Mathematics teachers' awareness of metacognitive strategies during the process of an adapted lesson study in the Intermediate Phase

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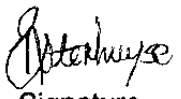
DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.



Signature

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Opsomming

Die onderrig van Wiskunde staan as ’n menslike aktiwiteit om verstandsprosesse te ontwikkel en logiese en kritiese denke te bevorder, bekend wat daartoe lei om besluite te neem en probleme op te los (DBE, 2011c). Om Wiskunde in skole toe te pas is dit nodig dat strategieë genereer moet word om probleme te kan oplos. Die Wiskunde prestasie is baie laag en talle opvoedkundige navorsers het verskeie redes vasgestel vir die swak prestasie wat in Wiskunde voorkom. Suid-Afrika het dus ’n assesserings instrument naamlik die ANA, ontwikkel om leerders se prestasie te meet in Wiskunde op ’n nasionale, provinsiale, distrik en skool vlak (DBE, 2013). ’n Benadering in die Suid-Afrikaanse konteks was om die Intermediêre Fase Wiskunde onderwysers se bewustheid van hul metakognitiewe strategieë gebruik te ondersoek.

Die hoofdoel van die navorsingstudie is om te verstaan, tot watter mate word Intermediêre Fase Wiskunde onderwysers bewus word van hul metakognitiewe strategieë gedurende die aangepaste les studie proses. Om hierdie doel te bereik streef die studie daarna om die onderwysers se bewustheid voor en na die aangepaste les studie proses te ondersoek.

Empiriese kwalitatiewe navorsing het plaasgevind, gebaseer op die ontwerp van navorsingsbenadering binne die interpretivistiese paradigma. Beskrywende data is deur dubbel medium deelnemers gegenereer deur semi-gestruktureerde fokus groep onderhoude wat deur ‘n dagboek inskrywing gevolg het. Data is geanaliseer deur inhoudsanalise deur gebruik te maak van breinkaarte waar kodes en temas vasgestel is vanuit die literatuur.

Die bevindinge dui daarop dat meeste van die onderwysers bewus was van hul metakognitiewe strategieë, maar dat hulle nie seker is van wanneer, waar en hoe om die strategieë te gebruik nie, aangesien hulle nie lesse op ’n gereelde basis beplan nie. Onderwysers is ook van mening dat hulle meer gemaklik is en meer by mekaar leer indien hulle lesse in groepsverband voorberei.

Ten slotte kan die aangepaste lesstudie proses as ’n positiewe plan van aksie beskou word om onderwysers die geleentheid te bied waarin hulle lesse in groepsverband kan beplan. Onderwysers kan meer bewus raak van hulle metakognitiewe strategieë wanneer hulle lesse saam beplan, om sodoende hierdie metakognitiewe strategieë toe te pas gedurende hulle lesse. Op hierdie manier kan leerders ook bemagtig word om metakognitief

te dink (denke oor hulle denke) en te reflekteer oor hul opinies en sodoende kan verbeterde prestasie meegebring word.

Trefwoorde: Metakognisie; metakognitiewe kennis; metakognitiewe strategieë, Intermediêre en Senior Fase onderwysers; bewustheid, lesstudie proses, aanpasbare lesstudie proses.

Summary

Mathematics education is a human activity that helps to develop mental processes in order to enhance logical and critical thinking which will contribute to one's decision-making process and to solve problems (DBE, 2011c). For one to be able to do Mathematics, strategies should be generated in order to solve problems. The performance in Mathematics is very poor and educational researchers have identified various reasons for the poor performance in mathematics. Therefore, South Africa has developed an assessment tool known as the ANA, to determine the learners' weaknesses in mathematics at national, provincial, district and school level (DBE, 2013). An approach research (in the South African context) was to explore Intermediate Phase Mathematics teacher's awareness of their metacognitive strategy use.

The main purpose of my research study was to understand, to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process. To achieve this purpose, the study aims to investigate the teachers' awareness of metacognitive strategies before and during an adapted lesson study process.

Empirical qualitative research based on a design research approach took place within the interpretative paradigm. Descriptive data was generated by means of semi-structured focus group interviews and a reflective diary was held with double-medium participants who were selected. The data were analysed by means of content analyses which proceeded by using mind maps, where codes and themes were related to the literature.

The results show that most of the teachers were aware of the metacognitive strategies, but it can be that they lack knowing when, where and how to use these metacognitive strategies as they do not plan their lessons on a regular basis. Teachers also feel more comfortable when planning lesson collaboratively as they feel that they learn from one another.

In conclusion an adapted lesson study could be a positive plan of action to provide teachers with the opportunity to plan lessons collaboratively and reflect on one another's' ideas. Teachers can become more aware of their metacognitive strategies when planning lessons in order to implement these metacognitive strategies during their lessons. In this way learners could be empowered to become metacognitive (think about their thinking) and to reflect on their actions which might contribute to their performance of mathematics.

Key words: Metacognition; metacognitive knowledge; metacognitive strategies; Intermediate and Senior Phase Mathematics teachers'; awareness; lesson study; lesson study process; adapted lesson study process.

Contents

List of Abbreviations

ANA	Annual National Assessment
CAPS	Curriculum Assessment Policy
DBE	Department of Basic Education
ECD	Early Childhood Development
IEA	International Association for the Evaluation of International Achievements
SANPADMATH	South African Netherlands project on Alternative Development
TIMSS	Trend in International Mathematics and Science Study

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Chapter 1
Introduction and contextualisation

1.1 Orientation and background

This research study seeks to explore Intermediate Phase Mathematics teachers' awareness of metacognitive strategies during an adapted lesson study process. In the orientation to this research study, I discuss possible reasons for learners' poor school performance in Mathematics; to emphasise why it is important to do research in Mathematics. Thereafter I situate my research within the framework of metacognition and lesson study.

1.2 Learners' school performance in Mathematics

For many years, the focus in South Africa has been on the grade 12 level, with emphasis on the Senior and National Senior Certificate examination results (Department of Basic Education [DBE], 2011a). Over the past few years, the need has arisen to improve grade 12 results in schools (ibid). Soobryan (DBE, 2011a) accentuates that in order to improve grade 12 Mathematics results, it is necessary to improve learners' Mathematical performance in lower grades. To improve the results the Annual National Assessment (ANA) as a monitoring tool is being employed for the measurement of progress in learner achievement in lower grades (DBE, 2013). This assessment tool is in its third year of implementation in South Africa (DBE, 2013). The purpose of this monitoring tool is to determine the weaknesses in Mathematics of learners in grades 1 to 6 and 9 nationally, provincially, district-wise and at school level (ibid).

The overall performance of learners in the ANA was below average in 2011; approximately 30% lower than expected (DBE, 2011). The numeracy scores in the Intermediate Phase were low and the domain of fractions seemed to be the most problematic area (DBE, 2011). The Mathematics percentages of the ANA results in 2012 and 2013 per grade in the Intermediate and Senior Phase are displayed in Table 1.1 (DBE, 2013).

Table 1.1 ANA results for Mathematics Intermediate Phase learners

Grade	Mathematics 2012	Mathematics 2013
4	37%	37%
5	30%	33%
6	27%	39%
9	13%	14%

Table 1.1 indicates that the average of the grade 4, 5, 6 and 9 learners are below expectation, and the aim for 2014 is to improve the levels of Mathematics and the quality of learner performance in South African schools (DBE, 2013).

Table 1.2 presents the percentage of learners that achieved at least 50% or more in Mathematics.

Table 1.2 The percentage of learners that achieved at least 50% or more in Mathematics

Grade	Mathematics 2012	Mathematics 2013
3	36	59
6	11	27
9	2	2

From Table 1.2 the overall percentage of learners that achieved at least 50% or more in 2012 and 2013 could indicate related problems as to the way in which learners are taught (DBE, 2011a). Traditional ways of teaching contribute to poor performance when teachers mainly focus on what must be taught, rather than when and how learners act passively during the process (Cardelle-Elawer, 1995).

A Mathematics classroom should be an interactive environment, where learners are encouraged to discover problems and where discussions take place (Cardelle-Elawer, 1995; NCS, 2011). These discussions should be between teachers and their learners as well as between fellow-learners (Cardelle-Elawer, 1995; NCS, 2011). These discussions may not only include what must be learnt but also the process of why and how to learn by using

different strategies (Cardelle-Elawer, 1995). These strategies may include metacognitive strategies which form a component of metacognition. A brief review of metacognition follows in Section 1.3.

1.3 Metacognition

In Section 1.2, I argued that learners' performances in the lower grades are below expectation and that different teaching strategies are needed to address this problem. When a teacher is teaching metacognitively (being aware of metacognition), it improves the interaction and effective facilitation of academic performances in a classroom (Hartman, 2001). Flavell (1978) explains that metacognition includes knowledge concerning the use of strategies, tasks, the self, and skills to evaluate strategies. Kluwe (1982) further states that metacognition includes two general attributes such as "the thinking subject has some knowledge about his own thinking and that of other persons and the thinking subject may monitor and regulate the course of his own thinking, i.e. thinking may act as the causal agent of his own thinking" (p.202). Paris and Winograd (1990) claim that the two essentials for metacognition include "metacognition-self-appraisal and self-management of cognition" (p.17). These two appraisals answer questions such as, "what do you know, how do you think, and when, where and why do you apply knowledge or strategies" (Paris & Winograd, 1990, p. 17).

Hartman (2001) further states that, by taking these appraisals of Paris and Winograd into consideration, implies that metacognition is needed in planning lessons effectively for "switching gears during or after a lesson upon awareness that a teaching approach isn't working as expected and selecting alternative approaches" (p. 151).

For purposes of this research the focus is on metacognition as described by Paris and Winograd (1990) and can be summarised as follows: To be aware of metacognition (to think about your thinking) is to reflect on actions, knowledge or thinking processes and to ask questions such as "what, when, where and how" you are going to apply knowledge or strategies during a certain task.

In this study the research process involved an adapted lesson study, which provides the setting for doing research on the teacher's awareness of metacognitive strategies in the classroom environment. Hence in the next section I explain lesson study.

1.4 Lesson study

Fernandez (2005) explains that lesson study provides a context in which teachers collaboratively plan lessons and talk about the content they teach and the strategies needed to teach the content. Lesson study is a form of professional development commonly and widely conducted in Japan (Fernandez, Chokshi, Cannon, & Yoshida, 2001; Lewis, 2000). Lesson study can be seen as a process that includes three phases, namely 1) collaborative planning of a lesson by a group of teachers, 2) teaching that is being observed by the other fellow-teachers, and 3) follow-up meetings during which the observed lesson is discussed by the lesson study participants (Gurl, 2011). Teachers think about lessons on a regular basis, and therefore it is necessary for them to be afforded opportunities such as lesson study, during which they can collaboratively develop their Mathematics teaching practices (Fernandez, 2005).

Lesson study also increases one's knowledge of the subject one is teaching (Yoshida et al*.,* 2003). When teachers reflect on a certain topic in preparing to teach it, they deepen their own understandings of it, which leads to new insights for teaching it (Fernandez, 2009). These insights include thinking about how learners would perceive these topics and how they could develop the same understandings of it (ibid). Lesson study is seen as a vehicle for teachers to see what and how they are teaching (Yoshida et al*.,* 2003). It is therefore, a process that contributes positively to teachers' ability to plan learning goals and to implement relevant metacognitive strategies (Lewis, 2005) in order to empower learners to become metacognitive (to think about their thinking) and to reflect on their actions.

One way of addressing problems such as the way in which teachers teach in the South African context and how they use metacognitive strategies is by using an adapted lesson study process. In the following section an adapted lesson study is discussed.

1.5 An adapted lesson study

From the research findings that emerged from this study it seems that the term *an adapted lesson study* is appropriate for this research study, since South African teachers teach in schools where they have minimum resources and where time for planning lessons, in collaboration with colleagues, is problematic. The Japanese lesson study process requires teachers to meet, plan lessons, observe one another's lessons, and reflect on the teaching process. In my research study we had to adapt this process to suit South African teachers' context. This was a case study on double-medium participants in a specific school and the results of this study cannot be generalized. The term *an adapted lesson study* will be used when referring to the South African lesson study process.

In the following section the rationale and justification for the study will be discussed.

1.6 Rationale and justification

My practical teaching experiences, as a pre-service Mathematics teacher in various rural schools, exposed me to the field of metacognition. I realised the importance of teachers' awareness of using different strategies while planning and doing Mathematics tasks and solving Mathematics problems. While doing my practical lessons, I focused on how a specific strategy was being used by the learners for a Mathematical task and the focus was to observe the learners during the lesson to distinguish learners that appeared to be confused. I then asked them to reflect on their understanding of the given task. Most of the teachers I met during my practical teaching period seemed not to plan their lessons adequately. It could be that they do not have time to plan a lesson, or that the lessons are already planned in the curriculum documents and therefore they might not be aware of strategies available to them to use during a lesson. It can also be that strategies are available to these teachers but that they do not know when, where and how to use these strategies during a lesson.

In the following section the problem statement will be discussed.

1.7 Problem statement

Most South African learners do not have the opportunity of receiving quality education in subjects such as Mathematics and Science (Howie & Scherman, 2008). Although education and training have been transformed in the post-apartheid period, the failure rates in Mathematics in South African schools are still very high (Atweh et al., 2008).

Educational researchers identify various reasons for the poor performance in Mathematics. Amongst these are out-dated teaching practices, teachers' lack of basic content knowledge, under-qualified or unqualified teachers, overcrowded and non-equipped classrooms (Makgato & Mji, 2006), inefficient teaching approaches and unprofessional attitudes (Kriek & Grayson, 2009); teachers' inability to help learners think about their own thinking and how to become problem solvers (Van der Walt & Maree, 2007; Zohar, 1999).

Although teacher education in South Africa provides teachers with classroom methods or strategies such as clarification of content for each grade, including the topics in the content areas, the concepts and skills, some clarification notes or teaching guidelines and

duration (in hours) to ensure quality teaching, it does not necessarily mean that teachers understand how to use these methods or strategies (DBE, 2011a; Hartman, 2001).

Bloch (2009) is of opinion that teachers lack subject content knowledge, and argues that “teachers do not seem to be very good at planning, at phasing the work they have to teach, at deciding how to get through the important and core aspects of work” (p. 102). Therefore the problem could be that teachers do not necessarily plan their lessons adequately and when they do, in most cases, they tend not to plan how to use these classroom methods or strategies, since they lack the understanding of how to use these methods and strategies.

According to Fernandez (2009), the lesson study process provides an incentive for teachers to develop their understanding of content. Hence the adapted lesson study process during which teachers plan lessons together (based on their different experiences) could play a role in contributing to more effective lessons that include the basic content knowledge and appropriate methods or strategies for the clarification of content in each grade.

In view of the foregoing, the following research questions are constructed to support the motivation for this study.

1.8 Research questions

1.8.1 Research question

To what extent do Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process?

In order to answer this critical question, the focus will be on the following sub-questions:

1.8.2 Sub-questions

1) How can metacognitive strategies be defined in literature?
2) Which metacognitive strategies are Intermediate Phase teachers aware of before undergoing an adapted lesson study process?
3) Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?

In the following section the purpose of this research is discussed.

1.9 Purpose of this research

The main purpose of my research study was to understand to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process. To achieve this purpose, the study aims to investigate the teachers' awareness of metacognitive strategies before and during an adapted lesson study process.

In the following section the research design and methodology are elaborated on.

1.10 Research design and methodology

The research design and methodology is based on how the empirical research was conducted through an adapted lesson study process. In the following section I discuss the research design.

1.10.1 Research design

A research design can be seen as a plan or procedure that includes assumptions to generate and analyse data, in order to answer specific research questions (Creswell, 2009; McMillan & Schumacher, 2001).

Empirical research took place within the interpretative paradigm based on a socio-constructivism theory, which seeks to understand the world in which participants live and work (Creswell, 2009). Jansen (2010) points out that the interpretivist paradigm draws no distinction between the subject (the Intermediate Phase Mathematics teachers) and the object (the metacognitive component being studied). Through an adapted lesson study process, interaction takes place by exploring and understanding the Intermediate Phase Mathematics teachers' historical and cultural norms operating in their lives, by providing these teachers with an opportunity (an adapted lesson study process) to share their meanings and experiences about their awareness of metacognitive strategies.

The study took the form of an exploratory design. During the exploratory design, descriptive data was generated with the aim of developing an understanding of the context (Nieuwenhuis, 2010). Furthermore, to construct the meaning of their experiences, this study also involved my understanding of the teachers' views of Mathematics and their awareness of metacognitive strategies during an adapted lesson study process in order to understand the world in which teaching in their classrooms takes place (ibid).

My research strives towards a better understanding of the context in a rural school, where this teaching took place, with the aim to empower the teachers in this process. In the next section the methodology will be discussed.

1.10.2 Methodology

By addressing the research questions, empirical research has been conducted in which the qualitative research methodology is that of design research (Shavelson, 2003). "Design research explicitly exploits the design process as an opportunity to advance the researcher's understanding of teaching, learning and educational systems" (Edelson, 2002, p. 107) and it also provides opportunities for researchers to improve their educational practice (Edelson, 2002, p. 105). Design research is a form of educational research, since it provides teachers with the opportunity of studying one other's lessons (Edelson, 2002) in a learning environment (Collins, Joseph, Bielaczyc, 2004), such as a classroom, and focuses on the objects and processes being explored (Burkhardt & Schoenfeld, 2003) to create meaning and understanding. Therefore, the purpose of design research, according to Cobb, Confrey, Disessa, Lehrer and Schauble (2003), is "supporting new forms of learning in those specific settings" (p. 10).

Design research approach can be compared with the Japanese lesson study process, through which teachers meet and work collaboratively in planning their lessons and refining their teaching practice through a cycle of developing sustainability, in a similar way design research operates through iterative cycles of design and implementation (Edelson, 2002). During the design research process, researchers and teachers work together to plan, develop, implement and refine the design (Greeno, 1998). In my study, design research operated through iterative phases, such as phase 1 to phase 4 (these phases will be discussed in Chapter 3) involving the researcher and teachers as partners (Greeno, 1998).

The design research methodology states that learning variables, such as the use of metacognitive strategies, are important as dependant variables (Collins, Joseph, Bielaczyc, 2004). The ontology of design research is to understand the forms of education. "If you want to change something, you have to understand it, and if you want to understand something, you have to change it" (Gravemeijer & Cobb, 2006, p. 17). Hence this study is situated in the interpretive paradigm.

In the following section the research site and participants are discussed.

1.11 Research site and participants

This design research study took place in a rural school in the North West Province. One rural school was selected with the help of the Department of Education. Double-medium participants where six Intermediate Phase (grades 4 to 6) Mathematics teachers and one Intermediate and Senior phase Mathematics teacher teaching this content area Number, Operations and Relationships in their second language (English and/or Afrikaans).

In the following section the research methods and date generation strategies are discussed.

1.12 Research methods and data generation strategies

Research methods involve specific forms of data generation used by researchers (Creswell, 2009). The following four phases during the two processes describe and explain the methods, data generation strategies, and research questions that will be addressed as well as the data analysis process. These phases are summarised in the diagram and further discussed in Chapters 3 and 4.

Table 1.3: An overview of the data generation methods and strategies in relation to the research questions during the two processes

Process 1				
Phase	**Methods**	**Description of how the methods are used**	**Research question/s addressed**	**Data analysis**
Phase 1	Semi-structured focus group interview	The participants gathered in the staff room and I welcomed them to the interview and started asking questions.	Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?	Content analyses
Phase 2	Semi-structured Focus group interview	A recorded Mathematics lesson from one grade 4 Intermediate Phase teacher, based on the topic "Common fractions" in the content area Number, Operations and Relationships, was played back to the participants. A semi-structured focus group interview followed in which the participants reflected on the metacognitive strategies that the specific grade 4 teacher used in the recorded lesson.	Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?	Content analyses
Process 2				
Phase	**Methods**	**Description of how the methods are used**	**Research question/s addressed**	**Data analysis**
Phase 3	An adapted lesson study process	During this intervention phase, an information session was held during which the teachers had been provided with all necessary information on the lesson study process in which they collaboratively planned a follow-up lesson from the one grade 4 Intermediate Phase teacher based on the topic "Common fractions" in the content area.	Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?	Content analyses
Phase 4	Reflective diary	A reflective diary on all the experiences of the entire lesson study process was kept by all the Intermediate Phase Mathematics teachers in order to investigate understanding of the use and implementation of metacognitive strategies when planning and applying future lessons.	Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?	Content analyses

Table 1.3 presents the data generation methods, description of how the methods were used, the data generation strategies and data analysis in relation to my research questions during each phase (Phases 1 to 4) in the two processes before and during an adapted lesson study process. The validation and trustworthiness will be explained in the following section.

1.13 Validation and trustworthiness

De Vos (2005) emphasises that "[c]redibility is alternative to internal validity" (p. 346). The aim of exploring a specific context or process (an adapted lesson study process) or a certain group, such as teachers, refers to the validity of this research study. The credibility (Nieuwenhuis, 2010) of the study was obtained by implementing different methods of data generation, such as semi-structured focus group interviews and reflective diaries.

The following five strategies in qualitative research are designed to ensure internal validity of the study (Merriam, 1998).

- Crystallisation: Research methods such as the semi-structured focus group interviews and reflective diaries in this study were used to understand the findings (awareness of the teachers' metacognitive strategies) in the two processes and different phases of the study.
- Member checks: The findings were verified by the Intermediate Phase Mathematics teachers to reflect on their awareness of metacognitive strategies from the recorded lesson during the semi-structured focus group interview.
- Short-term observation: The data was generated consistently across four phases in the study by means of my theoretical (teachers awareness of metacognitive strategies) and methodological research approach framework (an adapted lesson study process) to increase the validity.
- Peer examination: To include and focus on the awareness, opinions, meanings and understanding of the teachers.
- Collaborative research: My entire study was based on collaborative research in which all the teachers and the researcher participated in all the phases of this study. (The different roles of the researcher will be discussed in Section 3.5.) During an adapted lesson study process the teachers were afforded the opportunity of collaboratively planning and developing a lesson.

My role as researcher will be discussed in the next paragraph.

1.14 Researcher's role

My role, as the researcher and participant, was to serve as an instrument throughout the data gathering process to first obtain consent from the North West Province Education Department, the school principal and the teachers before the data generation proceeded (Nieuwenhuis, 2010). Joubert (2005) lists the roles of the researcher, which include:

- prepare and structure the semi-structured focus group interviews
- conduct interviews
- analyse all the data being generated
- crystallise all data

Within this interpretive study, my role was to empower the teachers to enter into a collaborative partnership during an adapted lesson study process in order to generate and analyse data with the aim of creating an understanding of the awareness, meanings, opinions, experiences and context of Intermediate Phase Mathematics teachers (McMillan & Schumacher, 2001).

As one of the roles I needed to fulfil as a researcher was to take the following ethical aspects of the research into consideration, which are discussed in the following section.

1.15 Ethical aspects of the research

The ethical clearance in this study was important for the protection of each of the teachers' identities and the rights of the participants that need to be protected at all times (Maree & Van der Westhuizen, 2010). The participation of the school and its teachers in this study was voluntary. Participants may have decided to withdraw from this study at any stage and without any penalty or loss of benefits to which they are entitled. If an individual participant withdrew from the study, any data pertaining exclusively to said participant would have been destroyed. Pseudonyms were used when reporting the findings from this study. All the data being analysed was shared in an ethical manner. The instruments in this study were used to generate data based on the research questions in the four phases.

My study forms part of a larger study in the SANPADMATH (South African Netherlands project on Alternative Development) project where the Netherlands financially supports the project in order for students in the project to do research in rural areas with the aim of focusing on development in the field of Mathematics. The research committee of the North-West University has granted ethical clearance for the SANPADMATH project and the clearance number of the project is NWU-00027-11-S2.

In the following section the possible contribution of this study to the field of Mathematics education will be elaborated on.

1.16 Possible contribution of this study to the field of Mathematics education

The possible contribution of this study to the field of Mathematics education includes possible contribution to the subject area and contribution to the research project (SANPADMATH) in the Research Focus Area. The possible contribution to the subject area will be discussed.

1.16.1 To the subject area

Since most teachers teach according to experience, they mostly teach in the same way they were taught (Artzt & Armour-Thomas, 2002). Although many papers have been published and presented on metacognition and lesson study, this study will attempt to promote the Mathematics professional teaching and learning practice, and additionally attempt to understand to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process.

The following section explains the possible contribution to the research project in the Research Focus Area.

1.16.2 To the research project in the Research Focus Area

My proposed study in the SANPADMATH project contributes to a research project in the Research Focus Area Self-directed learning (Metacognition, teaching-learning strategies for problem solving).

In the following section my conceptual framework on which my study is based will be elaborated on.

1.17 Conceptual framework

According to Trafford and Leshem (2007), a conceptual framework can be seen as a theoretical overview of one's research approaches. This study is based on the literature review, and contains two empirical processes to determine to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process.

This conceptual framework in Figure 1.1 for my study is a representation of the two frameworks (that operate consistently in each phase) on which my study is based. These frameworks are illustrated and described in order to understand the theoretical coding (definition will be discussed in section 4.5.2). The first framework relates to the theoretical research approach framework as metacognition that includes the thirteen metacognitive strategies (see section 2.4.4) and the second framework relates to the methodological research approach framework as an adapted lesson study process described in Chapter 3.

