THE NATURE OF MATHEMATICS TEACHERS' REFLECTIVE PRACTICE

by

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Lastly, I dedicate this research study to my grandchildren, Ciska and Anoux.

Declaration

I hereby declare that this thesis submitted for the degree Doctor of Philosophy at the University of Pretoria, South Africa, is my own original work and has not been submitted for any degree or examination at any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references.

Anna Barbara Posthuma

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Summary

Thoughts about reflection and reflective practice have evolved over many decades, through carefully constructed theory and research applications, mainly based on the work of Dewey (1933) and Schön (1983). Evidence also exists in the literature that the ability to reflect on practice is considered a necessity for effective instruction (Sowder, 2007). By reflecting critically teachers become more positive in the search for a new understanding of their teaching practice and design more ways to deal with the challenges that confront them daily. When teachers act reflectively, they consider carefully the problems in their own teaching and think about how those problems are related to their educational or social context. They are aware of the consequences of their teaching and how their own assumptions or beliefs can influence their teaching.

This main purpose of my research study was to explore the nature of mathematics teachers' reflective practice in the context of lesson study. To achieve this aim, an in-depth exploration of five mathematics teachers' reflection before, during and after teaching a lesson was conducted. The possible relationship between these teachers' reflection and their classroom practice was also examined. The research also aimed to explore whether and how mathematics teachers' reflections differ from the conceptualisations of reflection in classroom practice as found in the literature. Contextual factors that might influence the nature of mathematics teachers' reflective practice were also investigated.

My findings indicate that the mathematics teachers in my sample have a limited understanding of the concept of reflection. Furthermore, based on lesson plan analysis, there was no evidence that these teachers reflect-for-action. However, they all reflected on-action verbally and in writing, and three of the five teachers reflected-in-action while teaching. They all reflected on Level R1 (recall level of reflection) and Level R2 (rationalisation level of reflection) and three teachers reflected critically on their learners' understanding of mathematics and their own teaching of concepts towards the end of the research project (Lee, 2005). Language and the lesson study group experience emerged as contextual factors that seemed to influence the teachers' reflection.

Although the research study's results cannot be generalised due to the small sample, I believe that through engaging in the lesson study experience the five teachers of this study

improved their reflective practice, reporting an increase in self-knowledge and finding new ways of teaching mathematics to learners.

Key words: Reflection; Reflective practice; Reflective thinking; Mathematics; Reflection-for-action; Reflection-in-action; Reflection-on-action.

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List of abbreviations

ACE	Advanced Certificate in Education
CPTD	Continuing Professional Teacher Development
BMI	Body Mass Index

Chapter 1

Introduction and contextualisation

1.1 Orientation and background

This research study seeks to explore mathematics teachers' reflective practice in the context of lesson study[1]. In the orientation to this research study I discuss some views on teachers' reflective practice that have been expressed internationally and nationally to situate my research within this broader framework.

1.1.1 Earliest views on teachers as reflective practitioners: Dewey and Schön

One of the first American educational theorists to view teachers as reflective practitioners was Dewey. According to Dewey (1933) true reflective practice takes place only when the individual is faced with a real problem that he or she needs to resolve in a rational manner. In his book (first published in 1910), *How we think*, Dewey (1933) links the process of reflection to attributes of the **ideal** teacher. According to Dewey (1933) ideal teachers acquire the habit of on-going thoughtfulness and examination of the beliefs and theories they use to inform their instruction of learners. This process of reflection helps teachers develop specific orientations, such as open-mindedness, responsibility, and wholeheartedness. Although Dewey's reflective thinking was popularly endorsed, it was not widely practised in teacher education (Lee & Tan, 2004). The reason for this neglect was, according to Adler (1990), the strong influence of behaviourist ideas in teacher education. Lee and Tan (2004) report that during the 1980s teacher education reform and research shifted to issues surrounding teachers' thinking and their professional knowledge, and this shift sparked an interest in the teacher as a decision-maker.

After Schön's (1983) publication of *The reflective practitioner,* the slogans of 'reflective teaching', 'action research', 'research-based' and 'inquiry-oriented' teacher education have been embraced by both teacher educators and educational researchers throughout the world (Zeichner, 1994). Schön (1983) introduced the terms *reflection-in-action* and *reflection-on-action* to describe teachers' thinking in their classroom practice. The term *reflection-in-action* (Schön, 1987) is used to describe teachers' reflection on certain matters while they

[1] **Lesson Study** (or *kenkyu jugyo*) refers to a process in which teachers progressively strive to improve their teaching methods by working with other teachers to examine and comment on one another's teaching techniques (Baba, 2007).

are teaching (e.g. Are the group of learners engaged in the task at hand? Are they bored? Should I move on to a new topic?). Schön (1987) uses the term *reflection-on-action* for retrospective thinking, or thinking 'after the event'. Schön's ideas were attractive to teacher educators because he closely described daily classroom situations that teachers encounter and the kinds of thinking processes that accompany teachers' work (Lee & Tan, 2004).

According to a number of researchers (e.g. Gimenez, 1999; Lee & Tan, 2004; Zeichner, 1994) the range of interpretations of teacher reflection is extremely wide and there is no single definition of the concept, which leaves me with a dilemma. How can I best study a phenomenon that has been fairly vaguely defined and is so widely interpreted? I address this dilemma by synthesising insights from the vast amount of literature to develop a definition of reflection and reflective practice in Chapter 2.

A brief summary of some of the international and national research on teachers' reflective practice follows.

1.1.2 International research on teachers' reflective practice

International research on teachers' reflective practice has focused on different research lines. Whereas some researchers have attempted to document and describe the **processes of teachers' reflections and associated actions**, and the relationship between these processes and teacher development (e.g. LaBoskey, 1994; Russell & Munby, 1991), others (cited in Zeichner, 1994) have focused on studying the **social and individual conditions which influence the reflections** of teachers (e.g. Ashcroft & Griffiths, 1989; Erickson & Mackinnon, 1991; Grimmett & Crehan, 1990; Richert, 1992; Wubbels & Korthagen, 1990). In addition Sparks-Langer and Colton (1991) studied and identified three **elements of teachers' reflective practice:** *the cognitive element*, which is concerned with the knowledge that teachers need to make good decisions in and on the classroom situation; the *critical element*, which relates to social justice and ethics in education; and the *narrative element*, which has to do with teacher accounts of their own experiences in the classroom.

Some researchers focused on yet another facet of the phenomenon under discussion, viz. the **benefits of reflective practice**. York-Barr, Sommers, Ghere and Montie (2006) for instance claim that by engaging in reflective practices, educators increase their learning and improve their practice. This view is supported by Sowder (2007) who argues that reflective teachers plan more effectively because they anticipate students' difficulties. They know what prior knowledge must be present to understand something new and they know how to scaffold knowledge to assist students in developing understanding. Hill, Sleep, Lewis and

Ball (2007, p. 145) conclude that teachers who can describe, explain and reflect on their work are potentially better teachers, because *the ability to articulate one's practice is an indicator of deliberateness, and the ability to write cogent reflections is an indicator of analytic capacity, both of which may predict student achievement*.

According to Hill *et al*. (2007) **the relationship between articulate reflection and effective instruction** has not yet been established clearly. Sowder (2007) however believes that the ability to reflect on practice is a necessity for effective instruction and cites Darling-Hammond (p. 198) as follows:

> *Teachers need to be able to analyze and reflect on their practice, to assess the effects of their teaching and to refine and improve their instruction. They must continuously evaluate what students are thinking and understanding and reshape their plans to take account of what they have discovered.*

1.1.3 Research on teachers' reflective practice reported in Southern Africa

In the Southern African context Nyaumwe (2007) documents four chronological phases that Zimbabwean preservice mathematics teachers' conceptions of reflections went through: conceptions of classroom management, personal survival, teaching situations and individual learner needs. Case studies of four preservice teachers doing twelve weeks of teaching practice in two different schools provided data for the study through narratives of post-lesson reflective texts and interviews. The findings provide insight into the phases that preservice teachers go through to become reflective practitioners.

Polaki and Morobe (2007) were interested in the issues that teachers in Lesotho focused on as they attempted to reflect on their lessons. When challenged to reflect critically upon their lessons, these teachers either focused on organizational factors or on what the learners were unable to do during the lesson. They never made remarks about how their own actions could have been modified to better support learners' development of mathematical concepts.

Nyanjom (2009) investigated the relationship between mentoring and teachers' reflective practice at a technical college in Botswana and reports that reflective practice enhances the learning and development of educators. She concludes that reflective practice will assist educators to obtain clarity on issues that pose challenges to their practice (Nyanjom, 2009).

According to Hill (2003) reflective practice is one of the themes in current education discourse which impacts on teacher education in South Africa. She researched the

relationship between globalisation, reflective practice and assessment and concludes that reflexivity is adaptive discursive behaviour which connects researchers in South African contexts with multiple layers of disembedded relations in global space that impinge on how we function in our situation (Hill, 2003).

1.2. The context of this research study

The context of this research study is lesson study, which could be considered as a special type of case study. In lesson study the focus is on the concrete examination of practice and the testing of new ideas in actual classrooms. This examination of practice is a collaborative exercise in which a group of teachers design, reflect on, and deliver mathematics lessons to enhance learner achievement. Research has shown that lesson study impacts on teachers' understanding of learner thinking; it enhances teachers' content knowledge and awareness of new approaches to teaching; it helps teachers to connect their practices to school goals and broader goals; and it creates a demand for improved instruction and allows competing views to be heard during the reflection stage of the lesson study cycle (Lewis, cited in Sowder, 2007). According to Friedman (2005) the habits of personal reflections on one's teaching that occur during the lesson study process are habits that remain with teachers long after the research lesson is over. This is one of the reasons why I decided to situate my research in this context.

1.2.1 Origin of lesson study

Lesson study has played an important role in professional development in Japan since the beginning of the public education system more than a hundred years ago. One of the reasons for this popularity might be that lesson study provides Japanese teachers with opportunities to do the following: 1) make sense of educational ideas within their practices; 2) change their perspectives on teaching and learning; 3) learn to see their practices from a child's perspective; and 4) enjoy collaborative support among colleagues (Takahashi, Watanabe & Yoshida, 2006).

1.2.2 Definition

Lesson study is defined as *a form of action research that allows teachers to work with each other collaboratively as reflective practitioners* (Yoshida, cited in Jita, Maree & Ndlalane, 2007, p. 461). The lesson study process consists of a cyclical process and has the following basic components: 1) collaborative planning; 2) lesson observation; 3) reflection on the

lesson; and 4) implementation of changes. In Chapter 2 I will discuss lesson study in more detail.

Against this background the rationale for this research study follows.

1.3 Rationale for the study

I would like to believe that the vast majority of teachers have chosen the teaching profession in the hope of making a positive difference in the lives and development of young people. The rationale for the current research study is embedded in this personal interest in mathematics teachers' classroom practice on the one hand and a broader interest in making a contribution to the science and art of mathematics instruction on the other.

1.3.1 Personal interest in teachers' classroom practice

In the past fifteen years I have often observed teachers teaching mathematics lessons. I have also been involved with a mathematics Advanced Certificate in Education (ACE) programme in which students (who are experienced teachers) submit a portfolio with lessons they planned and taught as part of their formative assessment. In most cases they report that the lesson went well and if they ever had to teach the lesson again they would teach it in exactly the same manner. The examples of the mathematical activities they include indicate that they very seldom address higher-order thinking levels in their learners. They also report that the learners were "very happy with the lesson" and "gained a lot of knowledge".

1.3.2 Concern about mathematics teachers' ability to reflect on their practice

The reflections of the ACE students on their lessons appear to be very superficial and can be positioned on level 1 of Van Manen's hierarchical model of levels of reflectivity. Van Manen (1977) distinguished between three distinct levels of reflective practice. The first level is concerned with the effective application of skills and technical knowledge in the classroom setting. Nyaumwe (2007) found that preservice teachers at this level narrate pedagogy, information on learners, content mastery, and availability of instructional resources or make superficial conclusions and recommendations on their instructional practice. The second level, according to Van Manen (1977), involves reflection on the assumptions underlying specific classroom practices, as well as on the consequences of particular strategies, curricula, etc. Critical reflection occurs on the third level which entails the questioning of moral, ethical, and other types of normative criteria related directly and indirectly to the classroom (Van Manen, 1977).

1.3.3 Evidence for the need to reflect critically on teaching practice from research

A further incentive to undertake this study is drawn from the research on the importance of reflective practice for effective instruction. In my review of the literature I found that there is little evidence of research on mathematics teachers' reflective practice in the South African context, which strengthens my rationale to undertake this study. Yet the ability to reflect on practice is considered a necessity for effective instruction (Sowder, 2007). According to Hillier (2005) there are two reasons to reflect on practice: 1) to change existing practices that will in the long term not actually help learners learn effectively and 2) by reflecting critically teachers become more positive in the search for a new understanding of their teaching practice and find more ways to deal with the challenges that confront them daily. When teachers act reflectively, they consider carefully the problems in their own teaching and think about how those problems are related to their educational or social context. They are aware of the consequences of their teaching and how their own assumptions or beliefs can influence their teaching.

Having provided the rationale for conducting the study the statement of purpose will now discussed.

1.4 Statement of purpose

The main purpose of this research study is to explore mathematics teachers' reflective practice in a lesson study context. To achieve this aim an in-depth exploration of mathematics teachers' reflection before, during and after teaching a lesson will be conducted. The possible relationship between mathematics teachers' reflection and their classroom practice will also be examined. The research will aim to explore whether and how mathematics teachers' reflection differs from the conceptualisations of reflection in classroom practice as found in the literature. The study will also seek to examine how contextual factors influence the nature of mathematics teachers' reflective practice.

The research questions that will guide this inquiry will subsequently be discussed.

1.5 Research questions

Given these purposes and objectives and against the background of my working assumptions, the study will seek to address the following main questions:

Question 1: What is the nature of mathematics teachers' reflective practice?

To address this main question, the following subquestions will guide the enquiry:

a) How do mathematics teachers understand the concept of reflection?
b) How do mathematics teachers reflect before, during and after teaching?
c) What is the possible relationship between mathematics teachers' reflection and their classroom practice?

Question 2: How do contextual factors influence mathematics teachers' reflective practice?

Question 3: What is the potential significance of mathematics teachers' reflective practice for the science and art of mathematics teaching?

1.6 Methodological considerations

My principal concern is to understand the way in which the teachers in the lesson study group create, modify and interpret the social context in which they function as they plan, teach and reflect on the lesson. Therefore a qualitative inquiry with an epistemological perspective of the interpretive paradigm will underpin this study as I seek to explore the nature of these mathematics teachers' reflective practice. Within a qualitative approach, I propose a case study design.

1.7 Possible contribution of this research study

The importance of this research rests on its unique connection of reflective practice relating to teaching, specifically in the field of mathematics. Typically educators who are committed to excellent teaching continually seek growth and improvement, as the art of teaching is never a finished product. A changing community of learners requires teachers to grow professionally to be able to justify their pedagogy and educational philosophies. The rationale for this study stems from the premise that mathematics teachers need to find a vehicle for growth and improvement. The development of a reflective process can serve as an important technique in increasing self-knowledge and seeking new ways of educating learners in mathematics. The study can add to research findings concerning reflective practice and contribute to the discussion on the usefulness of including teacher reflection in professional learning programmes.

1.8 Structure of the thesis

Chapter 2 focuses on a review of the literature relating to teachers' reflective practice and lesson study, in order to situate this research study. In Chapter 2 a conceptual framework for investigating mathematics teachers' reflective practice is described. Chapter 3 describes the methodologies, data collection methods and data analyses for this study. Validity issues and ethical considerations are also discussed. In Chapter 4 the data obtained from the participants are presented and discussed. Chapter 5 provides a discussion on the findings related to the research questions, as well as a final summary, conclusions and recommendations for further research on teachers' reflective practice.

Chapter 2

Literature review

2.1 Introduction

In this chapter I review the theoretical underpinnings of teacher reflection and reflective practice as found in the literature. Research studies dealing with the reflective practice of preservice teachers as well as practicing teachers will be investigated. I focus on teacher reflection in general and mathematics teachers' reflective practice in particular. The different meanings of reflection found in the literature will be explored and a definition of teacher reflection for the purpose of this study will be developed. The conceptual framework for this study is based on this review and exploration, and the focus of my study is highlighted in this chapter.

2.2 Theoretical perspectives on reflective practice in education

Thoughts on reflection and reflective practice have evolved over many decades, if not centuries, through carefully constructed theory and research applications (York-Barr, Sommers, Ghere & Montie, 2006). John Dewey is frequently recognised as the eminent 20th-century influence on reflection in education (Ottesen, 2007; Pollard, 2002; Rodgers, 2002; York-Barr, *et al.*, 2006; Zeichner & Liston, 1996). The seminal work of Donald Schön (1983, 1987) has also inspired a renewed interest in reflective practice in the field of education (Lee & Tan, 2004; Valli, 1997). The contributions of Dewey and Schön are discussed in the following section.

2.2.1 Dewey's approach to reflective practice

Dewey (1933) views the purpose of education as promoting intellectual, social, and moral growth of the individual in order to create a strong democratic society. His interest is in how people think when faced with real and relevant problems. Dewey (1933, p. 17) states that it is reflection that

> *emancipates us from merely impulsive and routine activity ... enables us to direct our activities with foresight and to plan according to ends-in-view, or purposes of which we are aware. It enables us to act in deliberate and intentional fashion ... to know what we are about when we act.*

According to Dewey (1933, p. 6) reflection is the *active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends*. Rodgers (2002) distilled four criteria from Dewey's writing that characterise Dewey's concept of reflection and the purposes they serve:

1) Reflection is a meaning-making process that moves a learner from one experience into the next with deeper understanding of its relationship with and connections to other experiences and ideas.
2) Reflection is a systematic, rigorous, disciplined way of thinking, with its roots in scientific enquiry.
3) Reflection needs to happen in communities, in interaction with others.
4) Reflection requires attitudes that value the personal and intellectual growth of oneself and of others.

Rodgers (2002) concludes that Dewey was precise in what it means to think reflectively. For Dewey (1933, p. 4) reflection *involves not simply a sequence of ideas but a consequence – a consecutive ordering in such a way that each determines the next as its proper outcome, while each outcome in turn leans back on, or refers to its predecessors*.

As far as reflective practice is concerned Dewey (1933) claims that true reflective practice takes place only when the individual is faced with a real problem that he or she needs to resolve and seeks to resolve in a rational manner. He identified five general phases of reflective thinking: a problem situation, a tentative interpretation of the elements of the problem situation, careful survey of all attainable considerations which will define and clarify the problem, elaboration of a tentative hypothesis, and testing of the hypothesis. This reflective process of inquiry could be applied to *perplexed, troubled, or confused situations* in order to bring about a "cleared-up, unified, resolved situation" (Dewey, 1933, p. 106). According to Lee and Tan (2004) these ideas bring to mind an image of teaching as an inquiry into problematic situations where the reflective teacher is engaged in deliberative inquiry as he/she tries to resolve each problematic situation.

2.2.1.1 Critical evaluation of Dewey's work

Hillier (2005, p. 15) highlights two points in Dewey's approach to reflective practice. The first is that his suggestion of the use of a careful survey and elaboration of a tentative hypothesis constitutes a reflective approach to action, rather than a simple trial and error approach to action. Second, Dewey suggests that hypotheses are formulated and then tested through taking action. He draws a distinction between *routine action* (where external circumstances, habit and tradition, and externally perceived authority, are dominant, and where reasons for practices have not been considered actively) and *reflective action* (where actions are

persistently and carefully considered and justifications developed for them) (Dewey, 1933). In the context of teaching, teachers who act routinely accept the circumstances within which they teach, and will not question the curriculum or the social conditions of their schools, while teachers who act reflectively learn from their experiences, and are proactive in trying out new ideas and solutions to existing problems. These teachers are aware that any action they take leads to new challenges (Hillier, 2005).

According to Pollard and Tann (1993), Dewey's notion of reflective action, when developed and applied to teaching, is both challenging and exciting. They identified six key characteristics of its implications for teaching (Pollard & Tann, 1993, p. 9):

1) Reflective teaching implies an active concern with aims and consequences, as well as means and technical efficiency. The reflective teacher should consider not only the immediate aims and consequences of classroom work, but also acknowledge the political process and be willing to contribute to it both as a citizen and as a professional.
2) Reflective teaching is applied in a cyclical or spiralling process, in which teachers not only plan but also monitor, evaluate and revise their own practice continuously.
3) Reflective teaching requires competence in methods of classroom enquiry, to support the development of teaching competence.
4) Reflective teaching requires attitudes of open-mindedness, responsibility and wholeheartedness.
5) Reflective teaching is based on teacher judgement, which is informed partly by self-reflection and partly by insights from educational disciplines.
6) Reflective teaching, professional learning and personal fulfilment are enhanced through collaboration and dialogue with colleagues.
7) A seventh characteristic is added by Pollard (2002): Reflective teaching enables teachers to creatively mediate externally developed frameworks for teaching and learning. Pollard (2002, p. 23) concludes that *the aim of reflective practice is to support a shift from routine actions rooted in common-sense thinking to reflective action stemming from professional thinking*.

Valli (1997) observes that Dewey's theory separates teachers' thinking from their action, which means that theory and practice are kept apart. Whereas Dewey highlights a link between intentional reflection and intelligent action (a theme also found in the work of Schön), Schön further notes that skilful practice may reveal a kind of knowing that does not stem from a prior intellectual operation (Schön, 1992).

Schön's work, by contrast, emphasises that professionals continuously face unique situations that they frame and reframe in the light of previous experience, and he recognises the embedded reflection in practice (1983). The common thread between Dewey and Schön rests in the idea of inquiry and experiment in practice as the basis for the development of professional knowledge (Butke, 2003). However, Butke (2003) argues that reflecting on practice through a critical lens is typically related to Dewey's approach, whereas Schön's reflection-in-action is based on the notion of the intelligent knowing-in-action that teachers do as they act and interact within the immediacy of problematic situations.

2.2.2 Schön's approach to reflective practice

Schön (1983) developed his ideas about the reflective practitioner in response to three criticisms of the prevailing positivist epistemology of practice. In the positivistic view, good knowledge had to be scientific and systematic, which Schön called *technical rationality* (1987, p. 3). His first criticism relates to the fact that in many professions the product is more important than the process of getting there, a criticism directed at outcome-based projects in education and training. The second criticism is that researchers are not working with practitioners and practitioners are not finding out about recent research. Thirdly, Schön (1987) argues that there is a separation of knowing from doing and subsequently developed his **epistemology of practice** to argue the importance of practical knowledge. He argues that in a professional practice there are problems that can be solved through the application of research-based theory and technique, but there are also problems that can only be solved by a form of professional knowing, a form of artistry he called **reflection-in-action** (Schön, 1983, 1987). Reflection-in-action is a process that is prompted by experience and over which we have limited control (Russell & Munby, 1991). According to Russell and Munby (1991, p. 164), *the essence of reflection-in-action is hearing differently or seeing differently, a process that Schön calls reframing*.

Schön (1983, 1987) uses the term **reflection-on-action** for retrospective thinking, or thinking **after the event**. The sort of thinking characterised by reflection-on-action involves careful considerations of familiar data when one thinks critically about what has taken place (Russell & Munby, 1991). A teacher's reflection-on-action will involve all the different thoughts and feelings he/she has about the teaching of the lesson.

2.2.2.1 Critical evaluation of Schön's work

According to Kinsella (2007, p. 102) *the popularity of Schön's theory is tied in part to his* critique of technical rationality, and to his acknowledgement of the significance of practitioner

experience and indeterminate zones of practice in the development of expertise. Schön tapped into a growing disillusion with technical rationality that coincided with a crisis of knowledge across a range of disciplines (Kinsella, 2007).

A number of researchers (e.g. Court, 1988; Van Manen, 1995) however question the possibility of reflection-in-action and maintain that only limited true reflection is possible while teaching. For example Court (1988) argues that Schön's examples of "reflection-in-action" appear to involve removing oneself from the action in order to reflect, and thus the term may not be appropriate. Van Manen (1995) maintains that the classroom teacher must constantly act on the spot and cannot step back and postpone acting in order to first reflect on the various alternatives to this action and the consequences of the various alternatives. However, Russell and Munby (1991) argue that it is only from a researcher's perspective that reflection-in-action is difficult to detect and challenging to document.

According to Hughes (2009) Schön's work has been criticised because it does not allow for the complexity of ways in which people reflect on and consider their actions. She argues that *while sometimes reflection is immediate, at other times it is deferred with a need for distance from the event* (Hughes, 2009, p. 453). She cites Brockbank and McGill (1998) who believe that the action which follows a reflection can be instantaneous or postponed (Hughes, 2009).

