min.	87%
Total time spent on teacher input	**30 min.**	

The main mathematical concept was sustained throughout teacher input since more that 60% of the input time was spent on the main mathematical concept.

- *Is the main mathematical concept opened up?*

Table 19: Scaffolding strategies of teacher 5.32 (Lesson in 2006)

Modelling	x	Collaborating		Probing	
Delegated modelling	x	Guiding		Orienting	x
Instructing		Convince me		Reflecting	
Telling		Noticing		Excavating	
Focussing		Closed questioning (as scaffolding)			

In the first activity the teacher *modelled* and also used *delegated modelling* to teach the learners how to represent groups of three on the black board. Next, the teacher asked several learners to pick a number from a set of cards and to arrange these numbers (multiples of three) in order on a number line. This was also an example of *delegated modelling.* Since more than one scaffolding strategy was used to teach the main mathematical concept, the concept was opened up.

Opportunity provided by the teacher for learner uptake

The extract below depicts a portion of the learner uptake that was taught by teacher 5.32 in 2006.

Extract 21: Teacher 5.32 (Lesson in 2006)

Time	Line	Dialogue	Non-verbal actions
The class is divided into three groups. There are about ten learners in each group. In this excerpt the teacher asks a group of learners to use matches and to build a pyramid with it. In row one, three matches have to be pasted as a group. In row two, two groups of matches have to be pasted, etc. See the example below.			
30:00	497	T: Listen now group 1 this is your work.	An example of what the
	498	Gr1: Yes miss	teacher was expecting:
	499	T: You are going to take these lines and put them in groups of	III
	500	threes.	III III
	501	What are you going to do?	III III III
	502	Gr 1: we are going to put them in groups of threes.	III III III III
	503	T: We said it's going to be what Qhama?	Etc
	504	L: Its Qhama miss	
	505	T: Give them to Qhama. In-group of threes nhe?	
	506	Gr: yes miss	
	507	T: These three's. Like these; you are, you are, you are going to put	
	508	them. You are not going to put them as they follow. We are going	
	509	to use the same pattern we used to form this thing that looks like a	
	510	pyramid. That was there isn't that so?	
	511	Gr: Yes miss	
	512	T: Do you understand?	
	513	Gr: Yes miss	
	514	T: do it now so that I can see. I want you to look at this example; I	Giving the learner a
	515	want you to use this.	khoki pen
	516	T: I want you to use this. You do understand you are going to	
	517	write first?	2 Big cards and 2 pens to
	518	L: Yes miss	group of 10 L's
	519	T: Then the first one will put nhe?	
	520	L: yes miss	
	521	T: sorry! You put; you put; you put, but he must first write it	
	522	down.	
	523	L: yes miss	
	524	T: who is going to do this? It's the two of you.	Teacher shows the group
	525	LS: Yes miss	how to do the pyramid
	526	T: and the 2nd one you are going to do it like this? Isn't it so?	using glue and match
	527	Gr: Yes miss.	sticks

	T: and then you stop here. You stop on the 10th. Do you understand?	

In the next excerpt the teacher explained the assignment to a group of about ten learners. The group received one peg mould and different colored pegs. The learners were asked to pack out pegs in groups of three on a peg board. The learners also had to sort out the pegs according to color. Each row of pegs had to be a different color.

	T: Listen group 2. (Gives the group a blank chart and the peg mould	Teacher moves to another group.
33:00	T: The answer you will get here; you will write it on this chart nhe? I don't know where you are going to start writing? It depends on you. The only thing that I want; I want to know is; how your three's will follow on the peg mould. Do we understand?	Learners lift their hands up Teacher shows the group how to use the peg mould
	Gr: Yes miss	
	T: How they follow; how they follow. Don't speak so loud nhe you'll disturb other…	Teacher brings different colour peg to fit in the holes of the peag mould.
	T: So group 2, nhe?	
	Gr: Yes miss	Teacher gives them the pins
34:00	T: here it is nhe? You are going to take these out. You have to separate these colours nhe? Then you know from the first row of three's you are going to put another colour and the second one another colour so that it can be clear.	
	Gr: Yes miss	
	T: Because maybe it will stop here nhe? But the colour will direct you from where you stopped.	Teacher pointing to the holes in the peg mould.
	T: But, you have to skip one row so that your three's can stand out.	
	T: you are going to use these things to separate your three's do you understand?	
	Gr: yes miss	
	T: you are going to separate them using these things. Then you put in, and put in. (pointing to the holes.) who is writing?	
	L: answers but the voice is not audible.	
	T: All right, when you get the first one nhe? You are going to count and then write what you got from the first one; you put in again the second one and write. Isn't it?	