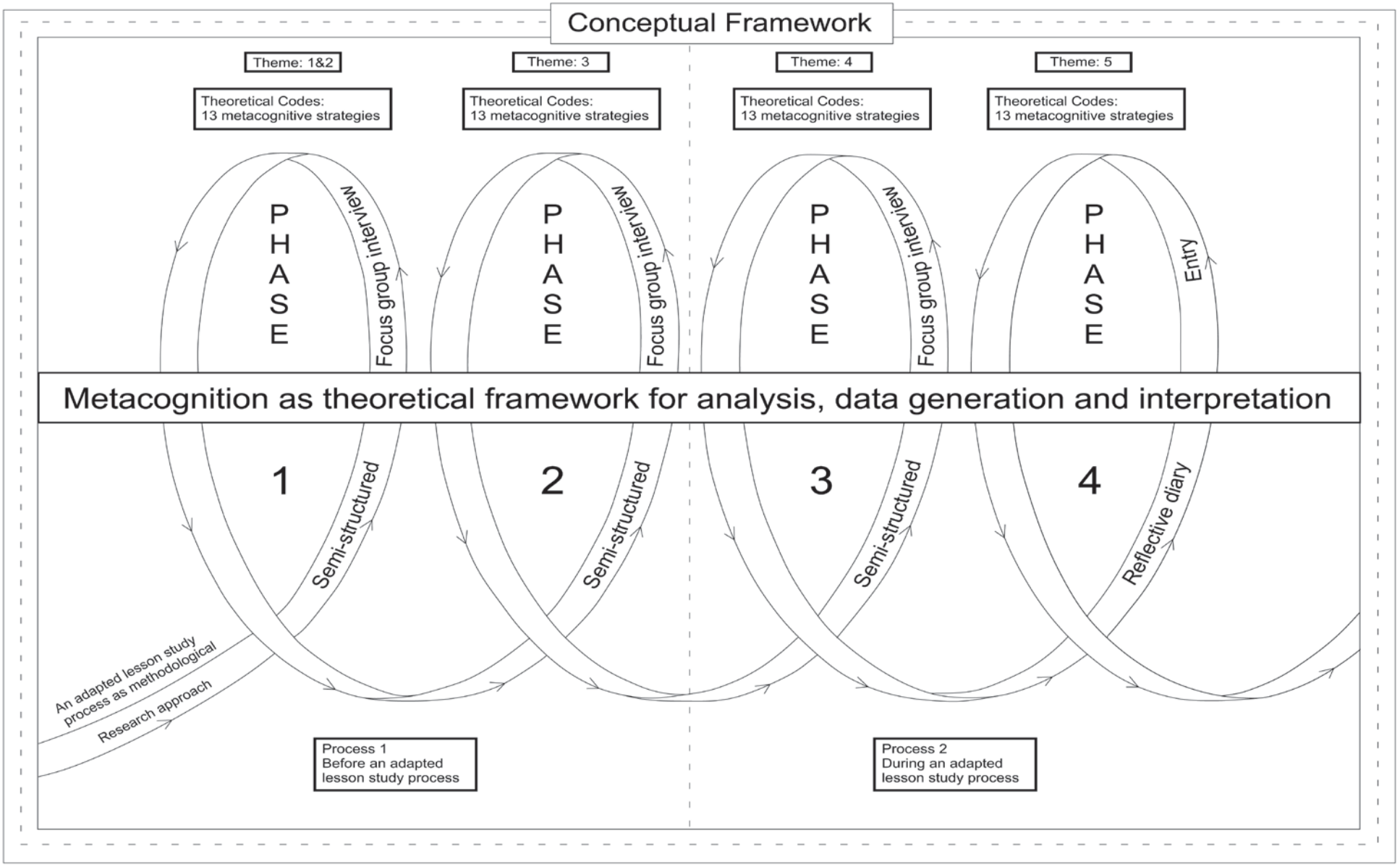

Figure 1.1 Conceptual framework

1.18 Chapter division

Chapter 1: Context and orientation of the study

This chapter provided a general overview of this study, which includes the problem statement, research questions, and review of the body of scholarship, purpose of the research, research design and methodology, researcher's role, ethical clearance, contribution of the study, chapter division, time framework and references.

Chapter 2: Metacognition and lesson study

A literature study, regarding information on metacognition and lesson study, have been provided.

Chapter 3: Research methodology

The research process was described in depth, which included the research design and methodology.

Chapter 4: Research results, contextualisation of findings

Analysis of the generated qualitative data.

Chapter 5: Summary, conclusions and recommendations

All the results was summarised, and conclusions as well as recommendations was presented from this study.

1.19 Summary

This chapter provided an overview of the school performances, an introduction to metacognition and lesson study, the rationale of and justification for my study, problem statement, research questions, and purpose of this research. Further on this chapter included the research design and methodology, validation and trustworthiness, researcher's role, ethical aspects of the research, the research project in the Research Focus Area, possible contribution of this study to the field of Mathematics education, my conceptual framework and the chapter division.

The theoretical research approach framework (metacognition) according to the literature is subsequently discussed in Chapter 2, and the methodological research approach framework (as an adapted lesson study process that followed from the literature in Chapter 2) is discussed in Chapter 3.

Chapter 2
Metacognition and lesson study

2.1 Introduction

In this chapter, I review the theoretical underpinnings of metacognition and lesson study, as found in literature. I focus on Mathematics in the classroom, nationally and internationally, Mathematics teachers' knowledge, teaching and learning, metacognition and all its components as well as lesson study with all its components. The theoretical framework (metacognition) – as seen in Figure 2.1 – for my study is based on this review and exploration, and the focus of my study (metacognition) is highlighted in this chapter.

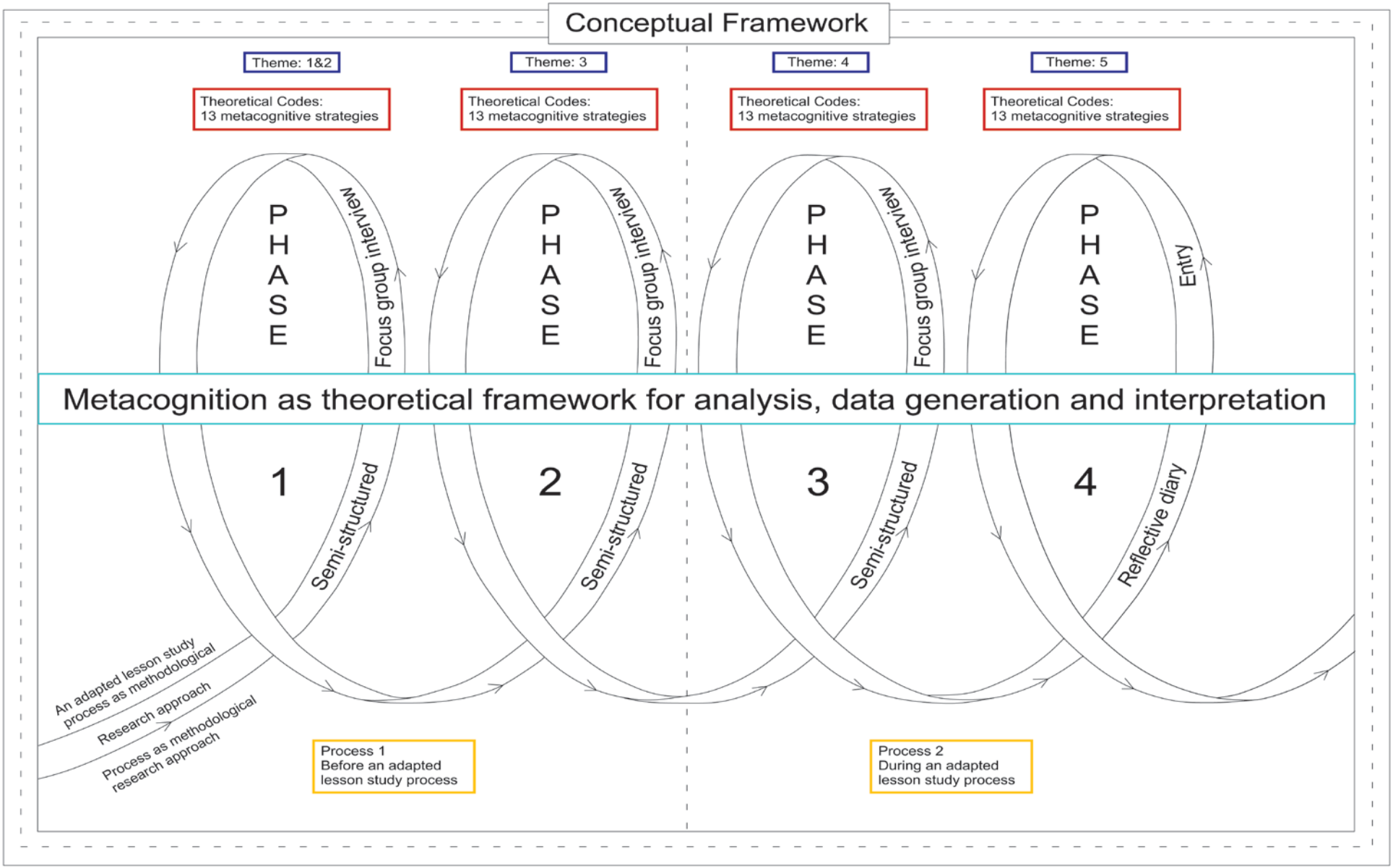

Figure 2.1 Conceptual Framework

In the following section, Mathematics will be discussed.

2.2 Mathematics

In the next section the definition of Mathematics, Mathematics in the classroom the Mathematics performance of South African learners in an international context and Mathematics performance nationally will be elaborated on.

2.2.1 What is Mathematics?

The ontology of the word “Mathematics” originates from the Greek term *Mathemata,* which relates to any subject, instruction or study. In general, Mathematics can be seen as a study of the quantitative nature previously developed through people’s experience (Burton, 2003:ix).

Browder (1976) explains that four fundamental explanations surround the term *Mathematics*. Mathematics 1) includes the operations that form part of people in the community. Mathematics 2) includes Mathematics techniques and concepts one can use in order to formulate and solve problems. Mathematics 3) relates to Mathematics research, by exploring concepts, methods, strategies and problems in diverse; and Mathematics 4) relates to the purpose of Mathematics, as a general form of all human knowledge.
The South African curriculum (DBE, 2011c) states that Mathematics:

> *is a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between Mathematical objects themselves. It helps to develop mental processes that enhance logical and critical thinking; accuracy and problem solving that will contribute in decision-making (p. 8).*

Mathematics in the classroom will now be explained in the following section.

2.2.2 Mathematics in the classroom

To make Mathematics more appropriate in classrooms and to contribute to teachers and learners’ perspectives, teachers and learners should be able to appreciate Mathematics, to develop the necessary confidence to handle any Mathematics situation, to identify relationships, to communicate effectively and to develop a passion for Mathematics (NCTM [1989], as cited in Gates & Vistro-Yu, 2003).

According to Van de Walle, Karp, Bay-Williams (2010) Mathematics includes more than just formulating tasks and explaining concepts in the classroom. For one to be able to do Mathematics, strategies should be generated in order to solve problems (ibid).

The metacognitive use of metacognitive strategies activates learners' thinking, which relates to better performance in learning Mathematics (Anderson, 2002).

A discussion of Mathematics performance of South African learners in international context follows next.

2.2.3 Mathematics performance of South African learners in international context

The World Economic Forum's Global Information Technology reported that South Africa's Mathematics and Science education is determined to be last in the world since it is about 140th out of 144 countries worldwide (Phakathi, 2013).

The Trends in International Mathematics and Science Study (TIMSS) is an IEA (International Association for the Evaluation of International Achievement), an organisation that has been conducting cross-national studies since 1959, which assesses the achievements of learners in Mathematics and Science along with other 45 countries (Wallace, 2013). The latest performance of countries participating in the TIMSS in 2011 has been above the expectations of the TIMSS improvement rate. TIMSS strives towards a 4-year cycle that a country should improve up to 40% by one grade. The South African scores have improved by an estimated 60% with an improvement of about 1.5 grade levels between 2002 and 2011 and therefore South African National average scores in Mathematics and Science performance improved besides the low base (Wallace, 2013).

In the following section Mathematics performance nationally will be discussed.

2.2.4 Mathematics performance nationally

The Department of Basic Education introduced the CAPS (Curriculum Assessment Policy Statement) during the past five years (2008-2013), with the aim of high-quality teaching and learning materials such as text books, the ANA (Annual National Assessment), provision of schools infrastructure, as well as access to ECD (Early Childhood Development) and teacher development. These systems focus on improving learners' development and performance in all grades.

The ANA is a national exam written for the past few years by grades 1 to 6 and 9 learners. The purpose is to determine what learners can or cannot do regarding their skills

and knowledge in a specific grade. Number, Operations and Relationships is one domain or area in which grade 6 learners lacked performance (DBE, 2011c), Since it is the largest component needed to contribute to the content in the examination-summative assessment at the end of the year (DBE, 2011c), the reason why these learners lack performance could be that the majority of grade 6 teachers in South Africa lacks knowledge and they are not able to answer questions in the curriculum which grade 6 learners ought to be able to answer (ibid).

Next to be discussed is Mathematics teachers' knowledge.

2.3 Mathematics teachers' knowledge

Teachers' knowledge is constructed from their experience, which includes self-knowledge, subject knowledge, curriculum development and instructions and is therefore reflected in practice (Da Ponte & Chapman, 2006).

Figure 2.1 presents four different aspects that might have an influence on teachers' knowledge, which are 1) knowledge of the content and strategies, 2) knowledge in practice, 3) teaching and learning, as well as 4) effectiveness of the teaching and learning process (Shulman, as cited in Hill et al., 1998).

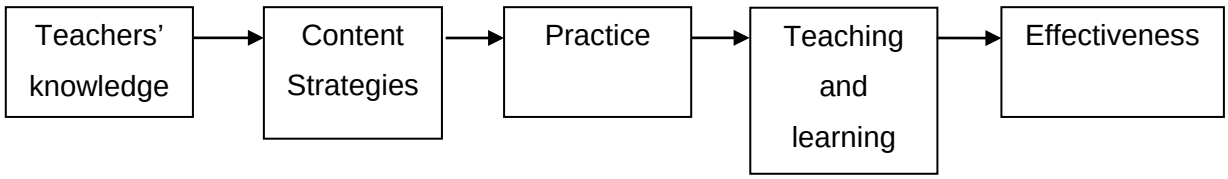

Figure 2.2 Aspects of teachers' knowledge

With regard to Figure 2.1, aspects of teachers' knowledge include knowledge of the Mathematics content and knowledge of strategies to use, as well as the influence of this knowledge of content and strategies on practice in order to contribute to effective teaching and learning (DBE, 2013). It is important for teachers to develop relationships between their knowledge and the components of Mathematics in order to ensure effective teaching and learning (Ingvarson et al., 2005).

According to English (2002), it is important for teachers to know "what" (knowledge about the content) and "how" (knowledge about which strategies to use) to teach; therefore it is necessary for them to be aware of learners' thinking in order to know how the learners would reflect with regard to certain problems. The awareness of which strategies to use and

knowledge of the content relate to metacognition, which will be elaborated on in the subsequent section.

2.4 Metacognition

Metacognitive beliefs, metacognitive awareness, metacognitive experiences, metacognitive knowledge, feeling of knowing, judgment of learning, theory of mind, meta-memory, metacognitive skills, executive skills, higher-order skills, meta-components, comprehension monitoring, learning strategies, heuristic strategies, and self-regulation are several of the terms commonly associated with metacognition (Veenman, Van Hout-Wolters, & Afflerbach, 2006, p. 2).

All these aspects, as Veenman, Van Hout-Wolters, and Afflerbach (2006) point out, relate to the term *metacognition* that will be described in the following sections.

2.4.1 Definitions of metacognition

Table 2.1 summarises some of the definitions of metacognition related to my study.

Table 2.1: Definitions of metacognition

Researchers	Definitions of metacognition
(Panaoura et al.,2003; Goh, 2008; Schraw, & Moshman, 1995)	Flavell was the first to define the phenomenon *metacognition*, which was constructed from metacognitive teaching and refers to one's knowledge and regulation of one's cognitive processes and products.
(Baker & Brown, 1984; Allen & Armour-Thomas, 1991)	Metacognition can be described as knowledge and control over one's thinking processes, which are interrelated.
(Gurl & Chong, 1999)	Metacognition is seen as a mirror/reflection of one's knowledge and thinking processes where insights about self-appraisal and self-management and self-discovery are promoted by oneself as well by other people surrounding that person.

Table 2.1: Definitions of metacognition (continues)

(Papaleontiou-Louca, 2003; Krätzig *&* Arbuthnott, 2009)	Metacognition is seen as all processes concerning cognition. This definition includes "thinking about one's own thinking", responding to one's thinking by monitoring and regulating one's cognitive ability and knowledge in order to take steps when problems are detected.
(Brown, 1978)	Metacognition can be analysed into three dimensional levels such as people's awareness, their thinking process and their ability to control these aspects.
(Goh, 2008)	The term *metacognition* refers to one's metacognitive awareness of thinking and learning. This includes what we are thinking, how we are thinking and why we are thinking in that particular way in relation to a task (activity) or situation

From Table 2.1 it becomes apparent that most researchers agree that metacognition can be seen as knowledge (what we are thinking and why we are thinking in that particular manner), and the awareness of one's thinking process in order for one to reflect on his/her actions/thinking processes, when solving a problem. This generalisation relates to the definition of metacognition that corresponds with my study.

According to Brown et al. (1983), *metacognitive knowledge* can be seen as information with regard to learning to be able to complete a task, while *metacognitive strategies* refers to general skills required for controlling and regulating one's learning process. Therefore in the following sections I will elaborate on metacognitive knowledge and metacognitive strategies.

2.4.2 Metacognitive knowledge

Figure 2.2 presents the different aspects of metacognitive knowledge, as well as the relationship between the components.

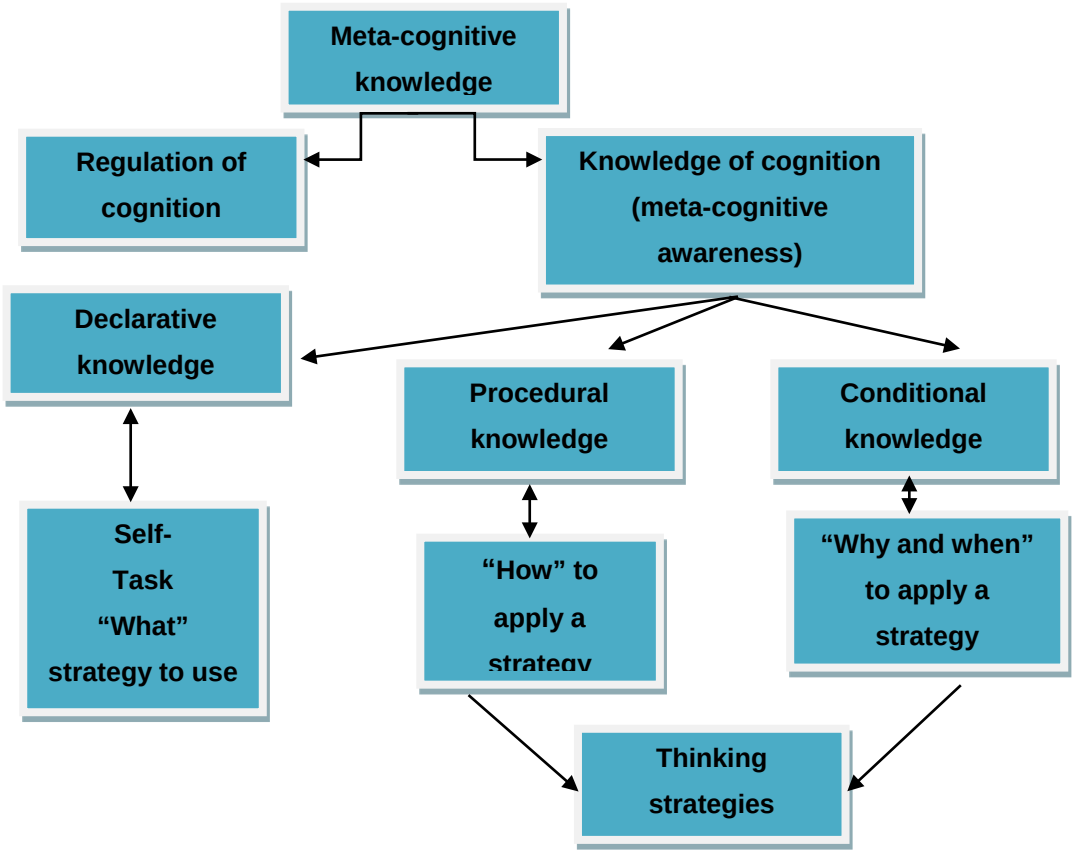

Figure 2.3 Relationships between the various types of metacognitive knowledge

A discussion of the different components illustrated in Figure 2.2 follows. "Metacognitive knowledge often is applied to refer to a systematic body of knowledge concerning one's cognition" (Schraw & Moshman, 1995, p. 7) – of what one knows and which strategies to use. Self-regulation can be seen as the highest level of metacognitive activities, which relates to cognitive resources such as strategies that can be implemented and the awareness of understanding to be utilised. Schraw and Moshman (1995) state that self-regulation includes how we can use what we know in order to regulate our thinking (ibid). Self-regulation and metacognitive knowledge are interdependent (Panaoura et al., 2003). For example, if you know you are good at solving a problem or task, self-regulation would lead you to monitor the process more thoroughly (ibid).

Table 2.2 The difference between the variables within declarative knowledge.

Variable	Discussion of the different variables
Self-component	The knowledge learners have of themselves or their knowledge of other learners' views.
Task variable	The way in which a task/problem is solved, the level of success one can achieve, the cognitive participation, the difficulty of the task as well as the available resources in order to solve the problem or task
Strategy variable	Ertmer and Neuwby (1996) differentiate between available and appropriate strategies, motivational and environmental strategies.

Adapted from Flavell (1979), and Ertmer and Newby (1996).

Table 2.2 illustrates the differences between the various metacognitive variables such as the self-component, task variable and strategy variable of declarative knowledge relating to the propositional knowledge with the focus on knowledge and strategies one possesses and the manner in which one solves a problem.

Procedural knowledge can be defined as knowledge that has to do with thinking strategies and the application of thinking strategies. This type of knowledge refers to the "how" component (Zohar & David, 2009; Paris et al., 1983), for example how a teacher teaches something (ibid). This knowledge includes evaluating the learner's thinking by asking the learner to describe the *what*, *where*, *when* and *why* of a problem. However, when teaching the learners to apply metacognitive thinking strategies it is important to talk and ask questions about problem-solving activities (Wilson & Bai, 2010).

Conditional knowledge represents the critical aspects of knowing when it is a good idea to use a specific thinking strategy and why it is helpful at that point , the "why" and "when" aspects of cognition (Panaoura et al., 2003; Schraw & Moshman,1995; Wilson & Bai, 2010;Zohar & David, 2009; Paris et al., 1983), for example when teachers ask learners questions and observe their reflective processes while solving a problem (Wilson, & Bai, 2010).

Ertmer and Newby (1996) state that performance is based upon self-regulation, by means of which learners should be able to know what (declarative knowledge) is important, how (procedural knowledge) the process works and when and where (conditional knowledge) the appropriate metacognitive knowledges should be applied. Metacognition is not only about which strategies one uses, but rather about knowing when and how to apply a strategy (Wilson & Bai, 2010; Cardelle-Elawer, 1995). Therefore it is necessary for teachers to understand what, how, and when strategies should be applied (Paris, Lipson & Wixson, 1994).

Metacognitive teaching includes training teachers and learners to implement relevant strategies, and not only does metacognitive teaching help to implement strategies but also to develop their metacognitive knowledge (Taib & Goh 2006). The cognitive and metacognitive strategies will be discussed in the next section.

2.4.3 Cognitive and metacognitive strategies

Metacognitive strategies are sequential processes one follows to control cognitive activities (what one knows), and to ensure that a cognitive goal (e.g. understanding a text) has been met (Livingston, 1997). The role of cognitive strategies is to help a learner to achieve a certain goal, for example to understand a text, while the role of metacognitive strategies is to ensure that a particular goal has been achieved; therefore one's metacognitive experience follows on a cognitive activity (ibid). Cognitive and metacognitive strategies may overlap, depending on what the purpose of using that certain strategy is (ibid). Cognitive and metacognitive strategies are interdependent; therefore acknowledging one without the other will not give a clear picture of achieving a specific goal (ibid). Cognitive processes and metacognitive strategies can be differentiated by the notion of awareness and control in order to control the *why, when, and how* questions to solve problems (Yoong, 2002). The difference between cognition and metacognition, according to Flavell (1979) and Garner (1987), can be summarised as depicted in Table 2.3.

Table 2.3 Difference between cognition and metacognition

	Cognition	**Metacognition**
Flavell (1979)	Cognitive strategies are necessary in order to progress in cognitive activities.	Metacognitive strategies are applied in order to monitor and evaluate the cognitive strategies.
Garner (1987)	Cognitive strategies are necessary in order to solve a problem.	Metacognitive strategies are necessary in order to understand how a problem is solved or how a

		problem can be solved.

Table 2.3, according to Flavell and Garner, describes the difference between cognition, which relates to strategies necessary to solve a problem as opposed to metacognition which relates to strategies for evaluating and understanding how the problem can be solved. In the following section the metacognitive strategies will be elaborated on.

2.4.4 Metacognitive strategies

Various metacognitive strategies aimed at developing teachers' metacognition (Costa, 1984, Blakey & Spence 1990), such as planning strategy, generating questions, choosing consciously, setting and pursuing goals, evaluating the way of thinking and acting, identifying the difficulty, paraphrasing, elaborating and reflecting learners' ideas, clarifying learners' terminology, problem solving activities, thinking aloud, journal keeping, co-operative learning and modelling while planning and teaching their lessons.

Figure 2.3 illustrates the metacognitive strategies.

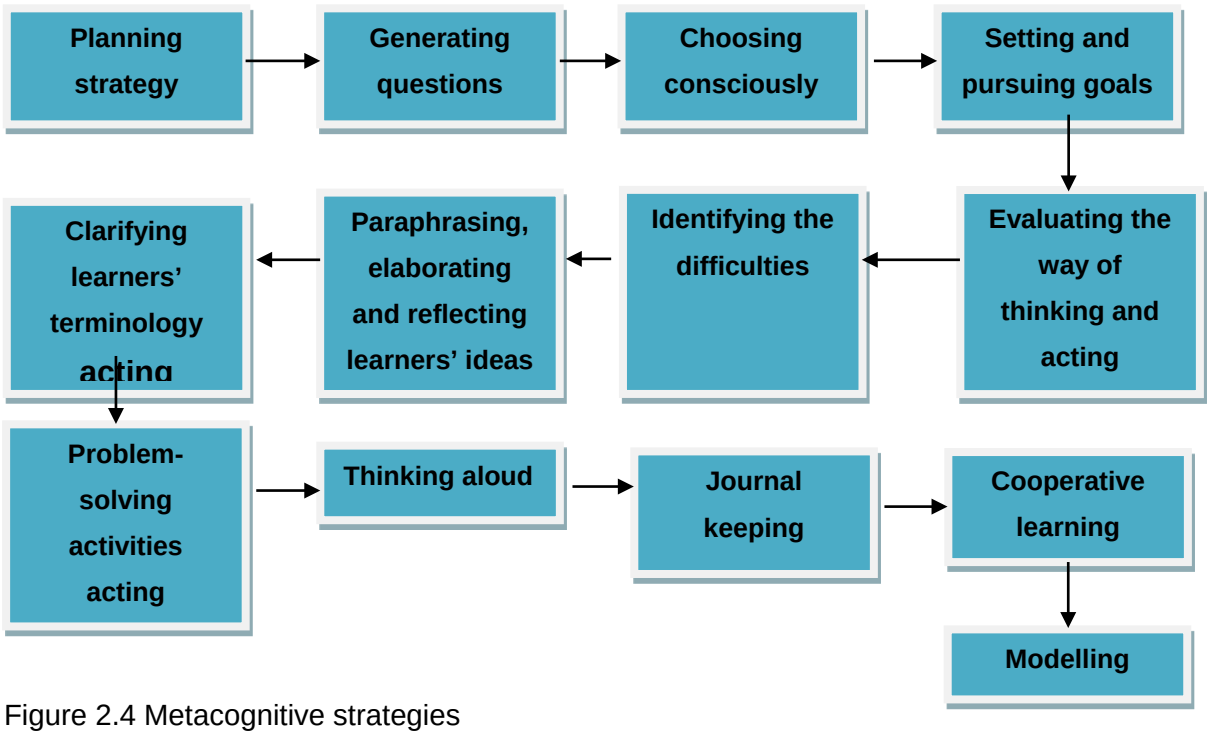

Figure 2.4 Metacognitive strategies

The different metacognitive strategies, as illustrated in Figure 2.3 will now be elaborated on.