Newman (1999) maintains that there are fundamental difficulties with Schön's theories which call into question the often uncritical use made of his ideas. Newman (1999) attributes the popularity of Schön's ideas in the area of teacher education to Schön's claim that we need to close the alleged gaps between means and ends, between research and practice and between knowing and doing. His argument is based particularly on criticisms of just how critically reflective Schön's case studies are and suggest that a better alternative to describe reflective practice would be "critical practice" or "practical philosophy" (Newman, 1999, p. 159). According to Newman (1999, p. 160) *both terms suggest an approach which practitioners can adopt in the different social contexts in which they find themselves.*

Zeichner and Liston (1996) argue that although Schön's conception of reflection-in-action and reflection-on-action and the accompanying spiral of appreciation, action, and re-appreciation add both texture and substance to Dewey's understanding, two features need to be added. First, although reflection can at times be a solitary and highly individualistic affair, it can also be enhanced by communication and dialogue with others. Second, reflection needs to focus not only within the classroom but on the contexts in which teaching and schooling are embedded (Zeichner & Liston, 1996). Hughes (2009) supports this argument and believes that an individual's reflection on practice must draw on the norms

and agreed behaviours of the professional community in which s/he is participating. Thus, *a teacher's reflections will be influenced by the practice of others in the local school, university or college environments as well as by current thinking on what is good educational practice and peer support for reflection will be invaluable* (Hughes, 2009, pp. 453-454).

According to Farrell (2004) the focus of reflective practice has dulled somewhat in the late 1990s, with some individuals in education believing it was just one more bandwagon that administrators and university researchers had jumped upon. He believes that it has become unclear just what reflective practice really means to the practising teacher. Hillier (2005) reasons that reflective practice has become a byword for a range of practices and meanings which do little to challenge our tacit assumptions and implicit, informal knowledge. Nonetheless, there continues to be tremendous conceptual and practical confusion surrounding what reflective practice is and in what ways it is distinct from other modes of reflective theorising (Clark, 2001; Fenstermacher, 1988; Procee, 2006). The debate over different definitions and approaches on reflection and reflective practice is addressed at a later stage in this review of the literature.[2]

Before I review the research studies in education based on reflection, it is necessary to explain how theorists in the past three decades have assembled working models to define and categorise the reflective process (e.g. Valli, 1997; Van Manen, 1977).

2.3 Categories of reflection in education

The depth of teachers' reflection can be measured at different levels as identified by a number of researchers (Dewey, 1933; Hatton & Smith, 1995; Jay & Johnson, 2002; Lee, 2005; Valli, 1992; Van Manen, 1977). For example Dewey (1933) has identified the following phases of reflection: interpretation of experience (recognition of possible solutions to the problem); description of experience (problematising or intellectualising the situation); analysis (generating hypotheses that might lead to possible solutions) and overt action on the part of the thinker (experimenting, testing hypothesis) (Lloyd, 2005; Mewborn, 1999).

2.3.1 Van Manen's levels of reflection

In my review of the literature on reflective practice I realised that Van Manen's levels of reflection (1977) are still used extensively to determine the depth of reflection during action. I will therefore start the discussion on the categories of reflection with Van Manen's levels of reflection.

[2] See paragraph 2.4.1.1

Van Manen (1977) distinguished between three distinct levels of reflective practice. The first level is concerned with the effective application of skills and technical knowledge in the classroom setting. Level one, **technical rationality**, consists of responses that deal with the technical application of educational knowledge and basic curriculum principles, such as are the students doing what the teacher asked them to do? At this level reflection entails only the appropriate selection and use of instructional strategies in the classroom (Van Manen, 1977). The contexts of the classroom, school, community, and/or society are not taken into consideration. This is the most basic level of reflection and is concerned with the efficiency and effectiveness of the means used to attain ends which are accepted as given (Zeichner, 1994). In essence, the first level is not reflective in the sense that it will result in changing behaviour. It is merely a reaction to an observation that a problem exists, and in that sense it links with behaviouristic ideas. Zeichner (1994, p. 13) argues that the reason why teachers reflect on this very superficial level is because *most schools are hostile to critical enquiry.* However, many researchers agree that this technical level of reflection is also important because it relates to the everyday world of the teachers (Griffiths & Tann, 1992; Zeichner, 1994).

At the second level, **practical action**, the teacher becomes more concerned with clarifying assumptions and predispositions while assessing the educational consequences towards which a teaching action leads. The teacher analyses student and teacher behaviour to see if and how goals are met. In other words, at the second level of reflectivity teachers would begin applying educational criteria to teaching practice to make individual and independent decisions on pedagogical matters (Van Manen, 1977). The outcomes for students are also investigated on this level (York-Barr *et al.,* 2006).

The third level is **critical reflection**. At this level, educators are concerned with worth of knowledge and the social circumstances useful to students without personal bias. The teacher asks her/himself several questions such as what were the strong points in the lesson, what should be changed, and was the content that was covered important to the students. At this level there will be a concern for justice, equity and the satisfaction of important human purposes within the larger social context. Critical reflection entails the questioning of moral, ethical, and other types of normative criteria related directly and indirectly to the classroom (Van Manen, 1977). A number of researchers question the essentiality of the role of critical reflection in education (Valli, 1997; Zeichner & Liston, 1987), emphasising that educators must critically examine how instructional and other school practices contribute to social equity and to the establishment of a just and humane society.

According to Van Manen (1995) reflection is central to the life of the educator. He notes that it is in the very nature of the pedagogical relation that the teacher reflectively deals with children, rather than doing so unthinkingly, dogmatically, or prejudicially. However, he argues that the concept of reflection is challenging and may refer to a complex array of cognitively and philosophically distinct methods and attitudes (Van Manen, 1995).

2.3.2 Valli's levels of reflection

Valli (1992) identified six different types of reflection. The lowest level is behavioural, which she admits is *prescribed, not reflective content* (Valli, 1992, p. 220). According to Valli (1992, p. 217), *technical reflection* is the second level of reflection, focusing on general instruction and management practices based on research. The focus of this type of reflection is on the narrow domain of teaching techniques or skills. The quality of reflection is to match one's own performance to external guidelines. Other levels of reflection that she proposes are: *reflection-in and on-action*, which focus on one's own teaching performance and making decisions based on one's own unique situation; *deliberative reflection*, which can focus on a wide array of teaching related practices and concerns but involves intentional consideration of assumptions, different perspectives, and research findings; *personalistic reflection*, which focuses on one's own growth and relationships with students and involves learning to listen to one's own inner voice, as well as the voices of others; and *critical reflection*, which focuses on social, moral and political dimensions of education and involves making judgements based on ethical criteria (Valli, 1992, pp. 217-219).

Zeichner and Liston (1987) acknowledge the importance of reflection at all the levels suggested by Van Manen and Valli, but encourage teachers to critically reflect also on curriculum goals, educational ends as well as school and societal structures. The focus here seems to be on the teacher and not on the teaching and learning situation. However, several other researchers have identified teacher reflection on their practice and student learning as critical to the success of reform (e.g. Artzt, Armour-Thomas & Curcio, 2008; Darling-Hammond, 1998). According to Darling-Hammond (1998, p. 8)

> *teachers need to be able to analyze and reflect on their practice, to assess the effects of their teaching, and to refine and improve their instruction. They must continuously evaluate what students are thinking and understanding and reshape their plans to take account of what they have discovered*.

According to Hatton and Smith (1995) there are several fundamental flaws in Valli's conception of reflection levels, especially with regard to the placement of Schön's reflection-

in-action at level 3. From his own description this would appear to be the most complex and demanding kind of reflection which needs considerable experience (Schön, 1983).

2.3.3 Jay and Johnson's levels of reflection

Jay and Johnson (2002) examined the various facets of reflection with respect to teaching and subsequently outlined a systematic classification of reflective thought on three dimensions.

The first level of reflection is **descriptive reflection** which involves describing a situation or a problem. Such problems may be specific and explicit, as when teachers know that the curriculum is not working for their students and find they need to make a change, or vague and implicit, as when teachers sense a resistant tone from a class but do not know why (Jay & Johnson, 2002).

The second level of reflection is **comparative reflection** which involves thinking about the situation from different perspectives. As opposed to a technical approach to teaching, in which a teacher accepts a problem immediately and sets about trying to solve it, a reflective practitioner looks for *distinct ways to pose a problem and attempts to get a different purchase on the students and the issues involved* (Zeichner & Liston, 1996, pp. 4-5). On this level teachers try to solve a problem while also questioning their values and beliefs.

The third level of reflection is **critical reflection** and on this level teachers consider all the different perspectives of a situation or problem and all the players involved: teachers, students, the school, and the community (Jay & Johnson, 2002).

Akbari (2007, p. 195) considers these levels of reflection useful, especially the last level, critical reflection, which she calls *the decision-making stage resulting from careful analysis of the situation and deliberation*. This last stage forms the basis for the formulation of alternative ways of teaching or approaching the problem on the part of the teacher.

2.3.4 Hatton and Smith's levels of reflection

Hatton and Smith (1995) contend that the reflective process was more developmental than hierarchical in nature. They defined three distinct levels of reflection. On the most basic level (in agreement with Van Manen (1970) and Valli (2002)), they place **technical rationality**. The nature of reflection on this level is a technical decision making about immediate behaviours and skills. On this level one begins to examine one's use of essential skills.

Hatton and Smith's (1995) second level of reflection is **reflection-on-action**. On this level they distinguish between *descriptive*, *dialogic*, and *critical* reflection (Hatton & Smith, 1995, p. 45). The nature of reflection-on-action is **descriptive** when one is analysing one's performance, giving reasons for actions; **dialogic** when one is weighing competing claims and viewpoints, exploring alternative ways of solving problems; and **critical** when one is thinking about the effect of one's actions upon others, taking into account social, political and cultural forces.

On the highest level they define **reflection-in-action**, where one is dealing with on-the-spot professional problems as they arise (Hatton & Smith, 1995).

2.3.5 Lee's levels of reflection

Lee (2005, p. 703) proposes the following levels to assess the content and depth of reflective thinking:

On a **recall level** (R1) one describes what they experienced, interprets the situation based on recalling their experiences without looking for alternative explanations, and attempts to imitate ways that they have observed or were taught.

On a **rationalization level** (R2) one looks for relationships between parts of their experiences, interprets the situation with rationale, searches for "why it was," and generalizes their experiences or comes up with guiding principles.

On a **reflectivity level** (R3) one approaches experiences with the intention of changing/ improving in the future, analyses experiences from various perspectives, and is able to see the influence of cooperating teachers on students' values/behaviour/achievement.

The following table summarises the proposed levels of reflection by the researchers discussed in this section. From the table it appears that although there is little agreement among researchers on the labels used to describe the various levels of reflection, the levels generally appear not to overlap each other. However, Hatton and Smith (1995) believe that Schön's reflection-on-action and reflection-in-action incorporate all levels of reflection, even critical reflection.

Table 2.1 Summary of levels of reflection proposed by researchers

Researcher	Reflective levels
Dewey (1933)	• Interpretation of experience • Description of experience • Analysis • Action
Hatton and Smith (1995)	• Technical rationality • Reflection-on-action • Reflection-in-action
Jay and Johnson (2002)	• Descriptive reflection • Comparative reflection • Critical reflection
Lee (2005)	• Recall level • Rationalisation level • Reflectivity level
Valli (1992)	• Behavioural • Technical reflection • Reflection-in and on-action • Deliberative reflection • Personalistic reflection
Van Manen (1977)	• Technical rationality • Practical action • Critical reflection

As can be seen from the table these theorists/researchers use different terms to identify the levels of reflective thinking. According to Lee (2005) reflection on Level 1 is mainly concerned with mastery and/or application of technical means for achieving given educational ends, and includes a simple description of observation or a focus on behaviours or skills from past experience. Reflection on Level 2 is directed at an interpretive understanding of the meanings of educational experiences and choices of action within a particular social and institutional context (Lee, 2005). Reflection on Level 3 links classroom practice to the broader arena of political, moral, and ethical forces (Lee, 2005). Reflection on the first level **directs** a teacher's practice, while reflection on the second level **informs** a teacher's practice through examining his/her beliefs that guide actions in light of context. Reflection on the third level **transforms** practice, *for it reconstructs experience in light of a life characterized by justice and equality* (Lee, 2005, p. 703).

2.4 Research studies in education investigating teacher reflection

In this section I will first report on research studies in teacher education investigating preservice teachers' reflection, and then explore research studies dealing with practising teachers' reflections. Lastly I will focus on research studies dealing with mathematics

teachers' reflective practice. I will use these studies to explore the different meanings of reflection found in the literature, the content of teacher reflection (what do teachers reflect on?), the nature of student teachers' and teachers' reflection (how do they reflect?), the moment of reflection (when do they reflect?), the benefits of and barriers to reflection reported in the literature, and the contextual factors that might influence teacher reflection.

2.4.1 Overview of research studies dealing with preservice teachers' reflections

From my literature review I have found that researchers focus on different research lines when investigating preservice teachers' reflections. Whereas many researchers are concerned about the **definition** of reflection (Hatton & Smith, 1995; LaBoskey, 1994; Lee & Tan, 2004), some focus on the **content** of student teachers' reflections (LaBoskey, 1994; Lee, 2005; Liou, 2000; Mewborn, 1999; Pedro, 2001), while others explore the **nature** of these reflections (Loughran, 2002; McKeny, 2006; Ottesen, 2007). Some researchers address the **moment** of reflection (depending on the methods they use to collect their data) (Pedro, 2001), a few mention **benefits** of reflection (LaBoskey, 1999) and some consider **contextual factors** that play a role in student teachers' reflection on practice (Lee & Tan, 2004). It seems that research on reflection in teacher education can be explored using the following lenses (as illustrated in Figure 2.1):

1) **definition** of reflection or reflective thinking;
2) the **content** of the preservice teachers' reflections;
3) the **nature** of their reflection;
4) the **moment** of reflection;
5) **benefits** of reflection or barriers to reflection; and
6) **contextual** factors that influence preservice teachers' reflections.

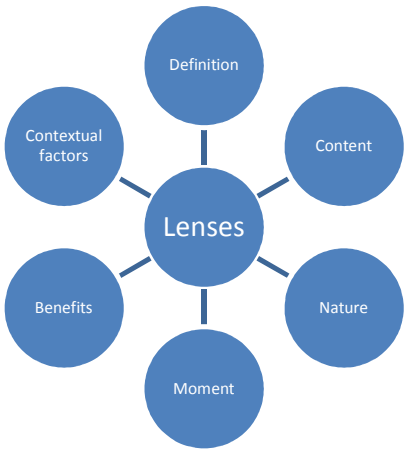


Figure 2.1 Lenses used to explore studies dealing with preservice teachers' reflections

A brief discussion of studies on reflection in teacher education follows. As will become clear, the studies focus on different facets of reflection, as depicted in Figure 2.1.

2.4.1.1 Concerns about the definition of reflection as revealed in studies dealing with preservice teachers' reflections

According to Hatton and Smith (1995) reflection is claimed as a goal in many teacher preparation programs, but its **definition** and how it might be fostered in student teachers are problematic issues. They cite Dewey (1933) who considered reflection as a special form of problem solving and debate whether reflection is limited to thought processes about action, or whether it is more inextricably bound up in action (Hatton & Smith, 1995).

Although Schön (1983; 1987) clearly relates reflection to action, using his terms "reflection-in-action" and "reflection-on-action", other researchers seem to view reflection as a special form of thought, (Artzt, Armour-Thomas & Curcio, 2004; Sparks-Langer & Colton, 1991). According to Rodgers (2002) thinking, particularly reflective thinking or inquiry, is essential to both teachers' and students' learning. However, she claims that *although the cry for accomplishment in systematic, reflective thinking is clear, it is more difficult to distinguish what systematic, reflective thinking is* (Rodgers, 2002, p. 842). She mentions four problems associated with this lack of definition that make achievement of such a standard difficult (p. 843):

1) It is unclear how systematic reflection is different from other types of thought.
2) It is difficult to assess a skill that is vaguely defined.
3) Without a clear picture of what reflection looks like, it has lost its ability to be seen and therefore has begun to lose its value.
4) Without a clear definition, it is difficult to research the effects of reflective teacher education and professional development on teachers' practice and students' learning.

According to LaBoskey (1994) one problem in using the term "reflection" in teacher education is that it is not made clear which particular meaning one has in mind. A second problem is that the definitions are not used consistently by the theorists, researchers, or teacher educators who employ them (*ibid.*). These views are supported by a number of researchers (e.g. Rodgers, 2002; Sparks-Langer & Colton, 1991; York-Barr *et al.*, 2006). However, she agrees that there are many well-constructed meanings of reflection and mentions Dewey's notion of reflection as the *active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the*

further conclusions to which it tends (LaBoskey, 1994, pp. 3-4). Dewey (1933, pp. 100-101) characterises reflection as a specialised form of thinking and describes its function as *transform[ing] a situation in which there is experienced obscurity, doubt, conflict, disturbance of some sort, into a situation that is clear, coherent, settled, harmonious*.

LaBoskey's **definition of reflective thinking** is based on what Dewey (1933, p. 8) called *grounded belief*: *Reflection thus implies that something is believed in (or disbelieved in), not on its own direct account, but through something else which stands as witness, evidence, proof, voucher, warrant; that is, as ground of belief*. LaBoskey (1994, p. 9) contends that good teaching requires thoughtful, caring decision making and that good teachers are constantly making decisions and formulating ideas about educational goals, practices and outcomes, and *these definitions and ideas are subjected to careful reconsideration in the light of information from current theory and practice, from feedback from the particular context, and from speculation as to the moral and ethical consequences of their results*. However, she claims that *reflective thinking is a necessary, though not sufficient, component of the teaching process* (LaBoskey, 1994, p. 122).

Pedro's (2001) qualitative study explores how five preservice teachers construct meanings of reflection, and how these meanings inform their practice. He (2001) found that the preservice teachers who were participants in his study possessed varying notions of reflection in teaching as interpreted in their **definitions of reflection**. Two of these participants stated that they looked back on their actions to think about what they could have changed; while three other participants said that they wanted to see what they could do to change or improve their performance in the future.

Lee and Tan (2004) propose four critical attributes as criteria to **define** and distinguish reflection from ordinary forms of thinking. The first criterion is an examination of practice, where reflection is not merely recalling a teaching incident in a general manner, but reflective thinking is seen as focused and directed at particular issues or concerns about practice (Lee & Tan, 2004). Reflective thinking is triggered by the need to examine one's practice because there is an awareness of some problematic aspects (*ibid.*, 2004). The second attribute of reflection which they mention is reflexivity or reflective awareness, which unites the external world (the classroom situation) with the internal world (personal beliefs, assumptions and values) of the practitioner (*ibid.*, 2004). Thirdly they regard reflection as a constructive process on which the reflective teacher is not merely practising his/her craft passively or without questions, but responds actively to potentially problematic situations (*ibid.*, 2004). The fourth attribute that Lee and Tan (2004) regard as a criterion to define reflection is a

process of transformation, whereby in the teacher education context, reflection aims at fostering professional growth which will leave the teacher with transformed understandings of the situation and a heightened sense of the self-as-teacher.

McKeny (2006, p. 18) agrees with other researchers (e.g. LaBoskey, 1994; Lee & Tan, 2004; Pedro, 2001) that *there is little consensus as to what constitutes reflection and what teacher educators might do to foster its development*. He **defines reflective teaching** as *the active use of reflection on the part of the participants in both oral and written forms as a way of coming to understand the complex task of teaching and coming to understand their efforts in the act of teaching* (p. 15). Reflection by preservice teachers is operationally defined as *an interactive process of reporting, reviewing and rethinking previously held beliefs and dispositions about teaching and learning as a means of developing personally useful and practical knowledge into action within the classroom* (McKeny, 2006, p. 19).

2.4.1.2 Research studies reporting on the nature of preservice teachers' reflections

It seems as if different interpretations are attached to what the "nature" of a teacher's reflection constitutes. LaBoskey (1994) investigated the nature and stability of reflection in preservice teacher education and a possible means for its measurement. Her research includes an exploration of the **interactions between individual beliefs, attitudes, emotions and inquiry skills and a particular reflective strategy**. Twelve student teachers enrolled in the same teacher education programme were selected as participants. Six of these students were rated as most reflective at the time of enrolment and called the *alert novices*, whereas the other six were rated as least reflective and called the *commonsense thinkers* (LaBoskey, 1994, p. xii). She found that the alert novices were concerned with "why" they were doing what they were doing, and with the meanings and implications of their values and philosophies (LaBoskey, 1994). An example of a "why" question is: "Why am I teaching what I am teaching in the way that I am teaching it?" (p. 108). Only two of the commonsense thinkers asked "why" questions, which means that four students were not concerned with reflecting on what they were doing. This finding is confirmed by Russell *et al.* (1988, p. 88) who cite examples of *both beginning and experienced teachers who seem unable to reflect on their practices, unable to reframe their problems and unable to interpret their practices in more than one way*.

The nature of the preservice teachers' reflections in Pedro's study (which he calls the **context in which reflection takes place**) was revealed through their self-reflections, verbal reflections and written reflections and journals (2001). All the students reflected on a technical level, and some engaged in reflections at the interpretive level when they moved

beyond thinking about their skills and knowledge, to think about the consequences of their actions, and the goals of teaching (Pedro, 2001). He reports that *the preservice teachers in this study demonstrated their ability to reflect with their peers and others about technical, as well as interpretive, and to some extent critical issues that they had dealt with in their practice* (p. 158).

Lee (2005) investigated three student teachers' reflective thinking in field experiences in Korea. The data collection involved interviews, observations, written journal entries and questionnaires. Lee (2005) found that these student teachers' reflective thinking levels were affected by the **mode of communication**. Some showed strength in written reflections while others reflected more deeply in the verbal format. It seems as if it is important to create various opportunities for reflective thinking, rather than to limit students/teachers to a particular approach. The students in this study all reflected on the three levels proposed by Lee (2005): Recall level, Rationalisation level and Reflectivity level. However, Lee (2005) found that the development of student teachers' reflectivity is influenced by conditions such as the cooperating teacher's characteristics, teaching opportunities and the teaching context.

Ottesen (2007) also investigated how student teachers reflect on their practice and what they accomplish through these reflections and found that although reflection is evident in nearly every session, it is commonly neither systematic, nor extended in time. She found that the **objects of reflection** emerge from puzzling or disturbing aspects of teaching experiences, or some problem they experience when planning their lessons (Ottesen, 2007).

According to McKeny (2006) the nature of preservice teachers' reflection is revealed only when they experience cognitive dissonance. *As long as classroom activities and processes run smoothly, there is no true call for learning and reflection* (*ibid.,* 2006, p. 421). When a problem arises the **level of reflection** is technical and practical in the sense that the problem situation is considered, potential action is considered and concerns for the possible implications for student learning are considered (McKeny, 2006).

Husu, Toom and Patrikainen (2008) also studied the **quality** (depth) of eight student teachers' reflection using the procedure of guided reflection and report that contrary to many previous studies (they cite Dinkelman, 2000; Francis, 1995; Harrington, Quinn-Leering, & Hodson, 1996) student teachers are capable of using various kinds of reflection when analysing their teaching practices. Furthermore, Husu *et al.* (2008) share the common assumption that it is hard for student teachers to move beyond immediate concerns of their teaching practice (habituation) to addressing long-term inquiries in their profession.

Ward and McCotter (2004) analysed exemplars of student teachers' reflection to study their **levels of reflection** by using a reflection rubric that consists of four levels of reflection: Routine (low level reflection lacking questioning and a sense of responsibility for change); Technical (reflection is used as a means to solve specific problems); Dialogic (discussion and consideration of the views of others) and Transformative (questions fundamental assumptions and purpose more deeply). They found that the reflections of beginning teachers reinforce the fact that reaching levels of transformative reflection is unusual and difficult (Ward & McCotter, 2004). Watts and Lawson (2009), who used Ward and McCotter's rubric (2004) in a meta-analysis activity where students identified the quality of critical reflection in their lesson evaluations, found that the activity can result in a qualitative improvement in the nature of critical reflection (Watts & Lawson, 2009).

2.4.1.3 Research studies reporting on the content of preservice teachers' reflections

The **content of reflection** of the participants in LaBoskey's (1994) study consists of reflections on the student, the teacher and the lesson. Only a few of these preservice teachers reflect on the personal enjoyment and degree of enlightenment gained from the teaching experience. In this study the data were collected using *case investigation write-ups*, *freewrites, questionnaires, supervisor summaries and interviews* (LaBoskey, 1994, pp. 32-34). The preservice students were not observed in the classroom.

Lee (2005) assessed student teachers' reflections and found that there are variations in the content, and that the pace at which reflective thinking deepens depends on the student teachers' personal background, field experience contexts, and the mode of communication. The three student teachers in this study reflected on pedagogical issues (curriculum/content, instructional skills, lesson preparation, and teaching styles), learner behaviour, and the gap between the ideal and the reality of education (Lee, 2005). The study provides insights into how to measure the quality of reflective thinking and how to enhance reflective thinking and cultivate reflective practitioners, including the kinds of experiences that could be incorporated in a teacher education program (Lee, 2005).

Liou (2000) studied 20 student teachers' written reports on their teaching practice and found that student teachers reflect on topics related to teaching and that the level of their reflections is more descriptive than critical. The student teachers wrote about theories of teaching and teaching approaches, classroom management and evaluating own and other teachers' teaching in their reports.