In this excerpt another group was asked to cover the multiples of three on a transparent number board. The learners had to use transparent square cards (with no number written on them) to cover the appropriate number.

	T: Listen group 3. You can draw on this. Take this and share amongst you. But listen carefully.	Teacher brings a transparent number board. Teacher hands out square transparent number cards to learners.
	L: Yes miss	
	T: As you are going to draw. Share. Lets say, no; no; don't do it like that each one must be given a turn to take. Nothing makes you fight over this. Do you understand?	
	Gr: Yes miss	
	T: Ok, How many times are you going to jump?	
	T: 1, 2 and then you put in on the 3rd one nhe?	
	Gr: yes miss	
	T: listen carefully.	Teacher pointing at number 9.
	Gr: yes miss	
	T: How many do you jump? I am going to put in here nhe? I am going to put in here.	

	T: How many times do I jump?	
	Gr: 2 times	
	T: 2 times nhe?	Teacher puts in the 3rd one.
	Gr: yes miss	
	T: I am going to jump 1, 2 and put where?	
	Gr: In the 3rd one	
	T: In the 3rd one nhe?	Teacher gives the square to one leaner.
	Gr: Yes miss	
	T: You jump two times; Where are you going to put this in? Come and show me I want to see if you understood.	
	T: You jump two spaces. Where do I put this?	
	L: Puts the square in number 6.	
	T: That's it! You jump two spaces again and where are going to put this one?	
	L: Points at number 9.	
	T: All right nhe. (Puts the square at number 9.)	The learners are making a noise in their groups.
	Gr: Yes miss	
	T: Share for the others now.	
For the remainder of the lesson, the teacher gave assistance to each group.		

- *What is the mathematical concept and underlying process of the learner uptake task?* The mathematical concept is the multiples of three and the underlying process is to represent the multiples of three in various ways.
- *What is the alignment between the mathematical concept of the teacher input and the mathematical concept of the learner uptake task?* For learner uptake, learners did one of three tasks, namely representing multiples of three with matches (task 1), packing out multiples of three with different colored pegs on a pegboard (task 2) and covering the multiples of three on a hundred board (task 3). All these tasks had the same mathematical concept, namely multiples. In this task there was a good alignment between the concepts for teacher input and learner uptake.
- *Was the lesson structured so that each learner could participate?* The learner tasks were done in groups of at least ten members each. In Task 1 there was only one page and one box of matches with which to perform the task. The task was not structured so that all learners could participate. In Task 2 the learners organized themselves so that each learner had the opportunity to cover at least one multiple of three. The same was for Task 3. The group organized themselves so that each learner had different coloured pegs to pack out. Only one small peg board was used for a group of about ten learners (even though the video showed other available peg boards). The teacher did not structure these tasks so that all learners could

participate, the learners arranged this. Thus in this lesson the teacher did not structure the tasks so that all the learners could participate.

- *How much time was spent on all the learner uptake tasks?* 14 minutes of a total lesson time of 44 minutes was spent on learner uptake. Since this is very close to a third of the lesson time, the time was classified as high.

Conclusion

In this lesson the mathematical concept was sustained and opened up. The learner uptake task had a good alignment with the main mathematical concept of the lesson, a high amount of time was spent on learner uptake and the lessons were not structured so that all learners could participate.

ANALYSIS OF THE DATA

The analysis of the data indicates both the discreet scaffolding strategies that were evident in the data and the lesson types signified by each lesson. Both of these aspects of the analysis will be discussed at this juncture in the chapter.