2.4.4.1 Planning strategy

When teachers' plan a lesson on solving a problem, teachers should keep in mind to plan on how to make learners aware of the rules, steps and strategies involved in this,

before they give their learners' the opportunity to solve the problem (Du Toit & Kotze, 2009). Teachers should then give learners the opportunity of being reflective in sharing their findings and as a result, teachers will be able to identify problem areas in learners' thinking so as to address misconceptions when planning for follow up lessons (Costa, 1984).

2.4.4.2 Generating questions

Blakey and Spence (1990) state that when planning a lesson teachers should generate questions for learners to make sure about what they know and understand and what not, before starting to solve a problem. Teachers' should continuously ask learners' questions to link to their prior knowledge and when they get to a point where learners' do not understand, they should pause and focus on that question (Ratner, 1991).

2.4.4.3 Choosing consciously

It is necessary for teachers to guide their learners and to explore their actions before and during a decision-making process (Du Toit & Kotze, 2009). Learners could then be aware of relationships regarding their actions and decision making (ibid).

2.4.4.4 Setting and pursuing goals

Teachers should set goals, since goals can be seen as expectations regarding social and emotional outcomes of classroom experiences, according to Artz and Armour-Thomas (1998).

2.4.4.5 Evaluating the way of thinking and acting

Teachers should plan for evaluating the way learners think and act and how they can assist in assessing the learners' understanding (Costa, 1984).

2.4.4.6 Identifying the difficulties

Teachers should support learners to distinguish between their current knowledge and the knowledge when they use phrases such as "I can't, I don't know how" (Costa, 1984).

2.4.4.7 Paraphrasing, elaborating and reflecting learners' ideas

Teachers should encourage learners to listen and compare their ideas with other learners' ideas. In so doing learners will be able to form their own thinking when linking it with their current knowledge (Costa, 1984).

2.4.4.8 Clarifying learners' terminology

It is important for teachers to focus on questions in circumstances where the terminology is difficult as learners use vague Mathematics terminology when they are making decisions (Du Toit & Kotze, 2009).

2.4.4.9 Problem-solving activities

Through problem-solving activities, one can enhance metacognitive strategies (Blakey & Spence, 1990). Schoenfeld (1987) explains that problem solving is a way in which one can become self-regulated by controlling and focussing on one's own decision making. A teacher's role is to be a moderator and to observe the learners' decision-making process. In this way, it is necessary for the teacher to pose questions to the learners in order to assess progress such as: What are you doing? Why are you doing it in that way? How does it help you?

2.4.4.10 Thinking out aloud

When thinking out aloud it is necessary for teachers to provide learners' with opportunities to talk about their thinking in order for teachers to identify their thinking skills (Blakey & Spence, 1990).

2.4.4.11 Journal keeping

Teachers should plan time for learners to take notes based on their experiences and mistakes, as well as ways for correcting these mistakes. In this way, learners are afforded the opportunity to facilitate the creation of their thinking process and actions (Du Toit & Kotze, 2009).

2.4.4.12 Cooperative learning

Teachers should plan to provide learners' with opportunities where cooperative learning can take place where learners can share their ideas, meanings and to become aware of their own as well as other learners' thinking and experiences (Du Toit & Kotze, 2009).

2.4.4.13 Modelling

According to Costa (1984) and, Muijs and Reynolds (2005) teachers should think aloud and demonstrate their thinking process by using models (instruments), and tell learners' about their thinking in order to motivate them for selecting other strategies when solving problems.

Using appropriate metacognitive strategies such as previously mentioned above can heighten teachers' awareness of their own learning processes when planning lessons, and the learners' abilities can be developed when teachers' teaching is based on metacognition (Goh, 2008). Metacognitive teaching therefore is a process of developing strategies to know how to make adaptations when errors occur (Yavuz, & Memis, 2010). In the following section teaching metacognitively will be discussed.

2.5 Teaching metacognitively

Teaching is a metacognitive, reflective and iterative process, which includes decision-making, performing actions, and monitoring (McAlpine, 1999). In order to teach, preparation is seen as a self-directed and self-regulated process by means of which one should explore and integrate one's own knowledge (Wagster, Tan, Wu, Biswas & Schwartz, 2007). Teachers should have a good understanding of their Mathematics content knowledge in order to structure this knowledge in a form that can be presentable to other teachers as well as learners (Bargh & Schul, 1980). It is therefore important for teachers to be aware of their own metacognitive knowledge and application of strategy to be able to teach learners to become metacognitive (Wilson, & Bai, 2010). Harpaz (2007) points out that metacognition is not just skill to be taught, but a disposition of what it means to think and learn" (as cited in Wilson & Bai, 2010, p. 4).

The twenty-first century requires learners to be metacognitive to know how to learn in order to think about their thinking and not only about the content knowledge (Wilson & Bai, 2010). Being metacognitive includes not simply being aware of problem solving strategies to use, but rather knowing when and how to use metacognitive strategies (Wilson & Bai, 2010). According to Carpenter et al. (2001), as cited in Hartman (2011), in order to develop learners' thinking, teachers need to see themselves as learners to be able to create their own understanding. The more teachers know and understand their own thinking processes, the better will they be able to teach their learners to become metacognitive (Paris & Winograd, 1990).

Learners must be taught how to attain knowledge, as well as how to apply this knowledge and to control what they have learnt (Yavuz & Memis, 2010). Hence metacognition involves teachers guiding learners in becoming metacognitive by providing them with time to be reflective during class and to share their knowledge and thinking processes (Wilson & Bai, 2010; Leat & Lin, 2007).

Metacognitive development occurs as a long-term product and producer of cognitive development – the same way in which intelligence develops when learners learn about themselves, their thinking processes, and strategies they choose and apply (Panaoura et al., 2003). Therefore, as learners progress in years, they develop more metacognitive knowledge (Carr, 1998).

To teach metacognitive thinking strategies and for learners to be reflective a teacher should be able to bear in mind the following when planning a lesson:

- Give the learners the necessary time to discuss their problem.
- Allow learners to share their thinking and model learners' thinking.
- Rate the level of their learners' metacognitive thinking to see if they are able to describe their actions as being able to describe and explain what they've learned.
- Facilitate the discussions.
- Allow learners to generate any questions regarding the content.
- Provide problem-solving activities for the learners.
- Ask learners to explain their thinking and how they come up with their answers during the problem-solving activity (Wilson & Bai, 2010).

Metacognitive teaching should also include learners' background knowledge for teachers to be aware of their knowledge of metacognitive strategies, as well as their implementation of these metacognitive strategies (Griffith & Ruan, 2005).

The importance of metacognitive strategies will be discussed in the following section.

2.6 Metacognitive strategies are important

Boekaerts and Simons (1995) explains that metacognitive strategies can be seen as the continuous decisions teachers and learners make before, during and after a learning process. Metacognitive thinking (decision making) stimulates one's thinking, in order to gain an understanding of a problem being solved. Metacognition plays a role in discussions for solving problems and these discussions include not only what must be learned, but also how (Cardelle-Elawer, 1995). Limited research has been done in exploring teachers' metacognitive knowledge and strategy application or their ability of thinking out loud, talking and writing about their own thinking processes (Wilson & Bai 2010; Zohar, 1999).

> Metacognition has the potential to increase the meaningfulness of students' classroom learning, and the creation of a "Mathematics culture" in the classroom best fosters metacognition that a 'microcosm of Mathematical culture" would encourage students to think of Mathematics as an integral part of their everyday lives, promote the possibility of students' decision-making connections between Mathematical concepts in different contexts, and build a sense of community of learners working out the intricacies of Mathematics together (Schoenfeld,1987, p. 190).

Lesson study focusses on learner's and teachers' interest in Mathematics, with the emphasis on planning lessons around problems where reflection and communication plays an important role and where learners can be motivated to develop a belief in their own ability to think and learn (Burghes & Robinson, 2010).

In the next section lesson study will be elaborated on.

2.7 Lesson study

Lesson study has proved to be a very effective process in helping teachers to consider new strategies for their teaching and learning (Burghes, 2010). It encourages teachers to see problems as difficulties to overcome and not as barriers (Lewis, 2005). It also encourages teachers to take risks, to try new ideas and to reflect on and share these ideas with others (ibid). Teachers meet to plan, observe and review lessons on a regular basis (Burghes, 2010). Teachers must then be able to allow others to learn from their experiences and also to be exposed to others' experiences so as to learn from them (Hiebert, Morris & Glass, 2003). Hence the emphasis is shifted from the teacher to the methods of teaching (Burghes, 2010).

In the lesson study process when planning, observing and reflecting on lessons there will always be room for improvement in teachers' knowledge and processes as no lesson is perfect (Loyiso et al., 2007). Therefore Burghes (2010) states that:

> *Lesson study utilizes a system of backwards design in which your overarching aim defines the changes desired in your students. In other words the changes become the goals that the professional development is intended to achieve (p. 20).*

Lesson study is therefore a process for improving one's teaching and learning so as to build on previous experiences when planning, observing and reflecting on lessons. In the

following section lesson study will be described as seen from an international and national perspective.

2.7.1 International perspectives on lesson study

2.7.1.1 Lesson study in Japan

Fernandez (2002) states that “lesson study is a literal translation of the Japanese word Jugyokenkyu—jugyo means lesson and kenkyu means study or research”, (p. 3) but lesson study itself is more than simply the study of lessons as it includes the collaborative examining of lessons by a group of teachers.

Lesson study in Japan forms an integral part of their pre-service teacher training programme; where teachers meet to plan, observe, analyse and refine actual classroom lessons (Burghes & Robinson, 2010). Lessons used during the lesson study process are based on the following principles: to learn best by seeing their peer teachers teach; to develop a deep understanding and to share knowledge and experience; and to cultivate in their learners interests by focusing on the quality of learning that takes place (ibid).

The lesson study process in Japan is as follows:

Phase one: Presentation of the problem.
Teachers present the problem to the learners so that they know what is expected from them while solving their problems (Stigler & Hiebert, 1999).

Phase two: Developing a solution.
Learners share their ideas with other learners in order to seek solutions while the teachers walk around the classroom observing and making notes based on learners’ reflections. The teachers then observe which learners will be best in presenting their answers to the rest of the class (Stigler & Hiebert, 1999).

Phase three: Progress through discussion.
The teacher selects two to three learners to give feedback (Stigler & Hiebert, 1999).

Phase four: Summarizing.
The teacher then summarizes the group of findings and then challenges the learners with similar problems for homework. In their journals, learners write their findings of what they have learnt (Stigler & Hiebert, 1999).

It is common for teachers in Japan to make detailed notes by focusing on pedagogical terms and describing their roles and experiences in the process (Stigler & Hiebert, 1999). In this way the work is available for future references on how teaching took place based on thinking and their decision making (Burghes & Robinson, 2010).

In the following section the functioning of lesson study in America will be discussed.

2.7.1.2 Lesson study in America

The first lesson study in the USA was conducted in 1993 and it created great interest in this technique for improving practice in schools in the USA (Burghes & Robinson, 2010).

The model comprises the following stages:

Phase one: Choosing a research theme.

Phase two: Creating lessons.

Teachers would select a lesson within a certain unit to focus on. A lesson planning template would be used to plan the lesson.

Phase three: Teaching and observing the lesson.

The lesson would be taught by one teacher of the group and observed by the rest of the teachers. The focus with the observation would be on their learners' thinking and responses to problems rather than the teachers' teaching.

Phase four: Discussing the lesson.

After the observation all the teachers would get together, usually on the same day of the lesson observation, to discuss their outcomes of the lesson, and their observations.

Phase five: Revising the lesson.

Revisions would be made of the lesson and lesson plans, based on the observations. If necessary, the lesson would be taught again and the cycle of observation, discussion and revision would be repeated.

Phase six: Documenting their findings.

At the end of the entire process all the teachers would produce a report entailing what they had learnt with regard to the research theme and goals.

Phase seven: Presenting findings.

The teachers would present their findings to other colleagues or at conferences.

In the following section the national perspectives of lesson study will be argued.

2.7.2 National perspectives on lesson study

A school-based, in-service education intervention programme, based on the Japanese lesson study, was established in Mpumalanga, where teachers were afforded the opportunity of discussing their experiences in their teaching of Mathematics, and exploring alternative solutions to problems they had acquired (Jita, Maree & Ndlalane, 2007).

Another study in South Africa was launched by Coe, Carl and Frick (2010) who proclaimed that, during the lesson study process, teachers were comfortable with having their colleagues observing them teaching the planned lesson where an increase in content knowledge was realised. Lesson study created a change in a culture of isolation that provided a sustainable method of focusing on learners' needs.

Lesson study is a collaborative process that includes a long-term developmental model which focuses on learners' learning and the direct improvement of teachers' teaching in context. Therefore, through the lesson study process, teachers can see themselves contributing to their own professional development by gaining knowledge of their method of teaching (Stigler & Hiebert, 1999).

The purpose of lesson study will be discussed in the next section.

2.7.3 The purpose of lesson study

According to Lewis (2002a), lesson study provides opportunities for teachers to discover gaps in their knowledge of Mathematics content and teaching that can be solved in a meaningful and motivated context (Hix, 2008). Fernandez (2005) further explains that lesson study provides a context within which teachers plan lessons collaboratively where they talk about the content they teach and how to teach this content while in a classroom context. Lewis (2002a) states that lesson study is a slow means for teachers of improving their teaching methods (Lewis, 2002a; Fernandez & Yoshida, 2004). In the following section lesson study as a development process will be explained.

2.7.4 Lesson study as a development process

> "Lesson study produces small incremental improvements in teaching over a period of time. It is emphatically not a reform-like [*sic*] process" (Stigler & Hiebert, 1999).

Lewis (2002a) states that professional development rather focuses on the reflection of teachers' practice when working collaboratively, than on experts from the outside who assist in training teachers. In contrast with Lewis (2002a), according to Perry et al. (2002) and Dudley (2005), collaboration encourages teachers with different perspectives from colleagues outside their teaching world to discuss problems and to come to joint understandings, since one's knowledge of a context causes one to be blinded to practices due to familiarity. It is therefore necessary to involve someone unfamiliar from a different context to help us to see what we know, or what we do not now (ibid). A factor that can enrich the lesson study process is the involvement of an outside advisor or specialist in the subject during the lesson study process (Fernandez, 2002). Fernandez (2002) states that advisors are chosen since they engage strong content, pedagogical, and/or curricular knowledge they can bring to the group. The role of the advisor is not to take over the work of the group, but rather to serve as a vehicle for teachers in order to help lesson study groups to learn from each other.

Therefore lesson study provides an environment in which professional development can take place by providing guidance for teachers about how to critically examine their own teaching practices and those of their colleagues (Hix, 2008). Hence lesson study allows teachers to work collaboratively in planning, teaching and observing each other's lessons and reviewing the process. When lessons are modified in order to be improved, lesson study provides a way in which a Mathematics practice can be examined (Anhalt, Farias, Olivas & Ulliman, 2009).

In the following section the lesson study's effect on learners will be elaborated on.

2.7.5 Lesson study's effect on learners

According to Fernandez (as cited in Pothen et al., 2008), lesson study should focus on teachers' examination of their learners' learning and thinking processes. The Japanese consider lesson study as a way of developing teachers' eyes to see children (Anhalt, Farias, Farias, Olivas, & Ulliman, 2009, p. 35). Lesson study is a structured process that focuses on learners' learning processes and development; it therefore aims to "shift from 'teaching as telling' to 'teaching for understanding'" (Lewis, 2002b, p. 3). Lesson study's main purpose is improved teaching, and to provide learners with opportunities to reveal their understandings

(Yoshida, et al., 2003; Schoenfeld et al., 2008). Learners are mirrors in which teaching is reflected (Yoshida et al., 2003). Therefore learners react according to what they think and understand, and they react to the way teachers plan their lessons as well as to the interaction that takes place in class (ibid).

Schoenfeld et al. (2008) and Yoshida et al. (2003) state that lesson study results in knowing your learners as thinkers. According to Yoshida (2005), teachers should develop new ideas about teaching and learning that are based upon a better understanding of learners' thinking. By seeing learners' way of responding to a lesson, teachers can determine areas to improve learners' learning and their planning of lessons (Yoshida et al., 2003). The more teachers understand their learners' learning and thinking processes, the more effectively lessons can be planned in order to provide learners with opportunities to reveal their understanding of subject matter (Schoenfeld et al., 2008; Yoshida et al., 2003). Lesson study therefore focuses on learners' learning and understanding processes and the emphasis is shifted to the planning of lessons (Lewis, 2002b). Lesson planning includes metacognitive teaching-learning strategies and aspects of Mathematics teachers' knowledge for effective contribution to learners' learning/understanding process such as evaluating learners' learning, assessing assignments and completing the curriculum content area and how the teacher is going to teach (Van der Walt & Maree, 2007; Ball, Thames & Phelps, 2008) with the aim of contributing to a better understanding.

The following section describes the aspects of the lesson study process.

2.7.6 The lesson study process

The collaborative lesson study process allows teachers to improve lessons with learners' best interests in mind, and to create modified versions of their lessons, based on their classroom observations (Anhalt et al., 2009). The lesson study process includes the following aspects: 1) long-term goals for learning; 2) planning and compiling the lesson; 3) observing and collecting data during the lesson being presented; 4) reflecting and discussing the collected data from the lesson being observed to determine implications for the follow-up lesson to be planned (Lewis, Perry & Marata, 2006).

The first aspect, namely long-term goals for learning, is discussed next.

2.7.6.1 Long–term goals for learning

In order to plan a lesson, teachers should set goals for their learners, which need to be addressed through teaching (Hix, 2008). In Japan, setting long-term goals includes the

"identification of gaps between the 'ideal' and 'actual' qualities of learners' thinking and learning (Burghes & Robinson, 2010)". These gaps include misconceptions determined throughout the teaching process, specific areas teachers find difficult to teach, or a new topic (ibid). In the following section planning a lesson will be elaborated on.

2.7.6.2 Planning a lesson

Planning of lessons is based on metacognitive teaching-learning strategies of a specific content area; therefore determines how teaching of that subject matter will take place (Van der Walt & Maree, 2007). When planning a lesson, the following principles should be taken into consideration: (a) Identify a topic or theme that is challenging for the learners or one that is difficult to teach, (b) identify lesson goals, and (c) create your lesson (Yoshida, 2002). The aim is not to create a perfect lesson but a lesson that will be able to make learners' thinking visible and for the other teachers to learn about how their learners learn (ibid). Table 2.4 indicates an example of a lesson plan, according to Fernandez and Yoshida (2004),

Table 2.4 Lesson plan

Steps of the lesson: learning activities and key questions The problem Problem format Solving the problem	Learners' activities/ expected learner reactions or responses	Teachers' responses to learner reactions/things to remember	Goals and methods/for evaluation
Time allocation			

(Adapted from Lewis, 2002a).

Table 2.4 is an example from a lesson plan which, according to Fernandez and Yoshida (2004), includes the steps of the lesson such as the problem, responses from the learners, teachers' responses and goals or methods for evaluating the teaching process as well as the time allocated for the lesson to take place in a classroom.

When teachers collaboratively plan lessons, the following should also be taken into consideration, namely the subject matter and pedagogical content knowledge (Shulman, 1986; Schoenfeld & Kilpatrick, 2008), as well as the knowledge of learners' thinking and the expected outcomes of the lesson (Yoshida, 2003).

Teachers planning lessons during the lesson study process need to obtain sources from the outside world for their lessons besides only using the curriculum documents they are provided with (Gurl, 2011). Lesson study is more productive when teachers collaboratively study existing lessons (Hix, 2008); therefore it is important for teachers to make use of previous or pre-existing lessons that need to be adjusted (Hix, 2008). Everyday topics can be used in planning lessons and therefore the purpose of effective teaching is to conduct and create good lessons (Yoshida et al., 2003).

In the next section teaching and observing the lesson will be discussed.

2.7.6.3 Teaching and observing the lesson

Research has shown that teachers selected to teach in front of other teachers have been nervous about their teaching (Fernandez, 2002). "What's very powerful is that people felt that because they'd planned together, it made it okay if it went wrong…" (Dudley, 2005, p. 7). It is necessary to provide teachers with trust in their own and others' knowledge (Hix, 2008).

During the observation process, one teacher takes the responsibility of teaching the final collaboratively planned lesson (Fernandez & Yoshida, 2004). The other teachers as observers need to have copies of the final collaboratively planned lesson and need to walk around the classroom and take notes of the learners' responses and teachers' responses to learners as indicated in columns 2 and 4 from Table 2.4 (ibid). Observers need to make notes on the lesson.

The following section describes reflection based on the observed lesson.

2.7.6.4 Reflection based on the observed lesson

The reflection based on the observed lesson must take place when sufficient time is available for in-depth discussion by all the other teachers that had participated in the lesson study process (Fernandez & Yoshida, 2004). The teacher who presented the planned lesson must be the first to report on his/her findings and experiences of the lesson and explain why he/she took any other actions when moving away from what was being planned to be taught (ibid). The other teachers should then be given an opportunity to reflect on their findings and give their input (ibid). When the teachers have reflected on the lesson being observed they should bear in mind the quality of the questions, their ability to anticipate the learners' responses to these questions, the effectiveness of their evaluation, and whether the goals of the lesson were met (Gurl, 2011; Fernandez & Yoshida, 2004).

Teaching the planned follow-up lesson will be explained in the following section.

2.7.6.5 Teaching the planned follow-up lesson

If necessary, after planning a follow-up lesson based on the observations from the first lesson, a second teacher will teach the new version of the planned follow-up lesson, while the others observe once again (Fernandez, 2002). Reflection on an observed lesson will take place, which will be discussed in the following section.

2.7.6.6 Reflection on observed lesson

When completing a lesson study process, teachers document their findings in a report; describing their experiences of what they had learnt, and how the lesson worked (Ono & Ferreira, 2010). Teachers are thereby being involved metacognitively, and by focusing on these learning activities and developing learning experiences, teachers acquire metacognitive knowledge and skills (Lewis, Perry & Murata, 2006).

In the following section the importance of lesson study will be elaborated on.

2.8 Importance of lesson study

Lesson study plays an important role since teachers see their lesson study as a form of research in their classrooms where they focus on conducting classroom experiments (Fernandez, 2002). Teacher practice-knowledge is built up over several years. Therefore, by "bringing multiple perspectives from other teachers and schools through the lesson study process can bring about hundreds of years of teaching experience into the classroom" (Dudley, 2005). Teachers should be able to learn in and from their own teaching practices (Ball & Cohen, 1999).

Lewis (2002a) states that "the point of lesson study is not to polish the skills of a few star teachers but to help all teachers progress in the teaching process, in order to reach as many learners as possible with successful lessons and a coherent experience" (p. 55). "However, I do not intend to suggest lesson study is the only way teachers can learn certain things about Mathematics teaching. I only present this as one experience that offers an opportunity for teachers to learn *about* the act of teaching while *in* the act of teaching". (Hix, 2008, p. 127.)

The benefits of lesson study will be discussed in the next section.

2.9 Benefits of lesson study

Lesson study, over a period of years, can change and influence teachers' dispositions towards Mathematics, Mathematics teaching and Mathematics learning (Hix, 2008). The lesson study process is a powerful way for teachers to examine their practice, and to discuss their daily teaching activities and learn from it. Characteristics of lesson study include, amongst others, sharing goals for teaching improvement, focusing on the learning process, gathering evidence of learners' thinking processes, sharing lesson observations and experiences, sharing videotapes, written cases, lesson plans, photographs and learners' work in analysis and improvement of the teaching and learning process (Anhalt et al., 2009).

Each teacher participating in the lesson study process learns something different based on that teacher's experience (Lewis, Perry, & Hurd, 2004). The impact of lesson study may occur in different domains of teacher development that includes teachers, knowledge, their practice, motivation towards learning, participation with their colleagues in sharing their knowledge and therefore it is important to understand how these dimensions of development interact with one another over a period of time (Perry et al., 2009).

Lesson study plays an important role in changing teachers' perspective and learning through 1) changes in norms, 2) changes in participation opportunities, and 3) changes in tools.

Changes in norms include lesson study in assisting in shaping teachers' perspectives, beliefs, values and expectations. Teachers do not have to worry about feeling responsible for doing their own thing since they would be able to quickly ask questions and advice, observe other teachers and in this case they can feel responsible for each other's practice (Perry et al., 2009).

Changes in participation opportunities refers to teachers having opportunities to share their knowledge and experiences about their learners' reactions, collegial observation, negotiation of a shared lesson plan; therefore these factors can contribute to the norms of the community (Perry et al., 2009).

Changes in tools are necessary *as* teacher communities can provide teachers with the necessary tools such as lesson plans as well as an agenda for post-lesson discussions that can assist teachers in developing their knowledge (Perry et al., 2009).

Therefore lesson study has the potential for planning professional learning programmes; where teachers can further construct new knowledge concerning lessons and the teaching and learning process, and learn by sharing their classroom experiences and challenges with one another in striving to build a reflective practice that will enhance learners' understandings of Mathematics (Posthuma, 2011; Dudley, 2005).

In the next section the summary on lesson study will be discussed.

2.10 Summary

In this chapter I focused on Mathematics in the classroom, nationally and internationally, Mathematics teachers' knowledge, teaching and learning. I reviewed theoretical perspectives on metacognition and lesson study in the literature and gave an overview of a number of research studies dealing with how the lesson study process was implemented. This theoretical framework was used as a basis for forming my conceptual framework as set out in Chapter 4. The following chapter (Chapter 3) describes and explains the research design and methodology on which my study was founded.