In a study of four preservice teachers during a field experience connected to a mathematics methods course, Pedro (2001) found that curriculum matters seemed to interest four of the preservice teachers in his study. The preservice teachers thought about their lesson planning, and how they could adapt the lessons to suit the diverse needs of the students. Assessment was another area that interested these preservice teachers. They reflected on the various forms of assessment they used in their student teaching practice. The issue of the diversity of students with special needs (and also diversity of race) seemed important to the preservice teachers who reflected on their concern for students with special needs in the classroom.

Mewborn (1999) investigated elements of mathematics teaching and learning that four preservice elementary teachers' found problematic during a field-based mathematical methods course. She identified four areas of concern that these preservice teachers reflected on (listed in the order they were addressed): 1) matters of classroom organization (physical arrangement of classroom) and management (behaviour of individual children); 2) mathematics pedagogy; 3) children's mathematical thinking; and 4) mathematics content.

2.4.1.4 Research studies reporting on the moment of student teachers' reflection

Student teachers reflect on their actions when encouraged to do so through reflective writings and journal entries, in interviews or during conversations with their mentors (Griffin, 2003). The moment of reflection will therefore usually be after-action. During classroom observations researchers might be able to see reflection-in-action. Hatton and Smith (1995) argue that it is therefore important to employ different methods to investigate teachers' reflections.

Griffin (2003) used critical incidents in a supervised field experience to increase the capacity of preservice teachers to develop reflective and critical thinking skills. These critical incidents provide a deeper and more profound level of **reflection-on-action** because it goes beyond a detailed description of an event that attracted attention, to analysis of a reflection on the meaning of the event (Griffin, 2003). The incidents were collected after the participants' field experience and reflections were analysed by a panel. The majority of the reflections were placed on Van Manen's (1977) Levels 1 and 2. The critical incidents appeared to assist concrete thinkers to look beyond themselves and the immediate situation to larger, contextual issues (Griffin, 2005).

The moment of reflection for the four preservice teachers in Pedro's study (2001) was after teaching a lesson, in other words they reflected **on-action**. They thought about actions that

did not go well in the classroom, and they questioned what could be done to change those actions (Pedro, 2001). Only one of the student teachers in this study reported how he reflected **in-action** (Pedro, 2001, p. 148): *I can reflect instantly, and I can tell by the class atmosphere if students understand things and you can instantly change your mind.* Three of the preservice teachers also thought about how they would change their actions in future (*reflection-for-action*) (*ibid.,* p. 114). The data was obtained through individual interviews, reflective journals and observation.

As far as the moment of reflection is concerned, Lee and Tan (2004) found that the participants' in their study only reflected when they encountered **problems** in their lessons. This over-emphasis on teaching problems prevented student teachers from deliberating on other aspects of teaching with their supervisors (Lee & Tan, 2004). The data for this study was collected using observations, post-conferences, interviews and artefacts (Lee & Tan, 2004).

2.4.1.5 Research studies reporting on the benefits of or barriers to reflection

It has been suggested by a number of researchers that there are certain **benefits** of reflective practice (Brubacher, Case & Reagan, 1994; Craft & Paige-Smith, 2008; Farrell, 2004; Loughran, 2002; Sowder, 2007; Valli, 1992). For example, Zeichner and Liston (1996, p. xvii) believe that it is through reflection on our teaching that we become more skilled, more capable, and in general better teachers. It seems that when teachers reflect on their practice they identify problems they experience while teaching and are able to make sense of their learners' understanding of concepts. García, Sánchez, Escudero and Llinares (2006) report that through reflection they have developed their own identity as teacher educators and as a consequence of reflection, their practice as teacher educators started to be modified and led to new understandings about how their student teachers learn.

However, LaBoskey (1994) found that some of the preservice teachers who were less likely to reflect were very good teachers who were skilful, well organised, and productive in the classroom. From her research it seems that reflection is not a prerequisite for being an effective teacher, although she claims that

> *we cannot afford to have teachers who are unwilling or unable to analyze the sources, meanings, and implications of their beliefs about their students and the learning process; who do not attempt to examine the nature of problems and their underlying causes or to explore alternative solutions* (LaBoskey; 1994, p. 123).

Loughran (2002) examined the value of reflection as a meaningful way of approaching learning about teaching so that a better understanding of teaching, and teaching about

teaching might develop. He concludes that *many teacher education programs have incorporated views of reflection into their course structures, but the effectiveness and forms of adoption may well be limited by the largely traditional nature of the programs to begin with* (Loughran, 2002, p. 42). Lee (2004) reports that reflective teacher education programmes lack clear conceptual focus because the concept of reflection is used in a generic sense. He believes that without supportive contexts, reflection fails to support student teachers' professional development, especially when the supervisors lack clear a understanding of reflection, which can be seen as a **barrier** to promoting reflective practice (Lee, 2004).

2.4.1.6 Research studies reporting on contextual factors that influence reflection

Lee and Tan (2004) investigated how reflection was implemented in the Malaysian teacher education context. Their findings indicate that student teachers reflect not only publicly through existing mechanisms (e.g. post-conference discussions, post-lesson analyses and weekly journals), but also privately by examining their own teaching, their pupils, and their beliefs or values on teaching. These private reflections were obtained through informal interviews. The public reflections were very weak in contrast with the private reflections that were rich and varied (Lee & Tan, 2004). Some reflections were focused mainly on technical skills such as how to implement activities, give instructions, or manage the pupils. On the private level Lee and Tan (2004, p. 126) found that students thought about *complex issues that were not directly related to day-to-day teaching events, for example the heavy responsibilities of teaching, their values, and their inadequacies as teachers*. Two significant findings were: 1) student teachers' reflective practices lack an element of enquiry, and 2) reflective practices were carried out individualistically.

Lee and Tan (2004) identified the following main **contextual factors that influence** reflection: 1) Interpersonal contexts play a crucial role on student teachers' understandings and practice of reflections. They report (Lee & Tan, 2004) that the mentor lecturers did not guide the students' reflections and the student teachers were left to learn to teach purely from their own experience. 2) Personal dispositions play a role in student teachers' practice of reflection. Lee and Tan (2004, p 137) report that *not all individual student teachers are equally predisposed to be reflective on their practices.* Competence and confidence have emerged as important factors.

2.4.2 Summary

Table 2.2 provides a summary of the studies discussed above dealing with preservice teachers' reflection.

Table 2.2 Summary of studies on preservice teachers' reflective practice

	Definition of reflection	**Content of reflection**	**Nature of reflection (Reflection levels)**	**Moment of reflection**	**Obtained by using …**	**Benefits/Barriers of reflection**	**Contextual factors that influence reflection**
LaBoskey (1994)	Constant reconsideration	Student, teacher and the lesson	Revealed by "why" questions, directed at the roots of problems and the meanings of ideas and actions (Van Manen's Levels 1, 2 and 3)	After action	The written word	Not evident in the study	Not evident in the study
Mewborn (1999)	Reflection is qualitatively different from recollection or rationalisation. Action is an integral part of the reflective process	Classroom context; Pedagogy of teaching mathematics; Children's mathematical thinking; Mathematical content	Used Dewey's phases of reflective thinking	After action	Individual interviews, group discussions, individual journals and teaching episodes	When thinking reflectively about the multiple aspects of their teaching, field experiences can have a positive effect on student teachers' learning about teaching mathematics	Teaching environment that promotes investigation and inquiry into the problems of mathematics teaching
Liou (2000)	Critical reflection is examining teaching experiences as a basis for evaluation and decision making and as a source for change	Practical teaching issues and evaluating other teachers' and own teaching	Mostly descriptive reflection and less critical reflection	No systematic procedures for reflection-in- and on-action evident in the study	Written reports by the students	Critical reflection raises teachers' awareness about teaching, enables deeper understanding of themselves as teachers and triggers positive changes in practice	Support needed from the educational system and the sociocultural context
Pedro (2001)	Thinking about an action to make some change	Curriculum, assessment and diversity of students	Van Manen's levels: Level 1: (technical reflection) and Level 2: (practical or interpretive reflection)	Reflection-on-action and reflection-for-action	Interviews, reflective journals and observation	Reflection as a conceptual device to help think about knowledge, and better teaching skills	Not evident in the study

Lee and Tan (2004)	Examination of practice in response to problem situation to obtain professional growth	Professional and own growth	Publicly on a technical level in problem situations (Level 1) and privately on practical and even critical levels (Levels 2 and 3)	Reflection-in-action and on-action	Observations, post-conferences, interviews and artefacts	When teachers act reflectively, they consider carefully the problems in their own teaching and think about how those problems are related to their educational and social contexts	Interpersonal contexts (mentor teachers) and personal disposition (competence and confidence) of teacher
Ward and McCotter (2004)	Reflection is situated in practice, cyclic in nature and makes use of multiple perspectives	Prior knowledge, instructional strategy, struggling students	Hatton and Smith's levels	After the action with reflective notes	Reflective text, lesson plans, samples of student work	Not discussing the qualities of good reflection with student teachers is a barrier to their reflective practice	Scaffolding needed to reach higher levels of reflection
Lee (2005)	Any form of thinking	Discipline, instructional skills, relationship with students	Recall level (R1); Rationalisation level (R2); Reflectivity level (R3)	Reflections focus on what they had observed, done and were unable to do, and hoped to do in future	Interviews, observations and written documents	The lack of a clear definition of reflection and vague criteria to assess the quality of reflective thinking create problems in implementing reflective activities	Cooperating teachers' characteristics; teaching context
McKeny (2006)	Rethinking previously held beliefs about teaching in order to develop as a teacher	Mathematics content, teaching styles, own competence as a teacher	Only in a problem situation and then on a technical and practical level (Levels 1 and 2)	Reflection-on-action	Questionnaires, reflective writing, observations, interviews, focus groups, supervisor feedback forms	Teacher growth, personal growth, professional growth and building a supportive community of learning	Mentor teachers, honesty and integrity of feedback, and personal freedom to explore own thinking
Ottesen (2007)	Reflection is seen as embedded in and emerging from activity. Thus, reflection is a social activity.	Puzzling or disturbing aspects of teaching experiences	Reflection as induction; reflection aimed at conceptual development; reflection on experience	When confronted with puzzling situation	Analyses of recorded conversations between student teachers and mentors	The motivation for reflective action must be sought in the object to be transformed	Interpersonal contexts

Husu, Toom and Patrikainen (2008)	Reflection is believed to be a genuine way of fostering change	Critical incidents selected by the student teachers	Habitual reflection and introspective reflection	After critical incidents	Analysing critical incidents	Students reported professional growth	Implementing the procedure of guided reflection in students' teaching practicum

From Table 2.2 it seems that most researchers agree that student teachers reflect on their actions when a problem situation arises in class. However, the nature of their reflection differs. Most preservice teachers reflect only on a technical level (Level 1), concerned with the effective application of skills and technical knowledge in the classroom setting (Brubacher, Case & Reagan, 1994). Some of these preservice teachers reflect on a practical level (Level 2), concerned with the assumptions underlying specific classroom practices as well as the consequences of particular strategies, curricula, and so on (*ibid.*, 1994). A few preservice teachers do reflect on a critical level (Level 3), which entails the questioning of moral, ethical, and other types of normative criteria related directly and indirectly to the classroom (*ibid.*, 1994)

According to LaBoskey (1994) reflection is incorporated in the goals and practices of the teacher education programmes in her study, and students must engage in acts of reflection in order to learn during the programme and beyond. Most of the preservice teachers reflect on-action after the teaching experience; although a few reflect for-action (also after the teaching experience but considering future actions should they experience the same problem situation again). They reflect on the student, the teacher and the lesson, but also on curricula, assessment and student diversity. The preservice mathematics teachers also reflect on the content they have to teach.

One of the benefits of reflection is to grow as a teacher, both professionally and personally (Sowder, 2007). However, LaBoskey (1994) found that some of those students whom she regarded as less reflective than others also turned out to be effective teachers. This is in contrast with the findings of a number of theorists and researchers (e.g. Dewey, 1933; Schön, 1983, 1987). According to Brubacher, Case and Reagan (1994, p. 18) *good teaching requires reflective, rational, and conscious decision making*.

One of the major contextual factors which seem to have an impact on preservice student's reflections is the role of mentor teachers. However, personal dispositions (like the competence and confidence of the preservice teacher), together with the quality of feedback from mentor teachers and university supervisors also appear to play a significant role.

2.5 The reflective practice of practising teachers

2.5.1 Introduction

It is generally acknowledged that reflection is an important part of the professional behaviour of teachers and essential for the stimulation of their professional development (Luttenberg & Bergen, 2008; Schön, 1983, 1987). Krainer (2001) regards action, reflection, autonomy and networking as four dimensions of teachers' professional practice (illustrated in the figure below). Krainer (2001) argues that most teachers are placed in the first quadrant, where there is much action and autonomy but less reflection and networking, in the sense of critical dialogue about one's teaching with colleagues, mathematics educators, the school authority, the public, and so forth. The author regards the promotion of reflection and networking as a powerful intervention strategy in the professional development of teachers (Krainer, 2001).

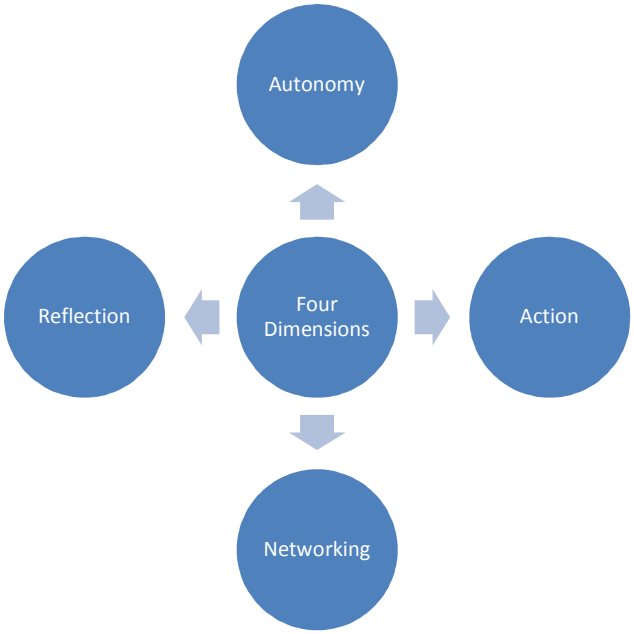


Figure 2.2 Four dimensions of teachers' professional practice (Adapted from Source: Krainer, 2001, p. 288)

In this section I will review the literature on practising teachers' reflective practices in more detail. I will also focus on evidence in the literature on the conditions that allow teachers to become reflective practitioners, the characteristics of a reflective teacher, why it is necessary to develop teacher reflection and the benefits of reflective practice. I will also investigate possible barriers to teacher reflection.

Brookfield (1995) proposes four lenses for teachers to become **critical reflective practitioners**: 1) the autobiographical lens (or self-reflection), 2) the students' eyes (student feedback), 3) colleagues' experiences (peer advice, mentoring and feedback) and 4) theoretical literature (teachers who research, present, or publish scholarly literature). In the following sections I will review the literature on reflective practice using these lenses.

2.5.2 Teacher reflection through self-study

Self-study involves inquiring into one's thinking, learning and instructional practices (Chapman, 2008). According to Moss (2008, p. xiii) reflection is generally regarded as a dialogic process, in which the dialogue may be with the inner self (*interior listening*). Ghaye and Ghaye (1998) refer to this process as a **reflective conversation**, which allows one to consider and question the values that one is committed to. Although these conversations may initially be private conversations with the self, at some point they are articulated with others (McIntosh, 2010). According to McIntosh (2010, p. 47) questions such as *What is my practice like? Why is it like this? How has it come to be this way? What are the effects of my practice?* and *How can I improve what I do?* enable a critical distance from reflective practice and the context in which it takes place. York-Barr *et al.* (2006) suggest a very similar process, which they call the 4-step process for guiding individual reflection, consisting of the following questions: 1) What happened (description) 2) Why? (analysis, interpretation) 3) So what? (overall meaning and application) and 4) Now what? (implications for action).

A number of researchers have investigated their own reflections while teaching as a result of **self-study** (Attard, 2008; Bartlett & Burton, 2006; LaBoskey, 2004; Loughran, 2007). Loughran (2007, p. 12) reports that *a central purpose in self-study is uncovering deeper understandings of the relationship between teaching about teaching and learning about teaching.* According to Dinkelman (2003) self-study is the intentional and systematic inquiry into one's own practice.

Hillier (2005) suggests that one way to start this process is to focus on a **critical incident** that occurred while teaching. According to Griffin (2003, p. 208) *a critical incident provides a deeper and more profound level of reflection because it goes beyond a detailed description of an event that attracted attention, to analysis of and reflection on the meaning of the event*. An example of a critical incident that forced him to critically reflect on his practice is mentioned by Kwok (2005). In his class, dealing with spirituality, two students raised the issue of race, and he was unprepared to deal with this sensitive issue (being of Asian origin himself). This incident caused him to reflect deeply on his own teaching of spirituality with a diverse group of students.

However, Convery (1998) argues that, for many teachers, the central impediment to fundamentally improving their practice is their self-protective individualism. He questions the possibility of improving practice through individual self-study. In his experience collaboration was crucial in helping him to develop beyond a reflective practice which focused on techniques for improving classroom experiences, to a reflexive appreciation of his actions (Convery, 1998). Moss (2008) agrees with this argument and claims that much of the time reflection involves relationships with others, listening to others and being listened to, thus contributing to a **community of practice**. In the next sections I will briefly review literature on teachers' reflection on feedback they receive from their learners and from their colleagues.

2.5.3 Teacher reflection on feedback from learners

Loughran, (2002, p. 33) states that *for reflection to genuinely be a lens into the world of practice, it is important that the nature of reflection be identified in such a way as to offer ways of questioning taken-for-granted assumptions and encouraging one to see his or her practice through others' eyes*. In my review of the literature I have found a paucity of evidence of teachers allowing learners to provide feedback on their teaching. One exception is Lighthall (2000, p. 154), who describes how he investigated his own teaching practice by reflecting after class with his students in, what he calls, a *pedagogical laboratory*. During this reflection the students revealed details about his teaching that were important to them.

Another researcher who allowed his learners (student teachers) to comment on his practice is Russell (2007) who, in the last 3 or 4 minutes of each class, gave each student an index card or small piece of paper and asked for responses to questions such as "What is the main idea you are taking from today's class?" and "What further questions do you have about something we did or discussed?" As the year proceeds, there are times when comments are entered anonymously on an electronic bulletin board, where all members of a class may read them. Russell (2007) reports that he was impressed by the value of this practice as a way of fostering clear communication between teacher (himself) and learners (students) and also among his learners (students).

2.5.4 Teacher reflection in communities

In order to achieve critical reflection, Day (1999) argues that other teachers are needed in the process. Systematic investigation of practice with the help of a critical colleague can enhance the reflective process. Teachers may for instance find it beneficial to come together in groups or teams to discuss their teaching in a supportive atmosphere (Farrell, 2004).

According to Pollard (2002) the value of engaging in reflective activity is almost always enhanced if it can be carried out in association with other colleagues. York-Barr *et al.* (2006) agree with Pollard and maintain that reflecting on practice with another person has the potential to greatly enrich understanding and support improvements in practice. They believe that reflecting with a partner can assist in gaining awareness of fixed assumptions and help a teacher to view events from another perspective (York-Barr *et al.*, 2006). They distinguish between reflecting with partners (two or three people) and group or team reflection (teacher communities). When reflecting with partners *listening, thinking and coaching are central to fostering reflective practice* (York-Barr *et al.*, 2006, p. 114). They contend that reflective practice in the context of horizontal relationships is sometimes more powerful than in hierarchical relationships (for example where a novice teacher is coached by an expert teacher).

Farrell (2004) suggests the following activities to enhance teacher reflection:

1) Group discussions, in which teachers talk to their colleagues and build on one another's insights to analyse and interpret classroom data and their experiences in the school. Discussion and collaboration within a group facilitate the sharing of different knowledge, skills, expertise and viewpoints.
2) Classroom observations, where teachers observe their colleagues' classrooms. However, Farrell (2004) argues that these observations should be descriptions of classroom events and not judgments ont what should or should not occur in class.
3) Teaching journals, which Farrell (2004) believes are excellent tools to aid reflection. Teachers can write in their journals at any time to record criticism, doubts, frustrations, questions, the joys of teaching, and the results of experiments.
4) Teaching portfolios foster reflection because to compile them teachers must examine their professional strengths and weaknesses (Farrell, 2004).

Another way that teachers can reflect critically is by describing **a significant event** or practice (Hillier, 2005). The reflective cycle begins when the teacher describes a significant event he/she experienced in their teaching. It then enters a phase of interpretation, where the teacher looks for significance of the event being reflected on. In the next phase colleagues assist the teacher to compare their theories in practice with their espoused theories, and in the final phase the cycle moves to reconstructing, through which the teacher devises new ways of proceeding (Hillier, 2005).

2.5.5 Opportunities that potentially allow teachers to become reflective practitioners

Reflective teaching requires that teachers examine their values and beliefs concerning teaching and learning so that they can take more responsibility for their actions in the classroom (Korthagen, 1993). Most theorists (Farrell, 2004; Hillier, 2005; York-Barr *et al.*, 2006) agree that teachers need **time** and **opportunity** to reflect on their practice. Richert (1992) studied the conditions that influence the reflective capabilities of novice teachers through journal writing, portfolio-inspired reflection essays, conversations with peers, and conversations with more experienced teachers. The results of this study indicate that a structured opportunity to reflect, time, and safety, all emerged as important elements (Richert, 1992).

In the next sections I review the literature to attempt to identify situations that potentially allow teachers to become reflective practitioners (conditions that promote teacher reflection), for example professional development opportunities, lesson study and action research.

2.5.5.1 Professional development as an opportunity for teacher reflection

Professional development provides an opportunity for teachers to reflect critically on their practice. The ultimate goal of any professional development program supporting school mathematics reform should be to develop among teachers the mindset that they are lifelong inquirers (Borasi & Fonzi, 2002). This means both developing the appropriate expectations and mindset, and providing teachers with strategies and skills to inquire effectively. According to Barnett (1998) teacher inquiry plays a central role in many of the prevailing conceptions of teacher learning including critical reflection, reflection-in and on-action, personal and pedagogical theorizing, narrative inquiry, action research and teacher research.

Professional development helps teachers to develop a sense of self as a teacher of mathematics (Sowder, 2007). Knowledge of self develops when teachers regularly engage in *reflection, in, on, and about their values, purposes, emotions and relationships* (Day & Sachs, 2004, p. 9). Shedding anxiety about the teaching of mathematics can lead to a sense of empowerment (Sowder, 2007) for teachers engaged in a professional development programme. These teachers work collaboratively rather than individually and have more opportunities for reflection.

Borko and Putman (1995, 1996) reviewed the literature on professional development programmes, much of it in mathematics education, and concluded that there was substantial evidence showing that teachers in these programmes did experience significant changes in

their instructional practices, depending on opportunities for teachers to construct knowledge of subject matter and pedagogy in an environment that supports and encourages risk taking and reflection (Borko & Putman, 1995, p. 59).

2.5.5.2 Professional learning through lesson study

Darling-Hammond *et al.* (2009) report that in comparison to Asian and European countries, not enough time for **professional learning** is structured into the work lives of teachers' of the United States. In a professional learning environment teachers meet on a regular schedule in learning teams organized by grade-level or content-area assignments and share responsibility for their students' success (Darling-Hammond *et al.*, 2009). These authors (2009) propose that teachers should devote non-classroom time to collaborative planning, **lesson study**, peer observations and action research.

Lesson study refers to a process in which teachers progressively strive to improve their teaching methods by working with other teachers to examine and criticise one another's teaching techniques (Baba, 2007). According to Rutledge and Benedicto (2007) it is actually a form of action research that allows teachers to work with each other collaboratively as reflective practitioners. The lesson study process is cyclic and has the following basic components: 1) collaborative planning; 2) lesson observation; 3) reflection on the lesson; and 4) implementations of changes.

Lesson study has played an important role in professional development in **Japan** since the beginning of the public education system more than a hundred years ago. One of the reasons for this popularity might be that lesson study provides Japanese teachers with opportunities to do the following: a) make sense of educational ideas within their practices; b) change their perspectives on teaching and learning; c) learn to see their practices from a child's perspective; and d) enjoy collaborative support among colleagues (Takahashi, Watanabe & Yoshida, 2006).

In **South Africa** a school-based in-service education intervention programme, modelled along the lines of the Japanese lesson study, was launched in 2000 in Mpumalanga (Jita, Maree & Ndlalane, 2007). The conceptual framework for this initiative is based on the social constructivist theories of learning which assert the importance of learning in collaboration (Jita, Maree & Ndlalane, 2007). According to Jita, Maree and Ndlalane (2007) the lesson study approach has managed to establish a system in which teachers have grown accustomed to relying on each other, coaching, leading discussions and exploring alternative solutions to problems experienced in their teaching of mathematics.