Scaffolding strategies evident in the lessons

The first research question of this study, *'What scaffolding strategies are evident in selected foundation phase mathematics lessons?'*, guides the following report on the scaffolding strategies of teachers in the study. This research question is:

Key Feature 1: The teacher strategies orient the learner to the main mathematical concept.

This key feature of scaffolding implies that the teacher should introduce the main concept(s) of the lesson for a sufficient amount of time. Table 20 indicated that two-thirds of the teachers in this study did not sustain the main mathematical concept. This suggests that in most of the lessons an insufficient amount of time was spent on orienting learners to the main mathematical concept of the lesson.

Table 20: Sustaining of the concept during teacher input.

	All lessons (Total of 18)	
	Sustained	Not sustained
Concept sustained	5	13

Previously it was reported that the teachers focus on the concept to achieve several purposes, namely to practise and revise mathematical concepts and their underlying mathematical processes and to teach the new concept. An analysis of how teachers in the data focused on these purposes indicated that each lesson represents at least two purposes. This is indicated by Table 21. *In the following table MC stands for mathematical concept, P stands for practice and the R for revising the mathematical concept. T 9.33 (04) stands for teacher 9.33 and the lesson was taught in 2004.*

Table 21: Time (in minutes) spent on the various purposes of teacher input

		T 9.33 (04)	T 9.33 (06)	T 3.11 (04)	T 3.11 (06)	T 2.11 (04)	T 2.11 (06)	T 1.11 (04)	T 1.11 (06)	T 4.22 (04)	T 4.22 (06)	T 8.13 (04)	T 8.13 (06)	T 5.32 (04)	T5.32 (06)	T 6.11 (04)	T 6.11 (06)	T 7.13 (04)	T 7.13 (06)	Total
Total amount of time spent on teacher input		37	25	23	23	42	33	20	42	16	23	12	20	7	30	50	50	12	34	499
Division of teacher input time: Total amount of time spent on	P & R	6	11	12	18	9	21	11	28	4	7	1	10	2	8	2	30	7	23	210 (42%)
	teaching the main MC	31 (83%)	14 (56%)	11 (48%)	5 (22%)	33 (79%)	12 (36%)	9 (45%)	14 (33%)	12 (75%)	16 (70%)	11 (92%)	10 (50%)	5 (71%)	22 (73%)	48 (96%)	20 (40%)	5 (42%)	11 (32%)	289 (58%)

Table 21 also points to the amount of teacher input time that was spent on these purposes. On average the teachers expended more than a third of the teacher input time on revising and practicing mathematical concepts. Slightly more time was used to introduce the main mathematical concept of the lesson. Half of the teachers had spent 50% or less of the teacher input time on the main mathematical concept. This suggested that some of the teachers placed equal value on practising the processes and teaching the new concept.

Table 21 points to a discrepancy in the data. This table illustrates that in eight lessons more than 60% of the teacher input time was spent on teaching the main mathematical concept, whilst Table 20 indicates that in only five lessons was the concept sustained. As previously discussed, a concept is only sustained if 60% or more of the teacher input time is spent on *one* concept or *one* process. The discrepancy raises the following questions: How many *different* concepts or processes did the teacher focus on during teacher input? Does this contribute to the insufficient amount of time that is spent on teaching one main concept or main process?

The following table was then created to indicate the number of concepts that were taught during teacher input. *In the table the P stands for practice and the R for revising the mathematical concept.*

Table 22: Number of concepts or processes that teachers focused on during teacher input

Number of concepts used for various purposes	The concepts of the 18 lessons added together	Average number of concepts
Total number of different processes that teachers focused on for the purpose of *practicing* these concepts and/or underlying processes	42	2.3 rounded off = 2
Total number of different concepts or processes that teachers focused on for the purpose of *revision*	1	
Total number of different concepts or processes that teachers focused on for the purpose of teaching the *main mathematical concept(s)* of the lesson.	38	2.1 Rounded off = 2

Table 22 indicates that, on average, the teacher input time accommodated four different concepts or processes, unless there was an overlap between these concepts. In some lessons there was an overlap as the processes that were revised, related to the main concept that had been taught. The teacher input time was divided to accommodate several concepts or processes. Consequently, relative little time was allocated to any one concept or process.