Chapter 3
Research design and methodology

3.1 Introduction

This chapter provides a description of the research paradigm, research approach and methodology, research design used in my attempt to understand and to focus on the phenomenon being studied. Furthermore I describe the research site and participants, data generation strategies, as well as the entire process based on the data generation, my role as researcher in each phase followed by the data analysis strategies. Lastly I focus on the critical issues such as the trustworthiness, the validity and reliability and ethical considerations applicable to my study.

3.1.1 Conceptual framework

In the following section my conceptual framework will be discussed.

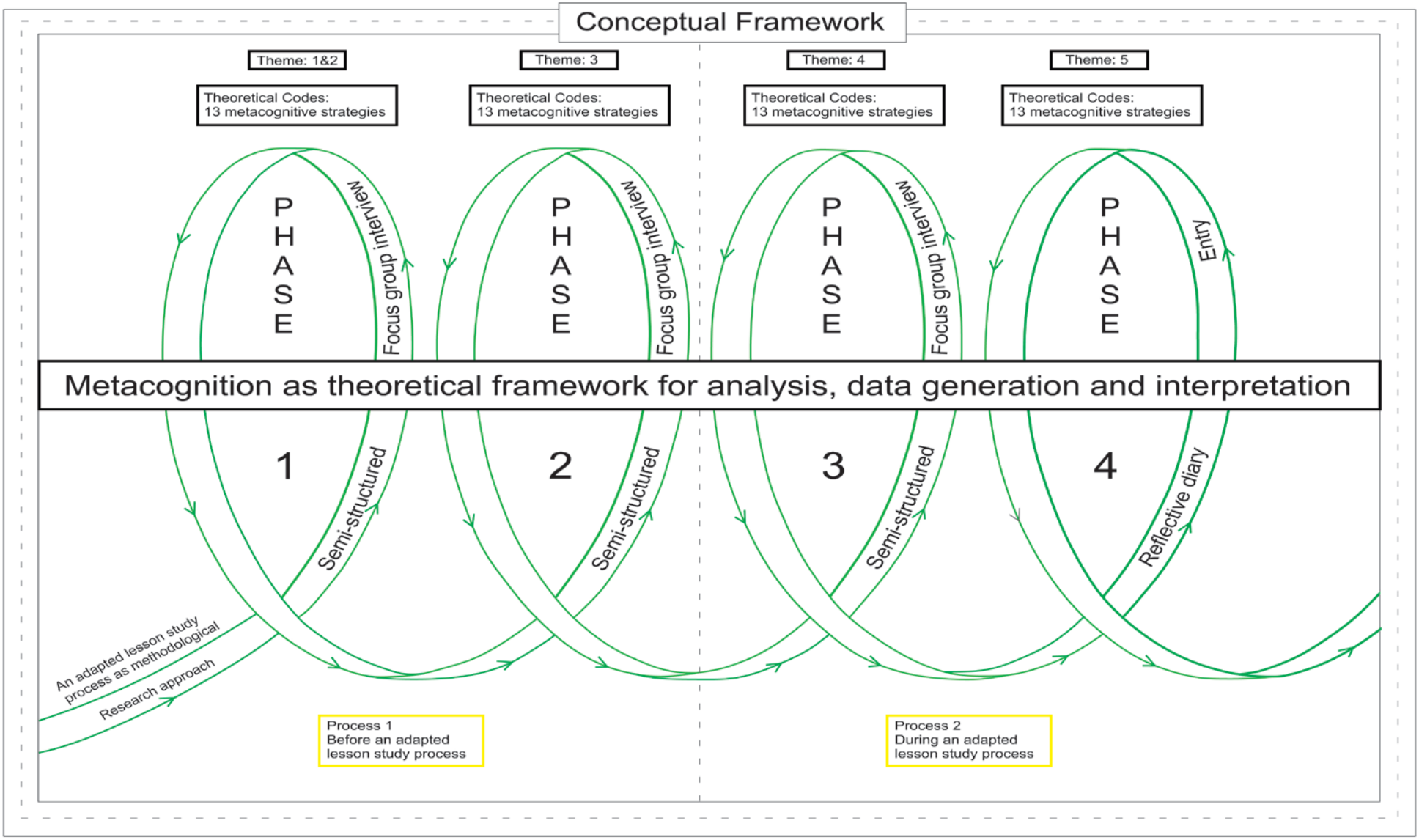

Figure 3.1 Conceptual Framework

In Figure 3.1 the methodology forms part of the conceptual framework. This conceptual framework consists of different parts. For this chapter the research design and methodology is represented in colour, since it is the focus of this chapter. It is based on the methodological research approach framework – in the case of this study it is the adapted lesson study process. This research took place in two processes and four phases. The two processes and four phases will be elaborated on in this chapter (see Section 3.4).

In the following section the research paradigm and assumptions will be explained.

3.2 Research assumptions and research paradigm

Lincoln and Guba (1985) state that a paradigm refers to what we think about this world, "as we think, so do we act" (p. 15). Nieuwenhuis (2010a) states that a paradigm serves as a lens or organising principle by which reality is interpreted. A paradigm or worldview can be seen as an orientation of the researcher towards the world (Creswell, 2009). Each person sees the world through a lens from a different perspective based on their existing knowledge (Shuard, 1986). Thus, according to Nieuwenhuis (2010a), a paradigm "addresses fundamental assumptions taken on faith, such as beliefs about the nature of reality (ontology), the relationship between knower and known (epistemology) and assumptions about methodologies" (p. 47). The next section includes the paradigmatic assumption that will be discussed.

3.2.1 Paradigmatic assumptions

As researcher, I acknowledge the fact that my own experience and background knowledge form part of how this study's interpretation will follow and therefore the nature (ontology) of my study is to be subjective where I am personally involved in the process of conducting meaning from the teachers' understanding of their experiences and the context they live and work in. The goal is to rely on the participants namely the Intermediate Phase Mathematics teachers' views of the situation being studied (Creswell, 2009).

Regarding epistemology, the study is based on an interpretative position that focuses on the teachers' subjective experiences of *how* they interact with or relate to each other during the adapted lesson study process (Nieuwenhuis, 2010a).

This ontological assumption and epistemological assumption influence the methodological assumption where the teachers' subjective experience, their perceptions and their actions can be explored, and therefore Lincoln and Guba (1985) state that "methodology can be seen as the way in which reality is understood".

In the following section the research paradigm will be elaborated on.

3.2.2 Research paradigm

The interpretative paradigm is a qualitative research approach based on a socio-constructivist theory, which seeks to understand the world in which participants live and work (Creswell, 2009; Mertens, 1998). In interpretivism no distinction is drawn between the subject and the object (Jansen, 2010). Interpretivism, according to Husserl (as cited in Nieuwenhuis, 2010, p. 59), "assumes that reality is not objectively determined, but it is socially constructed". Teachers are being placed in their social context so that they can understand their perceptions of their teaching and learning (ibid).

According to Olivier (1989), Mathematics teachers are guided by set theories of how learners learn Mathematics in their classrooms. Teachers are mostly wary of theory, as they want something practical. Theory is like a lens through which a person views facts concerning what one sees or doesn't see (Davis, 1984). Different teachers hold different beliefs, and therefore they address learners' mistakes in different ways (Olivier, 1989).

The socio-constructivist approach to teaching is to look at the learning process from the perspective of a learner, and therefore it is necessary for teachers to put themselves in the shoes of their learners to consider mental processes by which new knowledge is acquired. Knowledge cannot be transferred from one person to another (Olivier, 1989). Thus, in order for a learner to construct his/her own knowledge, discussions, communication and reflection are necessary components for a socio-constructivist approach to teaching.

The adapted lesson study process is a collaborative process that includes a long-term developmental model which focuses on learners' learning and the direct improvement of teachers' teaching in their context (Stigler & Hiebert, 1999). Therefore the adapted lesson study process can provide an opportunity for teachers to see themselves as contributing to their own professional development, and to understand their awareness and perceptions of their own activities that include knowledge (metacognition) about their teaching. "It is an experience in metacognition, to hold the act of teaching out at a distance, to look at it from all different perspectives, and then to place the teacher back into the act of teaching to monitor what happens." (Hix, 2008, p. 121.)

From this research socio-constructivism includes exploring and understanding the Intermediate Phase Mathematics teachers' historical and cultural norms operating in their

lives. Therefore the adapted lesson study process provided an opportunity for these teachers to discuss and share their meanings and experiences of their awareness of metacognitive teaching and learning. As researcher my overall interpretation was based on my understanding of these teachers' awareness of their metacognitive strategies by focussing on the teachers' specific context in which they teach and this can be verified by crystallisation for this study (see Section 3.8.1).

Table 3.1, which has been adapted from Botha (2011), provides an overview of the research methodology components of my study that will be discussed further on.

Table 3.1 Overview of the research methodology components

<table>
<tr><td>Research approach</td><td colspan="3">Qualitative research</td></tr>
<tr><td>Research design</td><td colspan="3">Design research: Exploratory
Design research methodology in my study entails Intermediate and Senior Phase Mathematics teachers working collaboratively in a specific context during an adapted lesson study process in order to answer the research question. As a researcher, I participated in their instructional practice in order to explore and understand the research question.</td></tr>
<tr><td>Research question</td><td colspan="3">To what extent do Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process?</td></tr>
<tr><td rowspan="2">Sub questions</td><td>Theoretical research approach framework</td><td>Process 1</td><td>Process 2</td></tr>
<tr><td>Question 1
How can metacognitive strategies be defined?</td><td>Question 2
Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?</td><td>Question 3
Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?</td></tr>
</table>

Table 3.2 Overview of the research methodology components (continue)

Objectives of the sub questions		To explore Intermediate Phase teachers' awareness of their metacognitive strategies before an adapted lesson study process.	To explore Intermediate Phase teachers' awareness of their metacognitive strategies during an adapted lesson study process
Participants in each phase		**Phase 1** All the Intermediate Phase Mathematics teachers as participants **Phase 2** All the Intermediate Phase Mathematics teachers. as participants	**Phase 3** All the Intermediate Phase Mathematics teachers. as participants **Phase 4** All the Intermediate Phase Mathematics teachers. as participants
Methods and data generation strategies	• Phase 1: One semi-structured focus group interview with all the participants. • Phase 2: One recorded lesson from one grade 4 Intermediate Phase Mathematics teacher and one semi-structured focus group interview with all the participants. • Phase 3: One semi-structured focus group during an adapted lesson study process with all the participants. • Phase 4: Reflective diary entry with all the participants.		
Data analysis	Content analyses where data were generated through the semi structured focus group interview based on the viewing of the recorded lesson (in phase 2), responses to semi-structured focus group interviews (phases 1, 2, and 3) and a reflective diary (phases 4).		

Table 3.1, provided an overview of the research methodology components such as 1) the research approach, 2) research design, 3) research questions, 4) objectives of the sub

questions, 5) participants in each phase, 6) methods and data generation strategies, and 7) data analysis of my study.

In the following section the research approach will be discussed.

3.3 Research approach

According to Creswell (2009), a qualitative approach can be seen as "socio-constructivist worldview which includes ethnographic design and observation of behaviour" (p. 16). The qualitative approach such as emerging methods, open-ended questions, semi-structured and focus group interviews, audio-visual data, text analysis, themes/patterns interpretation methods can be used to position the researcher in the shoes of the teachers to generate the teachers' meanings in order to bring personal values into this study (Creswell, 2009).

My decision to choose a qualitative approach rather than a quantitative approach was generated through my research questions and was inspired by Creswell (2009) who stated that a qualitative research approach is to generate meaning from data by using methods such as semi-structured focus group interviews and a reflective diary. The following section describes the research design this study was based on.

3.3.1 Research design

A research design can be defined as procedures that include assumptions to data generation strategies and data analysis (Creswell, 2009). In order to address my research questions this empirical study will be based on the design research methodology. Many labels in literature refer to design research such as design studies; design experiments; developmental research; formative research; formative evaluation; engineering research (Van den Akker et al., 2006). Design research as methodology will be discussed next.

3.3.2 Design research

According to Greeno (1998), design research focuses on understanding practices through aspects of the teaching and learning process. The philosophy of design research is to understand the aspects of education in order to produce them, and therefore "if you want to change something, you have to understand it, and if you want to understand something, you have to change it" (Gravemeijer & Cobb, 2006, p. 51). The second part of the statement that, "if you want to understand something, you have to change it" points to collaborative work on design research, the constructivist "teaching experiment methodology" (Cobb & Steffe, 1983; Steffe, 1983).

Design research approach has the ability to help develop educational interventions in order to provide opportunities for learning during the process (Van den Akker et al., 2006). Once designs or interventions are put in practice, design research estimates sustainability in the goals for designs or interventions (Walker, 2006). Design research improves the understanding of how to design for implementation in practice (Van den Akker et al., 2006). Kelly (2006) defines design research as an interventionist, iterative, process focused, collaborative and theory driven process.

When approaches, such as lesson studies, design research and learning studies are compared, their aim is not only to produce effective lessons, but most importantly, to bring about professional development of teachers in a specific context to understand why, when and how learning processes develop (Smit & Van Eerde, 2011).

Since design research focuses on processes being explored in a specific context (Burkhardt & Schoenfeld, 2003) this was the perfect methodology for this study where teachers work collaboratively during an adapted lesson study process.
In the following section the research site and participants will be elaborated on.

3.4 Research site and participants

This design research study took place in a rural school in the North West Province. According to Motshekga (2009), rural schools should receive more necessities such as basic needs (class rooms and basic services such as water and electricity). For purposes of this study, one rural school has been purposefully selected as we previously worked with this school during our SANPADMATH meetings.

According to Nieuwenhuis (2010b), qualitative research is based on non-probability and purposive sampling approaches, as it includes smaller sample sizes which involve settings, incidents, events and activities that are included for all data to be generated. Therefore, double-medium participants were selected, which included six Intermediate Phase (grades 4 to 6) teachers and one Senior Phase (grade 7) Mathematics teacher teaching this content area. Double-medium participants refers to the teachers of this school in which their teaching takes place in an English environment, but they make use of their home language in their classroom as teaching in their home language is more understandable for the learners. The reason for this small group of Intermediate and Senior Phase Mathematics teachers was to ensure that everyone was afforded an opportunity of

participating, while eliciting a range of responses from their teaching experiences (De Vos, 2005).

Table 3.2 gives an overview of the teachers participating in this study.

Table 3.2 Biographical details of participants

Intermediate Phase Mathematics teachers							
	A	**B**	**C**	**D**	**E**	**F**	**G**
Male/female	Female	Female	Male	Male	Male	Female	Male
Years of teaching experience	5	7	1	13	21	18	26
Number of years teaching Mathematics	4	2	1	9	15	18	26
Grades teaching in 2012	4	4	0	5	5,6,7,8,9	6	6 &7
Grades teaching in 2013	4	4	5	5	5	6	7
Home language	Setswana	Sotho	IsiXhosa	Setswana	Setswana	Zulu	Setswana
Language (medium) of instruction	English and Setswana	English and Setswana	English	English	English	Xhosa	English

The data generation strategies will be discussed in the next section.

3.5 Data generation strategies

Research methods, such as interviews and document collection, involve specific forms of data generation and analysis researchers use for their studies (Creswell, 2010). Nieuwenhuis (2010b) states “the aim of qualitative interviews is to see the world through the eyes of the participant” (p. 87). Semi-structured interviews define the inquiry line and require that participants answer predetermined questions developed by the researcher (Nieuwenhuis, 2010b). Focus group interviews comprise a group interaction that includes a variety of responses of the participants to build on each other’s ideas and views (ibid) and therefore semi-structured focus group interviews were conducted during process 1 and 2, phases 1, 2 and 3 to learn about and understand the teachers’ experiences and why they teach and plan their lessons in a certain manner.

According to Lehman (2003), document collection includes learning about certain things and Hodder (cited in Lehman, 2003) states that document collection provides data different from what was interpreted through the interviewing process and it allows the researcher to explore various interpretations of data that are more permanent than the spoken words during an interview which relates to a more historical insight. In this research, document collection includes teachers' reflection on the adapted lesson study process (during process 2, phase 4) by conducting a reflective diary entry.

The following two processes describe the way in which the data were generated during each process and each phase. During the first process, data were generated in two phases and, during the second process, data were generated through two phases.

The following section includes the discussion on process 1 phases 1 and 2.

3.5.1 Process 1

Process 1, Phase 1 describes and includes the workshop, teachers' reflection on previous lesson study processes, teachers determining lesson study goals for their following adapted lesson study process and a semi-structured focus group interview that followed.

3.5.1.1 Phase 1: Before an adapted lesson study

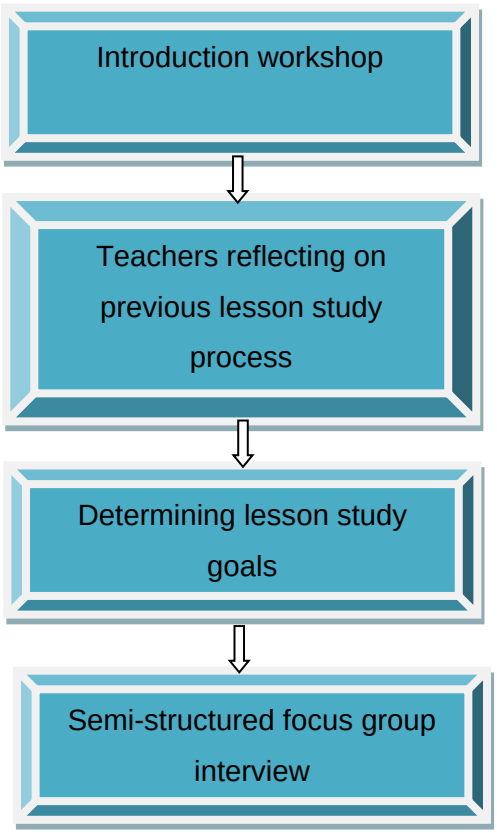

Figure 3.2 Illustration of phase 1 – introduction workshop.

During the first phase, an introduction workshop was held with the participants. The terminology, namely 'metacognition' and 'metacognitive knowledge', 'strategies' and 'lesson study' were clarified (See PowerPoint presentation on cd).

During the workshop, the participants reflected on their overall experience of lesson study (see Appendix A) (see Chapter 4 for the discussion of their experiences) as we previously worked with them and they determined goals together that they intended to achieve by the end of the adapted lesson study process. These goals were the following;

- To help learners by especially focusing on the content being taught or planned.
- For future purposes that learners can be able to put it in a practical phenomenon.
- Effectively assessing learners to participate in the teaching of Mathematics.
- To create a positive mind set in the calculation in designing methods.
- Provide learners with skills to be able to compete with their peers.

The way forward for the adapted lesson study process was discussed and the participants decided that one teacher out of each grade of the Intermediate Phase (grads 4 to 6) Mathematics teachers, thus three teachers should plan a lesson based on the topic area they have chosen in the Space and Shape content area. The reason for choosing this specific topic is that the teachers were busy teaching this topic at that stage in the curriculum. A semi-structured focus group interview (See Appendix B) followed with all the participants and the purpose during the semi-structured focus group interview was to answer the second sub research question, namely which metacognitive strategies Intermediate Phase teachers are aware of before an adapted lesson study process.

Process 1, Phase 2 describes the intervention phase during which teachers collaboratively met and reflected during a semi-structured focus group interview on a recorded lesson.

3.5.1.2 Phase 2: Intervention phase

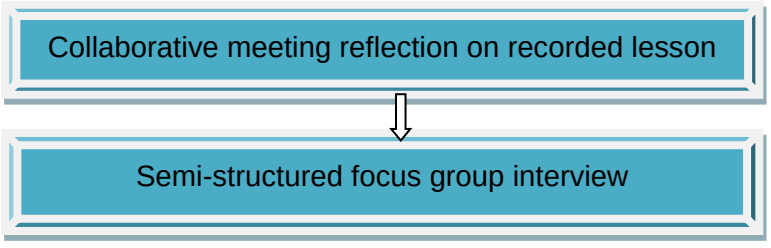

Figure 3.3 Illustration of phase 2 – the intervention phase

During the second phase, a recorded lesson was shown to the participants during the collaborative meeting. A semi-structured focus group interview followed in order to reflect on the metacognitive strategies being used by that specific teacher (teacher A) that appeared in the recorded lesson based on the topic "Common fractions" in the content area Numerations, Operations and Relationships (The reasons for the topic that changed will be discussed later on in Chapter 5). The semi-structured focus group interview can be seen in Appendix C. The semi-structured focus group interview encouraged the teachers to participate while I used probing questions to guide the research process in which the focal point was towards the second sub-research question (Nieuwenhuis, 2010b). This semi-structured focus group interview strategy was based on an interactive process where the participants shared their meanings from the video and where they were able to build on each other's ideas to create in-depth views (Nieuwenhuis, 2010b) and understanding of the lesson being studied.

The following section elaborates on process 2, phases 3 and 4.

3.5.2 Process 2

Process 2, Phase 3 describes the collaborative planning of a follow-up lesson, by all the participants during a semi-structured focus group interview.

3.5.2.1 Phase 3: Adapted lesson study process

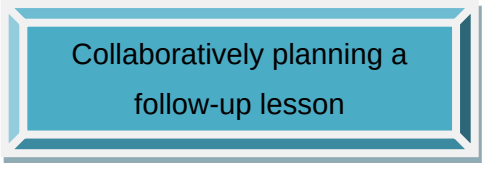

Figure 3.4 Illustration of phase 3 – adapted lesson study process

During the third phase, the participants were made aware of the lesson study process. An information session took place, during which the participants were provided with all necessary information on the lesson study process. The participants brought a lesson plan template as well as the CAPS document that included the information based on the content

area Number, Operations and Relationships and topic “Common fractions” for planning the follow-up lesson.

During the adapted lesson study process, we worked collaboratively and planned a follow-up lesson (see Appendix D), by using the CAPS materials and their school’s lesson plan templates, based on the one lesson that had been recorded and discussed during a semi-structured focus group interview in Phase 2 (see Appendix E).

The aim in this phase was not to create a perfectly planned lesson, but rather to create a lesson so that teachers can be open minded about different metacognitive strategies to use, to learn from their colleagues’ experiences and to bear in mind that one learns as one goes along (Hix, 2006). A semi-structured focus group interview followed on planning the follow-up lesson in order to reflect on the third sub-question as to which metacognitive strategies Intermediate Phase teachers become aware of during an adapted lesson study process.

In the following section, Process 2, Phase 4 describes the reflective diary of all the participants.

3.5.2.2 Phase 4: Reflective diary

During phase 4 a reflective diary of the lesson study process was compiled by the participants. The purpose of this diary was to understand the last sub-question of this study, namely which metacognitive strategies Intermediate Phase teachers become aware of during an adapted lesson study process (see Appendix F). Further on in the diary teachers reflected on their personal opinions about metacognition and the entire adapted lesson study process in general.

The next section describes my role as a researcher during the adapted lesson study process.

3.6 Role as researcher

According to Nieuwenhuis (2010b), the researcher's involvement in the changing, real-world situation is important, because the qualitative researcher must record changes in the real-life context. In this qualitative study, my role as a researcher and participant is subjective, as I am regarded as the “research instrument” during the data generation process. Therefore my role was to continuously recognise the participants’ values and personal interests with regard to my research process (Creswell, 2003).

In the following section ten themes have been adapted from Patton (1990) and Swanson and Holton (1997), as cited in Van der Walt (2006), for this study, which include:

Theme	Role of researcher
Naturalistic investigation	Research has been conducted in the classroom and in the school environment.
Inductive analysis (begin to generate detail that led to generalisations	Data were generated through various methods as previously been described above in order to determine relationships.
Holistic perspective	Metacognitive strategies were explored by Intermediate Phase Mathematics teachers.
Qualitative data	Detailed explanations were gathered through semi-structured focus group interviews, video recordings, reflective diaries and verbatim descriptions.
Personal contact with the other participants	Data generation was conducted at the school while I facilitated the semi-structured group interviews.
Dynamic system (seeing that the phenomenon can change throughout the study)	Each teacher's perspective in the Intermediate Phase differs from the other; therefore it was taken into consideration that each one's perspective on metacognition and metacognitive strategies differs.
Unique orientation for every teacher	Every teacher is unique in his or her special way and therefore they all had the opportunity to share their experiences and opinions.
Flexibility	The design research process was adaptable and changed as the setting and circumstances changed.

Figure 3.5 Themes and the role of the researcher

Figure 3.5 illustrates the ten themes and specific roles of the researcher during each theme. The following section describes my role as a researcher in each phase.

Phases 1 and 2

Observer as participant – whereby I focused mainly on my role as an observer during the semi-structured focus group interviews and where I looked for patterns and behaviours in the particular community in order to understand the context (Nieuwenhuis, 2010b).

Phase 3

Participant as observer – whereby I became part of the research process and worked with the participants in order to develop the lesson study process (Nieuwenhuis, 2010b).

Phase 4

As a researcher I did not participate during the reflective diary process.

The next section elaborates on the data analysis strategies.

3.7 Data analysis strategies

Creswell (2009) contends that data should be organised for the data analysis process. The data in my research were obtained through semi-structured focus group interviews with the participants, reflection on a recorded lesson by the participants during an adapted lesson study process, and document analysis, by means of a reflective diary. The data were organised according to the different phases, as discussed in the previous section, in order to understand the two processes dealt with in this study.

As a researcher, I conducted content analyses, where data were generated through visual media (in phase 2), responses to semi-structured focus group interviews (phases 1, 2 and 3) and document collection, such as a reflective diary (phase 4) in the content area Number, Operations and Relationships (Nieuwenhuis, 2010b). According to Nieuwenhuis (2010c), “content analysis is an iterative process” (p. 101). All data were transcribed verbatim. A list of a priory codes were compiled (Nieuwenhuis, 2010c) based on the metacognitive strategies discussed in Chapter 2 (see Section 2.4.4). The transcripts were read and re-read in order to familiarise myself with the data to create an in-depth reliability of the data. I summarised the data in order to categorise relationships and patterns in the data. After the codes had been allocated they were grouped into five themes (see Section 2.7.6.1-2.7.6.6) according to the processes of the data generation (Nieuwenhuis, 2010c). My goal was to summarise what I saw and heard to support my understanding and interpretation of what emerged from the data. Throughout this process I kept my research questions in mind.

The purpose of this data comparison is to bring structure and meaning (De Vos, 2005; Nieuwenhuis, 2010c) to form a clear understanding of the research question. Data reported in this study is a subset of data from a design research cycle which focuses on teachers' learning where a group of teachers collaboratively operate in an institutional setting of a school (Cobb, Zhao & Dean, 2009).

The following section describes and explains the trustworthiness of the study.

3.8 Trustworthiness of the study

Trustworthiness is related to qualitative research where multiple data sources are used in order to have more confidence in one's results (Nieuwenhuis, 2010b). Trustworthiness further indicates avoidance of generalisation but rather seeking to understand the teachers' perspectives in the context in which they live and teach (ibid).