Another study by Coe, Carl and Frick (2010) in a rural primary school in the Western Cape province sought to determine the value that a group of teachers placed on the process of lesson study as a model for their own learning and instructional improvement. The findings (Coe, Carl & Frick, 2010) highlight the following benefits of lesson study:

1) Lesson study offers an effective strategy to bring teachers our of isolation, allowing them to experience meaningful collaboration with fellow teachers.
2) The process of lesson study is embedded within the classroom context by setting goals and then planning instruction with the purpose of moving the learners closer to the goals. A connection between the content of the research lesson and the remainder of the curriculum is established. Furthermore lesson study provides an opportunity to observe the learners during the research lesson. The post-lesson discussion is also valuable to validate and develop the perceptions of learners in relation to the prescribed goal.
3) Lesson study has been experienced as the catalyst for transforming new instructional strategies into routine classroom practice.
4) Continuous support is embedded within the model of lesson study.

2.5.5.3 Professional learning through action research

Action research is an ongoing process of systematic study in which teachers examine their own teaching and learners' learning through descriptive reporting, purposeful conversation, collegial sharing, and reflection for the purpose of improving classroom practice (Sowder, 2007, p. 191). According to Sowder (2007) action research has multiple forms: teachers might work alone to pursue a research interest, they might work together in inquiry teams, or they might work with university researchers. Some concerns have been raised about the validity of action research by Jaworski (1998) who notes that the results reported by teachers should be seen in the context of these teachers' classrooms. Action research is a cyclical process of planning, acting and reflecting which teachers pursue to work on an element of their own practice (Goodchild, 2008).

In the next section I discuss the characteristics of a reflective teacher, as revealed in the literature. The benefits of teacher reflection and possible barriers to reflection will also be discussed.

2.5.6 Characteristics of a reflective practitioner

Dewey (1933) has suggested that teachers who want to be reflective practitioners must possess three characteristics. They must be **open-minded**, **responsible** and **wholehearted**. A teacher who is open-minded is willing to listen to more than one side of an

issue and give attention to alternative views (Farrell, 2004; Zeichner & Liston, 1996). A responsible teacher will carefully consider the consequences of his/her actions, especially as they impact on the students. When teachers act reflectively, they consider carefully the problems in their own teaching and think about how those problems are related to their educational and social contexts (Lee & Tan, 2004; Zeichner & Liston, 1996). Reflective teachers are aware of the consequences of their teaching and how their own assumptions or beliefs can influence their teaching. To be wholehearted implies a willingness to take risks and work through fears and uncertainties (Farrell, 2004). According to Zeichner and Liston (1996) teachers who are wholehearted regularly examine their own assumptions and beliefs and the results of their actions. Such teachers approach all situations with the attitude that they can learn something new (Zeichner & Liston, 1996).

Zeichner and Liston (1996, p.6) mention five key features that are central to reflective teachers. Teachers who are reflective 1) examine, frame and attempt to solve the dilemmas of classroom practice; 2) are aware of and question the assumptions and values they bring to teaching; 3) are attentive to the institutional and cultural contexts in which they teach; 4) take part in curriculum development and school change efforts, and 5) take responsibility for their own professional development.

Procee (2006) believes that reflective practitioners think about their experiences in practice and view them as opportunities to learn. They are concerned about the contexts of their practices and the implications for action, and they reflect on their assumptions and their theories of practice, and take action grounded in self-awareness. Finally, reflective practitioners recognise and seek to act from a place of praxis, a balanced coming together of action and reflection (Procee, 2006).

A summary of the discussion in Section 2.5.6 is given in Table 2.3.

Table 2.3 Summary of characteristics of a reflective practitioner according to different theorists

Theorist	Characteristics of a reflective practitioner
Dewey (1933)	Open-minded Responsible Wholehearted
Zeichner and Liston (1996)	Eager to solve dilemmas of classroom practice Awareness of own assumptions Attentive to institutional and cultural contexts Participation in curriculum development and school changes Take responsibility for own professional development
Procee (2006)	Consider experiences and learning opportunities Concerned about context of practice and implication for action Reflect on own assumptions Action grounded in self-awareness Act from a place of praxis

2.5.7 Benefits of reflective practice

The benefits of adopting a reflective practice are central to the purpose of this research study and can be divided in two broad categories: 1) gaining professional and personal knowledge and 2) changing/improving practice.

2.5.7.1 Gaining professional and personal knowledge

Korthagen (2001) believes that reflection broadens and deepens the professional development of teachers and thus their competence (Korthagen, 2001). He echoes Schön's (1983) argument that reflection helps teachers to find solutions in their own practice to problems which experts cannot solve with theories. Schön, (1987) maintains that when teachers are encouraged to develop a habit of reflection, they are more able to conceptualize and explain their classroom practices, thus gaining personal knowledge.

Darling-Hammond *et al*. (2009) mention that in some Swiss states, the new teachers in each district meet in reflective practice groups twice a month with an experienced teacher who is trained to facilitate their discussions of common problems for new teachers. In Singapore a Teacher's Network was established in 1998 to produce life-long learners by making schools a learning environment for everyone from teachers to policymakers and having knowledge spiral up and down the system. The network's mission serves as a catalyst and support for

teacher-initiated development through sharing, collaboration, and reflection. It has six main interrelated components: 1) learning circles, 2) teacher-led workshops, 3) conferences, 4) well-being program, 5) a Web site, and 6) publications (Darling-Hammond *et al.*, 2009).

2.5.7.2 Changing/improving practice

The primary benefit of reflective practice for teachers is a deeper understanding of their own teaching style and ultimately greater effectiveness as a teacher. According to Butke (2003) reflective teachers have the opportunity to think about their teaching behaviours and the context in which they occur, and through the cycle of looking back on events, making judgements about them, and then altering their practice based on craft, research, and ethical knowledge, teachers can effectively change their practice.

Rodgers (2002, p. 863) mirrors Dewey's view of reflection as a *vehicle used in the transformation of raw experience into meaningful theory that is grounded in experience.* According to him the process of reflection and steps of observation and description require the teacher to confront the complexity of learners and their learning, of themselves and their teaching, the content they teach and the contexts in which they operate (Rodgers, 2002). When teachers reflect after a lesson, they think back on their work, relating events that took place in the classroom to their understanding, taking into account their knowledge and expectations that influenced their plans for the lesson. These reflections might lead to further actions, changing current practices and seeking further resources that influence their planning of follow-up lessons.

2.5.8 Barriers to reflection

Butke (2003) divides obstacles that may be encountered in the process of reflection into the following categories: cultural barriers, issues of time, personal risk, and motivation. Brookfield (1995) mentions three **cultural barriers**: the culture of silence (teachers do not discuss their teaching practice with colleagues); the culture of individualism (teachers work in isolation) and the culture of secrecy (teachers are reluctant to reveal weaknesses, uncertainties and frustrations).

The perceived lack of **time** is, according to Butke (2003) a major constraint to reflection. Darling-Hammond *et al.* (2009) confirms that teachers lack time and opportunities to view each other's teaching, learn from mentors and work collaboratively.

Personal risks associated with critical reflection that can act as barriers against becoming a reflective teacher are for example the fear of being found out as a teacher who really does not know what he/she is doing (Brookfield, 1995).

According to Butke (2003) there is little incentive for a teacher to break away from habits and routines in the hope of advancing a teaching career. Teachers lack the **motivation** to become reflective practitioners.

2.6 Mathematics teachers' reflective practice

2.6.1 Introduction

In this section of the literature review I focus on research studies dealing with mathematics teachers' reflective practice. In my review of the literature I realised that research on mathematics teaching covers a vast range of themes, for example mathematical discourse or teacher change. These research studies address mathematics teachers' reflection on their practice indirectly, which presents me with a dilemma. Do I include these studies' findings or not? I have decided to include some of these studies to strengthen my argument that it is necessary for mathematics teachers to reflect on their practice in order to become more effective teachers, which will impact on their learners' understanding of mathematics.

A substantial body of research on teacher reflection and action has been conducted over the past four decades (e.g. Adler, 1990; Artzt, Armour-Thomas & Curcio, 2008; Brookfield, 1995; Butke, 2003; Convery, 1998; Griffin, 2003; Hughes, 2009; Korthagen, 1993; LaBoskey, 1994; Lee, 2005; Lee & Tan, 2004; Loughran, 2002; Mewborn, 1999; Nyaumwe, 2007; Pedro, 2001; Van Manen, 1977). This research contains a wealth of information on teachers' thinking about their daily work in classrooms. In this section I focus on studies that deal with mathematics teachers' thinking about their actions, before they teach lessons (reflection-for-action), while teaching lessons (reflection-in-action) and after they have taught lessons (reflection-on-action). The two domains that I focus on in this review are **action** and **reflection.** I report on those studies that link these two domains within the context of mathematics teaching.

My interest was to find established researched-based studies on teacher reflection and action. I focus only on practicing mathematics teachers' reflection and action and exclude any studies on mathematics teacher education, as this has been dealt with in Section 2.4. Studies dealing with teachers' self-study or action research are considered. I also refer to

studies that deal with teacher reflection in lesson study groups. In this discussion I focus on recent work (the term "recent" is defined here as the period 2000 – 2010).

Marcos and Tillema (2006) developed an analytical framework (see Table 2.4 for the adapted version) to review research on **action** and **reflection**. A brief discussion of this framework follows.

Table 2.4 Interpretive framework delineating studies on teacher reflection and action (Source: Adapted from Marcos & Tillema, 2006, p. 115)

Process measured	**Object studied**	
	Teachers' thinking	**Teachers' action**
What teachers say	**(a) Reflective thinking *about* teaching** *Object:* beliefs, prior knowledge about teaching (reported thinking) *Instrumental approach:* questioning	**(b) Reflection *on* action** *Object:* retrospective reflection on teaching (reported action) *Instrumental approach:* written documents (narrative inquiry)
What teachers do	**(c) Reflection (be)*for*(e) action** *Object:* prospective reflection about or in teaching (recorded thinking) *Instrumental approach:* written documents (plans and designs)	**(d) Learning by being engaged *in*/from action** *Object:* action (professional practice in teaching, recorded action) *Instrumental approach:* observation

From the table it appears as if this framework can be used to position studies in four categories (Marcos & Tillema, 2006):

a) Descriptive studies investigating how teachers' **beliefs** and prior knowledge interpret their work (studies focusing on **the teachers' voice**).
b) Studies on reported action; investigating **retrospective** accounts of actions that look back to interpret what was done (**reflection-on-action**).
c) Studies on teacher thinking; investigating teacher plans and intentions, taking their background and beliefs before taking action into account (**reflection-for-action**).
d) Studies on observed action; investigating in-depth how action itself exemplifies teacher knowledge (**reflection-in-action**).

Although these categories seem to be mutually exclusive, from my perusal of the literature I have found that researchers investigate combinations of aspects of teachers' reflective

practice. I am not convinced that researchers always differentiate between e.g. reflection-in-action and reflection-on-action in a reliable and valid manner. It seems necessary to clarify these terms once again, for the purpose of this review. The concept of teaching as **reflection-in-action** refers to the teacher's thinking about the teaching-learning process or problem-solving teaching/learning situations **while directly engaged in teaching**. Russell and Munby (1992, p. 4) consider the essence of reflection-in-action to be *hearing differently* or *seeing differently*. For Farrell (1998, p. 12) it is reflection that *gives rise to on-the-spot experimentation.* A teacher will demonstrate effective reflection-in-action when he/she changes his/her teaching approach in class after recognising that the approach is not working. The concept of **reflection-on-action** refers to the immediate thoughts **after teaching the lesson** on a) what the teacher might have done differently to meet the needs of learners even more explicitly, b) how the lesson could have been modified to solicit other particular kinds of thinking and representations of understanding from the learners, and c) how to solve logistical issues such as optimal learner groupings, ease of distribution of materials, or pacing of the lesson (Bruce, 2009). Reflection-on-action refers to recalling, explaining and evaluating after a lesson and includes thinking about reflections-in-action that were part of the lesson (Reed, Davis & Nyabanyaba, 2003). A description of these modes of reflection is summarised below in Table 2.5. **Reflection-for-action** is described by Farrell (1998, p. 12) as *proactive* in nature, where the teacher uses ideas from his/her reflections in-action and on-action to plan reflectively for future lessons.

Table 2.5 Summary of different modes of reflection
Source: Adapted from Boon Tiong, (2001)

Nature of thought	Description
Reflection-for-action	Before action – it leads to the design of actions and reactions
Reflection-in-action	During action – it leads to modification of action and learning while carrying out the designed action
Reflection-on-action	After action – it leads to retrospective evaluation and learning from remembered actions

From my review of the literature it seems as if most of the research studies focus on teachers' reflection-on-action. This may be because the research design of these studies allow for teachers to reflect on their practice during interviews.

2.6.2 Research studies linking reflection and beliefs about action

Cross (2009) conducted a collective case study to investigate the relationship between mathematics teachers' beliefs and their classroom practices. The study was part of a larger project focusing on the effects of mathematical argumentation (discourse) and writing on the

learners' understanding of Algebra. Five teachers of two high schools in a suburban county in the south-eastern United States agreed to be participants in this study. After orientation to the project the researcher observed each teacher twice while teaching. This was followed by a semistructured interview with each teacher to establish his/her views on mathematics as a discipline, mathematics pedagogy and learners' learning of mathematics. Over the next ten weeks each teacher was observed twice again, while the researcher took detailed field notes. After each observation the researcher and teacher had an informal discussion to elicit thoughts related to specific actions and decisions made during the lesson. Notes were taken during the discussions and copies of lesson plans as well as samples of work by learners were collected.

The teachers' narratives were examined and both similarities and differences regarding their views were observed. Three themes emerged: 1) A view of mathematics as computation versus a way of thinking, 2) Using demonstration rather than guidance as a teaching strategy and 3) Learners learn mathematics through practice rather than understanding. Three teachers described mathematics as formulas, procedures and calculations and two teachers considered thought processes and mental actions of the individual as fundamental aspects of mathematics (Cross, 2009). These views were translated into the teachers' classroom practice in two ways, the kinds of activities they designed and how they interacted with their learners.

As far as teacher reflection (gathered through reflective conversations with the researcher) is concerned, Cross (2009) reports that only by the end of the project, three teachers were beginning to question the effectiveness of their current practices. These teachers reported that although they had learnt alternative methods of designing and orchestrating instruction, they were not confident they could adopt these practices holistically, given the curricular and institutional constraints (Cross, 2009). This reflection on the part of the teachers was prompted by the fact that their learners performed poorly in conceptually rich tasks in relation to the learners in the larger project (Cross, 2009). She claims that it is clear that although the teachers welcomed the new practices they were filtered through the old belief system, resulting in minimal overall change (Cross, 2009). According to Cross (2009) belief change must be an ongoing process of awareness, confrontation and reflection. Her findings sustain Phillipp's (2007) argument that reflection is the critical factor for supporting teachers' changing beliefs and practices.

Another study which deals with the relationship between teachers' reflection and their beliefs was conducted by Warfield, Wood and Lehman (2005). Their sample consisted of seven

novice elementary mathematics teachers in a district that includes the portion of a county surrounding a mid-sized Midwestern city. The importance of reflection in learning, as well as the role of reflection in helping teachers connect their beliefs and practice, led them to question whether there were relationships among teachers' beliefs, their reflection, and their learning (Warfield, Wood & Lehman, 2005).

The seven participants engaged in private reflection on their teaching and the learning of their learners. Videotape was used to help the teachers reflect on their practice. In the first year of the project the teachers videotaped their mathematics lessons once a month. They developed a Personal Plan of Action (PPA) based on a dilemma they had encountered in their teaching, worked on that dilemma throughout the month, and used a structured procedure to analyse and reflect on their teaching (Warfield, Wood & Lehman, 2005). This procedure consisted of writing expectations related to the PPA prior to teaching the lesson; teaching and videotaping the lesson; watching the videotape and making detailed records of discourse that had occurred in the class discussion portion of the lesson; and comparing and contrasting their expectations with events that actually occurred. The expectations, records of discourse, and comparisons of expectations and what they observed on their tapes were written in reflective journals.

Warfield, Wood and Lehman (2005) found that four of the seven teachers did not learn to teach in ways that encouraged children to become autonomous learners. They often did not understand their learner's thinking and did not encourage the learners to clearly explain and justify their reasoning. These teachers also frequently interfered with their learner's thinking. They based instructional decisions on the expectations of external voices rather than on their children's thinking (Warfield, Wood & Lehman, 2005). As a result they did not reflect deeply about either their learner's mathematics or about their own teaching. Instead their thinking about teaching focused on classroom management and procedures. However, the remaining three teachers allowed their learners to solve problems in their own ways and expected them to both explain and justify their reasoning and to listen to and question the reasoning of other students. They also learned to reflect about their children's mathematics and about their own roles in developing learner's thinking (Warfield, Wood & Lehman, 2005).

2.6.3 Research studies dealing with teachers' reflection-on-action

In this section I report on studies that deal with reflection-on-action. According to García, Sánchez and Esquadero (2006) reflection-on-action can be 1) generated spontaneously with the help of researchers 2) included in mathematics teacher education programmes and professional development through the use of narratives and 3) generated in research

projects in which teachers and researchers collaborate. It seems as if teachers reflect on their actions when instigated to do so.

Although there are numerous studies in the literature on teachers' reflective practice I am going to focus on those studies that investigated teachers' reflection-on-action within the contexts of lesson study and action research.

2.6.3.1 Lesson study contexts that enhance reflection-on-action

The context of my research is lesson study, and in this section I focus on research dealing with mathematics teachers' reflection **on** their classroom practice in lesson study groups. Lesson study involves the planning of a research lesson (designed to focus on a pre-determined goal) by a group of teachers (Ono & Ferreira, 2010). The lesson is observed by the other teachers, recorded and reflected upon and discussed by the group. During the process of lesson study teachers of various levels of experience interact to examine their practice through the implementation of, and reflection on a research lesson (Ono & Ferreira, 2010).

A study by McDonald (2009), conducted in a semi-rural area at a P-12 College west of Brisbane, Australia, investigated the relationship between teacher professional development, teacher growth and any changes to learner outcomes in the context of a lesson study professional development model. This study was conducted over a one-year period with five teacher participants. Qualitative data were collected through interviews with teachers and learners, participant observation, teacher and learner questionnaires, field notes by the researcher and quantitative data were collected through pre- and post-tests for learners. The teacher questionnaires required participants to reflect and comment on current beliefs and values concerning mathematics learning and the place of problem-solving in mathematics instruction. The interviews provided opportunities to reflect on changes to beliefs or values as a result of participating in the lesson study model of professional development. The teachers in this study reflected on their own content knowledge, their pedagogical content knowledge and their professional confidence. They also reflected on their learners' achievement.

Although the data analysis needs to be treated with caution due to the small sample size, McDonald (2009) reports an increase in content and pedagogical-content knowledge of teachers (resulting from the collaborative planning and feedback during the lesson study process), and changes to their belief that problem-solving is an activity for the more able learners. Reflective practice in the context of this study refers to a deliberate and planned

process of reviewing and critical thinking about teacher practice, with the purpose of increasing learning opportunities for learners and modifying research lessons for teachers (McDonald, 2009). However, McDonald (2009) reports that it was due to her involvement as a researcher that the teacher-participants in her study focused on the learning of learners rather than on their own teaching in their planning of the research lesson.

Bruce and Ladky (2009) conducted a study on what happens between the stages of the lesson study cycle. During focus group interviews which occurred on three occasions, these researchers asked twelve mathematics teachers to describe the informal activities that took place between the formal stages of the lesson study cycle (Bruce & Ladky, 2009).

The first two stages involve identifying the lesson study goal and planning the first research lesson. Between these two stages Bruce and Ladky (2009) report that the teachers were busy with 1) searching and researching the internet, data-bases, and teacher resources on the topic in focus; 2) conceptualizing (through brainstorming, self-talk and informal conversations) valuable tangents for the lesson; 3) investigating and exploring the use of manipulatives and technological tools (such as using the white board and video) with learners to expand the teacher and learners' repertoire; and, 4) monitoring and keeping up with details such as on-going learner assessment which provided insights into learners' learning and assisted in the planning of lessons.

Between the second (planning stage) and the third stage (implementing the planned lesson) Bruce and Ladky (2009) report that the participants were e-mailing each other, planning pre- and post-lessons in the sequence carefully, and considering learner groupings. The teachers were committed to documenting the full lesson sequence because one of their primary goals was to provide learners with multiple opportunities to learn and understand complex mathematical ideas (Bruce & Ladky, 2009).

Between the third stage (lesson implementation) and the fourth stage (reflection on and evaluation of the lesson) Bruce and Ladky (2009) report that the immediate reflection-on-action teachers engaged in included thoughts about 1) what the teacher might have done differently to meet the needs of learners even more explicitly, 2) how the lesson could have been modified to solicit other particular kinds of thinking and representations of understanding from the learners, and 3) how to solve logistical issues such as optimal learner groupings, ease of distribution of materials, and pacing of the lesson. The teachers immediately began planning the follow-up lessons based on the observations of the research lesson. It seems, from this study, that it is very important that teachers focus constantly on the goal of the lesson study research lesson, and maintain contact with each other.

In Bruce and Ladky's study (2009) the participants in the lesson study group were committed to document the full lesson sequence in the planning stage because one of their primary goals was to provide learners with multiple opportunities to learn and understand complex mathematical ideas. However, in their reflection-on-action they focus on what the teacher might have done differently to meet the needs of learners even more explicitly; how the lesson could have been modified to solicit other particular kinds of thinking and representations of understanding from the learners; and how to solve logistical issues such as optimal learner groupings, ease of distribution of materials, and pacing of the lesson (Bruce and Ladky, 2009).

In another study Taylor *et al*. (2005) followed an action research approach to document a systematic inquiry into improving the classroom practice of four teachers, using the Japanese lesson study model of professional development. The study was conducted for 15 months in rural Carlinville, Illinois. Data was provided by carefully recorded field notes, meeting summaries, video recordings and interviews. The four participants confessed to similar teaching styles reflecting the way they plan lessons and their expectations of their learners during the interviews.

In the planning stage of the lesson study cycle the participants decided on a goal for the research lesson. According to Taylor *et al.* (2005) the lesson study group decided 1) to allow learners to do their own thinking and design their own way of solving a two-step word problem, 2) to give learners time to share their mathematical thinking with their classmates, and 3) to listen to their learners' mathematical thinking and become more flexible in their approaches to teaching two-step word problems. In the planning of the lesson they focused on what to teach, selecting a problem, thinking about logistics (where and when to present the lesson, how to display the problem for the whole group, the classroom management, etc.), materials (to be displayed on the board or overhead, hand out individual copies, provide rough paper, etc.), teacher script (what should be said, how much help should be given, etc.) and time management. The next phase of the lesson study cycle consisted of the teaching and collaborate reflection on the lesson. The lesson was videorecorded and the participants reflected afterwards on the different solutions that the learners produced to the problem. The lesson was revised to increase learner understanding and the lesson study cycle was repeated.

Taylor *et al.* (2005) report on the following benefits of the lesson study professional development model: an effective detailed lesson plan achieves the goal of more effective learning by learners; the lesson study model provides a highly motivated structure for

planning and teaching a lesson; reflecting and thinking in the company of other teachers allow for sharing, interacting, questioning assumptions, and reassessing common practices; observing a lesson enables a shift in thinking from a teaching focus to a learning focus; focusing on learner thinking provides opportunities for feedback to support changes in teaching mathematics; and lesson study transforms working relationships and conversations between teachers.

2.6.3.2 Action research contexts that enhance teacher reflection-on-action

Lesson study is not the only professional development context that involves teachers' reflection-on-action. According to Aldridge, Fraser and Sebela (2004) teacher action research may also promote teachers to become reflective practitioners. They investigated the success of (among others) using journals as a means of encouraging teachers to reflect on teaching strategies and improve their learning environments with a group of South African teachers (Aldridge, Fraser & Sebela, 2004). The second phase of their study focused on action research, involving two teachers and one mathematics class. The two teachers identified constructivist aspects of the learning environment that they would like to improve: using spiralling cycles of questioning, planning, implementing, collecting data and reflecting (Aldridge, Fraser & Sebela, 2009). The teachers were required to keep a teaching journal to use as a means of reflection.

Aldridge, Fraser and Sebela (2009) report that during the 12-week intervention phase, weekly observations of the classes of the two teachers were used to determine whether they were using their reflections in their classroom practice and to provide encouragement and feedback during the process. The results of the study indicate that the use of journals help teachers to keep on track and to think about possible solutions to problems, as well as encourage them to reflect and plan future activities (Aldridge, Fraser & Sebela, 2009).

2.6.4 Research studies dealing with teachers' reflection-for-action

Studies dealing with teachers' planning (reflection-for-action) intend to explore how teachers' thoughts are put in practice. Such studies should appraise planning before the action takes place and offer a comparison between the plans and performance to reveal their fit or alignment with the intended outcome (Marcos & Tillema, 2006). Some of these studies (Scherer and Steinbring, 2006; Taylor *et al.*, 2005) mention the collaborative planning of lessons by their participants but do not elaborate on the analysis of the lesson plan and how it aligns with what actually happens in class. Marcos and Tillema (2006) suggest that lesson plans and intentions should be appraised in their natural temporal order (before the action

commences, through written plans and designs), and that one should look for discrepancies, that is, compare differences between plans and practices. I did not find evidence of such comparisons in any of the studies that I reviewed.