To conclude, in the majority of lessons the main concept was not sustained during teacher input. Teachers spent considerable input time practising and revising concepts and processes that did not form part of the main concept of the lesson. The time that was then left to teach the main mathematical concept was also further divided across at least two different concepts or processes. Ultimately, little time was spent on introducing each of the main mathematical concepts of the lesson.

Key feature 2: The teacher strategies open up the main mathematical concept.

The data in Table 23 indicates that in most of the lessons the concept was opened up. This suggests that teachers in this study employed a minimum of one scaffolding strategy to teach the main mathematical concept of the lesson.

Table 23: Opening up the concept during teacher input

	All lessons (Total of 18)	
	Opened up	Not opened up
Concept opened up	13	5

An analysis of the type of scaffolding strategies that were employed in classrooms showed that teachers used on average two different type of scaffolding strategies. These strategies were predominantly modelling and instructing as indicated by Tables 24 and 25. Other scaffolding strategies that were also evident in some lessons were: telling, excavating, convince me, noticing, probing, orienting and closed questioning. These strategies, however, were utilised in a limited way during the lessons (each strategy occurred only once) and did not constitute the dominant teaching strategy of the lesson.

Table 24: Number of scaffolding strategies used by teachers

	Total (of 18 lessons)	Average
Number of scaffolding strategies used	35	1.9 Rounded off = 2

Table 25: Number of instances that scaffolding strategies were used by teachers

Modelling	Teacher Models	8	Collaborating	0	Probing	1
	Learner models (delegated modelling)	4	Guiding	0	Orienting	1
	Instructing	10	Convince me	1	Reflecting	0
	Telling	3	Noticing	4	Closed questioning (used as scaffolding)	3
	Excavating	1	Focussing	0		

The above tables suggest that teachers in this study did not use a variety of scaffolding strategies to teach the main concept. In the data, it was also evident that closed questioning was mostly used in a way that did not open up the concept. The most common strategies used in the lessons, were those that required learners to follow the teachers' lead and reasoning. Strategies that required learners to grapple with questions, problems and processes, such as reflecting, excavating, convince me, probing or reflecting were rare or absent.

Key feature 3: The teacher structures the learner task in a way that enables to learner to internalise the concept.

The third feature of scaffolding constitutes three different scaffolding strategies, namely, a good alignment, high time spent on learner uptake tasks and activities structured for participation. The following table indicates the measure to which these strategies were evident in the lessons.

Table 26: An analysis of the learner uptake that occurred in all 18 lessons

<table>
<tr><td></td><td colspan="4">Number of lessons</td></tr>
<tr><td>Alignment between the main mathematical concept(s) taught and that of the learner uptake task (Out of a total of 18 lessons)</td><td>Good alignment (scaffolding):
5 lessons</td><td>Partial alignment:
10 lessons</td><td>No alignment:
1 lesson</td><td>No opportunity for LU:
2 lessons</td></tr>
<tr><td>Time that was spent on the learner uptake task
(Out of a total of 16 lessons, since two lessons had no learner uptake)</td><td colspan="3">High time:
A third of lesson time spent on LU: (scaffolding) 1
More than a third of the lesson time spent on LU: 11
Total: 12 lessons</td><td>Low time:
Less than a third of total lesson time:
4 lessons</td></tr>
<tr><td>Structuring of the activity so that all learners can participate (Out of a total of 16 lessons, since two lessons had no learner uptake)</td><td colspan="2">All learners have the opportunity to participate (scaffolding):
8 lessons</td><td colspan="2">All learners do not have the opportunity to participate:
8 lessons</td></tr>
</table>

The dominant trend was that teachers structured learner uptake tasks that had a partial alignment with the main mathematical concept that was being taught. In just over a fifth of the lessons a good alignment was evident. Furthermore, in most of the lessons teachers spent more than a third of the total lesson time on the learner uptake tasks. For this strategy to be labelled as scaffolding, though, teachers should structure the task so that learners spend no more than a third of the lesson time on learner uptake. This strategy was therefore not used in a manner that displays scaffolding. The learners in this study consequently had more than a sufficient amount of lesson time to internalise the concepts that was taught. Lastly, no dominant trend was observed regarding how teachers structure their lessons for learner participation.
Group work activities were structured for partial participation, that is not all learners could participate actively in the whole task. Learners that could not participate either passively watched or became distracted.