Validity and reliability of the study will be discussed in the following section.

3.8.1 Validity and reliability of the study

Crystallisation (qualitative research) probes a deeper understanding in penetrating one's awareness and understanding of a phenomenon (Nieuwenhuis, 2010b). By looking at it from an interpretivist perspective based on a socio-constructivist approach, multiple realities people have in their minds and the different insights gained, describe the perspectives and awareness that refers to the reality constructed (through an adapted lesson study process) and participants working with in this study (ibid). Crystallisation furthermore ensures internal validity that can be seen as a conclusion that is drawn to understand different methods being used to compare findings with one another in a specific context for a certain purpose (Maree & Van der Westhuizen, 2010; McMillan & Schumacher, 2001; Merriam, 1998). Five different validity aspects such as 1) describable validity, 2) interpreted validity, 3) theoretical validity, 4) a general validity and 5) evaluating validity of qualitative research can be described that relate to aspects in my study.

Describable validity can be seen as the accuracy with which the voice recorder, a digital video recording and reflective diaries were used as secondary recourses in order to fill the gaps of the findings. Interpreted validity refers to my ability to make interpretations – meanings of all the data being generated. Theoretical validity refers to a phenomenon (of metacognition and to what extent Intermediate Phase Mathematics teachers become aware

of metacognitive strategies during an adapted lesson study process) being described and explained. A general validity refers to data being collected in order to understand certain situations such as the context in which these Intermediate Phase Mathematics teachers experience their way of teaching. Lastly, evaluating validity is described as a validity that evaluates the phenomenon (teachers' metacognitive awareness) being described (Cohen, Manion & Morrison, 2001).

Reliability refers to "the consistency and re-applicability over instruments and over a group of people (Cohen et al., 2001 p. 117). The following aspects of my study ensure that qualitative data can be exported as reliable – to ignore generalisations rather by focussing on the teachers' metacognitive awareness and perceptions in order to generate data that are understandable. The purpose was to participate and show an input in the teachers' views, experiences, attitudes and behaviours. Limitations of my research were discussed as I have experienced some problems (that will be further on explained in Chapter 5) (Nieuwenhuis, 2010c).

In the following section the ethical considerations will be elaborated on.

3.9. Ethical considerations

Ethics can be described as a perception of what is right and what is considered to be wrong, what is acceptable and what is not, what is good and what is bad (McMillan & Schumacher, 2001). This research formed part of the SANPADMATH project, for which ethical clearance was granted by the Ethics Committee of the NWU. Participation was voluntary and it was of paramount importance to be aware of the aspects regarding the data generation, as the results were highly confidential. The principal and teachers were informed about the research process and their roles in it. They were then invited to participate in the study. After having agreed to participation the teachers signed the informed consent forms (consent forms can be seen in Appendix G).

These consent forms contained important information such as 1) voluntary participation, 2) the potential benefits and risks, and 3) the confidentiality, which was brought under the attention of the principal and teachers:

Voluntary participation

Participation in this study was voluntary. Any teacher could decline from answering any questions or participating in any component of the study. Furthermore, they could decide to withdraw from this study at any time and might have done so without any penalty

or loss of benefits to which they were entitled. If an individual participant would have withdrawn from the study, any data pertaining exclusively to that participant would have been destroyed. There were no consequences resulting from withdrawing from the research study.

The potential benefits and risks

There were no known or anticipated risks associated with participation in this study. During the data generation process, the study contained a medium level of sensitivity since the teachers were voice-recorded during the interviews and one teacher was videotaped in order to generate a clear understanding of the process. The only possible harm teacher A could have experienced was the invasion of privacy while videotaping the lesson and by reflecting on the recorded lesson during the semi-structured interview in phase 2, but teacher A did not show any reaction that signalled discomfort. During the semi-structured interview, I experienced that some teachers felt uncomfortable when answering some of the questions. I then repeated the question or changed the question and gave the teachers time to think about the question. I have realised that teachers are very busy and although this research took place after school hours, could have invaded their normal routine and activities.

Confidentiality

Pseudonyms, such as teachers A-G, have been used for the names of participants in the reporting of the findings from my study.

On December 31, 2021 (seven years after the completion of the study in 2014) all data including paper documents will be destroyed by shredding them, and electronic files (emails and computer files) deleted or erased. Until this date, all data will be stored by the researcher.

3.10 Summary

In this chapter I discussed the socio-constructivist paradigm as my research paradigm. My study entails a qualitative research approach, based on an exploratory design research methodology with six Intermediate Phase and one Senior Phase Mathematics teacher, to determine to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process.

The next chapter (Chapter 4) will be explaining the presentation and interpretation of the findings.

Chapter 4
Presentation and interpretation of findings

4.1 Introduction

The research design, methodology, data generation and data analysis strategies were discussed in Chapter 3 (see Sections 3.4 and 3.6). This chapter starts with a brief overview of the data generation process, and data analysis strategies, followed by the data analysis, based on my conceptual framework (Figure 4.2). Data analyses proceeded by using mind maps, where codes, families and themes were related to the literature discussed in Chapter 2. Finally, the results are presented and discussed.

In the following section my conceptual framework will be discussed.

4.2 Conceptual framework

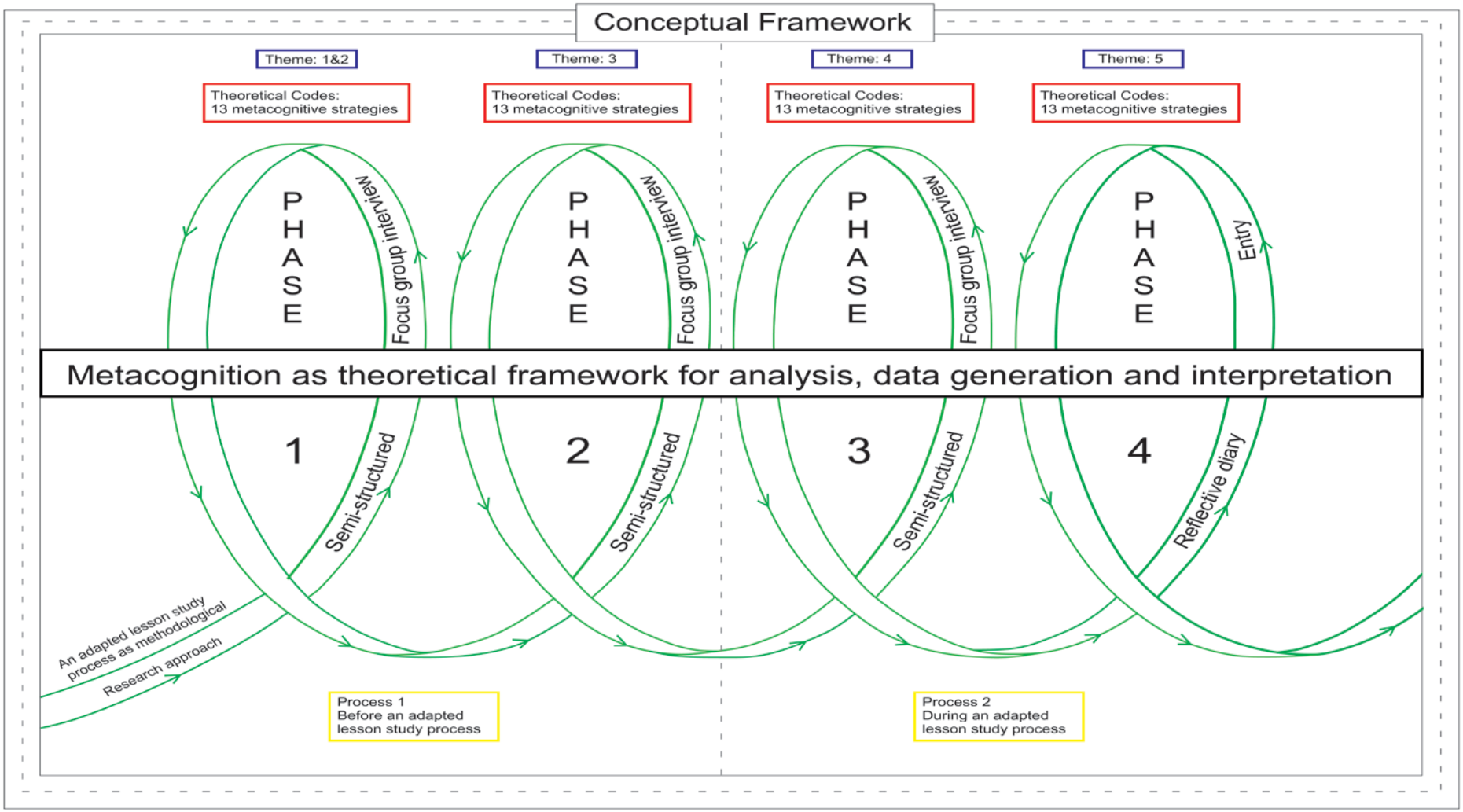

Figure 4.1 Conceptual Framework

In Figure 4.1 the conceptual framework is visually presented. See also Chapter 1 where it is one of the two frameworks that were described. Part of my conceptual framework is the theoretical aspect and the methodological aspect. The theoretical aspect consists of the thirteen metacognitive strategies (see Section 2.4.4) is engaged with in Chapter 2. The methodological aspect which entails the adapted lesson study process is laid out in Chapter 3. The purpose of the conceptual framework is to assist in answering the question: "To what extent do Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process?"

The data were analysed based on the conceptual framework. In the following section I will elaborate on the data generation process.

4.3 The data generation process

Data generation took place in a rural school in the North West Province, during the third school term of 2013. This study formed part of a larger research project in which we had worked with the teachers before this study commenced; therefore it was possible to conduct further research. This research project was titled SANPADMATH and was funded by South Africa-Netherlands Research Programme (SANPAD). I contacted and met the principal. She and the teachers were willing to participate and signed informed consent forms (see Appendix G). The teachers agreed to attend meetings after school hours.

The data generation included two processes. During the first process, data were generated in two phases (phases 1 and 2), and during the second process, data were also generated in two phases (phases 3 and 4). The purpose of process one was to answer the second secondary research question, namely: “Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?" The second process was planned to answer the third secondary research question, namely: "Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?"

Different data generation strategies were used, namely semi-structured focus group interviews (phases 1, 2 & 3), and a reflective diary in phase 4. In Table 4.1 a summary of the data generation methods follow.

Table 4.1 Timeline of the data generation process

	Process 1	
Phase	**Data generation methods (instruments)**	**Date in 2013**
Phase 1	Semi-structured focus group interview	9 +10 September 2013
Phase 2	Semi-structured focus group interview	11 September 2013
Phase 3	Semi-structured focus group interview	12 September 2013
Phase 4	Reflective diary	13 September 2013

In Table 4.1 the timeline of the data generation process is provided. The empirical research on which this study reports was conducted over the span of one school week. In the following section the data analysis strategies will be discussed.

4.4 Data analysis strategies

The data were analysed by means of content analysis. A priori codes were formulated by means of the thirteen metacognitive strategies which aimed in developing teacher's metacognition as discussed in Section 2.4.4 and displayed in Figure 4.2, the conceptual framework. In this chapter I report on different themes. These themes (see Section 2.7.6.1-2.7.6.6) are integrated in the different phases (phase1-4) of the adapted lesson study process as visualised in Figure 4.1 (The conceptual framework) and will be discussed in section 4.5.

The following section designates the transcribing of the interviews.

4.4.1 Transcribing the interviews

All data were generated by using semi-structured questions. Semi-structured focus group interviews (phases 1 & 3) and a semi-structured interview based on a video recording (phase 2) was recorded by means of a voice recorder. These interviews were verbatumly transcribed, immediately after the data had been generated. None of the data were interpreted during the transcription phase. Transcripts were read several times while listening to the voice records so as to ensure that the transcripts were true accounts of the data on the voice records.

In the following section the coding of data will be discussed.

4.4.2 Coding of data

In coding the data, I have used theoretical coding consistently in each phase. Theoretical codes relates to finding a specific theme of the research which functions as an umbrella that covers for all the other codes being formulated in order to explain what the research is all about (Saldana, 2009).

These theoretical codes consisted of the a priory codes as the thirteen metacognitive strategies from Costa (1984) and Blakey and Spence's (1990) that emerged from my theoretical research approach framework as discussed in the literature chapter (Chapter 2). These a priori codes were: 1) the planning strategy, 2) generating questions, 3) choosing consciously, 4) setting and pursuing goals, 5) evaluating the way of thinking and acting, 6) identifying the difficulties, 7) paraphrasing, elaborating and reflecting learners' ideas, 8) clarifying learners' terminology, 9) problem-solving activities, 10) thinking aloud, 11) journal keeping, 12) cooperative learning and 13) modelling. The theoretical coding entails categorising the codes into families in each phase (Archer, 2009). Archer (2009) points out that this process relates to comprising the codes that relate to one another. Data were then analysed and clustered together by referring to five of the themes based on the methodological research approach framework in my qualitative design that relates to an adapted lesson study process such as: 1) long-term goals for learning, 2) planning a lesson, 3) reflection based on the videotaped lesson, 4) the planned follow-up lesson and 5) reflection on planned lesson were determined according to Lewis, Perry and Marata (2006).

In the following section the teachers' awareness of metacognitive strategies before an adapted lesson study process, as presented by the raw data, will be discussed.

4.5 Process 1: Teachers' awareness of metacognitive strategies before an adapted lesson study process

Process 1 that includes phases 1 and 2 will now be elaborated on in the next section, based on my understanding of the teachers' awareness of metacognitive strategies before an adapted lesson study process.

4.5.1 Phase 1: Teachers' reflection on previous lesson studies before the adapted lesson study process of this study

Phase 1 includes the discussion on teachers' reflection on previous adapted lesson studies as well as the long-term goals for learning that they have compiled for their adapted

lesson study process that followed during this study. Phase 1 also includes the teachers' reflection on planning a lesson before an adapted lesson study process.

4.5.1.1 Teachers' reflection on previous lesson studies

Since the Intermediate and Senior Phase Mathematics teachers formed part of a SANPADMATH project during which we regularly visited them and worked collaboratively during previous adapted lesson studies, they were given the opportunity to reflect on their previous experiences and feelings.

During the semi-structured focus group interview, the participants reflected on their previous experiences of lesson study and (teacher G) felt that,…..*the lesson plans is important*. A lesson plan can be seen as guideline,…..*we are actually guided by the schedule* (participants refer to it as a schedule) which helped the teachers,…..*the lesson plan so it means now that less of the duties are been done like before (teacher B),* to share ideas from previous experiences…….. *some of the concepts that we are maybe sharing in a grade* (teacher B). Teachers are now able to know exactly what is expected from them in order to teach. The aim is to focus on the learners' learning/understanding,….. *then one doesn't actually get now a clear picture of learners* (teacher G) to "shift from 'teaching as telling' to 'teaching for understanding and therefore the emphasis is moved to the effective planning of lessons (Yoshida et al., 2003; Schoenfeld et al., 2008; Lewis, 2002b). Teacher B stated that lesson study will work in South Africa or in our school systems……*It will work, if you are teaching together…. And you sit together and plan for that grade I think it will work* (teacher F), when teachers of the same grade sit together to plan for lessons. Teachers learn more when conducting lesson plans collaboratively and teaching it…. *the lesson plans were actually good in terms of the, the modelling part of it* (teacher G).

In the next section the teachers compiled the following long-term goals for learning during the workshop before an adapted lesson study process. These goals include what the participants strive for when planning and teaching lessons during the adapted lesson study process that followed in my study. In the following section the long-term goals for learning will be discussed.

4.5.2 Theme 1: Long-term goals for learning

Long-term goals for teaching relate to setting goals while planning for each lesson or topic which one needs to address when teaching the lesson in order to determine whether or not a lesson is successful. It is important for one to set these goals to focus on specific areas teachers feel are difficult for them to teach.

These goals were the following:

- To help learners by especially focusing on the content being taught or planned.
- For future purposes so that learners can be able to put it in a practical phenomenon.
- To effectively assess learners to participate in the teaching of Mathematics.
- To create a positive mind-set in the calculation in designing methods.
- To provide learners with skills to be able to compete with the others.

In the following section the reflection by the teachers when planning a lesson, will be discussed.

4.5.3 Theme 2: Phase 1: Planning a lesson

Planning lessons is based on metacognitive teaching-learning strategies of a specific content area and therefore determines how teaching of that subject matter will take place (Van der Walt & Maree, 2007). Planning of a lesson during phase 1 furthermore includes what the teachers agreed on should be included in a lesson plan and what was important when planning a lesson.

The following thirteen metacognitive strategies were analysed according to my theoretical research approach framework according to my understanding of which metacognitive strategies the teachers are aware of when planning a lesson before an adapted lesson study process.

Planning a lesson as metacognitive strategy will be discussed in the next section.

4.5.3.1 Planning a lesson strategy

From the interviews it can be concluded that teachers are aware of what lesson planning is,.... *it is what you are going to do in a classroom what's your objective, your aim, was it effective in a way and where to improve* (teacher F). Lesson planning is regarded as very important. Teachers' reactions to it were,....*you can't go to class without planning* (teacher F),*....no you cannot go to class not prepared* (teacher G). *… so you must plan before you go the class* (teacher G).

Teachers plan for lessons and their learners' needs are taken into consideration,…. *You must know what type of learners we are going to approach when we plan the lesson*

(teacher G), as it is their goal in teaching Mathematics,… *that learners should understand the content* (teacher B).,*….. for the learners to be able to can do calculations* (teacher E).

When teachers responded to the question as to where to use a specific strategy when planning their lessons, they could demonstrate a clear response of what a strategy is and they see a strategy as the topic…. *fraction, even in area, it has to do with different techniques of an object, when you measure the area of an object* (teacher G), that should be taught.

Teachers also felt that it is important to plan for what one must do and use during the teaching phase… *you plan what you are going to do in class* (teacher E),*…… like for example if you give the examples and activities they must actually appear in your lesson plan to say that today we are dealing with fractions or dealing with area, so I talked about 1,2 and 3 and the activity that I gave for that day is 1, 2 and 3 or you have maybe have written them on your lesson plan, group work, I think to sometimes I allow them to do corrections on the board to see when the learners actually understood without giving them extra exercises, the surrounding, that classroom examples, the chalkboard, the tables,* learners, *box of matches* (teacher E).,…. *they should answer what they know and what they don't know. They know the square and the rectangle but they don't know about the length and the breadth, learners should actually understand that and then what type of instrument will be used in terms of measuring those, because if I talk about in terms of area of this chalkboard, they must actually know this thing is able to be measured or what will I use in terms of measurement if I'll be perhaps if I have a measuring tape or a ruler, I think that will be fine so that they can actually see and I must be able now to show them the length and the breadth in terms of their sizes,…..that one is and that one is so much* (teacher E).

It seems that teachers do not plan their lessons on a regular basis…*in general. The content* (teacher E). *…. Experience maybe you got 2 weeks then you got to deal with that concept for 2 weeks if maybe its 3 days then its 3 days, now if you are going to teach, you are going to teach for this period like you are going to take part of that lesson plan or preparation you are not going to do all the lesson plan at the same time, so maybe you speak about fraction today I am dealing with common denominators, but tomorrow different denominators, you see* (teacher G)., and that lesson plans are only worked out about a topic that should be taught according to the timing that's in the curriculum documents.

Generating questions strategy will be elaborated on in the following section.

4.5.3.2 Generatings question

When teachers think of planning lessons, the generating questions strategy is important as it includes teachers being aware of their learners' thinking,…*they should answer what they know and what they don't know. They know the square and the rectangle but they don't know about the length and the breadth* (teacher F), s*o if I, the first one is the rectangle and the square that's what they know they are known to them as the length and the breadth* (teacher F).,*…… the other thing I think, that we should also know about the measurements like centimetre, kilometres, the units* (teacher E).,*….. that when I talk about distance what type of unit am I using? When I talk now about calculation with a ruler, what type of units am I talking about?* (teacher E).,*…. Because this learners, when they go to grade 5 they already know the units for length and so cm, m, km so when I ask them* (teacher D). *…it's just a continuation…… Continuation* (teacher D). *When they go to gr 6 now they talk about the units no* (teacher G). *…..for example if they use cm, you must use cm for length and breadth and the answer they get must be in square. They must know the formulas of area of a rectangular and square, they must know that* (teacher G).. According to Blakey and Spence (1990), it is necessary for learners to make sure about what they know and understand and what they don't know or understand at the beginning of solving a problem; therefore it is the teacher's responsibility to generate questions to establish what these learners are familiar with.

Teachers reported that they do ask questions during lessons,…..*during the lesson I have to ask questions to see if the learners are concentrating, or if they are understanding* (teacher D). *….you ask questions about their basic knowledge* (teacher F). *…. Can you show me the rectangles, can you show me the square;* to see if learners understand what is being taught to them (teacher E)..,…..*I think now if they start to participate we will be able to see now if they understand* (teacher G).*,* learners should continuously ask themselves questions to link to prior knowledge and when they get to a point where they don't understand, they should pause and focus on that question (Ratner, 1991)*,….even if you give them an activity and they do, most of them do well in the activity they understood what you've taught them* (teacher E).

The choosing consciously strategy will be discussed in the following section.

4.5.3.3 Choosing consciously

Teachers felt that metacognitive questions are important when planning a lesson in order to guide their learners during the decision-making process,…. *I think if you are a good teacher always such questions come to your mind. You can't go to the class without those*

questions (teacher G)*. Teaching and being prepared, definitely. That come to your mind, you can't go to class without those questions* (teacher G)*. You must ask yourself what am I going to do when, how am I going to tackle this problem. So we must ask those questions when we go to classes* (teacher G).*,*…..y*ou ask questions about their basic knowledge* (teacher F),…. *Can you show me the rectangles, can you show me the square* (teacher F). …..*They should answer what they know and what they don't know. They know the square and the rectangle but they don't know about the length and the breadth* (teacher F). Learners could then be aware of relationships regarding their actions and decision making (Du Toit & Kotze, 2009).

Another strategy mentioned by the teachers that can be included in the lesson planning is that learners should do corrections on the board……*I think to sometimes I allow them to do corrections on the board to see when the learners actually understood without giving them extra exercises* (teacher C).*,* because in most cases the problem is that learners do not understand the questions being asked them during a lesson. The following examples were given by a few teachers,… *Say 3 books plus 5 red books = how many books, do you have, when they work with numbers and this, so it's a problem they don't know that they have to add 3 + 5 to give them 8. You see it's a problem. So they don't really understand the questions being asked*. *Yes they don't really understand the question to add on. Sometimes they don't understand the instruction, what does the question requires, so it is difficult* (teacher E).

Therefore it is necessary for teachers to plan their lessons ahead bearing in mind to plan for questions that learners might be struggling with when solving a problem…*But if you give class there might pop up something that you are going to do from that lesson plan* (teacher G),in order to prevent misconceptions from being formed.

The setting and pursuing goals strategy will be elaborated on in the following section.

4.5.3.4 Setting and pursuing goals

Setting goals when planning is very important and the teachers felt that,….. *it is what you are going to do in a classroom what's your objective* (teacher F).*,, your aim was it effective in a way and where to improve* (teacher F).*,.* The timing is also very important for setting goals in order to be realistic when teaching or striving towards a certain goal that was planned for,….. *for the learners to be able to can do calculations* (teacher E).*, … In general. The content* (teacher F).*, …. Experience maybe you got 2 weeks then you got to deal with that concept for 2 weeks if maybe its 3 days then its 3 days* (teacher E).*,.* Artz and Armour-

Thomas (1998) believe that teachers should ensure that the goals that are set should be seen as expectations for learners about social and emotional outcomes of classroom experiences.

The strategy of evaluating the way of thinking and acting will be explained in the following section.

4.5.3.5 Evaluating the way of thinking and acting

When planning lessons teachers considered it of importance to know their learners' thinking in order to plan how to evaluate their understanding of a certain topic being taught bearing in mind the types of assessment as well as other strategies to use,…. *You must know what type of learners we are going to approach when we plan the lesson* (teacher G),*…..I think to sometimes I allow them to do corrections on the board to see when the learners actually understood without giving them extra exercises* (teacher C).*,. …..I think now if they start to participate we will be able to see now if they understand* (teacher G).*,.*Teachers feel that through formal assessment they would be able to determine their learners understand the content being taught. Evaluating learners' thinking and acting can assist in assessing their understanding (Costa, 1984).

The strategy of identifying difficulties will be elaborated on in the following section.

4.5.3.6 Identifying difficulties

When teachers plan lessons it is not always possible to plan for all difficulties learners may encounter, since every teaching phase has its own difficulties and therefore teachers feel that,…. *Ummm….at some stage you do but umm… usually they just arrive when you are in class then you see it how to deal with that because I think it will be something on line with what's in class* (teacher E),*…..you handle the difficulties as they come up during a lesson*. When learners respond in ways where they don't know how to do something it is necessary for teachers to know how to support these learners to distinguish between their current knowledge and the knowledge they gain from the lesson being taught (Costa, 1984).

In the next section paraphrasing, elaborating and reflecting on learners ideas will be discussed.

4.5.3.7 Paraphrasing, elaborating and reflecting on learners' ideas

When teachers reflected on whether there is any other strategy that they can think of while teaching the lesson, to plan for, they responded that learners are given opportunities to

write and do corrections on the board,….. *I think to sometimes I allow them to do corrections on the board to see when the learners actually understood without giving them extra exercises* (teacher E). Their level of understanding could be enhanced as they reflect on how they solved their problems. It is necessary for teachers to encourage other learners to listen, compare their ideas. By doing so they will be able to form their own thinking when linking it with their current knowledge (own experience) (Costa, 1984).

Clarifying terminology will be discussed in the next section.

4.5.3.8 Clarifying terminology

Terminology and language are seen as challenges in the Mathematics classroom,…. *language is the problem* (teacher E)*,…. yeah, the language as you when you just say* (teacher E)*….They must calculate, the sentence* (teacher E)*…. Say 3 books + 5 red books = how many books, do you have, when they work with numbers and this, so it's a problem they don't know that they have to add 3 + 5 to give them 8. You see it's a problem* (teacher E)*. But sometimes there is a problem, they can answer it clever, but when coming to writing it become a problem* (teacher G)*.* Since the language and terminology is a problem it requires teachers to pose the right questions where the terminology is difficult and to focus specifically on the terminology and language when planning lessons.

In the next section problem solving activities will be elaborated on.

4.5.3.9 Problem solving activities

During problem solving it is very important for teachers to give learners opportunities to observe other learners,… *I think to sometimes I allow them to do corrections on the board to see when the learners actually understood without giving them extra exercises* (teacher C)*.* Teachers should ask learners questions in order to assess their progress when being reflective: what are you doing? Why are you doing it in that way? How does it help you?, in order to become aware of their learners' thinking (Schoenfeld, 1987),….. *I think now if they start to participate we will be able to see now if they understand* (teacher G).