According to Scherer and Steinbring (2006) one could focus on many different aspects of improving the quality of mathematics teaching. They argue that for a better understanding of learners' mathematical learning processes or teaching and learning in general, reflection on, and analysis of concrete classroom situations are of major importance (Scherer & Steinbring, 2006). Their research focuses on the joint reflection between teachers and researchers on the participating teacher's own classroom interaction by means of concrete examples (Scherer & Steinbring, 2006). In a three-year project in Germany two researchers and an assistant worked with three mathematics teachers, teaching Grade 3 and Grade 4 in an elementary school, to improve their classroom practice. The study focused on the professional teaching activity of the participating teachers and the systematic reflection that followed each teaching activity. The researchers collaborated with the teachers in intensive discussion and development of didactical ideas on the mathematics topic, and the transition of informal strategies to standard algorithms. The researchers however, were not involved in the actual planning of the lessons or designing of the worksheets.

Data were collected through informal observations by researchers (taking field notes) in initial mathematics lessons taught by the teachers. They also collected learners' work for analysis. Observations of three teaching experiments taught by the teachers followed, each containing 3 – 6 lessons (about fifty lessons were recorded). A mutual guest observation (to which the researchers were invited by the teachers) and subsequent reflection provided more data. There were also group meetings where the researchers and teachers reflected on the learners' work and teaching episodes. Final reflections took place during in-service courses.

According to Scherer and Steinbring (2006) the actual project focused mainly on reflection-for-action in the beginning through discussions or reflections on didactical orientations or on the planning of teaching experiments. However, Scherer and Steinbring (2006) report that in the course of the project, the focus shifted to reflection-on-action while teachers and researchers reflected jointly on video documents. The study does not explicitly explain the link between planning and action. There is no evidence of any document analysis reported in the study. The study also does not report on the planning of the lesson and possible adaptations to the plan while teaching the lesson as a result of unexpected events happening in class. The focus on the teachers' reflection-on-action is more clearly described

and a definite link established between their actions and their reflection on their actions in class.

2.6.5 Research studies dealing with teachers' reflection-in-action

Eraut (cited in Jaworski, 2004) suggests that teaching is too complex for reflecting-in-action to be a serious option for most teachers. According to Jaworski (2004) Eraut emphasises that a teacher has to be constantly assessing the situation, responding to incidents, deciding whether to change the activity, and be alert for opportunities to tackle difficult issues. However, Jaworski (2004) reports that from her own experience and research with teachers (Jaworski, 1994) reflection-in-action does happen with consequences for immediate teaching action.

Recent research by Ross and Bruce (2005, p. 4) on teachers' self-assessment confirm that reflection-in-action is possible and occur as self-assessments *in the moment.* Artzt, Armour-Thomas and Curcio (2008, p. 138) refer to reflection-in-action as *thinking on your feet.* They describe a case study of one teacher's reflection-in-action to illustrate this interactive aspect of teaching and in their final commentary on the case, Artzt, Armour-Thomas and Curcio (2008, p. 140) conclude that *during a lesson teachers must continually assess the understanding of their learners to regulate their instruction in ways that will meet the learners' needs*.

Reflection-in-action is also addressed in a study by Leikin and Dinur (2003) who conducted research on one teacher's flexibility in the course of a whole-class mathematics discussion in Israel. Leikin and Dinur (2003, p. 1) consider a teacher being flexible at a particular point of the discussion if s/he adjusts the planned learning trajectory in accordance with students' contributions that *differ from* those that s/he *expects* of them. In this study Leikin and Dinur (2003) focus on a teacher's flexibility associated with situations in which learners' replies are unexpected by the teacher. To describe the teacher's flexibility they compare the teacher's plans regarding the lesson with the actual events and procedures that occur in the classroom (Leikin & Dinur, 2003).

The first purpose of Leikin and Dinur's (2003) study was to zoom in on the teacher-learner interactions in the context of a whole-class mathematical discussion in order to describe patterns of flexibility. The second purpose was to analyse how different types of teacher knowledge influence teacher flexibility. The data collection and analysis were on-going, using a qualitative approach. The data were collected in triads of planning, teaching in the classroom, and stimulated recall. The three elements of each triad were connected by a

particular lesson. All the lessons chosen for the investigation included a whole-class discussion. The data was video-recorded and transcribed. Additionally the researcher took written field notes while collecting the data. When analysing the data they performed multiple observations of the videotapes and careful reading of the transcripts (Leikin & Dinur, 2003).

Leikin and Dinur's (2003) analysis focuses on the teacher's behaviour in the cases where learners' replies differed from those that the teacher had expected. At the stage of stimulated recall, based on chosen episodes, the teacher was asked to discuss the lesson and to analyse how and why her plans coincided or did not coincide with the real management of the lesson (Leikin & Dinur, 2003). She explained to the researcher her reasons for the decisions taken in the course of the whole-class discussion.

In their findings Leikin and Dinur (2003, p. 8) state that they *applied the idea of the mathematics teaching cycle to the micro-situations in a junior-high school classroom in order to develop a theory of teacher flexibility-in-action that corresponds to teacher reflection-in action.* They identified four patterns of teacher flexibility that differ concerning: 1) outcomes (representing teacher-learners interactions associated with an unexpected learner's reply which lead to a learning trajectory that ends differently from the one planned by the teacher); 2) strategies (representing teacher-learners interactions associated with an unexpected solution strategy/explanation suggested by a learner); 3) sequencing (representing teacher-learners interactions associated with a connection between equivalent properties of mathematical objects, whose direction is opposite to the one expected by the teacher) and 4) scopes (representing teacher-learners interactions associated with questions/conjectures that are "bigger" than those which the teacher deems possible for discussion in the particular classroom) (Leikin & Dinur, 2003).

A summary of the research reviewed follows in Table 2.6.

Table 2.6 Summary of research on mathematics teachers' reflective practice

Study	**Object of study** (Categories of Marcos & Tillema, 2006) **(a), (b), (c), (d)**	**Instrument(s)** **I, ID, WD, O, V, FN, Q, T;**	**Sample** **NvT, ExT**	**Limitations mentioned**	**Link between reflection and action**
Cross (2009)	(a)	I; O; WD; FN	ExT, NvT (5)	Small sample	Reflection on beliefs prompted by interview questions and informal discussions with researcher
McDonald (2009)	(a), (b), (c)	I; O; Q; FN; T	ExT (5)	Unable to use consistent and paired data collection methods; researcher acts as the professional development facilitator	Reflection-for and -on action in lesson study cycle; reflection about beliefs in teacher questionnaire; interviews provided opportunities for reflection-on practice and about beliefs
Bruce & Ladky (2009)	(b), (c)	I	ExT (12)	None	Reflection about actions between stages of lesson study cycle
Aldridge, Fraser & Sebela (2004)	(b)	WD	ExT (2)	Small sample	Reflection-on-action through the use of journal writing and action research
Scherer & Steinbring (2006)	(b), (c)	O; V; WD; FN; ID	ExT (3)	Small sample	Joint reflection between teachers and researchers on their practice
Taylor *et al.* (2005)	(b), (c)	FN, V, I	ExT (4)	Small sample	Reflection-for-action and on-action in lesson study cycle
Leikin & Dinur (2003)	(c), (d)	V; FN	ExT (1)	Small sample	Reflection prompted by researcher probes of behaviour in-action

(a): beliefs about teaching; (b): reflection-on-action; (c): reflection-for-action; (d): reflection-in-action;

I: interviews; O: observation; V: video recordings; WD: written documents; FN: field notes; ID: informal discussions: T: tests; Q: questionnaires; ExT: experienced teachers; NvT: novice teachers

The table portrays the research I reviewed on the link between teacher reflection and action. Two of these studies involve teachers' beliefs about their teaching (Cross, 2009; McDonald, 2009). Five of the studies I reviewed deal with mathematics teachers' reflection on their practice (Aldridge, Fraser & Sebela, 2004; Bruce & Ladky, 2009; McDonald, 2009; Scherer & Steinbring, 2006; Taylor *et al.,* 2005). The recognition of teachers as reflective practitioners, who as professionals learn from experience and construct knowledge for their practice, lies at the heart of this domain of studies (Marcos & Tillema, 2006). Three of these studies probe teachers' reflection-on-action in the context of lesson study (Bruce & Ladky, 2009; McDonald, 2009; Taylor *et al.*, 2005), while Aldridge, Fraser and Sebela (2004) used action research to determine their participants' reflection-on-action. Reflection-on-action is part of action research and the lesson study cycle, and the design of these studies therefore allows teachers' to reflect on their teaching practice. Two of these studies used video recordings to stimulate teacher reflection-on-action (Bruce & Ladky, 2009; Taylor *et al.*, 2005). According to Marcos and Tillema (2006) the stimulated recall technique is appropriate to assess reflective processes because it is tied to a specific context (lesson) and has memorable references to reflected practices. Moreover they claim that participants' freedom to reflect remains intact: they are not subject to researcher guidance (framed), but may report reflections whenever they want (by stopping the video and commenting on it) (Marcos & Tillema, 2006).

None of the studies I reviewed deal exclusively with teachers' reflection-for-action. In addition, I reviewed only one study that deals with mathematics teachers' reflection-in-action (Leikin & Dinur, 2003), mainly because there was a lack of evidence of such research in the literature. According to Marcos and Tillema (2006) these studies are most difficult to conduct because they require a wealth of data collection methods and a careful analysis of different data sources. They also maintain that they have not been able to identify many studies in this domain, nor have they been able to determine a number of strategies that can analyse teacher activity in action.

2.7 The conceptual framework for this research study

My investigation is influenced by the conceptual framework for my research study, as visualised below, which I call the *Framework for reflective teaching of mathematics* (FRTM).

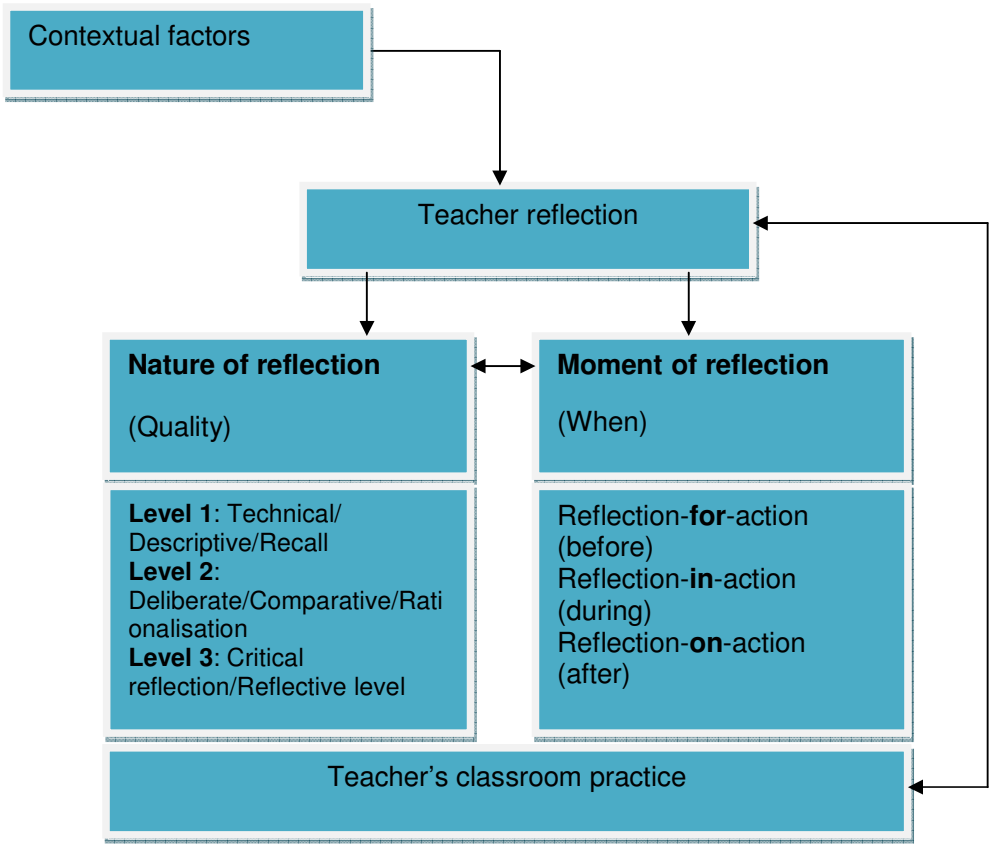


Figure 2.3 Framework for reflective teaching of mathematics

In this visual representation it is acknowledged that **contextual factors** may influence mathematics teachers' reflection and ultimately also their reflective practice. Lee and Tan (2004) identified personal dispositions, interpersonal relationships, instructional and curricular practices and institutional values, norms and practices as contextual factors that influence mathematics student teachers' understanding of reflection. I believe that these are not the only contextual factors that may influence mathematics teachers' reflective practice in the South African context, and this study will explore the possibility that other factors such as language, culture and socio-economic circumstances may play a role. The context of this research study is lesson study, and this context may also influence mathematics teachers' reflective practice.

This research study seeks to examine **teacher reflection** by *inter alia* focusing on the **nature of reflection** and the **moment of reflection**. The **nature** of mathematics teachers' reflections will be explored by investigating *whether* they reflect on their classroom practice, *how* they reflect and the content of their reflections (*what* they reflect on while teaching mathematics). The level of teacher reflection will be determined by using Lee's (2005) levels of reflection as visualised below.

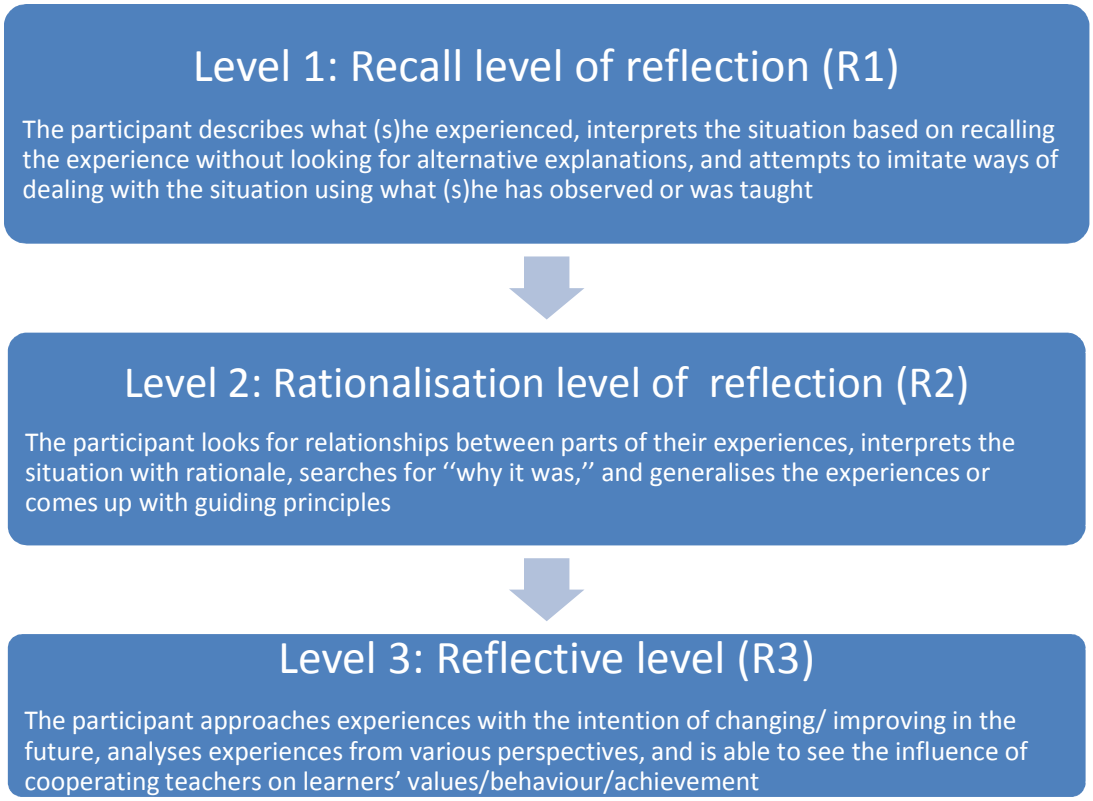


Figure 2.4 Lee's reflection levels (2005)

The **moment of reflection** will be explored against the theoretical background of Schön's terms *reflection-in-action* and *reflection-on-action* (1983). The term *reflection-for-action* is different from the previous types of reflection in that it is proactive. Killon and Todnew (cited in Farrell, 2004, p. 31) argue that reflection-for-action is the desired outcome of both previous types of reflection. They believe that *we undertake reflection, not so much to revisit the past or to become aware of the metacognitive process one is experiencing, (both noble reasons in themselves) but to guide future action (the more practical purpose)*.

As indicated in the visual representation of the conceptual framework, teacher reflection, which includes the nature of reflection and the moment of reflection, impacts on a teacher's **classroom practice** and *vice versa*. Classroom practice involves what the teacher does

before entering the classroom, in terms of his or her planning and preparation; while in the classroom, both while functioning as an educator and in all the other roles expected of the teacher; and retrospectively after she/he has left the classroom (Brubacher, Case & Reagan, 1994). The arrows in the conceptual framework indicate a possible reciprocated relationship between the concepts or influence of one concept on another.

Finally, I present the definition of reflection that guides this research study.

2.7.1 Definition of reflection and reflective practice to guide this research study

The criteria that Lee and Tan (2004) propose to define teacher reflection[3] and reflective practice accommodate the interpretations of Dewey (1933) and Schön (1983) in the following way. Dewey (1933) maintains that teachers should acquire a habit of on-going thoughtfulness and examination of the beliefs and theories they use to inform their instruction of students (which relates to the first two criteria that Lee and Tan (2004) mention). Schön (1983) regards teaching as so complicated that teachers cannot merely apply what they have learned in an inflexible manner. They have to reflect-in-action when the practitioner is suddenly confronted with a problematic situation and must resolve it and reflect-on-action after a teaching episode to determine whether matters were resolved in a satisfactory manner (Schön, 1983).

The tentative operational definition of teacher reflection and reflective practice for this study, based on these criteria, follows.

> *Teacher reflection is an interrogation of practice before, during and after the act of teaching (reflection-for-practice, reflection-in-practice and reflection-on-practice), asking questions about the effectiveness of the teaching and learning experience and how these might be refined to meet the needs of the learner. The teacher is reflectively aware of the context in which he/she teaches as well as his/her own beliefs, knowledge and values regarding not only mathematics, but also the learners in the class. Reflection on practice happens actively in response to potentially problematic situations and allows for professional growth and change.*

[3] See Section 2.4.1.1

2.8 Conclusion

In this chapter I have reviewed theoretical perspectives on reflective practice in the literature and have given an overview of a number of research studies dealing with teacher reflection, focusing on mathematics teachers' reflective practice. I have also provided the conceptual framework for this study. In Chapter 3 I will discuss the research design that will guide this study.

Chapter 3

Research Design

3.1 Introduction

A research design is a plan or strategy that moves from the underlying philosophical assumptions to specifying the selection of respondents, the data-gathering techniques to be used and the data analysis to be done (Nieuwenhuis, 2010).

Within the qualitative approach, the design chosen for this research study is a case study design. According to Cohen, Manion and Morrison (2005) a case study provides a unique example of real people in real situations. Nieuwenhuis (2010) argues that case studies offer a multiperspective analysis in which the researcher considers not just the voice and perspective of one or two participants in a situation, but also the views of other relevant groups and the interaction between them. A key strength of the case study method is the use of multiple sources and techniques in the data-gathering process, which includes interviews, observation and field notes.

In this chapter I firstly discuss the paradigmatic assumptions and perspectives underlying my research. I then reveal the research site and sampling of this research study, followed by a discussion of the data-gathering procedures. Subsequently the strategies for data analysis, quality assurance and ethical considerations that guide this study are discussed. Lastly I mention perceived limitations of this research study.

3.2 Paradigmatic assumptions and perspectives

A paradigm is a set of assumptions or beliefs about fundamental aspects of reality which give rise to a particular world-view (Nieuwenhuis, 2010). In defining my paradigmatic perspective as a qualitative researcher, I am aware that I approach my research with certain basic assumptions about the world and how it should be studied. In this section I address my fundamental assumptions about the nature of reality (ontology), the relationship between knower and known (epistemology) and my assumptions about human nature.

3.2.1 Ontological assumptions

This research study seeks to explore the nature of mathematics teachers' reflection in their classrooms and in the lesson study group. I believe that teachers' construction of reality lies in their sense-making and negotiation of the external world (the context of classroom, school

and community) and their interpretation of this world. This research study therefore follows a qualitative research approach that focuses on teachers' reflections on their classroom practice. Qualitative research is based on a philosophy that views reality and truth as subjective, multifaceted and a shared social experience (McMillan & Schumacher, 2006). Its goal is to understand the situation from the participants' perspective. I am undertaking this research in the belief that human life can only be understood from within and not as a form of external reality, and that the human mind is the purposive source of meaning (Nieuwenhuis, 2010). The focus of this study is therefore on teachers' subjective experiences and how they share these experiences with their fellow teachers.

3.2.2 Epistemological assumptions

In terms of epistemology an underlying assumption I bring into the inquiry is that people create reality by learning from others, teaching others and reflecting with others on their own knowledge. In my research study I allow for a rich understanding of social reality by using the context of lesson study, which allows teachers to share their ideas about their classroom practice with one another. Lesson study provides teachers with the opportunity to learn from one another's experiences, thus building up a shared body of knowledge. I do not believe that precise, systematic and theoretical answers to complex human behaviour are possible, and that is one of the reasons why this research study will be qualitative. According to Nieuwenhuis (2010) knowledge should emerge from the local context and should privilege the voice of the *insiders* (p. 56), taking into account what people say, do and feel, and how they make meaning of the phenomena under investigation. In the context of the lesson study group my role as researcher is to understand the teachers' reflections from their point of view, and not from my own.

Because this research study seeks to understand the nature of teachers' reflection and their reflective practice it is situated within an interpretive paradigm. The central endeavour in the context of the interpretive paradigm is to understand the subjective world of human experience (Cohen, Manion & Morrison, 2005). It is characterized by a concern for the individual and efforts are made to get inside the person and to understand from within (*ibid.*, 2005).

3.2.3 Assumptions about human nature

As a researcher I share my participants' frame of reference and try to understand how their views shape the action which they take within that reality (Beck, cited in Cohen, Manion & Morrison, 2005). The experiences of teachers regarding their reflective practice are investigated against the social context of interaction between fellow teachers as well as in the social context of mathematics classrooms. I acknowledge that an interactive relationship between me as researcher and the participants exists. The experiences and narratives of the teachers are the medium through which this research study explores their reflective practice.

These assumptions impact on my methodological choices and require consideration of different research methods. Because this study addresses teachers' reflective practice, I wish to adopt an approach that has been described by various authors as "reflective" (Evans, 2002). According to Alvesson and Sköldberg (2002) reflective research has two basic characteristics: careful interpretation and reflection. Reflection means interpreting one's own interpretations, looking at one's own perspectives from other perspectives, and turning a self-critical eye onto one's own authority as interpreter and author (Alvesson & Sköldberg, 2002).

3.3 Research site and sampling

The research site for this study is in the Thabo Mofutsanyana district in the Free State. Permission to access a school in this district was obtained from the Free State Education Department. A meeting with the principal of the school was arranged and permission from him was obtained to meet with potential participants. The participants in this research study are five mathematics teachers, teaching Grades 8 - 11. One participant teaches Mathematical Literacy. The criteria for selection as a participant include the factors of convenience, access, and willingness to participate. The expectations of the study were presented to potential participants verbally and in writing. Meetings with these teachers took place in the teachers' school environment.

3.4 Data-gathering procedures

This research study takes place in the context of lesson study. Underlying the practice of lesson study is the idea that teachers can best learn from and improve their practice by seeing other teachers teach (Stephens & Isoda, 2007). There is an expectation that teachers who have developed deep understanding of and skills in subject matter pedagogy should be encouraged to share their knowledge and experience with colleagues (*ibid.*, 2007). Whereas

the focus appears to be on the teacher, the final focus is on the cultivation of learners' interest and on the quality of their learning (*ibid.,* 2007).

The lesson study cycle involves a planning phase, a teaching phase and a feedback (reflection) phase. In this research study the participants decided to cooperatively plan a lesson on equations, which is one of the topics that is covered by Grades 8 – 12. The planning phase will last two weeks. The lesson study group will plan a lesson on linear equations for Grade 8. Each teacher will then adapt the Grade 8 lesson to the grade that he/she teaches, taking into account that the content and context of each grade should show progression from simple to complex. During the teaching phase of the lesson study cycle the planned lesson will be taught by the Grade 8 teacher. This lesson will be observed by the researcher together with an assistant who will manage the video recorder. During the feedback (reflection) phase of the lesson study cycle the participants of the lesson study group will view the video-recorded lesson the same afternoon in a post-conference to improve on the lesson plan. The focus will not only be on the teachers' presentation but also on the learners' understanding of the concepts that were taught. Figure 3.1 illustrates the lesson study cycles for this research study.