Table 27 indicates that teachers, on average, spent slightly less than 50% of lesson time on learner uptake tasks. This suggests that when teachers utilise group work activities during learner uptake, a significant number of learners employ a substantial proportion of the lesson time to passively observe their peers doing tasks.

Table 27: Percentage of time spent on teacher input and learner uptake

	Total amount of time for all 18 lessons	Percentage of total lesson time
Total lesson time	877 min	
Time spent on teacher input	499 min.	57%
Time spent on learner uptake	378 min.	43%

The following teacher practices were observed regarding group work activities:

- When group work activities occurred, no roles were assigned to individual learners. The teacher did not explicitly guide learners on how they could participate in the task.
- Group tasks were short and easy to perform. They were usually quickly completed by one or two group members.
- When a limited number of resources were available for group work tasks, the teacher did not insist that equal opportunities be given to group members to participate.
- During problem solving tasks, only one sheet of paper and one pencil were provided for each group. Most group members then passively observed while one or two learners solved the problem. In large groups, learners also had limited opportunities to comment on the solution process.

When learners worked in pairs, the tasks were also not necessarily structured so that each learner could participate. Many of the tasks required only one learner to participate. An example was a lesson where pairs had to pack out counters to represent a number on a card. Only one number was given to each pair and therefore only one learner had the opportunity to pack out the counters.

Types of lessons evident in the data

As was previously mentioned, the data in this study represents 13 types of lessons. This distribution is represented in Table 28 on the next page. These 13 lessons were classified according to the degree in which the three features of scaffolding were combined in these lessons.

Table 28: The classification of the classroom lessons according to lesson types

VARIOUS TYPES OF OPPORTUNITIES FOR LEARNER UPTAKE			VARIOUS TYPES OF TEACHER INPUT			
	Time spent on learner uptake	**Learner participation (LP)**	**Mathematical concept sustained and opened up**	**Mathematical concept sustained and not opened up**	**Mathematical concept not sustained but opened up**	**Mathematical concept not sustained and not opened up**
Good alignment	High	Structured for LP	Combination type 1(a) ▪ Teacher 4.22 (2006)	Combination type 2(a)	Combination type 3(a)	Combination type 4(a)
		Not structured	Combination type 1(b) ▪ Teacher 5.32 (2004) ▪ Teacher 5.32 (2006)	Combination type 2(b)	Combination type 3(b)	Combination type 4(b)
	Low	Structured for LP	Combination type 1(c) ▪ Teacher 6.11 (2004)	Combination type 2(c)	Combination type 3(c) ▪ Teacher 2.11 (2006)	Combination type 4(c)
		Not structured	Combination type 1(d)	Combination type 2(d)	Combination type 3(d)	Combination type 4(d)
Partial alignment	High	Structured for LP	Combination type 1(e) ▪ Teacher 8.13 (2004)	Combination type 2(e)	Combination type 3(e) ▪ Teacher 3.11 (2004)	Combination type 4(e) ▪ Teacher 3.11 (2006) ▪ Teacher 7.13 (2004)
		Not structured	Combination type 1(f)	Combination type 2(f)	Combination type 3(f) ▪ Teacher 1.11 (2004) ▪ Teacher 8.13 (2006) ▪ Teacher 4.22 (2004)	Combination type 4(f) ▪ Teacher 7.13 (2006) ▪ Teacher 9.33 (2006)
	Low	Structured for LP	Combination type 1(g)	Combination type 2(g)	Combination type 3(g)	Combination type 4(g) ▪ Teacher 6.11 (2006)
		Not structured	Combination type 1(h)	Combination type 2(h)	Combination type 3(h)	Combination type 4(h)
No alignment	High	Structured for LP	Combination type 1(i)	Combination type 2(i)	Combination type 3(i)	Combination type 4(i)
		Not structured	Combination type 1(j)	Combination type 2(j)	Combination type 3(j)	Combination type 4(j)
	Low	Structured for LP	Combination type 1(k)	Combination type 2(k)	Combination type 3(k)	Combination type 4(k)
		Not structured	Combination type 1(l)	Combination type 2(l)	Combination type 3(l) ▪ Teacher 1.11 (2006)	Combination type 4(l)
No structured opportunity for learner uptake	Not applicable	Not applicable	Combination type 1(m)	Combination type 2(m)	Combination type 3(m) ▪ Teacher 2.11 (2004)	Combination type 4(m) ▪ Teacher 9.33 (2004)