The thinking out loud strategy will be discussed in the following section.

4.5.3.10 Thinking aloud

For teachers it is important to think out aloud and ask learners questions in order to determine what the learners know and what they do not know,…. *You ask questions about their basic knowledge* (teacher F)*…. Can you show me the rectangles, can you show me the*

square (teacher F). *Teachers assume learners know about the different units therefore it is necessary for them to think aloud and ask learners and to not only assume that all learners are familiar of it* (teacher E)…. *Because this learners, when they go to grade 5 they already know the units for length and so cm, m, km so when I ask them…it's just a continuation* (teacher D).

In the next section journal keeping will be explained.

4.5.3.11 Journal keeping

Learners and teachers are not aware of journal keeping; therefore journal keeping was not expected from them when planning and teaching lessons.

Cooperative learning will be elaborated on in the next section.

4.5.3.12 Cooperative learning

Teachers are aware of planning for using the strategy *cooperative learning*…. *What about group work?* (teacher F).

The modelling strategy will be discussed in the following section.

4.5.3.13 Modelling

Teachers are aware of changing their approaches by using different classroom examples when learners don't understand a question…. *When we are aware that the learners don't understand after you have presented the lesson, so maybe if you try now to ask the question, there they don't understand the question, then you have to change your approach* (teacher G). By using different classroom examples such as….. *The surrounding, that classroom examples, the chalkboard, the tables* (teacher F).

4.5.3.14 Conclusion of phase 1

In conclusion, the teachers are aware of the type of learners they are going to approach and their learners' thinking and therefore it is important to plan to generate questions in order to evaluate and determine what learners are familiar with (prior knowledge) before teaching the lesson. Difficulties can't always be planned for but it is important for the teachers to know how to support learners when difficulties do arise.

In the following section, Phase 2, reflection based on the videotaped lesson before an adapted lesson study process will be discussed.

4.5.4 Theme 3: Phase 2: Reflection based on the videotaped lesson

During phase 2 the theme *teaching and observing the lesson* was excluded (see Section 2.7.6) since phase 2 had already been videotaped previously. The teachers therefore only reflected during the semi-structured focus group interview on the videotaped lesson.

4.5.4.1 Reflection based on the videotaped lesson

The second phase included a recorded lesson that had been shown to the other teachers to reflect on the metacognitive strategies they could determine of which teacher A (the teacher that was recorded) was aware when she taught the lesson before an adapted lesson study process.

The following thirteen metacognitive strategies were analysed according to my theoretical research approach framework in accordance with my understanding of which metacognitive strategies the teachers reflected on that teacher A were aware of in her recorded lesson.

Planning a lesson as a metacognitive strategy will be discussed in the next section.

4.5.4.2 Planning a lesson strategy

When planning a lesson it is very important to state what the current topic is in order for the learners to know what the specific lesson entails. In the observed lesson there was no clear understanding of what the topic of the lesson really was. When the teachers reflected upon the question as to whether or not it was a good lesson, teacher G commented,….*But now if you are dealing with that, you should put it in the right corner in brackets to say equivalent fractions you are teaching fractions….because most of the time I see there she was handling equivalent fractions,* teacher D also further commented that,…. *when we introduce a concept you must write it on the chalkboard and try to get now the interpretation of the heading of the lesson so that learners should actually know what are actually fractions* (teacher G). Teacher D further on supported teacher G by explaining why it is important for teachers to be specific and to include the topic,… *If you are going to deal now with the signs, learners should be given an example of an = sign, >,< and now what teacher G just said that if you are actually talking about the signs we must actually stick on that signs the =,>,< and they must actually be made aware that from the teaching aids in the way they require that we are actually able to derive this fraction from a whole, that is most important.* Teachers were confused because this observed lesson was not very clear about the topic; it included two topics in one lesson, such as equivalent fractions and >,<,

equivalent fractions. Teacher E then stated,….*that's it you see I think it is important for them also know and to make use of signs. If we made now the fraction as part of the whole then they will be able to use now the =,>,< signs after one has given them examples because I think they struggle now to get 3 over 6 and 1 over 2. Where it is = or not.*

The learners were confused during the lesson since they understood what equivalent fractions is but when it got to the signs they could not understand the relationship between why a fraction now is > or < and not equal. The lesson was not planned according to the topic. The teacher taught the lesson from the CAPS which includes only basic detail about the topic *equivalent fractions* which has to be taught over a period of time… *I think that's what's important because it's one in the (what is that…) in the CAPS they speak that, that when you introduce and teach a lesson you must make sure that you specify the lesson of that specific lesson, that content* (teacher D). Since the CAPS only includes basic detail of what should be taught, the teacher did not also plan for group work; therefore the learners were not familiar with what was expected from them during the lesson,…. *Mam, I just want to talk about the group work* (teacher G)*….Maybe mam did not prepare the learners before then that thing of changing the lesson it was time consuming* (teacher G).

The teacher changed her strategy by letting the learners work collaboratively but the other teachers felt that it was necessary for her to have planned for that before teaching the lesson,…..*she should arranged just before she started the group work* (teacher G). Teacher E made a final statement,…. *I think something very important to write now is to give signification of actually what are they going to dealing with* (teacher E).

The generating questions strategy will be discussed in the following section.

4.5.4.3 Generating questions

The generating questions strategy entails that learners should be able to know what is expected from them at the beginning of a lesson in order to link to their prior knowledge of what they are familiar with (Ratner, 1991),….. *I think something very important to write now is to give signification of actually what are they going to dealing with* (teacher E). Three of the teachers' responses were that they didn't know what the topic was; therefore they also seemed confused about knowing what they know and understand of what was being taught,…. *What I want to know, I don't know, what was the teacher telling was the topic, was it equivalent fractions or what?* (teacher G) The outcome of the lesson was not clear as well*….. She didn't just make drawings and explanations but she showed that you can also apply what you know* (teacher C). How can one (the learners) know something if there is no

clarity of what they are going to learn*. Because in terms of circles and squares the shaded ones, and all of that and I wanted to say that you must bear in mind that when you teach a lesson the learners must know what should be the lesson outcome – what should be done at the end of the lesson* (teacher C)*….I think that's what's important because its one in the (what is that…) in the CAPS they speak that, that when you introduce and teach a lesson you must make sure that you specify the lesson of that specific lesson, that content* (teacher C)*.* The teacher applied the generating questions strategy by asking the learners questions at the beginning of the lesson as she explained the work in order to establish whether they understood but she did not ask questions at the beginning of the lesson to determine what their prior knowledge was (what they already knew) about the specific lesson (equivalent fractions).

In the next section the strategy c*hoosing consciously* will be elaborated on.

4.5.4.4 Choosing consciously

Choosing consciously entails that the teacher should guide her learners in order to explore their actions (Du Toit & Kotze, 2009). In this lesson observation the teacher did ask the leaner's questions,…. *questioning and answering is the other approach but she did used it, it is one of the approaches* (teacher C)*,… Telling approach, to tell them what to do is still one of the approaches, and … demonstration is one of the teaching approaches* (teacher G).

The learners struggled with the concept that a fraction is part of a whole when they work with the signs >,<,=, especially when a fraction is > or <*,…. . If we made now the fraction as part of the whole then they will be able to use now the =,>,< signs after one has given them examples because I think they struggle now to get 3 over 6 and 1 over 2. Where it is = or not* (teacher E)*.* Teacher E also felt that when some of the learners went to the board they were not sure whether effective learning had taken place since the teacher was not there to explore the learners' actions and thinking,…..*and now the lesson was ok…..Umm in terms of the understanding of the learners because I actually don't know what was the title* (teacher E)*.They went now to the chalkboard, counting there* (teacher E)*. Were they actually counting the correct things or what? (Laughing*) (teacher E)*.*

The *setting and pursuing goals strategy* will be explained in the next section.

4.5.4.5 Setting and pursuing goals

It is very important for teachers to set and pursue goals in order for learners to be aware of what is expected from them,….. *I think something very important to write now is to*

give signification of actually what are they going to dealing with (teacher E)*. She should arrange just before she started the group work* (teacher G)*.* Many of the teachers felt that there was no clear understanding of the lesson as the topic and outcomes were not provided,… *Because in terms of circles and squares the shaded ones, and all of that and I wanted to say that you must bear in mind that when you teach a lesson the learners must know what should be lesson outcome what should be done at the end of the lesson* (teacher C)*.* Although the CAPS document provides goals for each lesson, such as equivalent fractions in general, it is important that the teacher should indicate clear goals for the specific lesson (about equivalent fractions or equivalent fractions >,< or =) in order for the learners to be able to know what is expected of them at the end of a lesson,….. *I think that's what's important because it's one in the (what is that…) in the CAPS they speak that, that when you introduce and teach a lesson you must make sure that you specify the lesson of that specific lesson, that content* (teacher C) *.* The outcomes for the lesson should also include the importance of where this topic can be seen or be applicable in real life in order to form a relationship between what is being learnt and where it could be used,…. *and they can also learn that fractions is about sharing* (teacher F)*.* The teachers should also make sure that learners can demonstrate their thinking when working with fraction problems.

Evaluating the way of thinking and acting strategy will be discussed in the next section.

4.5.4.6 Evaluating the way of thinking and acting

The teachers replied that they did not know whether teacher A that was being video recorded, evaluated her learners' thinking and acting, because when the learners went to the chalkboard the teacher was not there to evaluate their thinking. She was busy helping another group. Teachers also could not tell whether the lesson goals were achieved, but they stated that learners did interact en worked collaboratively with each other,…. *Ummmm I can't tell you, because now we don't know* (teacher G)… *but there is an interaction of the learners, one can say maybe they did actually achieved* (teacher E),*…And now the lesson was ok* (teacher G)*…Umm in terms of the understanding of the learners because I actually don't know what was the title* (teacher E)*…They went now to the chalkboard, counting there. Was they actually counting the correct things or what? (Laughing)* (teacher E)*.*

Identifying difficulties will be elaborated on in the next section.

4.5.4.7 Identifying difficulties

From the lesson observed by the teachers the only strategy in which one can determine difficulties was the questioning and answering strategy where the teacher asked the learners at the beginning of the lesson (as one can see on the video), to distinguish between their prior and new knowledge.

Paraphrasing, elaborating reflecting on learners' ideas will be discussed in the following section.

4.5.4.8 Paraphrasing, elaborating reflecting on learners' ideas

Learners worked collaboratively in groups where they had the opportunity to compare their ideas with others and share their meanings and to link their ideas to one another's ideas. Some of the learners went to the front to use the fraction wall and came back to their groups where they reflected on their findings,….*the strategies that they also apply there is that now the learners to go to the front and write it, the fractions table* (teacher G).

In the following section term *clarifying terminology* will be discussed.

4.5.4.9 Clarifying terminology

Since there was no lesson planned, the use of the incorrect terminology could not be identified during the lesson.

The problem-solving activities strategy will be explained in the following section.

4.5.4.10 Problem-solving activities

During the problem-solving phase the learners worked collaboratively and shared their ideas. The teacher went from group to group by using the questioning and answering strategy in order to determine whether the learners understood the work. The role of the teacher was also to ask questions such as what are you doing, what do you think?

The *thinking aloud strategy* will be discussed in the following section.

4.5.4.11 Thinking aloud

When the teacher was busy explaining and showing the learners the equivalent fractions, she was able to determine her learners' understanding when they answered the questions being asked during the introduction phase. In that way she was able to determine their thinking as they all answered together. When the learners worked collaboratively during

the lesson, some of them went to the board in order to solve their problems,….. *The strategies that they also apply there is that now the learners to go to the front and write it, the fractions table* (teacher G)…. Learners looked for answers and ran back to their groups to report on their findings. The teacher's absence (the teacher was busy helping other groups) when the learners were thinking out loud at the board, lacked the forming of misconceptions, the correct use of terminology and therefore it could be that the report by the other teachers on whether the lesson was successful and all the outcomes had been achieved, was very vague.

The journal keeping strategy will be explained in the following section.

4.5.4.12 Journal keeping

Learners and teachers are not aware of journal keeping; therefore this strategy was not applied when the lesson was being observed.

Cooperative learning strategy will be elaborated on in the following section.

4.5.4.13 Cooperative learning

The teacher made use of the cooperative learning strategy as the learners were participating in groups. The teachers felt the group work strategy in this lesson wasn't really successful as the learners were not informed, neither was it planned,… *Ummmm I can't tell you, because now we don't know* (teacher G)… *… but there is an interaction of the learners, one can say maybe they did actually achieved. Mam, I just want to talk about the group work. Maybe mam did not prepare the learners before then that thing of changing the lesson it was time consuming* (teacher G)….

In the next section the modelling strategy will be discussed.

4.5.4.14 Modelling

The modelling part of the observed lesson included that the teacher made use of examples showing what an equivalent fraction is. The teachers also felt that the practical part of the lesson was important….. *Demonstration is one of the teaching approaches* (teacher G)… *….. Teaching aids* (teacher E)… *….. The teacher has used the teaching aids for her presentation* (teacher F)…. *She didn't just make drawings and explanations but she showed that you can also apply what you know* (teacher C)…. *Because in terms of circles and squares the shaded ones* (teacher C)…. Other teachers stated that one should state clear what equally sharing of fractions means, for example to have a practical object or to

use ones hands, which can bring forth the relationship when especially focusing on equal fractions when using the signs >,< or =,…. *Ummm not to change something but to add….To me… I think something like this and I share it, that is, among the learners maybe four or five of them and no… then that is part of sharing that is everything from a whole so just like for an example you show them now the equal parts, you show them the other one that is > than the other one from maybe those pieces that you have cut from this so that practically you can see that 1 over 6 is actually < than 8 over something* (teacher E)… *…. The other thing now is this…. The > sign …..the teachers should have made an example of < and point in wrong direction…using hands* (teacher G)…. *Maybe < this one right hand sign* (teacher G)… *…. No, if now they doesn't know which side is > so they can use their hands. Right is > and left is <* (teacher G)… *…… Yes because we believe that most of us are right handed and the right hand is stronger than the left hand so always right will be > and left will be < will be less* (teacher E).

When the teacher had completed her demonstration, she decided that the learners would work in groups. Her demonstration included an example of a fraction table. While the learners were working in groups she gave an example of circles that indicated the different fraction parts on the board. The teachers felt that at that moment there was no clear indication that the learners understood the work; therefore she changed her strategy to group work,…..*I think like some of the things she did after maybe realising that the learners do not understand and the other most important thing is that the teaching aids the different types of the things that she brought* (teacher E).

4.5.4.15 Conclusion of phase 2

In conclusion it can be stated that the teachers' reflection on the videotaped lesson clearly revealed that the topic of the recorded lesson was not very clear. Teacher A did not give the learners an indication of what they were about to do and what was expected of them during the lesson. Hence the content and lesson outcomes taught were not successful. The teacher provided learners with questions to answer in order to determine the difficulties and she changed her approach to provide the learners with an opportunity to work cooperatively during which they interacted and shared opinions.

In the following section (process 2) the teachers' awareness of metacognitive strategies during an adapted lesson study process will be discussed.

4.6 Process 2: Teachers' awareness of metacognitive strategies during an adapted lesson study process

Process 2 includes phase 3 (an adapted lesson study process) and phase 4 (the reflective diary), which will be elaborated on in the next section based on my understanding of the teachers' awareness of metacognitive strategies during an adapted lesson study process.

4.6.1 Theme 4: Phase 3: The planned follow-up lesson

Phase 3 includes the discussion and planning of a follow- up lesson based on the recorded lesson from phase 2.

The following thirteen metacognitive strategies were analysed according to my theoretical research approach framework based on my understanding of which metacognitive strategies the teachers reflected while planning the follow-up lesson during an adapted lesson study process.

Planning a lesson as a metacognitive strategy will be discussed in the next section.

4.6.1.1 Planning a lesson strategy

During the lesson study planning phase, a template was provided by the teachers and was used in order to plan for the follow-up lesson (See Appendix D). The teachers agreed that a date should not be put into the lesson because, according to the CAPS the lesson will flow over a week,…. *More than that ….. a week or more than that* (teachers D and F). The teachers agreed that the topic of the lesson that should be taught over a week is*,… describe and compare common fractions in a diagram form* (teacher D). The lesson outcomes of the topic already are on the lesson plan according to the CAPS and teachers should have just marked which outcomes for this topic were appropriate. They had agreed that the following outcomes are related to this topic,…..*identifying, solving problems, work effectively with each other*, *they have to organise and manage fractions*, *re-organising that problem solving do not exist in isolation* (teacher D). When looking at the specific lesson outcomes for the content area the teachers at first agreed that this topic relates to…. *Patterns, Functions and Algebra* (teacher D)…. As researcher I have realised that according to the CAPS, this topic relates to Number, Operations and Relationships and therefore corrected the teachers.

When we reached the activity outcome the one teacher said,…*the learners should be able to compare the fractions in a diagram form, they should be able to compare and decide* (teacher F). Another teacher stated that,….*No…. they should understand the factors in*

diagram form (teacher F), and another teacher commented that,…..*Ja, the fractions bars*,….*at the end they must be aware of common fractions* (teacher F)…. *Identify common fractions.* Teachers have agreed that the developmental outcome for the lesson is that learners should,…. *acting as a responsible citizen* (teacher D)…. There was no explanation as to why they had chosen this developmental outcome. The integration that will take place with other subjects would be with Technology, Art and Culture.

When looking at the skills that should be developed the teachers referred to the following,….*You can just say drawing, thinking, identifying, describing, I think the other one was comparing, differentiating, because the need to differentiate between fractions, knowledge* (teacher C). Teachers felt that the teaching strategy or methods include explanation and discussion, investigation when learners determine the concepts *sharing* and *equivalency*. The teachers agreed that it is very important for learners at the beginning of a lesson to know what is expected from them by giving them examples,…..*that you must remember to show them what you want them to understand about the lesson, The learners must….. think about common fractions*. *The learners, they must also give themselves examples to see whether they understand* (teacher G).

When planning the lesson the teachers said that the learners would be able to*,….identify the same and different fractions which mean that the common fractions* (teacher C). Learners must be able to distinguish between the same and different denominators and numerators.

Teachers were of opinion that at the end of a lesson one must determine whether the learners had understood but did not explain how they would be able to determine whether the outcomes of the lesson were reached. When we get to the end of the lesson, what would you say is the….. What must the teachers do? *To see whether the learners understand. What they have just done* (teacher C).

They agreed on working together in order to learn from their peer participants. *I think it is easier to make a lesson plan if we do it together than doing it alone, when doing together, we learn something* (teacher B).

The generating questions strategy will be elaborated on in the next section.

4.6.1.2 Generating questions strategy

When planning the follow-up lesson, teachers are aware that learners must be given examples in order to think about common fractions. Teachers stated that learners already know the meaning of what a common fraction is in order to link what follows with their prior knowledge,… *They already know now the meaning of common fractions at their stage* (teacher F). Teachers felt that it is important for learners to give themselves examples and to ask questions when they would reach a point where they do not understand,…. *The learners, they must also give themselves examples to see whether they understand* (teacher C).

In the following section the strategy of choosing consciously will be explained.

4.6.1.3 Choosing consciously

It is necessary for teachers to monitor their learners during the decision-making process to ensure what learners know and what they do not know to give them examples of common fractions in order for them to link it to their prior knowledge,….*The learners must….. think about common fractions, we give them an example of common fractions* (teacher C)….,…. If the learners do not understand, the teachers said they would use the modelling strategy by giving them the fraction wall,….y*eah, the fraction wall, the sharing so there gonna be when we talk about half, they don't understand, but if you use it practical* (teacher B).

Setting and pursuing goals will be explained in the following section.

4.6.1.4 Setting and pursuing goals

When it came to setting goals a teacher stated that the outcome of the lesson should be… *metacognitive*. Teachers had several answers when it came to suggest lesson outcomes for this lesson,….*The learners should be able to compare the fractions in a diagram form, they should be able to compare and decide* (teacher F),*…No…. they should understand the factors in diagram form* (teacher E)…. *….Ja, ja the fractions bars,…at the end they must be aware of common fractions. Identify common fractions* (teacher F). All of these activity lesson outcomes were then included in the lesson plan which, according to the teachers, suite the topic. Teachers stated that the learners should,… *Acting as a responsible citizen* (teacher G).

Evaluating the way of thinking and acting metacognitive strategy will be discussed in the next section.

4.6.1.5 Evaluating the way of thinking and acting

When you reach the end of the lesson, teachers stated that one must,... *see whether the learners understand* (teacher G)*. What they have just done.* Other teachers felt that one should give the learners a test or an activity, class- and homework, assignment when the learners do not understand. None of these as examples was included when planning the lesson.

In the next section identifying difficulties will be explained.

4.6.1.6 Identifying difficulties

For teachers to identify the difficulties they were of opinion that one should give the learners a test or go back to the example of using the fraction wall when the learners do not understand… *to those who are not understanding, we use the fraction wall* (teacher B)*.*

The paraphrasing, elaborating reflecting on learners' ideas strategy will be elaborated on in the next section.

4.6.1.7 Paraphrasing, elaborating, reflecting on learners' ideas

Teachers are aware of the fact that they need to plan for learners to be reflective. Where learners can compare, investigate and share their findings,…*The interpretation of fractions* when *participating effectively* (teacher F)*. Investigating, we are looking at the bars, they investigate that this fraction, that this fraction equals to that fraction* (teacher A). *Yeah to look, to compare* (teacher C). *The learners, they must also give themselves examples to see whether they understand* (teacher C)*.*

Clarifying learner's terminology will be discussed in the next section.

4.6.1.8 Clarifying terminology

Teachers took no terminology into consideration when planning the follow-up lesson.
Problem-solving activity strategy will be elaborated on in the next section.

4.6.1.9 Problem-solving activities

When planning for problem solving the teachers suggested that one should give the learners an activity or class work to do as an assessment in order to determine their understandings by sharing and comparing their answers,… *We talked about compare, now the learners given them an activity actually* (teacher F). *Given them according to the*

educator have to test, help the learners along the way (teacher G). When learners do not understand the teacher refers to doing something rather practical,…*Yeah, the fraction wall, the sharing so there gonna be when we talk about half, they don't understand, but if you use it practical* (teacher B).

In the following section the thinking aloud strategy will be discussed.

4.6.1.10 Thinking aloud

During the lesson that was planned teachers stated that one should give the learners an activity or class work where they can do sums on the board in order to think out loud and to demonstrate their understanding,… *maybe give them the class work, what about allowing them to do sums on the board of enrichment so that you spot the one with the difficult….. would you say* (teacher F).

In the following section journal keeping strategy will be discussed.

4.6.1.11 Journal keeping

Learners and teachers are not aware of journal keeping; therefore this strategy was not applied during the planning of the follow-up lesson.

The cooperative learning strategy will be elaborated on in the next section.

4.6.1.12 Cooperative learning

Another strategy the teachers felt to plan for was group work. Teachers stated that if they work collaboratively when planning lessons they learn something in the process…. *I think it is easier to make a lesson plan if we do it together than doing it alone, when doing together, we learn something* (teacher B).

The modelling strategy will be discussed in the following section.

4.6.1.13 Modelling

When discussing the modelling part teachers indicated that the following resources are necessary in order to bring about a clear understanding of the topic,…. *Textbooks, chalkboard, Fraction wall, books, board, to take an apple as an example,…Counting the sticks* (teacher B). These resources can be used in order to clarify the concept of sharing (equally), *sharing of fractions* (teacher F).

Teachers reflected on what they should use as a teaching strategy or methods,….*Like the sharing, they investigate,* by using these examples,… *I mean here I saw the diagram so now you give a diagram so teacher will give diagrams where you will show and explain it, those common fractions as the diagrams are drawn from each of them, by showing different bars, yeah* (teacher C). When learners do not understand teachers plan to go back to using the fraction wall and the board,…. *Yeah, the fraction wall, the sharing so there gonna be when we talk about half, they don't understand, but if you use it practical* (teacher B) *What about allowing them to do sums on the board of enrichment so that you spot the one with the difficult* (teacher F).

4.6.1.14 Conclusion of phase 3

From the above-mentioned metacognitive strategies determined during phase 3 (the planned follow-up lesson) the topic planned was Number, Operations and Relationships. Teachers were aware, while planning, that they need to give their learners examples and to ask questions during a lesson. Teachers felt that when difficulties would arise they would go back to using examples such as the fraction wall or the chalkboard.

In the following section (process 2) during phase 4 (a reflective diary) the teachers' awareness of metacognitive strategies during an adapted lesson study process will be elaborated on as well as on an overall feeling and reflection of metacognitive strategies and the adapted lesson study process.

In the following section the reflection on the planned lesson is discussed.

4.6.2 Theme 5: Phase 4: Reflection on planned lesson (reflective diary)

During phase 4 the teachers conducted a reflective diary on if they were to teach this planned lesson from phase 3. Therefore the theme of reflection on observed lesson was replaced with reflection on planned lesson.

The following thirteen metacognitive strategies were analysed according to my theoretical research approach framework in accordance with my understanding, as to which metacognitive strategies the teachers reflected on if they were to teach this planned lesson according to what was planned in phase 3.

Planning a lesson as metacognitive strategy will be discussed in the next section.

4.6.2.1 Planning a lesson strategy

When teachers reflected on whether they were to teach this planned lesson, the aspect of the planning strategy was absent since the lesson had been already planned.

Generating questions as metacognitive strategy will be discussed in the next section.

4.6.2.2 Generating questions

When teachers responded to the question as to whether they were to teach this planned lesson the metacognitive strategies they would apply during the lesson while teaching would be to generate questions. Teachers also indicated that generating strategy is important in order to determine their learners' understanding,…. *I would apply the question and answer method to see and observe what the learners understand about fractions. The previous knowledge is important as it will lead you to what you will teach and understand* (teacher F). *I would use questions from the known to the unknown questions* (teacher G). Another teacher felt that when the learners get to a point of understanding the question, he/she would just give the answer…..*When the learners understand what the question is, if some of them understand what a fraction is, then give them the answer* (teacher F).

In the following section the choosing consciously strategy will be elaborated on.

4.6.2.3 Choosing consciously

Teachers reflected on the fact that they would guide their learners and explore their actions while asking questions and waiting for answers. They also felt that the learners' previous knowledge is important since it will lead one to what one would will teach,….. *The previous knowledge is important as it will lead you to what you will teach and understand* (teacher F).

In the following section the setting and pursuing goals strategy will be discussed.

4.6.2.4 Setting and pursuing goals

Teachers planned for the goals during an adapted lesson study process in phase 3.

In the next section evaluating the way of thinking and acting will be elaborated on.