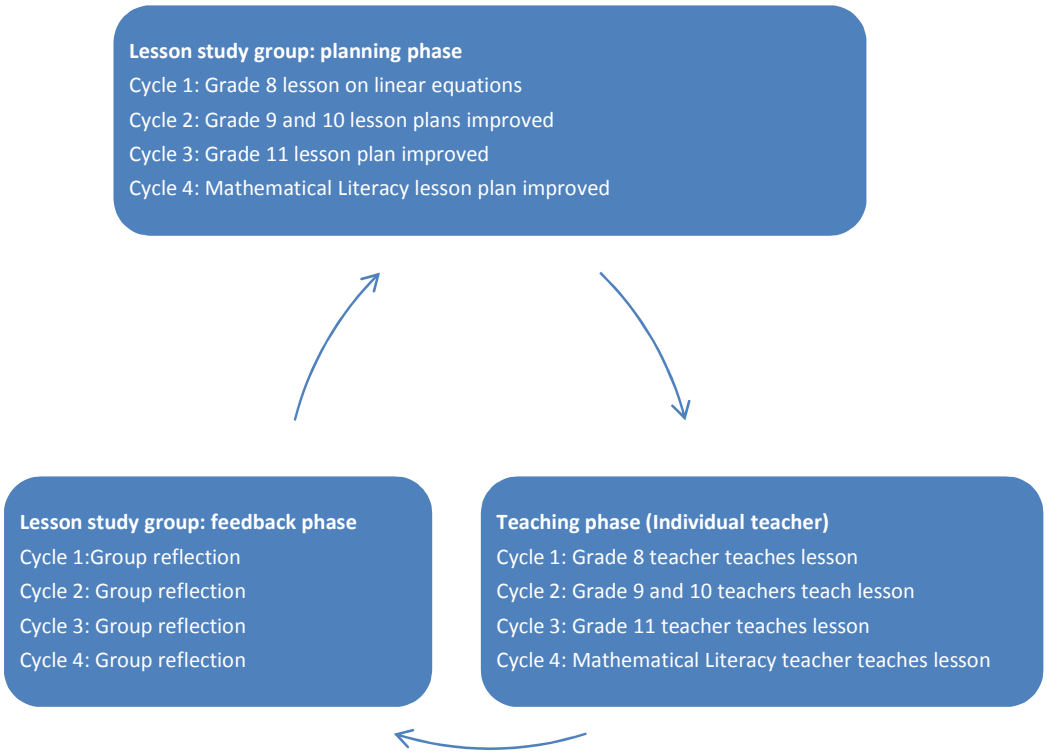


Figure 3.1 Illustration of the lesson study cycles for this research study

The figure illustrates the continuous cycles of lesson study: planning, teaching and reflection. This research study will have four lesson study cycles. The first cycle will involve the planning of a Grade 8 lesson on linear equations, the teaching of the lesson and the post-conference during which the group will reflect on the learners' understanding of the equation concepts. The second lesson study cycle will involve the adaptation of the Grade 8 lesson plan to Grades 9 and 10. The teaching of this revised lesson will be followed by a reflection session during which the participants will try once more to improve the lesson plan. This cycle is repeated again by the Grade 11 teacher and lastly by the Mathematical Literacy teacher.

My principal concern is with understanding the way in which the teachers in the lesson study group create, modify and interpret the social context in which they function as they plan, teach and reflect on the lesson. Therefore a qualitative inquiry with an epistemological perspective of the interpretive paradigm will underpin this study as I seek to explore the nature of these mathematics teachers' reflective practice.

In this research study my role as researcher will be that of participant observer. Participant observation is useful when the focus of interest is how activities and interactions within a setting give meaning to beliefs or behaviours. This fits in with the assumption that everyone in a group or organization is influenced by assumptions and beliefs that they take for granted. It is therefore considered the qualitative method of choice when the situation or issue of interest is obscured or hidden from public knowledge and there are differences between what people say and what they do.

My role as researcher will also take on a reflective stance: interpreting my own interpretations, looking at my own perspectives from other perspectives, and turning a self-critical eye onto my own authority as interpreter and author.

3.5 Data-gathering instruments

A discussion of the methods of data collection follows. The link between the research questions posed by this study and the method of data collection is provided after the discussion.

3.5.1 Interviews

The aim of qualitative interviews is to see the world through the eyes of the participant in order to obtain rich descriptive data that will help to understand the participant's construction of knowledge and social reality (Nieuwenhuis, 2010). According to Bernard and Ryan (2009) probing is the key to successful in-depth interviewing and they mention the following probing techniques (which I will keep in mind while interviewing the participants in my study):

- The silent probe (waiting for a response
- The echo probe (repeating the last thing someone has said and asking them to continue)
- The uh-huh probe (making affirmative statements)
- The tell-me-more probe (asking questions like "Could you tell me more about that?" or "Why do you say that?")

I will conduct a semistructured interview[4] with each of the five teachers individually before the research study commences. A list of prepared questions will be used as a guide to explore these teachers' understanding of reflection. During this interview I will also use a lesson plan from each teacher as a discussion document to probe whether, how, when and on what they reflect when teaching their lessons.

A second individual interview[5] with each teacher will be conducted after each lesson observation to probe their experiences while teaching the lesson, as well as to understand any deviations from their lesson plan (reflection-in-action and on-action).

A final group interview[6] with all the participants will be conducted after the last lesson study cycle to establish how the reflexive processes of lesson study affect their classroom practice. This group interview will take place during the final phase of the research study.

3.5.2 Observations

Observation is an essential data-gathering technique which allows the researcher to hear, see and begin to experience reality as participants in the research group do (Nieuwenhuis, 2010). Bernard and Ryan (2009) argue that observation behaviour should be recorded as accurately as possible, in order to produce unique valuable qualitative data.

[4] See Appendix D
[5] See Appendix D
[6] See Appendix D

3.5.2.1 Individual teacher observation

Each teacher will be observed while teaching the planned lesson. I will observe this lesson which will be video-recorded by an assistant. The video-recording will be viewed afterwards by the lesson study group to determine whether the goal of the lesson (improving learners' understanding of equations) was met. It might be necessary to view the video-recording more than once in order to focus on the teacher's reflection-for, on- and in-action. I will take field-notes during this group reflection.

3.5.2.2 Lesson study group observation

Teachers in the lesson study group will be observed during the reflection-on-action stage (while reflecting on the lesson in the post-conference phase). These observations will reveal the nature of the teachers' reflective practice. I believe that the lesson study process will foster the participant teachers' reflective awareness and hope to see evidence of this in their classroom practice. The lesson study group will be video-recorded and audio-taped while they reflect on the lessons. I will take fieldnotes while observing the participants.

Throughout all the observations, I will try to remain sensitive to the ethnographic data emerging from the participants' professional lives.

3.5.3 Document collection

Simply stated, document collection is about learning from things (Lehman, 2003). According to Hodder (cited in Lehman, 2003) document collection is important in qualitative inquiry for the following reasons: it provides easy and low cost access to information; the data may differ from what is interpreted from direct observation and interviewing, allowing the qualitative researcher to explore multiple voices and conflicting interpretations; and material culture is more permanent than the spoken word and can provide historical insight.

In this research study I will collect data from the participants' lesson plans.

3.5.3.1 Lesson plans

Lesson plans of teachers provide striking evidence of the whole nature of teaching and classroom life (Burton & Bartlett, 2005). A set of lesson plans from each teacher before participation in the research study will be analysed to establish levels and moments of reflection before participating in the lesson study group. The lesson plans might also reveal

their assumptions about their learners' mathematics knowledge and their own views on mathematics teaching. The lesson plans will provide additional data regarding the main research question.

The lesson plan of the lesson study group will also be analysed to reveal the quality of their collective reflection. I believe that reflection is better carried out in collaboration, but there might be limitations involved that I am unaware of at this stage.

3.5.3.2 Researcher diary

I will enter my own reflections in a researcher diary. In this diary I will reflect on my role as researcher during the research process, and record possible dilemmas or unanticipated incidents that might occur. Such reflections might help in framing my own dilemmas, and serve to clarify issues and keep the focus on the study. New understandings might emerge as previous views regarding the research process are re-assessed. I intend to reflect not only on issues concerning the participants involved but also on the process of the research in my own personal journal. Entries will be made during each lesson study session, and on the days that I meet with the teachers. It is important for me to reflect on: the progress of the study, my communication with the teachers, the reactions of the teachers to the study, and my observations of the congruencies in what I see in their teaching versus their reflections in the interviews. I will share some of my reflections with the teachers when they are beneficial to the study or if they are helpful to the individual teacher. Throughout the writing process I might become aware of what my biases and interests are, and that those biases might play a part in the reflections that the participants reveal to me.

The knowledge gained by this exercise might, together with the knowledge gained by analysing the teachers' reflective diaries, contribute to the existing body of knowledge that exists in the literature on teacher reflection.

Table 3.1 summarises the relationship between the research questions and the data collection techniques described in this section.

Table 3.1: Relationship between research questions and data collection techniques

Research question	Data collection technique	Purpose
Question 1: What is the nature of mathematics teachers' reflective practice?		
How do mathematics teachers reflect before, during and after teaching?	Interview Document collection (lesson plan) Observation Field notes	To investigate **whether** teachers reflect on their practice To explore **how** teachers reflect on their classroom practice To determine the moment of reflection (**when** do teachers reflect on their practice: before, during and/or after the lesson?) To examine the **content** of mathematics teachers' reflection (what they reflect on) To determine the **level** of teachers' reflection using Lee's levels of reflection (2005): R1: Recall R2: Rationalisation R3: Reflective
What is the possible relationship between mathematics teachers' reflection and their classroom practice?	Interview Observation Field notes	To explore possible **benefits** of being a reflective practitioner when teaching mathematics
Question 2: How do contextual factors influence mathematics teachers' reflective practice?	Interview Observation Field notes	To gain a sense of how the context of lesson study influences teachers' classroom practice. To explore other possible contextual factors that influence teachers' reflective practice
Question 3: What is the potential significance of mathematics teachers' reflective practice for theory building in mathematics teaching?	Researcher diary Field notes	To contribute to the body of knowledge on mathematics teachers' reflective practice

3.6 Strategies for data analysis

The data for this research study will be obtained through interviews with the participants, observations of both participants teaching a lesson and the lesson study group reflecting on the lessons, and document analysis. I intend to analyse the qualitative data using both an inductive and deductive approach. According to Nieuwenhuis (2010) the main purpose of an inductive analysis is to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by a more structured theoretical orientation.

Nieuwenhuis (2010) claims that the data analysis in a qualitative study tends to be an ongoing and iterative process, implying that data collection, processing, analysis, and reporting are intertwined. I will therefore continuously consult my fieldnotes to verify conclusions, as well as solicit feedback from the participants to clarify gaps which have been noticed. My goal is to summarise what I see and hear in terms of words, phrases, themes or patterns, to help my understanding and interpretation of what emerges from the data. Throughout this process I will keep my research questions in mind.

The data gathered during the lesson study cycles will be analysed during and after the data-gathering process, based on Creswell's (2003) approach. I plan to inductively analyse the gathered data using content analysis and conversation analysis to develop themes, patterns and categories that identify and describe the participants' reflectivity whilst planning and teaching lessons. I will use the computer software program Atlas.ti 6 to assist me with the data management, the coding, categorisation, abstracting and conceptualising stages of the analysis. Atlas.ti 6 allows for the analysis of textual, graphical and audio data.

1) Data will be obtained through interviews (individual and group), observations (video-recorded), field notes and document analyses (lesson plans).
2) I will organise and prepare the data for analyses. Interviews (individual and group) will be transcribed *verbatim.* My goal is to summarise what I see and hear in terms of common words, phrases, themes or patterns that would aid my understanding and interpretation of that which is emerging (Nieuwenhuis, 2010).
3) The transcripts of the interviews will be read and re-read and I will watch and re-watch the video recordings to familiarise myself with general patterns that emerge and to gain information about the depth, reliability and usability of the information.

4) I will then assign codes to meaningful segments of text in a transcript, using the computer programme Atlas.ti 6. Coding is the process of reading carefully during the transcribed data, and dividing it into meaningful analytical units (Nieuwenhuis, 2010).
5) The next phase of the data analysis process involves the organisation or combination of related codes into themes or categories (known as "families" in Atlas.ti 6).
6) Interpretation and explanation of the data follow. All conclusions reached will be based on verifiable data.

According to Nieuwenhuis (2010) computer-aided data analysis can, on face value, appear deceptively easy, where the coding, clustering and searching functions make data analysis quick and satisfying. He argues that there are no short cuts to the demanding process of reading and rereading the data, and searching to unfold the meanings constructed by the participants of the study (Nieuwenhuis, 2010). I will take this argument into account when using the computer-aided data analysis programme.

3.7 Quality assurance: data verification

It is important in any study to ensure that the research is valid and reliable. The analogous criterion in naturalistic inquiry to establish validity and reliability is *trustworthiness* (Lehman, 2003).

3.7.1 Trustworthiness

According to Nieuwenhuis (2010) trustworthiness is of the utmost importance in qualitative research. The qualitative data being collected from this research study is in the form of observations, interviews and document analysis. The observations and interviews will be electronically recorded and transcribed. Participants will have the opportunity to review these transcriptions at the end of the entire data collection period to ensure accuracy and provide additional research data.

To enhance the trustworthiness of qualitative research studies Nieuwenhuis (2010, pp. 113-115) suggests that the following steps be taken:

1) Using multiple data sources
2) Verifying raw data
3) Keeping notes on research decisions taken
4) Greater trustworthiness in coding data
5) Stakeholder checks
6) Verifying and validating your findings

7) Controlling for bias
8) Avoiding generalisation
9) Choosing your quotes carefully
10) Maintaining confidentiality and anonymity
11) Stating the limitations of your study upfront.

To ensure the trustworthiness of this research study, data from multiple sources will be used to help me verify my findings. For example data collected through interviews will be verified with information gathered from the observations and the document analysis. In addition, the transcripts and fieldnotes will be submitted to the participants to correct factual errors. During the second interview the participants will be asked to verify whether my interpretation of what they have shared with me during the course of the study is correct. I will write down my thoughts and decisions during the research process and document the category labels I create. Any revisions I make to categories and any observations I note concerning the data will be written in my researcher diary.

3.7.2 Triangulation

Qualitative inquirers use several major procedures to ensure that their research produces highly credible findings. Triangulation is a general term in naturalistic inquiry, incorporating the use of multiple methods, various investigators, diverse theories, and different resources to establish credibility in a qualitative study (Cohen, Manion, & Morrison, 2005). According to Terre Blanche and Durrheim (cited in Maree & Van der Westhuizen, 2009, p. 34) *triangulation is essential to ensure* ***interpretive validity*** *and establish* ***data trustworthiness***. In this study I will use observation, interviewing, and document collection as multiple sources to ensure that the trustworthiness of the data. I will also compare patterns that emerge from the data with other theories found in the literature review.

3.7.3 Crystallisation

Crystallisation refers to the practice of “validating” results by using multiple methods of data collection and analysis (Maree & Van der Westhuizen, 2009). Different perspectives that all reflect the unique reality and identity of participants are necessary to provide for a complex and deeper understanding of the phenomenon (Nieuwenhuis, 2010). Richardson (2005) proposes the use of the term “crystallisation” rather than “triangulation” in qualitative research, asserting that the central image for qualitative inquiry should be the crystal, not the triangle, because *crystallization provides us with a deepened, complex and thoroughly partial understanding of the topic* (p. 963).

To establish the trustworthiness of this research study, various techniques will be employed to gather data and peer debriefing will be used to provide feedback on my notes and to verify my evolving interpretations of the study.

3.8 Summary of the layout of the research design

Table 3.2 summarises the layout of the research design for this research study.

Table 3.2 Summary and layout of research design

Purpose	Data gathering	Data analysis	Participants	Trustworthiness
Qualitative investigation	29-07-2010 and 30-07-2010: • Initial semi-structured individual interview with each teacher 24-02-2011 until 05-05-2011: • Lesson plan analysis • Classroom observations, video recorded • Post-lesson individual interview with each teacher • Lesson study group feedback sessions on each observed lesson • Final group interview	Analysis of data during and after the data-gathering process using Atlas.ti 6 Follow the seven steps for data analysis proposed by Creswell (2003): • Gathering data • Organising data • Overview of data • Coding • Creating categories • Report writing • Interpretation and crystallisation • Final report	Five practising mathematics teachers teaching Grade 8 – 11 of whom one teaches Mathematical Literacy	Key criteria of trustworthiness (Lincoln & Guba, 1985, cited in Nieuwenhuis, 2010) are: credibility, applicability, dependability and confirmability. The following steps are necessary: • Engaging in multiple methods of data collection (observation, interviews and document analyses); • Describing those findings which crystallise from the data will add to the trustworthiness of the research (Nieuwenhuis, 2010).

3.9 Ethical considerations

According to Bogdan and Biklen (2003) two issues dominate traditional official guidelines of ethics in research with human participants: informed consent and the protection of participants from harm. These guidelines ensure that participants enter research studies voluntarily, understand the nature of the study and the dangers and obligations that are involved, and are not exposed to risks that are greater than the gains they might derive.

I verbally briefed each participant and presented the following information in writing using Butke's guidelines (2003): 1) the purpose of the study; 2) risks involved in the study, which may include the discomfort of analysing a teaching practice and the loss of time for other facets of life; 3) general procedures of the study; 4) demands upon participants' time in the study; 5) timeline of the study; 6) confidentiality concerning anonymity of participants in the study, which include the use of pseudonyms (however the five participants would know each other and would be intertwined in the reflective process via the lesson study meetings); 7) rights of participants in the study which include one that determines that the participant is acting in a voluntary role and may withdraw at any time without penalty; 8) the phone numbers of the researcher; and 9) benefits of the study to the participant and the profession. I have asked each teacher to sign a permission contract indicating consent to participate in the study. In addition, the following principles will guide my process of ensuring ethical research (University of Pretoria, 2010): the principles of respect for personal autonomy, benevolence and justice.

3.10 Limitations

One limitation of this research study relates to the lack of generalisability of case studies. It is, however, not my intention to generalise these results of individual cases but to add to the body of knowledge on the nature of mathematics teachers' reflective practice as well as to generate new research questions and hypothesis.

A second limitation of this research study relates to fact that the five participants are of the same cultural and language group, teaching at the same school. I would have preferred a more diverse sample, excluding ethnic and geographical biases.

3.11 Conclusion

In this chapter I have described the research design and methodology that will guide this research study. In Chapter 4 I will discuss the research results obtained using this qualitative research design.

Chapter 4

Results and discussion

4.1 Introduction

In Chapter 3 the focus was on the research design for this study. In this chapter the interpretive findings are presented and discussed. First I discuss the coding of the data and how the codes fit into the themes that emerged from the research questions and the tentative conceptual framework for this study. Then I reveal the personal ethnographies of each of the five participants. Ethnographic information includes the demographic data of participants, how they view themselves as teachers, and their perceived strengths and challenges of being a mathematics teacher. I proceed with an individual profile of each participant in relation to the themes. The six major themes of this study are understanding of reflection; content (level) of reflection; reflection-for-action; reflection-in-action; reflection-on-action and contextual factors influencing reflective practice. This is followed by an analysis of the participants' lesson study group reflections after lesson observation. Finally the participants' reflection on the lesson study group experience is revealed in a reflective interview with the group.

In the following section I describe how the data was coded (or categorised).

4.2 Coding the data

According to Dey (2005) data must always be considered in context. He argues that it is often essential to regard the researcher as part of the context being studied, which is obviously relevant in interviews, where the respondent is responding to some sort of stimulus on the part of the interviewer (Dey, 2005). I took this view into account when I started the process of coding (or categorising) the data for this study.

4.2.1 Coding the transcripts of the interviews with the participants

The data for this research study was obtained through two interviews with the five participants, document analysis (lesson plans and reflective writings) and three group reflections after lesson observation. During the initial interview I familiarised myself with the participants and explained the nature of my research study to them. I conducted a second interview with each participant after observing them teaching a lesson, to probe their reflections on their lesson, as well as to clarify their deviations from their lesson plans.

I transcribed these interviews *verbatim* and I read and reread these transcripts a number of times to familiarise myself with the participant's views on teaching mathematics, their planning and how they reflect on lessons.

I used the programme Atlas.ti 6 to code the transcripts. This programme allows the researcher to assign codes by selecting text in the transcripts considered to be relevant to the research focus. I used the *open coding* option to create a new code for a selected piece of text. While coding I read and reread selected sections of text and asked myself: *Does this code really capture the essence of this section?* I focused on meanings of sentences and not only on single words. The initial interviews were coded before the post-observation interviews. Although my interviews were open-ended, they were also structured in such a way as to gather information about participants' understanding of reflection, how and whether they reflect when they plan lessons, how and whether they reflect while teaching a lesson, and how they reflect on their lessons. The research questions and my conceptual framework were constantly in the back of my mind as I coded the data. However, I did not have a preset list of codes, but rather coded the text as I read through the transcripts. This means that although the themes that emerged were determined *a-priori* (in line with the conceptual framework for this study and the research questions guiding the study), the coding was done inductively, using detailed codes for each piece of selected text. I take cognisance of the fact that, *no matter how hard we try there are no purely inductive studies* (Bernard & Ryan, 2009, p. 107).

In Table 4.1 I provide a timeline of the data-gathering process. I have used pseudonyms to protect the identities of the participants.

Table 4.1 Timeline of the data gathering process

Data gathering instrument	**Participants (pseudonyms)**	**Date**
Initial interviews	Dianne, Mary, Vicky, Sipho	2010-07-29 2010-07-30
Classroom observation	Mary Morgan Vicky Dianne Sipho	2011-02-24 2011-03-04 2011-03-10 2011-03-11 2011-03-11
Post-observation interview	Mary Morgan Vicky Dianne Sipho	2011-02-24 2011-03-04 2011-03-10 2011-03-11 2011-03-11

Group reflection on observed lesson	Mary's lesson Morgan's lesson Vicky's lesson Dianne and Sipho's lesson	2011-02-24 2011-03-04 2011-03-10 2011-05-05
Final group interview	Mary, Morgan, Vicky, Dianne, Sipho	2011-05-05

The initial interviews took place in July 2010. The initial interview with Morgan was not taped (due to my nervousness I forgot to press the 'record button' on the tape recorder). The classroom observations could only be conducted in 2011 due to a national teachers' strike during the third term of 2010 and examinations during the fourth term. All the post-observation interviews were conducted immediately after the observation of each lesson. The lesson study group reflected the same afternoon on the lessons of Mary, Morgan and Vicky, but this was not possible in the case of Dianne and Sipho because of the start of the school holidays.

4.2.1.1 Inclusion criteria that determined the coding of the data

Keeping in mind the research questions that guide this study as well as the tentative conceptual framework for the study, I coded text in the transcripts that reveal the participant's

- thinking about his/her mathematics teaching in general (description of self as a teacher; perceived strengths, challenges and joys of being a teacher; teaching style, classroom management, time management, etc.);
- understanding of reflection (I considered the participant's verbal description of reflection during the initial interview and understanding of reflection as revealed in the example of reflective practice he/she provided during this interview);
- reflection-for-action (Before the initial interview I requested that each participant present a lesson plan for discussion. Before the observation lesson I received lesson plans from all the participants that I used during the lesson to determine the participant's reflection-for-action.);
- reflection-on-action (as revealed during the initial and post-observation interviews);
- reflection-in-action (as revealed by the deviations of the provided lesson plan);
- view of situational factors that may influence his/her reflective practice (time, class arrangement, interruptions while teaching, the presence of the researcher in his/her classroom, lesson study experience, etc.).

Table 4.2 summarises the inclusion criteria that determined the coding of the data.

Table 4.2 Inclusion criteria for coding the data

Inclusion criteria	Codes
Reflection on teaching in general as revealed during the two interviews and in the discussion of the lesson plan	Reflection on reason for becoming a mathematics teacher Description of self as a teacher Perceived strengths as teacher Perceived challenges Joys as a teacher Reflection on class management/arrangement Reflection on teaching in line with curriculum Reflection on teaching style Reflection on time management Language
Reflection on specific actions while teaching the lesson	Reflection on action: feelings about the lesson Reflection on action: external factors Reflection on aspects of the lesson that could change Reflection on challenges experienced in lesson taught Reflection on class management/arrangement Reflection on deviation of lesson plan Reflection on lesson plan: teacher's expectations of learners Reflection on other ways to teach the lesson Reflection on strengths of lesson taught Reflection on teaching in line with curriculum Reflection on teaching style Reflection on time management Reflection on unexpected happenings during lesson Language
Reflection on lesson planning	Discussion of lesson plan: perceived challenges Discussion of lesson plan: perceived strengths Discussion of the lesson plan: possible changes Reflection on deviation of lesson plan Reflection on lesson plan: teacher's expectations of learners
Reflection on learners' understanding of mathematics	Reflection on learners' understanding of concepts Reflection on challenges experienced in lesson taught Reflection on other ways to teach the lesson
Reflection on being a participant in this study	Reflection on lesson study experience
Reflection on contextual factors that influence being a reflective teacher	Reflection on action: external factors Reflection on class management/arrangement Reflection on time management Reflection on unexpected happenings during lesson Language

4.2.1.2 Exclusion criteria that determined the coding of the data

I excluded any text that did not provide answers to the interview questions or did not relate to the research questions that guide this study or to the tentative conceptual framework for the study. I also excluded any remarks by the participant that had no direct bearing on the focus of this study. I summarise the exclusion criteria for coding of data in Table 4.3.