The analytical framework of this study suggests that there are a total of five sets of scaffolding strategies that can assist the learner to acquire the concept. These are: sustaining and opening up the concept, a good alignment between the concept of the learner uptake activity and the concept taught, a high amount of time spent on learner uptake and a learner uptake activity which is structured for all learners to participate.

The second research question of this study, '*What are the scaffolding features of these lessons in relation to combinations of scaffolding strategies that orient learners to concepts, open up these concepts and structure activities in which learners can work with these concepts'*, was used to guide the discussion below.

A small number of lessons (five out of 18) in this study represented a combination of scaffolding strategies that included a good alignment between concepts. Only one of these lessons designated complex scaffolding practice, as all three features of scaffolding were evident in this lesson. The remainder of the lessons indicated partial combinations of these features. Most of the good alignment lessons represented a combination of four scaffolding strategies, whilst one lesson combined three scaffolding strategies. In all the good alignment lessons the concept was opened up and sustained. No dominant trend was observed regarding high and low time and regarding learner uptake activities that were structured or not structured for participation.

Partial alignment was evident in most lessons. In the majority of these lessons the concept was opened up and all learners were able to participate in learner uptake activities. In all but one of these lessons the concept was not sustained.

Only one lesson in the data exhibited no alignment between the concept of the learner uptake activity and the main concept of the lesson. In this combination lesson only one scaffolding strategy was evident, namely, opening up the concept.

Only two lessons included no learner uptake activity. In one of these two lessons only one scaffolding strategy was utilised, whilst in the other there was no evidence of any form of scaffolding.

The analysis shows that when teachers aligned the concept of the learner uptake activity and the main concept of the lesson, they were more likely to use more scaffolding strategies to teach the concept. Complex scaffolding practice is rare and most lessons combine only some scaffolding strategies.

CONCLUSION

This chapter presented case studies to demonstrate how the data of this study was analysed. Each lesson was examined according to the scaffolding features that were evident during both teacher input and learner uptake activities. This was done by asking seven pertinent questions that, when answered, examined the manner in which the three features of scaffolding occurred in each lesson. Next, the lessons were classified according to the combination of their scaffolding features. There was a total of 52 combinations and 13 of these were represented in the data.

Chapter 6 will summarise the findings of this study in order to comment on the pedagogical scaffolding practices of teachers in this study.

CHAPTER 6: CONCLUSION

This chapter provides an overview of this study; discusses the various contributions of this study and also suggests possibilities for further research.

OVERVIEW OF THIS STUDY

In the light of the prevalent poor performance of South African learners in especially numeracy and literary, Chapter 1 sketched the concern that stakeholders in education have regarding the quality of the pedagogical practices of teachers. This study was undertaken to examine the pedagogical practices of teachers in terms of how concepts are scaffolded in the classroom. The manner in which concepts are taught impacts upon learner acquisition of these concepts and this has a significant effect on how learners perform and achieve tasks. This study is thus relevant in the context of the current crisis in schooling outcomes.