4.6.2.5 Evaluating the way of thinking and acting

Teachers reflected on the fact that they would evaluate their learners' thinking in order to assess their understanding while asking questions and waiting for answers**.**

Identifying the difficulties will be explained in the next section.

4.6.2.6 Identifying the difficulties

There was no indication of an intention to identify difficulties when teachers reflected on the use of metacognitive strategies if they were to teach this lesson.

Paraphrasing, elaborating and reflecting on learners' ideas will be discussed in the following section.

4.6.2.7 Paraphrasing, elaborating and reflecting on learners' ideas

When teachers reflected on which metacognitive strategies they would apply while teaching it, according to what was planned during an adapted lesson study, the paraphrasing, elaborating and reflecting on learners' ideas strategy was important since teachers felt that by sharing ideas and group work one can use different strategies to help the learners,….. *I'll also ask for different ideas from my colleagues, I am using different strategies to help the learners.* Group work is effective since it provides an opportunity to share each other's ideas,….. *Group work will help learners to develop skills such as sharing, communication, problem solving and decision making* (teacher B)*. The teacher also needs to give guidance and supervision* (teacher G)*. Learners will be able to work together effectively and exchange and sharing ideas* (teacher B)*. I will choose group work and telling method, because this type of method will encourage learners to communicate, share, decision making and problem solving* (teacher C)*. Learners will get feedback from others* (teacher F)*. Tell them fraction is the same as sharing amongst ourselves* (teacher F)*. Learners can sit in a group of 4 and can share equally one apple. One learner of the group will be given* $\frac{1}{4}$ *of an apple. That* $\frac{1}{4}$ *is a part of a whole* (teacher B)*.*

Clarifying learners' terminology will be discussed in the next section.

4.6.2.8 Clarifying learners' terminology

There was no indication of clarifying learners' terminology when teachers reflected on the use of metacognitive strategies if they were to teach this lesson.

The problem-solving activities strategy will be explained in the next section.

4.6.2.9 Problem-solving activities

There was no indication of the problem-solving activities strategy when teachers reflected on the application of metacognitive strategies if they were to teach this lesson.

In the next section the thinking aloud strategy will be elaborated on.

4.6.2.10 Thinking aloud

When teachers reflected on which metacognitive strategies they would apply during their planned lesson, the thinking out loud strategy was taken into consideration as the learners can avail themselves of the opportunity of talking about their thinking while working in groups. Teachers are of opinion that learners then have the opportunities of developing skills,…. *I will choose group work and telling method, because this type of method will encourage learners to communicate, share, decision making and problem solving* (teacher B). *Learners will get feedback from others* (teacher F). *Group work will help learners to develop skills like sharing, communication, problem solving and decision making* (teacher B). *The teacher also needs to give guidance and supervision* (teacher G). *Learners will be able to work together effectively and exchange and share ideas* (teacher B).

The journal-keeping strategy will be discussed in the next section.

4.6.2.11 Journal keeping

Learners and teachers are not aware of journal keeping; therefore this strategy was not applied when they reflected on the metacognitive strategies they would apply if they were to teach this lesson.

The cooperative learning strategy will be discussed in the next section.

4.6.2.12 Cooperative learning

Teachers indicated that the cooperative learning strategy is very important as it provides learners with opportunities to think out loud, to paraphrase, to elaborate and to reflect on learners' ideas where learners can share ideas and experience and develop skills in order to solve problems….*I will choose group work and telling method, because this type of method will encourage learners to communicate, share, decision making and problem solving* (teacher B). *Learners will receive feedback from others* (teacher F). *Group work will help learners to develop skills like sharing, communication, problem solving and decision making* (teacher B). *The teacher also need to give guidance and supervision* (teacher G). *Learners' will be able to work effectively together, exchange and sharing ideas* (teacher G).

In the following section the modelling strategy will be elaborated on.

4.6.2.13 Modelling

There was no indication of the modelling strategy when teachers reflected on the use of metacognitive strategies if they were to teach this lesson.

4.6.2.14 Conclusion of phase 4

From the above-mentioned metacognitive strategies determined during phase 4 (reflection on planned lesson) it became evident that teachers were of opinion that they will make use of the generate questions strategy in order to determine the learners' understanding while providing them with opportunities such as group work during which they can share their opinions and experiences.

In the following section teachers' reflection based on their overall feeling on metacognitive strategies and the adapted lesson study process are discussed.

4.7 Teachers' reflection on metacognitive strategies and the adapted lesson study process

During the second part of the reflective diary entry (the metacognitive strategies being used are not determined during the second part) teachers reflected on whether it is necessary to always be aware of the metacognitive strategies during the planning phase and implementation of one's lesson. The following opinions are summarised.

Teachers are of opinion that it is necessary to always be aware of the metacognitive strategies to apply during the planning phase and implementation of the lesson as this…. *helps the educators to have more understanding of the prior knowledge that the learners have as well as their level of understanding, so that it can be linked with the new topic that they are going to learn* (teacher G)*. This makes the learner and educator to enjoy the lesson because the communication between the learner and educator will be very much effective* (teacher F)*. It will also give learner the opportunity to give their own opinion on how to communicate their lesson* (teacher G).

Teacher G also is of opinion that educators must not stop to improve their teaching skills and their teaching methods. Teachers must share the difficulties they experience in Mathematics with their colleagues in order to improve colleagues' working together (teacher G). In this way teachers can contribute to increase learners' performance in Mathematics (teacher F).

When teachers reflected on their personal opinion regarding the entire adapted lesson study process, teacher G was of opinion *that it is very much interesting as this will help me as an educator to know actually what I need the learners to know, how to approach a problem and when they understand how to solve the problem. It also help me to make the learners think and how I as educator to know when and how to apply the different strategies of my learned experiences in solving the problems they encounter in the lesson plan. I will be pleased if all the educators can be acquainted using the metacognitive strategies during the planning in the phases* (teacher G).

4.8 Summary

This chapter provides an overview of my conceptual framework which includes my research questions, data generation process, data analysis strategies, transcribing the interviews, coding of data, as well as the description on the following processes:

- Process 1: Teachers' awareness of metacognitive strategies before an adapted lesson study process
- Phase 1: Teachers' reflection on previous lesson studies before an adapted lesson study process
- Long-term goals for learning
- Phase 1: Reflection on planning a lesson
- Phase 2: Reflection based on the videotaped lesson before an adapted lesson study process

- Process 2: Teachers' awareness of metacognitive strategies during an adapted lesson study process
- Phase 3: The planned follow-up lesson during an adapted lesson study process
- Phase 4: Reflection on planned lesson (reflective diary)
- Teachers' reflection (overall feeling) on metacognitive strategies and the adapted lesson study process.

The following chapter (Chapter 5) describes and explains the results and conclusions according to my awareness based on my conceptual framework in order to understand to what extent do Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process.

Chapter 5
Conclusion and implications

5.1 Introduction

In this chapter, I synthesise the previous chapters. The aim of this study is to verify the results that correlate with the research questions. I reflect on my research as to what I would have done differently during the data generation process. This is followed by the conclusions, recommendations for further research, and limitations of this study. This chapter concludes with final reflections.

In the following section the summary of the chapters in this research will be discussed.

5.2 Chapter summary

The chapter summary includes an overview of the four chapters in this study. Chapter 1 will be elaborated on in the next section.

5.2.1 Chapter 1

In Chapter 1, I introduced and contextualised the research study. This chapter provides an overview of learner performance in Mathematics where it can be concluded that in South Africa learners perform below expectations. An introduction to metacognition and lesson study was introduced, since it forms part of the conceptual framework of this study. I elaborated on the rationale of and justification for my study where I drew on my personal experiences. The problem statement was discussed where research questions were stated that provided the scope for this study. Relevant literature was reviewed to introduce the background to the study. The purpose of this research was stated and the research design and methodology was provided. I argued why this study is valid and trustworthy. I explained the complex role as a researcher which I had to fulfil. The ethical aspects of the research were discussed and the possible contribution of this study to the field of Mathematics education was provided. This chapter concluded with the chapter division.

The purpose of this study was to explore, by means of a design research approach, to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process.

In the next section an overview of Chapter 2 will be discussed.

5.2.2 Chapter 2

This chapter represents an in-depth view of the theoretical underpinnings of metacognition and lesson study, as found in the literature. I focused on Mathematics in the classroom, both nationally and internationally, Mathematics teachers' knowledge, and teaching and learning Mathematics in the Intermediate Phase. I elaborated on metacognition that includes, cognitive and metacognitive strategies and metacognitive knowledge. Teaching metacognitively, learners' learning and the importance of metacognitive strategies were discussed. I also focused on international and national perspectives on lesson study, the process and the possible benefits of lesson study for the effective teaching of Mathematics.

Chapter 3 will be summarised in the following section.

5.2.3 Chapter 3

Chapter 3 included a description of the qualitative methodology approach based on an exploratory design research methodology with the Intermediate Phase Mathematics teachers to determine how Intermediate Phase Mathematics teachers apply metacognitive strategies in the content area Number, Operations and Relationships during the adapted lesson study process used in this study. Furthermore, I discussed the research paradigm, and described the research site and participants. I elaborated on the data generation strategies, as well as the process based on the data generation, my role as a researcher in each Phase followed by the data analysis strategies. I focussed on the critical issues, such as trustworthiness, and argued the validity and reliability and ethical considerations applicable to my study.

Lastly an overview of Chapter 4 will be discussed in the following section.

5.2.4 Chapter 4

Chapter 4 included a brief overview of the data generation process, and data analysis strategies, based on my conceptual framework (Figure 2.4). A deductive approach to coding my data was used with an a priory coding approach.

In the following section my verification of research questions and results will be elaborated on.

5.3 Verification of research questions and results

5.3.1 Verification of research questions

Based on my rationale and problem statement, I have realised the importance of planning lessons and how teachers could be aware and think about their use of different metacognitive strategies while planning lessons and solving Mathematics problems. I have decided to explore to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process.

To address the main critical research question, the following sub-questions guided the enquiry:

- How can metacognitive strategies be defined?
- Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?
- Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?

I have utilised the socio-constructivist approach as research paradigm (the epistemological approach), which focussed on the teachers' subjective experiences on how they interact with or relate to each other (Nieuwenhuis, 2010a) during an adapted lesson study process, to verify my questions and to create subjective meanings of the teachers' experiences (Creswell, 2009). The following section describes the results of the data generated in this study.

5.3.2 Results

The primary purpose was to determine to what extent Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process. The first sub-question relates to the literature (see section) based on the definition of/and metacognition. The results are further summarised in accordance with my interpretation of the teachers' awareness of their metacognitive strategies so as to answer the second and third sub-questions during each process and in each phase, and then followed by the main critical question in the conclusion.

In the next section the sub-questions will be addressed.

5.3.2.1 Sub-question 1: How can metacognitive strategies be defined?

Sub-question 1 included the definition, discussions and theoretical underpinnings of metacognition and metacognitive strategies.

5.3.2.2 Sub-question 2: Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?

The following section describes the results based on process 1, Phase 1: planning a lesson and Phase 2: reflection based on the videotaped lesson.

Process 1 Phase 1: Planning a lesson

In order to address the second sub-question, the Intermediate Phase Mathematics teachers were aware of the following metacognitive strategies during the first phase based on planning a lesson.

Table 4.1 Results based on Phase 1

Results	Metacognitive strategies
Teachers are of opinion that it is very important and essential for one to plan lessons in the Mathematics class. Teachers feel they are aware of what they should teach according to what is provided in the curriculum documents.	Planning strategy
Teachers stated that it is important to ask questions during their lessons in order to determine what learners are familiar with (their prior knowledge) before teaching their lesson. Teachers stated that one must be aware of the type of learners one is about to approach in order to plan for misconceptions.	Generating questions Choosing consciously
Teachers stated that setting goals in each class and for every lesson is very important in order to determine what one is going to do and to establish whether one's lesson was successful.	Setting and pursuing goals

Table 5.1 Results based on Phase 1 (continued)

Evaluation is important to assess the learners' understanding.	Evaluating the way of thinking and acting
Teachers are aware that difficulties can't always be planned for, but teachers are of opinion that it is important for teachers to know how to support learners when difficulties do indeed arise.	Identifying the difficulties
Teachers reflected that learners must be afforded opportunities such as doing, group work and/or chalkboard work by means of which they can share their experiences, thoughts and understanding.	Paraphrasing, elaborating and reflecting learners' ideas Thinking aloud Cooperative learning
Teachers are aware of changing their approaches by using visual methods when learners do not understand, but they do not plan for it.	Modelling

From Table 5.1 during Phase 1 (planning a lesson) the teachers stated that planning of lessons is very important and they are usually aware of what they should teach (the topic). Setting goals is also very important in order to know what you are going to do in your class and in order to evaluate whether or not a lesson was successful.

Teachers are also aware of the type of learners they are going to approach and their learners' thinking; therefore it is essential to plan by generating questions to be asked during a lesson in order to evaluate and determine what learners' prior knowledge is. Teachers are that difficulties can't always be planned for but it is important for the teachers to know how to support learners when difficulties come up.

The following metacognitive strategies (Costa, 1984; Blakey & Spence, 1990) were not mentioned during Phase 1 when teachers reflected on planning a lesson before an adapted lesson study process:

- Clarifying learners' terminology
- Journal keeping
- Problem-solving activities

During Phase 2 the theme of teaching and observing that lesson was excluded since Phase 2 was videotaped previously, the teachers therefore only reflected on the videotaped lesson.

The following section elaborates on Phase 2: refection based on the videotaped lesson.

Process 1 Phase 2: Reflection based on the videotaped lesson

In order to address the second sub-question, the Intermediate Phase Mathematics teachers were aware of the following metacognitive strategies during the second Phase, based on the reflection on the videotaped lesson.

Table 5.2 Results based on Phase 2

Results	Metacognitive strategies
Teachers stated that teacher A that was videotaped provided her learners with opportunities to answer questions as she explained the work in order to identify difficulties.	Generating questions Identifying the difficulties
Teachers reflected on the fact that they could see from the video that the teacher asked questions at the beginning of the lesson. She changed her approach by going back to the fraction wall. The learners then worked in groups as she facilitated them and they went to the board when they did not understand.	Evaluating the way of thinking and acting. Thinking aloud Cooperative learning Modelling
Teachers were of opinion that the learners had the opportunity to work collaboratively and interact with one another to share meanings and experiences.	Thinking aloud Paraphrasing, elaborating and reflecting Learners' ideas Cooperative learning

From Table 5.2 the above-mentioned metacognitive strategies revealed what teachers were aware of during Phase 2 (reflection based on the observed lesson). The teacher provided learners with questions to answer in order to determine the learners'

difficulties and when teacher A saw that the learners did not understand, she changed the approach to work collaboratively where the learners interacted and shared their meanings.

The following metacognitive strategies did not appear during Phase 2 when teachers reflected on the videotaped lesson prior to the adapted lesson study process:

- Planning strategy
- Choosing consciously
- Setting and pursuing goals
- Clarifying learners' terminology
- Problem-solving activities
- Journal keeping

5.3.2.3 Sub-question 3: Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?

The following section describes the results based on Process 2, Phase 3: the planned follow-up lesson and Phase 4: reflection on planned lesson.

Process 2 Phase 3: The planned follow-up lesson

In order to address the third sub-question the Intermediate Phase Mathematics teachers were aware of the following metacognitive strategies during the adapted lesson study process where they planned a follow-up lesson.

Table 5.3 Results based on Phase 3

Results	Metacognitive strategies
The lesson outcomes were planned according to the CAPS in general, based on the theme and not only for the specific topic (compare fraction in a diagram form) of the following up lesson.	Planning strategy
Teachers stated that they would use explanation and discussion strategies by giving learners examples and asking them questions. These examples and questions were mentioned in the planned follow-up lesson but did not appear in the lesson plan itself.	Generating questions Choosing consciously Thinking aloud

Table 5.3 Results based on Phase 3 (continued)

Teachers were of opinion that it is essential for learners to know from the start what is expected from them.	Setting and pursuing goals
Teachers reflected that when learners do not understand you should go back to other examples, the board or the fraction wall.	Evaluating the way of thinking and acting Identifying the difficulties
Teachers planned for learners to do group work and investigation activities where they can share meanings and experiences. These group work and investigation activities were mentioned in the lesson plan but it did not appear in the lesson plan.	Paraphrasing, elaborating and reflecting learners' ideas
Teachers stated a variety of resources is necessary to form a clear understanding of the topic such as chalkboard, fraction wall and textbooks.	Modelling

From Table 5.3 the metacognitive strategies teachers were aware of to plan for during phase 3 (the planned follow-up lesson) was based on the topic Number, Operations and Relationships. Clear outcomes were planned according to the curriculum documents. Teachers were aware that when planning their lessons they need to give their learners examples and to ask questions during the lesson. Teachers also felt that when difficulties arise they would go back to using examples such as the fraction wall or the board.

The following metacognitive strategies did not appear during Phase 3 when teachers planned the follow-up lesson during the adapted lesson study process.

- Problem-solving activities
- Journal keeping
- Cooperative learning

Process 2 Phase 4: Reflection on planned lesson

In order to address the third sub-question the Intermediate Phase Mathematics teachers were aware of the following metacognitive strategies when they reflected on the planned lesson.

Table 5.4 Results based on Phase 4

Results	Metacognitive strategies
Teachers reflected that the generating questions strategy is important during a lesson in order to determine learners' understanding.	Generating questions Choosing consciously
It is important for learners to have opportunities such as group work where they can share their ideas and experiences and it is an effective way of communicating their decision making when solving problems.	Paraphrasing, elaborating and reflecting learner's ideas Thinking aloud Cooperative learning

From Table 5.4 the metacognitive strategies teachers were aware of during phase 4 (reflection on planned lesson) relates to making use of the generating questions strategy in order to determine learners' understanding. Teachers will provide their learners with opportunities such as group work where they can be able to share their meanings and experiences.

The following metacognitive strategies did not appear during phase 4 when teachers reflected on the planned lesson.

- Planning strategy
- Setting and pursuing goals
- Evaluating the way of thinking and acting
- Identifying the difficulties
- Clarifying learners' terminology
- Problem-solving activities
- Journal keeping
- Modelling

The following section is a summary of the research questions, objectives of the questions as well as the research findings.

Table 5.5 Summary of verification of research questions and objectives

Research questions	Objectives of the questions	Research findings
Question 1 How can metacognitive strategies be defined? **Process 1** **Question 2** Which metacognitive strategies are Intermediate Phase teachers aware of before an adapted lesson study process?	To explore Intermediate Phase teachers' awareness of their metacognitive strategies before an adapted lesson study process.	Metacognition as theoretical framework have been discussed in Chapter 2. **Phase 1: Planning a lesson** • Teachers are of opinion that they are usually aware of what they should teach according to what is expected from them as stated in the curriculum documents. • Teachers know they need to ask learners questions and to observe learners' reflective processes while they solve a problem. **Phase 2: Reflection based on the videotaped lesson** • The topic of the recorded lesson was not very clear. The teacher did not give the learners an indication of what they were going to do and what is expected from them; therefore the content that was taught was insufficient. • The teacher provided learners with questions to answer in order to determine their difficulties. • The teacher changed her approach to provide the learners with an opportunity to work collaboratively where the learners interacted and shared their meanings.

Table 5.5 Summary of verification of research questions and objectives (continued)

Process 2 **Question 3** Which metacognitive strategies do Intermediate Phase teachers become aware of during an adapted lesson study process?	To explore Intermediate Phase teachers' awareness of their metacognitive strategies during an adapted lesson study process.	**Phase 3: The planned follow-up lesson** • The theme planned for was Number, Operations and Relationships and the topic was to compare fractions in a diagram form. • The teachers are aware that they should plan for examples and asking questions during the lesson. • Teachers mentioned that they would use concrete examples such as the fraction wall when difficulties arise or give the learners opportunities such as group work in order for learners to share their meanings. **Phase 4: Reflection on planned lesson**. • Teachers will make use of the generating questions strategy in order to determine the learners' understanding while providing them with opportunities such as group work where they are able to share their meanings and experiences.

Table 5.5 provided a summary of the research questions, the objectives of the questions and the research findings that relate to it. In the following section the conclusion of this research study will be discussed.

5.4 Conclusions

In order to answer the critical research question as to what extent do Intermediate Phase Mathematics teachers become aware of metacognitive strategies during an adapted lesson study process, I conclude that teachers were aware of the following metacognitive strategies that appeared clearly in the results during processes 1 and 2:

- Generating questions
- Choosing consciously
- Paraphrasing, elaborating and reflecting learners' ideas
- Evaluating the way of thinking and acting
- Thinking aloud
- Cooperative learning
- Modelling

Teachers are of the opinion that planning lessons is very important and that one should be prepared before teaching your lesson. It is also very important to generate questions from the beginning of the lesson in order to change one's strategy when learners do not understand. Teachers stated that making use of appropriate examples and providing learners with opportunities, such as group work where they can share their experiences and meaning in order to form their understanding is important.

From this research it became evident that teachers are aware of metacognitive strategies but do not regularly plan their lessons, in contrast to finding that the teachers were of opinion that planning lessons is important. If lessons are planned it is according to what the theme in the curriculum documents includes, but teachers do not plan their lessons for each topic in each theme. Teachers are also aware of having specific goals for each lesson and that the curriculum documents provide them with these necessary goals for each theme but since teachers do not plan and set goals for each topic, they lack metacognitive strategies, such as identifying learners' difficulties and this could result in learners forming misconceptions. It is also very important that teachers should know how to accommodate learners when difficulties arise and group work is not always an appropriate way of solving the problem. One metacognitive strategy that did not appear during any of the phases, was

journal keeping. How can learners keep journals or determine whether the outcomes or goals of each topic have been met at the end of their lesson to form a clear understanding of what was taught, if lessons were not planned for?

In conclusion teachers are aware of most of the metacognitive strategies but it can be that they lack knowing when, where and how to use these metacognitive strategies as they do not plan lessons regularly. Teachers also feel more comfortable when planning lessons collaboratively as they feel they learn from one another and therefore an adapted lesson study could be a positive plan of action to provide teachers with the opportunity to plan lessons collaboratively and reflect on one another's ideas.

The following section describes the limitations of this study.

5.5 Limitations of this study

One of the major limitations that I have experienced during my study was the timing of the data generation process. When we came to the process of data generation for this research study the teachers indicated that the time of the year is appropriate. Unfortunately various factors such as the preparation for the ANA and teachers leaving the school at 15:00 due to the availability of transport had an influence on the data generation process.

During the introductory workshop we had agreed that one teacher of each grade of the Intermediate Phase (grades 4 to 6); thus three teachers, would plan and bring a lesson based on the topic Area, (in the content area Space and Shape). The reason for this theme is that teachers were busy teaching this topic at that stage in the curriculum.

During Phase 1, a semi-structured interview was planned to be held with the three Intermediate Phase Mathematics teachers based on their planned lessons, but eventually I had to change my strategy in conducting a semi-structured focus group interview with all seven teachers based on the topic Area, as none of the three Intermediate Phase teachers planned the lesson we had decided on the previous day. The semi-structured focus group interview included previous knowledge and teaching experiences of teaching the content area Space and Shape (geometry).

During the first part of Phase 2 a Mathematics lesson presented by the one Intermediate Phase Mathematics teacher based on the topic Area in the content area Space and Shape should have been recorded by a digital video camera. The lesson could not have been recorded because the school was busy with the ANAs (Annual National Assessments) at that specific time. The teachers only had one hour after school for this adapted lesson

study since transport was a problem. As I worked previously during the SANPADMATH project with these teachers we had recorded lessons on their reflection and Mathematical language problems and metacognitive strategies. I therefore made use of the one grade 4 teacher's previously recorded lesson based on the topic "Common fractions" in the content area Number, Operations and Relationships.

The theme for the adapted lesson study was from the**n** on based on "Common fractions" in the content area Number, Operations and Relationships, for process 2, Phases 3 and 4.

The recorded lesson based on "Common fractions" in the content area Number, Operations and Relationships, has been shown to the other teachers during the collaborative meeting. A semi-structured focus group interview followed with the other Intermediate Phase teachers to reflect on the metacognitive strategies being used by that specific teacher that appeared in the recorded lesson. The lesson study process was then adapted to suit the context in which these teachers teach. During the adapted lesson study process we worked collaboratively and planned a follow-up lesson (see Appendix E) with the curriculum documents and their school's lesson plan templates, based on the one lesson that had been recorded and discussed during the semi-structured focus group interview.

During Phase 4, the initial plan was that I would record the grade 4 Mathematics teacher's actual follow-up lesson which was collaboratively planned during the adapted lesson study process in Phase 3. Once the lesson would have been recorded, all the Intermediate Phase Mathematics teachers would have once again, during a semi-structured focus group interview, reflect on the metacognitive strategies implemented during the actual recorded lesson based on the metacognitive strategies planned in Phase 3 during the adapted lesson process. Due to the ANAs the teachers suggested that they would prefer to make a reflective diary of the whole lesson study process. In my role as a researcher who explores and makes meaning of the teachers' social context in which they live and work, I had to accept the facts and circumstances and could not continue with the originally planned process. A reflective diary was the answer to accompany the teacher's requests.

5.6 What would I have done differently?

In order to reflect on what I would have done differently in my study, the following aspects relate to implications that could have had a major role in exploring and interpreting the findings differently:

- I personally feel that the timing for generating the data was not successful, as it was during the ANAs and the teachers were focussed on spending as much time as they could with their learners in preparation for the ANAs examination.
- More time should have been spent on the lesson study process, since an hour after school during a week and a half is not enough to generate meaningful data.
- I would have liked to have semi-structured focus group interviews with the teachers in each Phase, based on their planned lesson, in order to understand the awareness of their own metacognitive strategies that they plan for in their lesson plan, as to how they would be aware of it when teaching their lesson.
- To videotape three Mathematics teachers in each grade that are willing, based on the lessons they planned.
- To play back the recorded videos and have a semi-structured focus group interview with the other teachers in order to reflect on what was planned and what was revealed during the lesson.
- I would have preferred to have planned a follow-up lesson with all of the other Intermediate and senior Phase Mathematics teachers based on one grade.
- To record the one lesson that was planned by all the teachers.
- To let the teachers reflect on what was planned and what was revealed during the recorded lesson and to plan for a follow-up lesson by focussing on the misconceptions and metacognitive strategies which can contribute to a more successful lesson.
- Lastly to record that follow-up planned lesson and to have a semi structured focus group interview during which the teachers could reflect on the entire process.

The following section includes the recommendations for further research.

5.7 Recommendations for further research

For further research, the following aspects that relate to my study could be focussed on:

- Lesson study is a solution to be a possible way of increasing our learners' performances as teachers can work collaboratively in planning lessons based on the curriculum documents, as it is a new curriculum where all the teachers should teach the same content at the same time.
- Since the lesson study process is effective and teachers feel positive about it, one can receive inputs from experienced people working with lesson studies to have workshops with our country's teachers.