Table 4.3 Exclusion criteria for coding data

Exclusion criteria	**Example of text excluded from coding**
Personal anecdotes not related to the focus of the study	*Because actually what happened I had to pay for my signature ...they did not send modules. They confirmed on the other side, we have sent you modules. I said to which post office ... because the first letter I received was from attorneys right away*[7]
Elaborations on their knowledge of mathematics not related to the focus of the study	*You've got mixed numbers here, the other one is just a mixed number and the other one is an ordinary whole number and then you see a fraction somewhere, this is an expression with three terms ... and then you can't add them or subtract them if they are like that, you have to make them to be the same, right, so they must all change. You have to change the mixed number to ... to an ordinary fraction*
Biographical detail not related to the focus of the study	*... then we went to the college because we wanted to alleviate this poverty and then uplift the background then with my youngest sister, all of us we are teachers at home*
Elaborations on past experiences not related to the focus of the study	*... poor backgrounds ... didn't allow us to get bursaries to university we did not have those opportunities in the Eastern Cape, especially the homelands*

The list of codes created for the two interviews are displayed in Table 4.4. During the initial interview I aimed to get acquainted with the participant and this interview probed the biographical background of each participant as a mathematics teacher.

[7] Language used by participants only slightly altered so as not to change the original meaning and nuance.

Table 4.4 List of codes created for the two interviews

Examples of questions during the initial interview	**Codes**
Why did you become a teacher?	Reflection on reason for becoming a mathematics teacher
How would you describe yourself as a teacher?	Description of self as a teacher
What are your strengths as a teacher?	Perceived strengths as teacher
What are the challenges you face as a maths teacher?	Perceived challenges
What are the joys you experience as a maths teacher?	Joys as a teacher
Do you know what reflection is?	Understanding of reflection
Can you give me an example of how you reflected in a lesson? (Discussion of lesson plan brought along)	Example of reflection Reflection on learners' understanding of concepts
Examples of questions during the post-observation interview	**Codes**
What are your feelings about the lesson?	Reflection on action: feelings about the lesson
What were the essential strengths of your lesson?	Reflection on action: external factors
Any challenges you experienced during the lesson?	Reflection on aspects of the lesson that could change
What were your expectations of your learners?	Reflection on challenges experienced in lesson taught
If you had to teach this lesson again what would you change?	Reflection on class management/arrangement
Can you think of any other way you might have taught the lesson?	Reflection on deviation of lesson plan
Do you think the content that was covered was meaningful to the learners?	Reflection on lesson plan: teacher's expectations of learners
(Discussion of deviations from the lesson plan)	Reflection on other ways to teach the lesson
(Discussion of what happened during the lesson)	Reflection on strengths of lesson taught
If you finally reflect on your lesson, how do you feel about it?	Reflection on teaching in line with curriculum
Is there anything else you want to add or say about your lesson?	Reflection on teaching style
	Reflection on time management
	Reflection on unexpected happenings during lesson
	Discussion of lesson plan: perceived challenges
	Discussion of lesson plan: perceived strengths
	Discussion of the lesson plan: possible changes
	Language

The codes in the second column display the categories I created by coding the text after the two interviews. When I coded the transcripts of the second interview, where the participants talked freely in response to a question, I found that more than one code could be associated with one interview question. In my selection of codes I tried to adhere to the following suggestions for categorisation (Dey, 2005):

- Become thoroughly familiar with the data: I read and reread the transcripts numerous times and watched the videos twice.
- Always be sensitive to the context of the data: I interpreted the meanings of phrases as an informed reader who knows the teacher and the context of that teacher's practice.
- Be flexible – extend, modify and discard categories: I located key phrases that speak to the phenomenon in question and discarded those that do not.
- Consider connections and avoid needless overlaps: I created networks of connections with Atlas.ti 6.
- Record the criteria on which category decisions are to be taken: I have provided inclusion and exclusion criteria for coding the transcripts.
- Consider alternative ways of categorising and interpreting data: I did not only rely on the codes that emerged using Atlas.ti 6, but also created matrices to categorise and interpret the data.

4.2.2 Deductive style of indentifying themes

In the next phase of the data analysis I used the programme Atlas.ti 6 to cluster the codes which I considered to be related to each other. These clusters are known as families, which can be broad collections of codes. To create coding families I selected codes from the non-member window in the code family manager in Atlas.ti 6 and made them members of a family by clicking in the member window. Families are not mutually exclusive, which means that one code can be found in more than one family. I used my research questions and my conceptual framework to name the families, which means that my themes were determined *a-priori*, in a deductive way. Six themes were created using Atlas.ti 6, illustrated in the following section with their code links. The themes are mentioned in the following order:

1) Understanding of reflection (as revealed by the participants during the initial interview);
2) Reflection-on-action (as revealed by the participants during the initial and post-observation interviews);
3) Reflection-for-action (as revealed by the participants in their lesson plans);
4) Reflection-in-action (as revealed by the participants during the observation lesson);
5) Content of reflection (revealed during both interviews); and
6) Contextual factors (revealed during both interviews).

4.2.2.1 Theme 1: Understanding of reflection

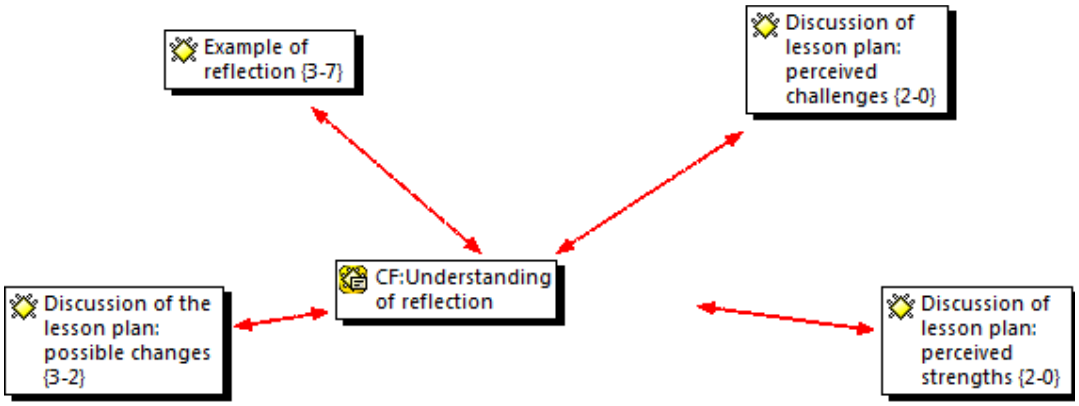


Figure 4.1 Theme: Understanding of reflection

Four codes are linked to the theme **understanding of reflection**. These codes are assigned to this theme based on the discussion of the lesson plan and the example of reflection in their teaching that participants provided during the initial interview.

Each code has a pair of numbers attached to it, for example, the code *example of reflection* has the set of numbers {3-7}. The 3 refers to the groundedness, which is the frequency with which the code was attached to quotations (three participants discussed an example of reflection in their classes). The 7 is the density. This is how many times a code has been linked to another code in the networks that were created. It can give an indication of how pivotal in the different interactions the code is (Archer, 2009). The code *example of reflection* was associated with seven other codes: perceived challenges, perceived strengths as a teacher, external factors, class management, strengths of a lesson taught, feelings about the lesson and aspects of the lesson that could change.

The theme **understanding of reflection** relates to the example of reflection that the participants described during the initial interview. In their discussion of their lesson plans the participants revealed perceived challenges, perceived strengths, and possible changes to the lesson. Through the example of reflective practice that they provided, they revealed their understanding of reflection.

4.2.2.2 Theme 2: Reflection-on-action

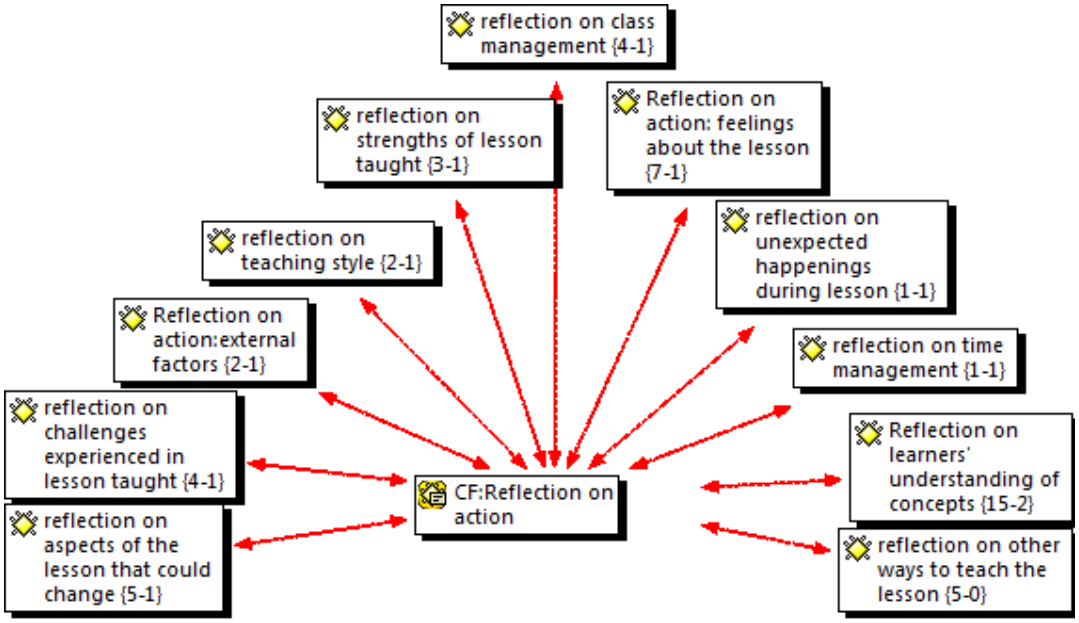


Figure 4.2 Theme: Reflection-on-action

The theme **reflection-on-action** emerged throughout the interviews. The participants reflected on their teaching during the initial interviews as well as during the post-observation interviews. They also reflected on their action during the group reflections on their lessons. They were concerned mainly with unexpected things that happened in their classes while teaching, their feelings regarding the lesson they taught and the fact that they could or could not relate the content to the real-world of the learners. They reflected on their classroom arrangement (working individually, in groups or pairing learners), their time management (they planned to do more examples and class work than possible within the period); most of them lamented their learners' lack of basic knowledge; and they reflected on the challenges they experienced while teaching the lesson (for example their own command of English as well as their learners' reading skills).

4.2.2.3 Theme 3: Reflection-for-action

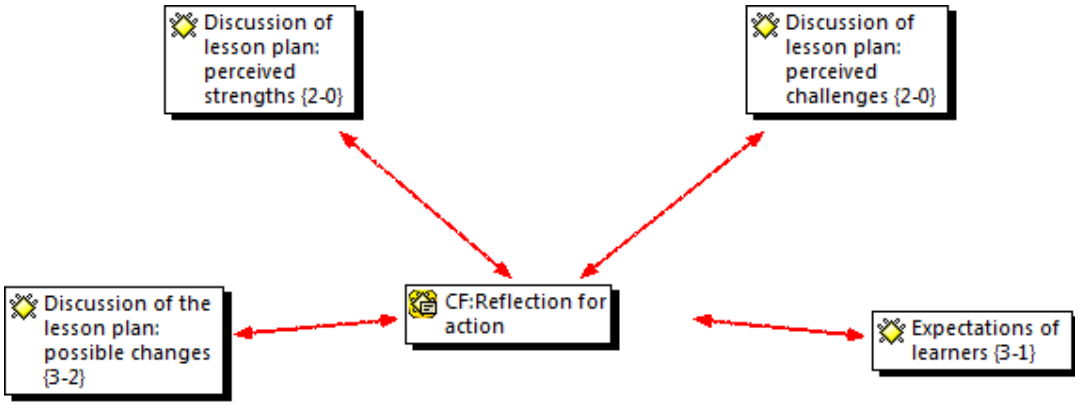


Figure 4.3 Theme: Reflection-for-action

The theme **reflection-for-action** emerged through discussions of the participants' planning of lessons. These lesson plans were discussed during the initial interviews, and also after each lesson observation. Furthermore the lesson study group cooperatively planned the first lesson on linear equations for a Grade 8 class. The lesson was taught by one participant, and after the first group reflection on the observed lesson, each participant had to adapt and change the lesson plan to the level of his/her class. During the interviews the lesson plans were discussed, revealing teachers' reflection-for-action.

4.2.2.4 Theme 4: Reflection-in-action

Figure 4.4 Theme: Reflection-in-action

I coded the participants' reflection on their deviations of their lesson plans for the observation lesson as relating to the theme **reflection-in-action**. Three teachers deviated from their original lesson plans while teaching the lesson, and I associate their deviations with the theme. In all three cases they revealed that they were thinking on their feet.

4.2.2.5 Theme 5: Content of reflection

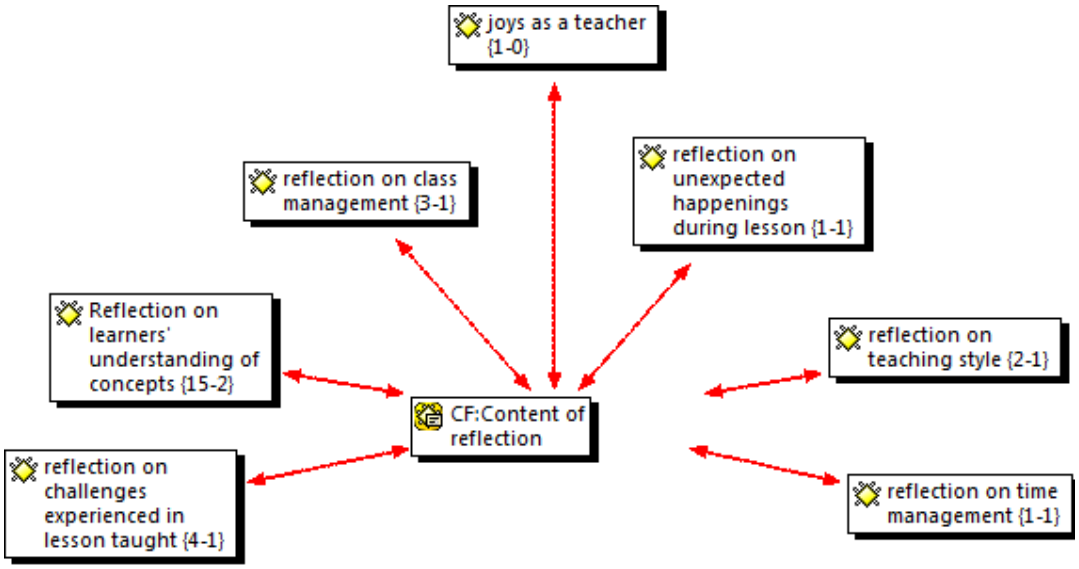


Figure 4.5 Theme: Content of reflection

The theme **content of reflection** basically deals with the content that the teacher reflected on and how deeply he/she reflected. The participants revealed that they reflect on their teaching styles, unexpected things that happen in class, their learners' understanding of concepts, their own time management and class management, the joys of being a teacher and the challenges of being a mathematics teacher.

4.2.2.6 Theme 6: Contextual factors

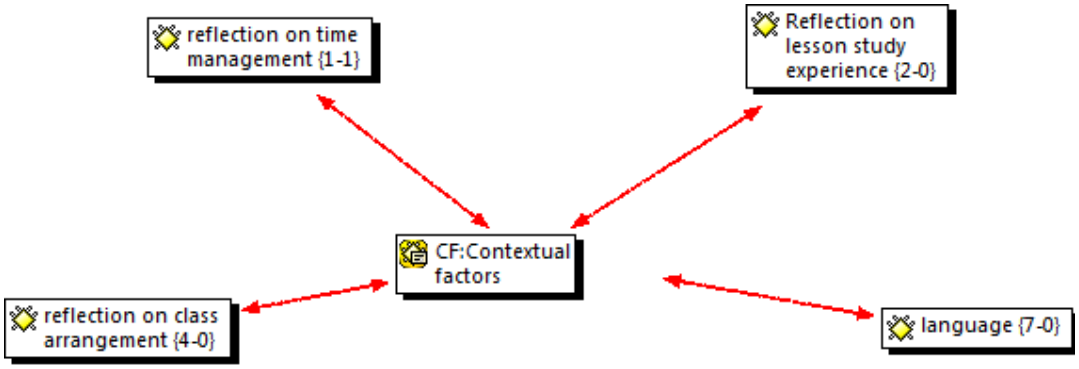


Figure 4.6 Theme: Contextual factors

The theme **contextual factors** reflects the participants' class arrangement, time management, their reflections on being part of the lesson study group and language issues. At first I did not assign the code *language* to this theme, but as I read and reread the transcripts I found that three of the participants repeatedly mentioned the fact that their

learners were struggling with language issues. One of the participants acknowledged that she was not fluent in English and frequently code-switched to Sesotho in her class.

In the next section I discuss the personal ethnographies of each of the five participants. I include demographic data as well as how the participants view themselves as teachers, and their perceived strengths and challenges as a mathematics teacher as reported during the interview.

4.3 Personal ethnographies of the participants

The biographical information of the five participants is provided in Table 4.5. I have used pseudonyms to protect the identities of the participants.

Table 4.5 Biographical information of participants

Participant	Dianne	Mary	Morgan	Sipho	Vicky
Age	32	44	39	48	44
Highest qualification	ACE at UFS	FDE at UP	BSc Ed at Uni QwaQwa	FDE at Uni QwaQwa	BEd Hons at Unisa
Number of years teaching	8	19	14	22	17
Mathematics Grades teaching	11,12 ML	8	10, 12	8, 9	9, 10, 11
Home language	Sesotho	Sesotho	Sesotho	Sesotho	Sesotho

From the table it is clear that these participants are all experienced teachers, with basic teaching qualifications and, except for Dianne, have all been teaching for 14 years or longer. They are all currently teaching in a rural township school where the pass rate for mathematics was 19% in 2010. The participants are pressurised by the school management and district office to improve the pass rate. The school building and grounds are neat and I used the boardroom as an office for the duration of the research. The language of instruction and learning (medium of instruction) at the school is English. Setati, Reed and Bapoo (2002) argue that in the remote rural areas of South Africa where access to English outside the classroom is severely limited, the classroom context is more appropriately described as a foreign language learning environment in which English is a foreign language. This finding has implications for my study, where the participants are teaching in a rural environment and they had to reflect on their practice through the medium of English. In addition, these participants all teach mathematics to learners who do not have textbooks.

4.3.1 Dianne

Dianne is a female teacher with an Advanced Certificate in Education (ACE) qualification obtained from the University of the Free State, QwaQwa Campus. She has been teaching mathematics for eight years and is now teaching Mathematical Literacy, which she claims is *much easier than maths*. When I asked her to describe herself as a teacher she replied:

> *Oh ... describe myself as a teacher, oh ... I am a role model to my learners, I work very hard and I want also them to work very hard, to not to be lazy and, jô ... as a teacher, hey, I do a lot of things, I'm helping also the people outside, not only the learners, like in church, in community with some ideas ... if they go to interviews, I help them ...*

She became a mathematics teacher because *I want to teach the learners maths and to show them mathematics is not a difficult subject*. According to Dianne her strengths as a mathematics teacher lie in the fact that *most of the time I'm not absent, I attend school well and work very hard during school time*. She claims:

> *I enjoy (laughs) ... what I'm enjoying as a teacher ... (laughs) ... Yes I'm enjoying to be with people, yes, I know every morning I'm going to meet the learners ... some are rich, some are poor, they are hungry ... I am enjoying helping them, giving money for break to eat something, I ... I love learners, yes ...*

The challenges she experiences teaching mathematics are in her own words:

> *Jô ... You taught to learners ... when you go out, you give them test ... they've got zero ... everything you taught them you ask as it is, but they got zero ... feeling that's very challenging, because ... Hey, they say when you talk ... they write class work ... they pass, after two weeks, test ... they fail, they say that it is easy when you talk to them or when you're still explaining ... when they are alone, they say they forget everything ...*

4.3.2 Mary

Mary is a female teacher who has a Primary Teaching Diploma (PTD) and a Further Diploma in Education obtained from the University of Pretoria. She has been teaching for 18 years and is currently teaching mathematics to Grade 8. She describes herself as a teacher as follows:

> *I'm very, very good ... I enjoy doing everything, explaining mathematics, also Life Sciences and I'm real-life centred, that's what makes my learners understand easily ...*

However, when asked about the challenges she experiences as a teacher, she replied:

Even if you can explain so many times, they say ma'am we understand, now we understand ... but just leave them like that and give them a task, the following day you find that when you are teaching ... the problem is that when you are teaching ... they can't take examples that you are writing. They don't write, they don't like to write ... They don't want to practise ...

4.3.3 Morgan

Morgan has a BSc (Ed) qualification obtained from the University of Free State QwaQwa campus. According to him he became a teacher because he saw there was a shortage of mathematics teachers. He enjoys working with the learners but feels challenged when they struggle.

I think the challenge one ... that I have is where you ask the learners basic questions like the LCM ... it becomes frustrated to me if you have two numbers, 5 and 2, and you ask them what is the lowest common multiple then the learners cannot give you the lowest common multiple ... to me it is very, very frustrating ... because I expected that one to be a basic one ...

4.3.4 Sipho

Sipho is a male teacher with a Further Diploma in Education from the University of Free State QwaQwa campus. He has been teaching mathematics for 20 years. According to him, he chose teaching as a career *because I love to work with kids and mathematics teaching because when I was at school I was a person who was loving mathematics*.

However, in our discussion of the lesson plan he brought with during the initial interview, he revealed that he felt challenged by learners' lack of reading skills. In his words:

you know that ... usually after I've done that, I try to bring about an application, that is the problem solving of this ... now what is challenging to the kids, usually I find that the interpretation of a question, the language, they cannot read the language ...

4.3.5 Vicky

Vicky is a female teacher with a BEd (Hons) obtained from Unisa. She has been teaching mathematics for 16 years. Vicky claims that she became a teacher because of her love of learners, but then she admits that

actually it was not ... for the first time it was not my intention but ... due to financial constraints that we had then I decided to take teaching as one of the things because I was able to ...

She mentions that the learners struggle with mathematics and regards that as her biggest challenge:

> *Jô. Here the challenge that I face, since I came here is ... the learners, I don't know, I really don't understand ... they don't have background of maths, they don't have the interest or the love of what they are doing. You can do whatever ... try to come with different methods and challenges but ... they don't cope, I don't know what's hindering them, those, like today I was presenting, we have done ... dealt with this for so long, equations ... with them, then today I come with a puzzle, so that we can do a puzzle on that one, jô, I am struggling ... because they have forgotten everything I have done (laughs) ...*

She describes herself as a teacher in the following way:

> *Sjoe, as a teacher, being a teacher you ... you are more than what you thought you are, you ... you become a guardian to them, or to many of them ... you become a preacher and a minister. I find myself most of the time being a social worker because when I was studying I deviated a little bit from maths and science. I do an honours of psychology of education, therefore I see that these learners, they need parental involvement through their lives. I want to help the learners therefore that is one of the things that mostly I do here at the school ... is more like counselling ... because we find that most of them, when you say why did you not do your homework, they will say that's because we don't have food at home ... because if you look at the background of the learners, most of them are suffering ...*

In the next section I portray the participants' reflections in relation to the six themes of the study. These themes characterise the similarities in the data but also reveal the subtle differences because of the individuality of each participant.

4.4 Participants' reflections in relation to the themes of the study

4.4.1 Theme 1: Participants' understanding of reflection

Only two of the five participants were able to verbally explain what the term reflection was and three of them were able to give an example of how they reflected in class (see Table 4.6). Although all the participants reflected during the interviews on their strengths as a teacher, the challenges they experienced when teaching mathematics, and their learners' understanding of mathematics concepts, they did not seem to realise that they were actually **reflecting** on their practice.