A review of literature was presented in Chapter 2 to consider what the concept of scaffolding entails. The review revealed that the concept of scaffolding has been utilised in the contexts of parent/tutor and child interactions and teacher/learner interactions and that these environments have shaped the meaning of the concept in various ways. The application of this concept in the context of the classroom has especially challenged the meaning of scaffolding. Vygotksian notions like the ZPD and mediation and other alternative notions such as assisted performance have been recruited to extend the conception of scaffolding in this context. The literature generally views scaffolding in the classroom in terms of discrete scaffolding strategies. Since 1976, when the term was first used, scholars have identified and described a number of discrete strategies that can be labelled as scaffolding. Although Julia Anghileri (2006) has qualitatively differentiated between different scaffolding strategies, including arrangement of classroom environment, literature commonly analyses scaffolding practices in terms of verbal interactions with learners.

Chapter 3 discussed the analytical framework for this study and drew attention to the unique contributions of this study to the concept of scaffolding. The notion of mediation highlighted that the acquisition of scientific concepts is a vital part of assistance. Since the terms mediation and scaffolding are closely related, the idea of connecting the concept with scaffolding seemed significant. A critical review of the literature indicated that this relationship between scaffolding and the concept has not been sufficiently explored and that a study that explicitly relates these notions would be innovative. In Chapter 3, a definition for scaffolding is presented that emphasized this connection. The development of such a definition and a consideration of the implication thereof for scaffolding, constitutes the first contribution of this study. This definition states that scaffolding in the classroom refers to *the actions of the teacher that assist the learner to acquire scientific concepts. This assistance occurs when the lesson is focused on or oriented to a particular concept, the concept is opened up and learner activities are structured in a way that enable the learner to internalise the concept. The success of scaffolding is evident when a learner can perform a task or solve a problem aligned with the concept(s) taught once assistance has been removed.*

This definition indicates that scientific concepts can be scaffolded through three sets of discrete scaffolding strategies, referred to as features in this study. These features are: the teacher orients the lesson to acquisition of a concept, the teacher opens up the main mathematical concept, and the teacher structures a learner task so that each learner has the opportunity to perform this task independently. These features are interdependent and need to jointly occur in a lesson so that the learner can acquire the concept. When these features are combined in a lesson, they constitute *complex scaffolding practice*. The term, complex scaffolding, was developed within this study and the meaning of this term and its implication for scaffolding in the classroom signifies the second contribution of this study.

This definition combines the two distinct components of scaffolding, namely teacher assistance which takes place during *teacher input,* and structuring of opportunities for learners to work without assistance which takes place during *learner uptake activities*. I have argued that pedagogic strategies can only be considered as scaffolding if they introduce learners to new concepts, help learners to understand the concept by opening it up and provide for opportunities for learners to work with and internalise the concept. This would suggest that discrete pedagogic strategies, such as probing questions, can be seen to be scaffolding strategies only if they take place within a broader complex scaffolding approach.

In accordance with the above view of scaffolding, this study developed an analytic framework that does not analyse scaffolding in terms of discrete strategies, but as a combination of these strategies. This framework is the third significant contribution of this study. Chapter 3 outlines how the three features of scaffolding (taken from both teacher input and learner uptake) were combined in various ways to produce 52 possible descriptions of the pedagogical scaffolding practices of teachers. In this study, these descriptions are called *lesson types*. The analytical framework describes complex scaffolding practice (called combination type 1(a)) and also describes lesson types that partially combine the three scaffolding features. Furthermore, this framework includes some lesson types that include no scaffolding strategies.

Chapter 4 outlined the research design for this study. The chapter presented several questions that were used to identify the scaffolding practices in each lesson.

The analysis of the data is presented in Chapter 5. Six case studies were chosen to illustrate how each lesson was analysed according to the features of scaffolding and categorized as a lesson type.

FINDINGS OF THIS STUDY

This study examined how nine teachers in the COCA project scaffolded mathematical concepts. A requirement for scaffolding is that the strategies employed by the teacher should firstly focus on the mathematical concept. This implies that if a teacher is, for example, probing (a strategy that is labeled by literature as a scaffolding strategy) the learners' understanding of an idea and the idea itself are not related to the concept of the subject, then probing was not employed in a manner that suggests scaffolding.