- The lesson study process could be adapted to a South African context and a few schools could be taken over a period of time as pilot studies where a design research approach is followed by choosing a theme and a topic in the curriculum documents, plan a lesson, record that planned lesson, reflect on that lesson, plan a follow-up lesson based on the misconceptions observed, record that follow-up lesson and reflect on that lesson once again.

My final reflections will be discussed in the following section.

5.8 Final reflections

My experience during my study, and as a teacher teaching Mathematics for grades 8 and 9 learners in a rural school, led to the understanding that one cannot be responsible alone for planning lessons and teachers need one another to motivate and assist one another in order to learn from others' experiences. Time is in most of the cases a problem if teachers were to plan lessons collaboratively such as an adapted lesson study process, but from my experience, lesson study could be possible if it is adapted to each school's context. As the curriculum documents expect teachers to teach the same theme at the same time teachers in each grade could find a way in sitting together and planning their lessons according to the different topics in each theme. At the end it is not about planning a perfect lesson but rather a lesson that one can learn from to improve and where learners could form an understanding in order to make meaning of what has been taught to them to use it in real life.

5.9 Summary

In this chapter, I discussed the chapter summary as well as the results based on each phase during each process. Furthermore I elaborated on the limitations of this study, what I would have done differently and recommendations for further research.

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Appendixes

Appendix A

Process 1

Phase 1

Semi-structured focus group interview

1. What can you remember from previous lesson studies?
2. Will an adaptive lesson study work in South Africa or in our school systems?
3. What is you're feeling about lesson study overall?
4. Did the lesson plan help you? Is there time for developing lesson plans while you teach?
5. Would you say that there is time in our curriculum to sit together and collaboratively plan lessons? What are you're feeling about that, do you think it will work?

Appendix B

Process 1

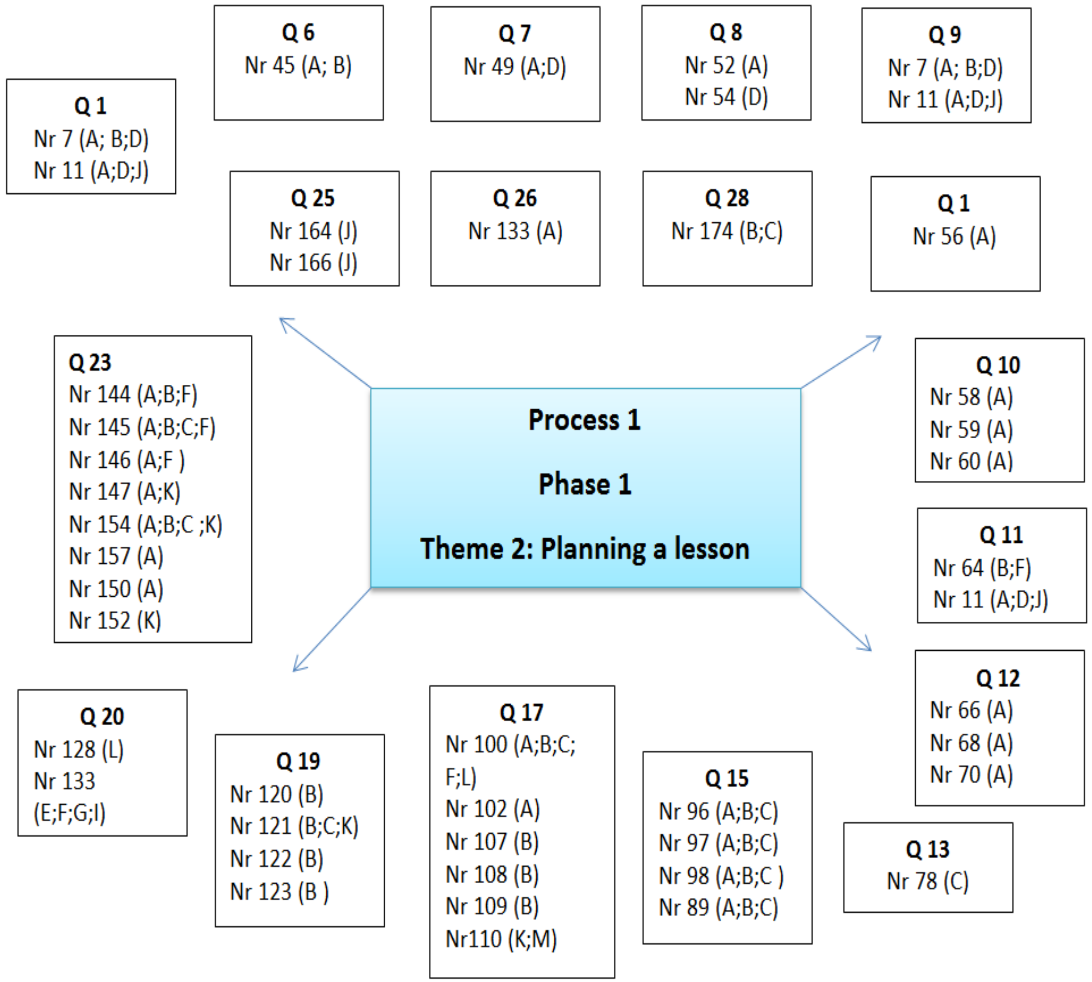
Phase 1

Semi-structured focus group interview

1. What are your goals in teaching mathematics?
2. What do you like about mathematics?
3. What do you not like about mathematics?
4. What does the term meta-cognition mean to you? What is a metacognitive strategy?
5. What is a strategy?
6. Can you give an example when you do a lesson where there is a specific strategy to use?
7. What does planning a lesson mean to you?
8. Do all of the teachers have to plan lesson? How often do you plan lessons?
9. When teaching mathematics, do you usually make provision for time to prepare your lessons before teaching it and why or why not?
10. What are most important factors that you take in consideration when planning a lesson?
11. Do you look for misconceptions that can be formed before teaching a certain topic?
12. You say you can't plan fully? You have a basic plan of what you are going to do, but when you teach it, and then you plan as you go along with the lesson when things come up?
13. Does the lesson plan include what you are going to do for teaching that certain topic?
14. Which topic in the content area space and shape did you use to plan your lesson and why?
15. What are most important factors that you take in consideration when planning this lesson?
16. What factors do you take in consideration when you think of planning the lesson based on area on the rectangle and square when planning a lesson?
17. The length and the breath. What else would you consider as important during the teaching phase to plan for it in the lesson?
18. Which strategies did you plan to apply concerning this topic, and why did you plan to use these specific strategies?
19. Explain why question and answering strategy or give an example why question and answering?

20. Is there any other strategy that you can think of while teaching the lesson, to plan for?
21. So you ask some of the learners to go to the board?
22. Do you usually give learners homework?
23. How will you know if your learners understand the content being teach?
24. What do you do when teaching your topic and realizing that learners do not understand?
25. What do you do? When do you do that, during the lesson? That afternoon, the day after that?
26. How will you help learners who struggle to understand the content being taught?
27. Do you have time for extra classes?
28. When planning your lessons and while teaching, do you think of questions such as what am I doing, what must I do and how am I going to do that?
29. Is there anything about the topic that you want to comment on?

Appendix B1
Process 1
Phase 1
Semi-structured focus group interview



KEY

Q: Questions

Nr: Number line on the coded transcript

Metacognitive strategies

- **A-** Planning
- **B-** Generating question
- **C-** Choosing consciously
- **D-** Setting and persuing goals
- **E-** Evaluating the way of thinking and acting
- **F-** Identifying difficulties
- **G-** Paraphrasig, elaborating and reflecting on learners ideas
- **H-** Clarifying terminology
- **I-** Problemsolving
- **J-** Thinking aloud
- **K-** Journal keepinng
- **L-** Cooperative learning
- **M-** Modelling

Appendix C

Process 1

Phase 2

Semi-structured focus group interview

1. What did you like best about this lesson?
2. What was good about the lesson?
3. Do the learners really struggle with that concept to see it as a fraction and that its part of a whole?
4. And do you think that when teacher A show the examples and where she presented it to show that 1 over 2 = same as 3 over 6, do you think that was a good strategy?
5. What in your opinion is essential strengths that you will say about this study, what was the strengths that stood out from this lesson
6. What did you think how did the teacher teach in general in the lesson, how youre feeling about the whole teaching process?
7. What strategies did the teacher apply while she was teaching the topic?
8. Group work? When and where did she apply specific strategies where something happened, what did she do or what can you realize that she do?
9. Would you say the learners achieved the outcomes at the end?
10. When and where did the teacher change the strategy when the learners did not understand?
11. So they responded to the using of the other methods?
12. Ok, when she putted up the circles, would you say that by using that, the learners understood more?
13. So would you say that when the teacher draw the o as a whole the learners understood more the term of this is part of a whole like 3 over 6. 3 parts are coloured in of 6 parts but in the circle?
14. Or in a rectangle and do you think the content being taught was meaningful to the learners and why?
15. Would you say it is very important for practical purposes outside the school area?
16. So it is necessarily for them to understand this content or concept?
17. Can you think of alternative approaches to teaching this lesson that might improve the learning process?
18. Or other approaches that might improve the learning process?
19. So was the approaches successfully being used?
20. Ok what if anything, would you like to change about this lesson

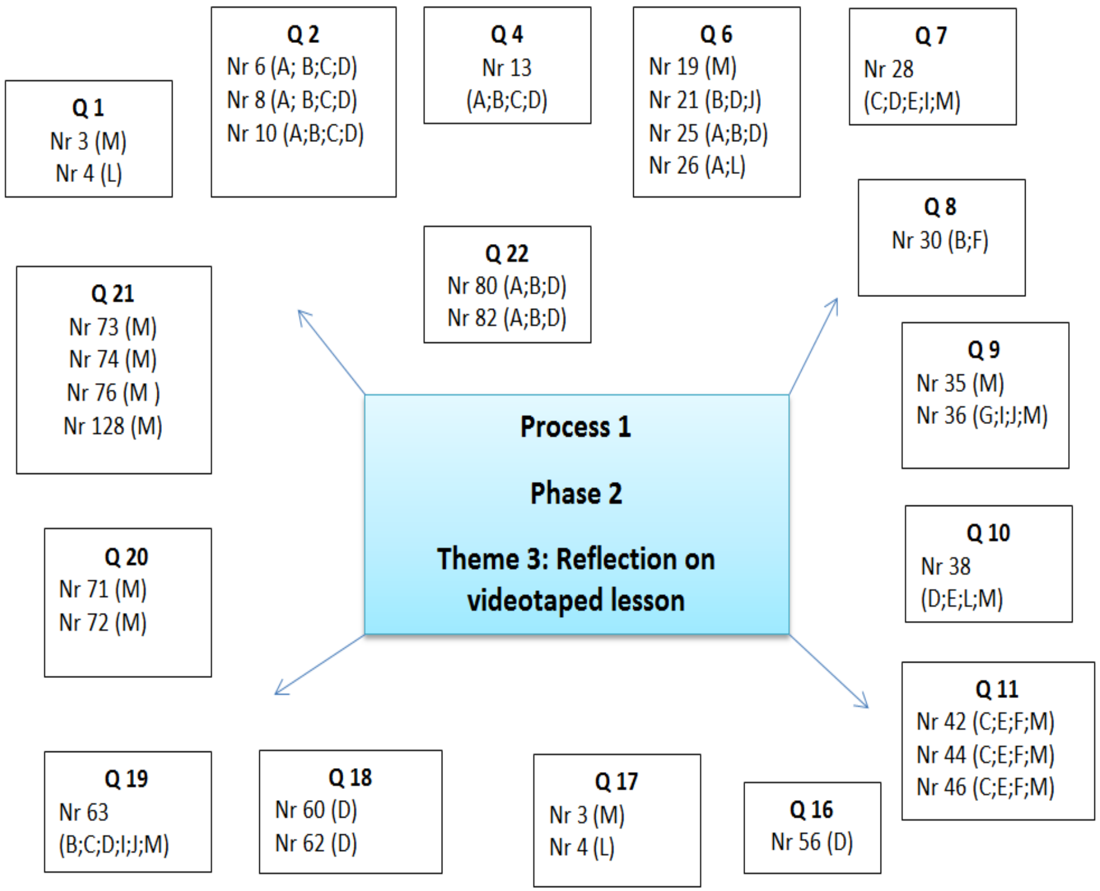
21. So would you say you should use your hands?
22. Ok so right is >
23. That actually nice
24. Is there anything that you would like to comment on about teachers A’s lesson?

Appendix C1

Process 1

Phase 2

Semi-structured focus group interview



KEY

Q: Questions

Nr: Number line on the coded transcript

Metacognitive strategies

- **A-** Planning
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- **I-** Problemsolving
- **J-** Thinking aloud
- **K-** Journal keepinng
- **L-** Cooperative learning
- **M-** Modelling

Appendix D

The follow up planned lesson

Lesson Plan: Mathematics

Grade: 4

Date: Start: ______ End: ______

Duration: 1 week

Critical Outcomes		
	Identify and solve problems	X
	Work effectively with others	X
	Organise and manage themselves and their activities	X
	Collect, analyse, organize and evaluate information	
	Communicate effectively using various methods	X
	Use science and technology effectively	
	Recognising that problem solving do not exist in isolation	

Developmental Outcomes		
	Exploring a variety of strategies to learn effectively	X
	Acting as responsible citizen	X
	Being culturally and aesthetically sensitive	
	Explore education and career opportunities	X
	Develop entrepreneurial opportunities	X

Learning outcomes		
	Numbers, operations and relationships	X
	Patterns, functions and Algebra	
	Space and shape	
	Measurement	
	Data Handling	

Assessment standards:

Theme: Describe & Compare common fractions in a diagram form

Activity outcome: * Learners should be able to compare and describe common fractions in a diagram form. Learners should understand fraction bars. Learners must be aware of identifying common fractions.

Integration Learning outcome	LLC	NS	TECH	EMS	SS	AC	LO
	X		X	X		X	

Core Knowledge/Context:

* Pre-knowledge of learners about common fractions for exaple numerator and clenominator, 1 over 2 ($\frac{1}{2}$)
* Shading of fraction

Skills	Drawing skills; identifying; describing; comparing; differentiating
Knowledge	Differentiate different fractions, interpretation of fractions.
Values and attitudes	Learners participate effectively.

Teaching strategy/ Methodology				
Question and answer	X	Investigation	X	
Explanation	X	Observation	X	
Discussion	X	Others: Specify:	Groupwork	

Activities

Learners	Educators
* Learners give examples back and ask questions. * Learners will identify the same common fractions and different fractions. * Must be reduced to the same and different denominators example $\frac{1}{2} = \frac{2}{4}$ & $\frac{1}{3} \neq \frac{2}{8}$ * Learners answer activities	* Teachers give learners examples of common fractions (Introduction) * Teacher gives diagrams & explanes common fractions showing different bars give example nr 15 (Teaching phase) * Teacher give activities from the books.

Assessment

Form		Test		Method	
Test/Exam	X	Memorandum	X	Educator	X
Class work/Homework	X	Checklist		Self	
Project		Task list	X	Peer	
Investigation		Rubric		Group	X
Assignment	X	Observation sheet		Other: Specify	
Other: Specify		Other: Specify			

Resources/References

* Text books
* Fraction wall
* Workbook
* Board
* An apple as an example
* Counting with sticks, coke bottles

Extra activities/opportunities

Enrichment	Remedial
* Fraction wall, shading for learners who struggles to use it practical. * More difficult examples or sums to do $\frac{3}{7} = \frac{12}{\square}$ to write missing numbers for the fractions. * Allow learners to do sums on the board.	→ To give previous example again to go back to previous examples

Appendix E

Process 2

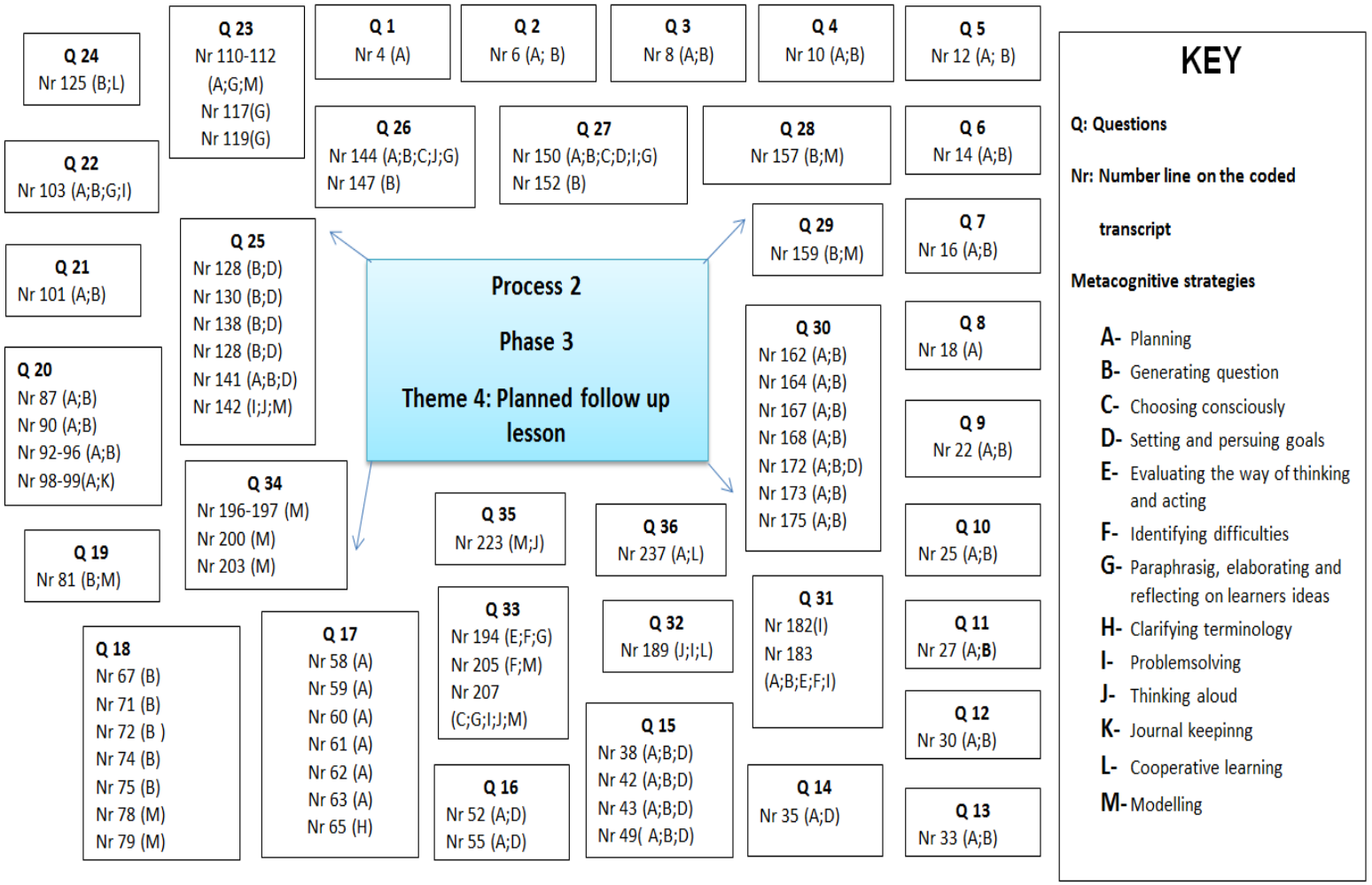
Phase 3

Semi-structured focus group interview

1. What is the duration you think for this lesson?
2. Is it going to be 1 week for the fractions part according to the CAPS?
3. When looking at your outcomes, is it identifying, solving problems?
4. Did it work effectively with each other?
5. Is it organise and manage themselves and their activities?
6. Is it collect, analyze and organize and evaluate information?
7. You don't think that appropriate for this lesson? Ok umm communicate effectively using various methods?
8. To use science and technology effectively?
9. If you look at the lesson outcomes are we going to do numbers, operations and relationship?
10. Space, shape data handling?
11. You say Patterns, functions and algebra, the theme? What would you say is the theme?
12. What would you say is the theme?
13. What is the activity outcome would you say?
14. What is the activity outcome for this lesson?
15. What would you say is the developmental outcome: exploring strategies effectively?
16. In interaction with other subjects, what would you say?
17. Then what would you say is the content or core knowledge?
18. Sharing of fractions, to actually can show it, not really to understand it by doing it practically or showing it?
19. Ok, what would be the skills… learning skills, drawing skills?
20. Ok, is there another knowledge that you can think of?
21. The interpretation of fractions. Values and attitudes?
22. Learners should participate effectively?
23. If you look at the assessment standards, keeping in mind the what, the how, the when and where, the meta-cognitive strategies. What do you use as a teaching strategy or methods?
24. Which other strategies or methods would you apply by teaching this lesson?
25. Then assessment standards, as a teacher, what would you do?
26. Ok but if we start at the beginning of the lesson the introduction, what must a learner do, what must a educator do, and how will they do it?

27. When the teacher gives the learners examples of common fractions what must the learners do or what do you think?
28. If we come to the teaching part of the lesson, what would you do teacher A, what strategy will you use or how will you apply it, how will you give the lesson, or will it be the same as the previous lesson?
29. How you going to teach your lesson?
30. If the teacher gives example she will explain it? So what must the learners then do?
31. When we get to the end of the lesson, what would you say is the….. What must the teachers do?
32. Will the teacher put the learners in groups, to facilitate them?
33. If the learners do not understand… what will you do?
34. What resources would you use?
35. To write the missing numbers and is there any remediation or enrichments that you can think of besides that she said to give more difficult sums?
36. Is there anything that you actually learned or that you would want to comment on?

Appendix E1
Process 2
Phase 3



Appendix F

Process 2

Phase 4

Reflective diary entry

1. If you were to teach this planned lesson, which metacognitive strategies would you apply during your lesson while teaching it, according to what was planned during the adapted lesson study and why would you focus on these specifically?
2. Which process will you follow in order to implement the various metacognitive strategies being planned?
3. Do you think it is necessary to always be aware of the metacognitive strategies to use during the planning phase and implementation of your lesson and why?
4. What is your personal opinion regarding the whole adapted lesson study process?

Appendix G

Example of an Educator Consent form

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Educator Consent form

Informed Consent: *Using adapted lesson study to facilitate mathematics teachers' meta-cognitive thinking skills when using mathematics vocabulary*

Date: September 2013

Project Title: *Intermediate phase mathematics teachers' application of meta-cognitive strategies during an adapted lesson study process*

Supervisor :
Dr. Annalie Roux
Lecturer: Mathematics Education
PhD (Mathematics Education)
School for Curriculum-based Studies
Faculty of Education Sciences
North-West University
+27+18 299 1861(office)
Annalie.roux@nwu.ac.za

INVITATION

Dear Mathematics educator

You are invited to participate in a design research study. Design research is a methodology with the aim to:

- Bring change in practice and
- Research to increase understanding.

The purpose of my research study is to understand how intermediate phase mathematics teachers apply meta-cognitive strategies in the content area space and shape – in addition,

to understand the implementation of the intermediate phase mathematics teachers' meta-cognitive strategies during an adapted lesson study process.

The study will take the form of an exploratory design. During the exploratory design, descriptive data is generated with the aim of developing an understanding of the context (Nieuwenhuis, 2010). Furthermore, to construct the meaning of their experiences, this study focuses on the views of mathematics teachers to understand the world in which teaching in their classrooms takes place (ibid).

This study will provide teachers with the opportunity to reflect more deeply on their own teaching skills and practices and involvement in the project and to experience another aspect of the education research process. The study that will be written about the team's work will be shared with the Intermediate phase teacher community for the purpose of advancing professional practice and development for teachers.

WHAT IS INVOLVED

This study will require that you take part in the following activities:

- Individual interview based on your lesson plan (Shape and Space).
- Two lesson observations which will be videotaped during school hours;
- Two focus group interviews based on the recorded lessons.
- At least two workshops (lesson study).
- Lesson study sessions and research team meetings.

Only the lesson observations for the lesson study purposes will be done in school time and on the school premises. All other research activities will be done after school hours. The project will be 2 years in duration (2012 and 2013).

Please take note: The information you provide will be kept confidential. Your name will not appear in any thesis or report resulting from this study; however, with your permission, anonymous quotations may be used.

POTENTIAL BENEFITS AND RISKS

This study will provide you with the opportunity to reflect more deeply on your own teaching practises focussing on more effective ways of using meta-cognitive strategies.

The results of your team's work will be shared with the Intermediate Phase teacher community for the purpose of advancing professional practice and the effective use of design research as a means of professional development for teachers. You will also have the opportunity to work towards an effective Mathematics lesson through lesson study. Another direct benefit is your own professional development and growth as a Mathematics teacher!

There are no known or anticipated risks associated with participation in this study. However, the lesson observation and lesson study activities that will be embarked upon in this project might hold some discomfort. You will also be participating in an intensive collaborative team project. This brings with it the possibility of conflict and differences of opinion amongst team members. The university facilitators are available to assist you in resolving inter-personal issues within your team should they arise. In addition, you will be asked about the success of the lessons and your work on the action research project. This might present potential for others to judge your expertise. However, pseudonyms will be used to keep your identity confidential. In addition to this, I will make sure that your rights will be protected.

CONFIDENTIALITY

Pseudonyms will be used for the names of participants in the reporting of the findings from this study. The master list of participants' real names and their pseudonyms will be kept in a locked cabinet in the researcher's office. If an individual participant withdraws from the study, any data pertaining exclusively to the participant will be destroyed.

On December 31, 2021 (seven years after the completion of the study in 2014) all data including paper documents will be destroyed by shredding and electronic files (emails and computer files) deleted or erased. Until this date all data will be kept by the principal researcher.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty or loss of benefits to which you are entitled. If an individual participant withdraws from the study, any data pertaining exclusively to the participant will be destroyed. There are no consequences for withdrawing from the research study.

FEEDBACK AND PUBLICATION OF RESULTS

There will be regular feedback and discussions at each visit. Results of this study may also be published in professional journals and presented at other conferences.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact me or the research office of the North-West University at +27-18-299 4780 or +27+18 299 4551or +27+18 299 1861 or at http://www.nwu.ac.za

CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name:_____ Date:_____

Signature:_____

Appendix H

Language editor letter

10 October 2014

I, Ms Cecilia van der Walt, hereby confirm that I took care of the editing of the mini-dissertation of Ms N Esterhuyse titled *Mathematics teachers' awareness of metacognitive strategies during the process of an adapted lesson study in the Intermediate Phase.*

MS CECILIA VAN DER WALT

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