The analysis showed that most lessons addressed several concepts, whether to practise, revise or to teach a new concept. There was evidence, though, that a significant amount of lesson time was spent on practicing and revising concepts that the learners had already acquired. Where a discrete scaffolding strategy was employed to revise or practise concepts or associated processes, then the strategy was not been utilized in a scaffolding way. Teaching new concepts is a prerequisite for scaffolding. Where as many as four concepts were covered in one lesson, little time was left to introduce each of the main (new) concepts or processes of the lesson for a sufficient length of time.

The study highlighted that the second feature of scaffolding, opening up the concept, was evident in most of the lessons. However, the type of scaffolding strategies employed by the teachers suggested that learners were usually passively engaged with concepts and that teachers did not respond contingently to learners' needs. The preferred teaching strategy was to model concepts and to instruct learners to undertake actions that represented these concept (for example, learners were required to draw the number seven on the board). There were also many instances of deferred modeling when learners modelled concepts to their peers. A common strategy used in most of the lessons was *closed questioning*. This strategy was often used to elicit correct answers from learners and these answers were never explored. This strategy did not open up the concept. The frequent use of modelling, instructing and closed questioning indicated a style of teaching where learners mostly watched and copied the teacher's actions. The learners' engagements with the concepts were passive, and the types of questions asked during the lessons did not necessarily require the learners to think, reason or critically engage with the concept. Scaffolding strategies that invited learners to talk about or apply concepts and that enabled the teacher to gauge the learners' level of understanding and to contingently respond to the learners' needs were rarely utilised.

With regard to learner activities, the analysis suggest that, while most of the teachers structured opportunities for learner uptake, these tasks were in most cases not fully aligned with the main mathematical concepts that was taught. In these cases, the ways in which learners approached these tasks could not provide feedback regarding the degree to which learners had acquired the concepts. In some instances there was no alignment between the learner uptake tasks and the main concepts that had been taught. In these lessons, no opportunities were provided for learners to internalise the new concepts.

In general teachers used a very limited range of discrete scaffolding strategies. In the context of the lesson as a whole, these discrete strategies were not combined to constitute a general complex scaffolding approach. Scaffolding the concept requires that the three features of scaffolding be present in both the teacher input and learner uptake components of the lesson. Most of the teachers in this study therefore, did not adequately assist their learners to acquire mathematical concepts.

The teachers in this study work in an environment where learners perform poorly in numeracy. This crisis is exacerbated by pedagogical practices that do not assist learners to understand and internalise concepts. This study suggests that teachers need to employ complex scaffolding practices in the classroom, in order to enable learners to acquire the concepts and have the ability to perform tasks and solve problems that are related to these concepts. Developing the pedagogical scaffolding practices of teachers is, therefore, an essential contributing factor to resolving the current crisis in the classroom.

LIMITATIONS OF THE STUDY AND FURTHER RESEARCH POSSIBILITIES

This study has adopted a broad approach to three sets of scaffolding strategies. The analysis has aimed to show how these strategies, separately and in combination, are effective only to the degree that they make concepts available to learners. This broad approach has meant that it has been beyond the scope of the study to do a fine grained analysis of particular discrete strategies and the ways in which these strategies engage with the complexity of concepts, processes and the relations between these. This general approach could provide a frame for more focused and fine grained studies in future.

The data set that I worked with revealed very few scaffolding practices and the framework was useful for highlighting this. However, this framework could be extended and strengthened if it were employed across a more diverse data set, which includes lessons where complex scaffolding practices are also in use.

To conclude, in the lessons described in this study, learners were on the whole very passive in the sense that they reproduced answers and activities modeled by the teacher, or answered closed questions, and seldom produced their own novel solutions or even asked questions. This is in direct contrast to the image of the 'active learner' associated with outcomes based education and 'learner-centered teaching'. This study gestures towards the possibility that these teachers associate outcomes based education with particular ways of organizing activities (group work and the use of apparatus) but not with cognitive forms of engagement such as questioning, reasoning, justifying and so on. This study did not focus on this issue, i.e. on ways in which the pedagogic strategies of teachers relate to their understanding of the curriculum. This question suggests fruitful directions for future research.

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