Table 4.6 Participants' understanding of reflection

Participant	Theme: Understanding of reflection
Dianne	Unable to explain what reflection and also unable to give an example of when she reflected in her class. When asked to give an example of reflection she said: *When I'm introducing a lesson, I gave them the explanation simple ... like mean, what is mean ... sum over ... and then after explanation, I do problems and examples, lots of examples ... I give them exercise too, like class work ...*
Mary	Unable to explain what reflection is and unable to give an example of when she reflected in her class
Sipho	Unable to explain what reflection is and unable to give an example of when he reflected in his class. I asked him: *When you taught this lesson was there any instance when you stopped and wondered ... shouldn't you do it differently ... because you can see the learners are struggling? Was there such an instance here?* He replied: *No ... no ...*
Morgan	Views reflection as follows: *Reflection is thinking back to last year's results, comparing last year's results to this year.* As an example he says: *I reflect in class when seeing learners misunderstanding something and then I think of another way to explain it.*
Vicky	Explains reflection as: *... how do I see myself or my learners ...* She reflects on her learners' poor backgrounds, for example: *Therefore I think that is through refection that I've changed the way of teaching. I have tried to come closer to them and see their own problem and how can I help them. What is it that they are lacking?*

Compared to the way reflection is defined in the literature[8], both Morgan and Vicky were able to explain what the term means. However, their explanations differed in the sense that Morgan focused on the mathematics results (which were very poor) and his concern about improving the results. In the literature Zeichner and Liston (1996, p. 11) believe that this type of reflection indicates a reflective teacher who is asking the broader question: *Are the results good, for whom and in what ways?* On the other hand Vicky focused on her view of herself and on her learners, taking her belief structure into account in her understanding of reflection. These two participants have different understandings of reflection. This finding mirrors results of Pedro's (2001) study where the participants provided different definitions of reflection. It seems that more than one perception of reflection is possible (Osterman & Kottkamp, 1993; Sparks-Langer, 1992; Zeichner & Liston, 1996).

[8] See Chapter 2, Section 2.4.1.1

To analyse the participants' example of reflection which they explained to me during the first interview, I have kept the four criteria for defining reflection[9] of Lee and Tan (2004) in mind. Measured against the first criterion, **examination of practice**, where reflection is not merely recalling a teaching incident in a general manner, but reflective thinking is seen as **focused and directed at particular issues or concerns about practice**, Dianne's example of reflection cannot be regarded as true reflective thinking because she is not reflecting about concerns that she has about her practice, but merely recalling the teaching incident in a general manner. (Lee & Tan, 2004). Morgan's example relates to his learners' understanding of mathematics, which he finds problematic and reflects on possible changes that he will have to make in order to meet his learners' needs, thereby demonstrating reflective thinking. Vicky's reflection on her learners' poor backgrounds might be considered to be critical reflection if one takes into account Liou's (2000, p. 199) definition of reflection: *Critical reflection is examining teaching experiences as a basis for evaluation and decision making and as a source for change.*

In the next section I discuss how the participants reflected on their classroom practice during the interviews.

4.4.2 Theme 2: Reflection-on-action

According to Schön (1987) reflection begins with the recognition that an educational dilemma or emotional discomfort exists in response to professional experiences. Not all the participants in this study reflected on their actions in the class, especially in relation to their learners' lack of understanding of concepts. However, they did reflect on events that had happened in class, but some of them failed to relate these events to their actions. All these reflections were prompted by the questions in both the interviews, as well as while they cooperatively watched the video recordings of their observed lessons. A discussion of each participant's reflection-on-action follows.

4.4.2.1 Dianne

During the two interviews Dianne reflected on the **needs of learners**, *some poor, some hungry*; the value of teaching mathematics related to real world, (for example teaching learners about BMI (body mass index) and data handling (how to gather information). She also reflected on her own **inability to use English fluently**:

> *the challenge is eh ... eish ... language ... I, I thought my English tongue is not so well ... that is the challenge ...*

[9] See Chapter 2, Section 2.4.1.1

She felt proud of her grouping of her learners (**class arrangement**) but concerned about her **time management**. She also reflected on other ways to teach her lesson on BMI:

> *Other way? Hmmm ... hey ... if they can come with the young graphs, what is this, clinic card, sometimes they can come with their baby clinic ... their own ... but I don't think they have ... and also to take the scale ... what is this ... is the scale, to make sure they know their weight, they stand there and you see your weight? ... Right, now from today you know your weight ... and then to take a tape for me to measure them, and then we can calculate the real BMI for each one. I can teach it that way again, it is practical too.*

4.4.2.2 Mary

In Mary's reflection on her action, she reflects on technical details only, for example blaming her **learners' lack of interest in mathematics** on their calculator usage and their obsession with their cell phones. In this instance she did not relate their lack of understanding to her teaching, but to external events.

> *I've given them some work to do, they will take out their cell phones and they would put in those earphones ... I don't know ... then they play music. When outside ... they are playing, they like playing, especially with the cell phones. When they get home it's TV time. Not homework time ...*

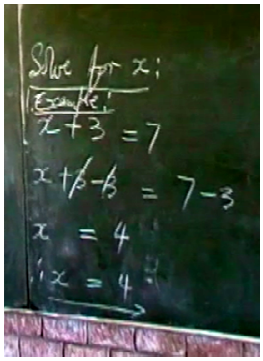
Like Dianne she was also concerned about her **time management** in class, and rationalised that she could not finish or wrap up a lesson because of **external factors**, such as the learning facilitator of Life Orientation who interrupted her class to get the work books of learners.

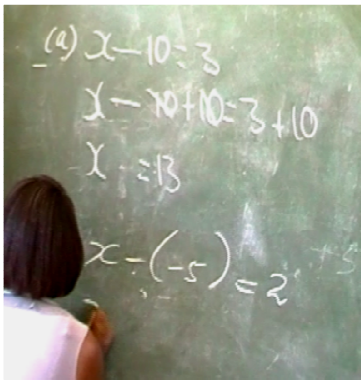
> *Yes, I taught them but ... I did not get ... eh ... did not really wrap up the lesson, maybe according to time that I allocated there, I said 40 minutes, OK strictly 40 minutes, OK, maybe I'll be on the body (*of the lesson*)10 minutes, 5 minutes interruption or 2 or less, and then get a child (unclear) ... I did not also give a full homework to say OK, I'm now applying my lesson ... I did not get a chance to apply my lesson, as if it was not planned ... I'll also blame what, though not negatively, the situations that emanated, the process to plan our own things, there are other things that are coming all of a sudden, now you have to step, now you have to open cupboards, now you have to take books, now you have to choose ... within this time that I was supposed to be teaching ... and now I have to cater for the learning facilitator of life sciences at the same time ...*

However, Mary reflected on the **content** she taught (e.g. the examples she selected for the class) and admitted that she did not do them from simple to complex (see Picture 4.1 below):

> *I would think of calculations ... it was more complex, because I ... I had just given them a fresh calculation that is very simple. Now all of a sudden the second example is more difficult, it's having brackets ... so there, I nearly ... killed them, that's why*

they struggled. I was also confused, I was now confused, I wanted ... I was having a feeling of say ... but now I have to catch up, hey, I've mentioned these things in my plan, I said I'm going to give them this rather than ... you know, I did not now think of them grasping gradually ... you see they were not suppose ... at least I should do about five calculations of the simple started form ...





Picture 4.1 Pictures portraying Mary's examples and class work for Grade 8

The first picture shows how Mary explained to her Grade 8 mathematics class how to use the additive inverse when solving linear equations, using a very basic example, $x + 3 = 7$. The second picture illustrates the equation that the learners struggled to do on their own: $x - (-5) = 2$, which is much more complicated than her first example, or even the second one, $x - 10 = 3$. In addition, she started her explanation of $x - (-5) = 2$ when the bell has already rung for break, and the class was not paying attention at that stage.

Mary referred to the **curriculum** when discussing the challenge of catering for all learners in her mathematics class as follows:

I look at what I give them in the form of activities, that at least my activities ... there must be those that are simple for learners with low levels of abilities and then, those who are moderate, but there should be those that are challenging also for very intelligent learners, likewise those who have low abilities ... they are forced now by the curriculum if you can see, they are forced to know, they have to know ... setting of question papers is so hard now, they have to know everything, they don't compromise when they set these papers, those even in Grade 12, for learners, they can't say, even in Grade 9, they can't say, now let's think for those who have low abilities, that at least they pass ... make 50% of the paper to be very simple, no, they don't do that ...

4.4.2.3 Morgan

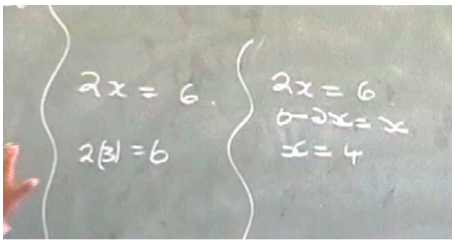
In the post-observation interview with Morgan he reflected constantly on his **learners' understanding of mathematics** concepts. Unlike Mary he reflected on how his actions

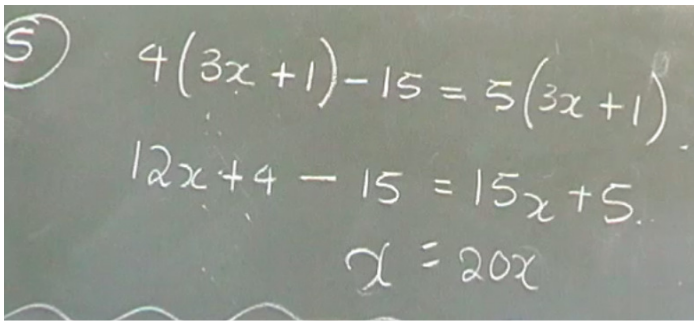
influence the learners' understanding of mathematics. He reflected on how to link new knowledge (solving linear equations in Grade 10) to learners' pre-knowledge (using the distributive law):

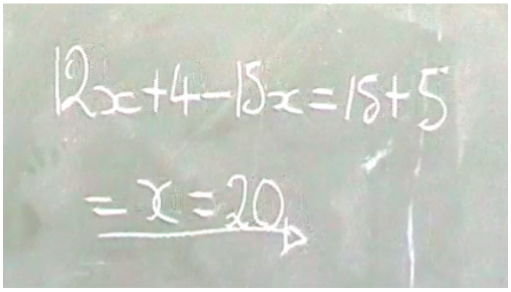
> *According to my understanding, if you are dealing with the learners, you do not need to frustrate them, you take them from the easiest one, eh ... from what do they know from other grades, then you take it step by step by taking the linear equation from Grade 8 then I take it to Grade 9, until I arrive at the Grade 10 where I expect them, where they have the brackets, so that they can apply what they learned in Grade 9, to apply the distributive law, from the distributive law ... eh ... we have equation where they have unknown on either side, where I expect them to discover from that they can be able to take the unknown from one side and the constant to the other side, and from thereafter when I see they are able to do that, I introduce the fractional equations ...*

Morgan asked his Grade 10 mathematics learners to clarify concepts and explain verbally how they would calculate a sum. He used questioning effectively and called on learners to do examples on the board (see Picture 4.2). When I asked him about not correcting the wrong examples on the board he said

> *I leave it to the learners so that the learners, they try to compare ... for them to make their own conclusion ... that this one is wrong, maybe it's wrong ... where ... what are the things that are wrong ...*







Picture 4.2 Examples of Morgan's Grade 10 learners' problematic work on the blackboard

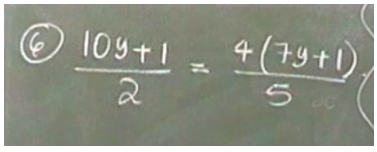
These examples portray some of the misconceptions of Morgan's Grade 10 learners, for example in the last picture one can see that the learner adds $12x$ to 4, gets $16x$ and then subtracts $15x$ from it to get x.

Reflecting on his **teaching style** (which he calls the discovery method) he said:

> *The most thing that I liked about the lesson is the discovery method where I invite the learners to come and show me what they are doing on the board, so that I can exactly know what they know and what they don't know.*

I asked Morgan what he would change if he had to teach the lesson again and once again he reflected on **learners' understanding of concepts**. In his lesson on linear equations it emerged that the learners did not understand how to obtain the lowest common multiple to solve fractional equations (see Picture 4.3 below), which he regarded as a challenge.

> *I think if I have to review the lesson, because I'm going to do it tomorrow, the things that I have to emphasise are the following: the important one is to make sure that all of them understand how to take the unknown to one side and the constant to the other side, and the other thing that I need to revisit is eh ... to find the lowest common multiple ... I need ... I need to go back to the algebraic fractions where they are dealing with the LCM so that all of them they can be on the same par ... so that they are not struggling ...*



Picture 4.3 Solving fractional equations

4.4.2.4 Sipho

Sipho reflected on **learners' lack of understanding English** during the discussion of the lesson plan in the initial interview:

> *you know that usually after I've done that I try to bring about an application, that is the problem solving of this ... now what is challenging to the kids usually, I find that interpretation of question ... the language, they cannot read the language ...*

In the post-observation interview he once again reflected on **learners' lack of understanding concepts** because of language issues:

> *sometimes the problem of English, when you say ascending order ... they don't understand ... ascending order ... what is that ... ascending ... to go up ... to start with the bigger exponent ... instead of starting with the smaller exponent*

However, Sipho not only reflected on his learners' understanding of mathematics concepts, but also on their **thinking**:

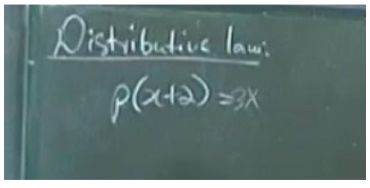
> *Sometimes when they struggle, sometimes it's important that, perhaps ... when someone stands up and come to the board and write something ... it's good to give him a chance perhaps to explain what he has written, to see how does he think, why he's writing it in that way, so that you can understand the way he thinks, because people think in different ways ...*

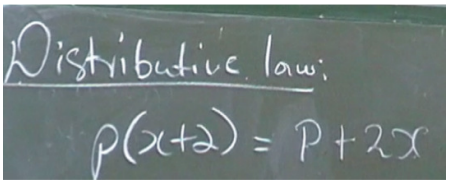
Sipho also reflected on **learners' lack of basic skills** and said *they got that intrinsic motivation but they don't have basic mathematical skills.* He was also, like Mary and Dianne, concerned about his **time management** in class:

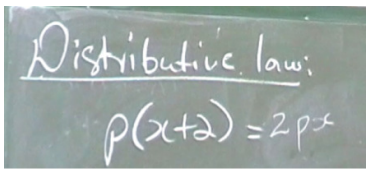
> *Sometimes I wanted to ask them questions, but due to time ... cause I realise that ... time ... eh ... I won't finish ... that is ... I won't be able to finish my lesson ...*

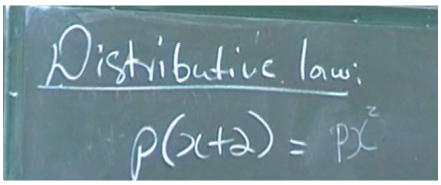
Sipho reflected on the **challenges** he experienced in his lesson (illustrated by the pictures below) on the product of the binomial as follows:

> *They amazed me because I expected them to be in a position to multiply ... you see, but I realised that they cannot ... they amazed me because I expected them to in the position to identify like terms and ... add them quickly but ... they struggled ... they amazed me with basic things you see ... hmm ...*









Picture 4.4 Examples of Sipho's Grade 9 learners' problematic work on the board

These pictures display some of the learners' misconceptions regarding the distributive law, for instance in the last picture one can see that the learner multiplied p by x and then confused the "+ 2 " with an exponent.

Sipho also reflected on his **learners' needs**:

> *but most ... the majority ... they are very weak ... they are very weak ... so they need one to give themselves time ... the motivation to show them that ... you know, sometimes if you show you care for them, if you try to give them that individual attention ... sometimes it helps them to be somehow independent ... to do things the way you do them ... they need that kind of consideration ...*

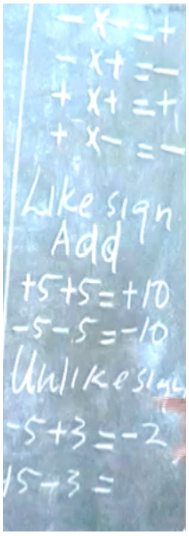
4.4.2.5 Vicky

Vicky reflected not only on the **needs of learners** but also on her own **shortcomings as a teacher** and her impatience with her Grade 9 learners' slow understanding of concepts.

> *How I speak, that is the first thing that I would change. I talk very quickly, that is ... I don't know how to change that one ... I expect them to understand quickly ... that is my problem ... I want them to ... I'll give them first problem, second problem, third problem, when we get to the fourth one ... Ai, ... I loose my temper sometimes (laughs) ... then I'll go to them straight away and usually I give ... eh ... a what ... twist their ears ... that is what I normally do ...*

She knew that her class was struggling with basic concepts and while she was teaching the lesson she wrote all the rules for integer computations down on the board and constantly referred the learners back to it when they made mistakes (see Picture 4.5). She reflected on her **teaching style** as follows:

> *but for this class, I have to repeat it two times before they understand. Even, like normally ... when I deal with them, I have to write negative multiplied by negative, all the formal things, the basics, that they must know from the previous Grade 8, Grade 9 ... normally I have to do it, because I know this particular class is having this kind of problem ...*



Picture 4.5 Vicky's rules for multiplication and addition of integers for Grade 9

The picture portrays Vicky's teaching of mathematics by using rules. This might be a reflection of her view of mathematics.

I summarise the participants' reflections on their actions in class in Table 4.7.

Table 4.7 Summary of participants' reflection-on-action

	Dianne	Mary	Morgan	Sipho	Vicky
Learners' needs	2		1	1	5
Learners' understanding	1	4	4	2	4
Language issues	2			1	1
Time management	1	1		1	
Classroom management	1			1	1
Teaching style		1	1		1
Learners' thinking				1	
Curriculum		2			
External factors		3			
Shortcomings as a teacher					2

In this table the quantity of each participant's reflection on certain issues is shown. For example, Mary, Morgan and Vicky constantly reflected on their learners' understanding of concepts, but only Sipho reflected on his learners' thinking. Although Mary reflected on her

learners' understanding, she did not think about how her actions might influence their lack of understanding. She was also the only participant concerned with external factors in explaining her actions (she reflected on three occasions during the various interviews on her learners' preoccupation with their cell phones and their need to use calculators for the most basic calculations, as well as blaming learning facilitators for her poor time management). Dianne, Sipho and Vicky reflected on learners' lack of understanding English, and Dianne also revealed her concerns about her own poor command of English during the post-observation interview.

According to Korthagen and Vasalos (2005) teachers usually reflect on aspects such as the classroom environment, learner behaviour, competencies of learners and beliefs about learners. The issues that the participants in my research study reflected on confirm the results of Korthagen and Vasalos (2005) and I categorised the content of their reflection-on-action as follows: 1) Reflections on pedagogical issues (classroom management, time management, teaching style, learners' understanding of mathematics) 2) Reflections on personal issues (language, shortcomings as a teacher) 3) Reflections on external factors (curriculum, interferences while teaching, class size) 4) Reflection on critical matters (learners' needs, learners' thinking).

Using these categories it appears that all the participants reflected on pedagogical issues and this finding is supported by a number of researchers (e.g. Butke, 2003; LaBoskey, 1994; Lee & Tan, 2004). Two participants, Dianne and Vicky, reflected on personal issues (Dianne's lack of fluency in English and Vicky's impatience with her learners and the knowledge that she speaks too fast). Unlike these participants' reflections, LaBoskey (1994) revealed that the participants in her study reflected on personal enjoyment and degree of enlightenment gained from the teaching experience. However, the participants in my study did reflect on the joys and challenges they experienced while teaching mathematics during the initial interview. Only Mary in my study reflected on curricular matters, unlike the four preservice teachers in Pedro's (2001) study. Three participants, Morgan, Sipho and Vicky, reflected on critical issues (their learners' needs, learners' thinking and addressing learners' lack of understanding of mathematics). This category is also addressed by Butke (2003) in her study of five choral teachers' reflective journeys. However, in contrast to my study, she found that her participants reflected on critical issues such as the importance of student citizenship, building a relational practice, issues of multicultural education, gender issues, and creating a sense of community.

In the literature consulted it is mentioned that teachers reflect on their actions when instigated to do so (García, Sánchez & Esquadero, 2006; Sowder, 2007) and this is also true for the participants of my research study who were required to reflect on their classroom practice in the lesson study group. What I found interesting is that none of the teachers reflected on their assessment of their learners. One reason for this might be because I did not specifically address this issue during the interviews or during the group reflections.

In the next section I discuss the participants' reflection-for-action.

4.4.3 Theme 3: Reflection-for-action

I used the participants' lesson plans to analyse their reflection-for-action. They were asked to bring a lesson plan along for discussion during the initial interview. For the observed lesson I provided them with a basic lesson plan template[10] which they used to cooperatively plan the first Grade 8 lesson on linear equations in the lesson study cycle. This template makes provision not only for reflection after the lesson, but also for reflection before the lesson is taught (in a column where the teacher reflects on his/her expectations of learner responses or understanding). None of the participants completed these reflection sections.

Each participant had to adapt this lesson plan to teach his/her observation lesson in the next lesson study cycle. The lesson plan was discussed and adapted after each group reflection on the lesson observed, and the aim was to try and improve the lesson plan in order to enhance learners' understanding of the concepts (which was the goal of the lesson study group).

The lesson plan for the observation lesson was analysed while the participant was teaching the lesson and any deviations that occurred were discussed during the post-observation interview.

4.4.3.1 Dianne's lesson planning

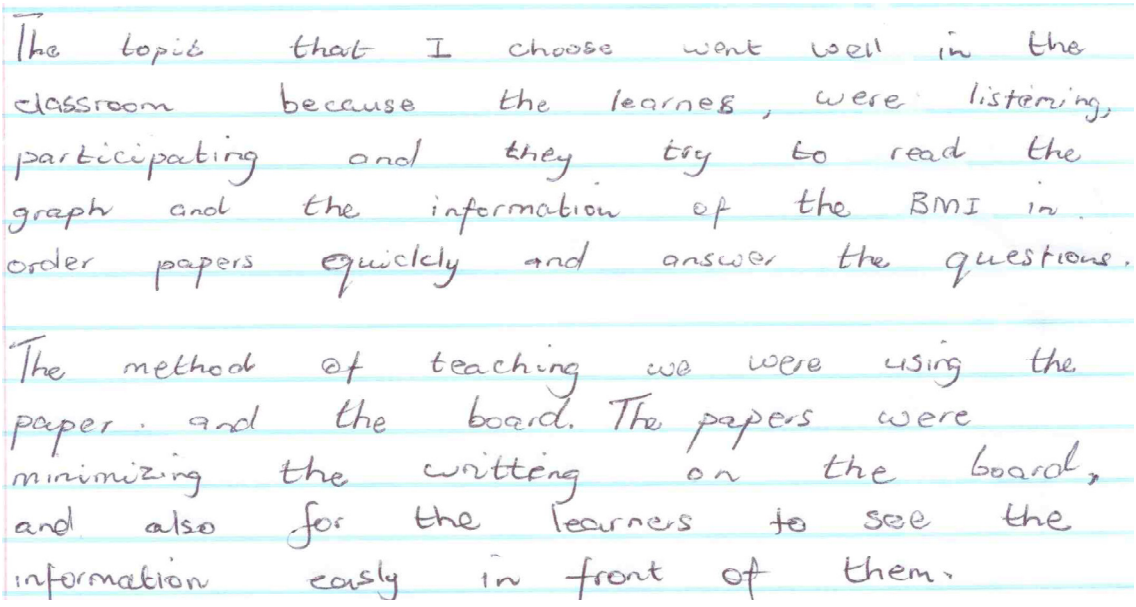
Dianne brought a one-page lesson plan template along during the initial interview. The template contained lesson plans for Grade 11 during the week 13 July to 26 July. Three data handling activities were provided with limited detail of the activity. Next to the teacher activity Dianne wrote *explain and give examples*; next to learner activity she wrote *do homework/class work*; next to expanded opportunities she wrote *more activities*; next to assessment instrument she wrote *memo*; her resource(s) was the *text book* and next to teacher reflection she wrote nothing. However, before the observation lesson she submitted

[10] See Appendix A

a detailed lesson plan on BMI for the Grade 11 Mathematical Literacy lesson. She admitted that she had learned a lot about lesson planning during the group reflection sessions we had after watching Mary and Morgan's lessons. In her teaching of the lesson Dianne adhered closely to her lesson plan and did not deviate from it, although she did not have enough time to complete the conversion of degrees Celsius to degrees Fahrenheit. In her lesson plan she made provision for learners' understanding of the content as follows: *I want learners to know how to substitute into a formula and to work with different formulas and use correct formula for a calculation also in life.*

She briefly mentioned their prior knowledge and future knowledge and her class arrangement and assessment. She provided two detailed examples as well as the activity the learners will be engaged in. However, she did not reveal her expectations of her learners or special needs that learners might have.

In her written reflection after the observation lesson she wrote: *It was easy for me to present the lesson because of the lesson plan Barbara designed for us.* She reflected on her learners' conduct in class, describing what happened in class.


The topic that I choose went well in the classroom because the learners, were listening, participating and they try to read the graph and the information of the BMI in order papers equickly and answer the questions.

The method of teaching we were using the paper. and the board. The papers were minimizing the writting on the board, and also for the learners to see the information easly in front of them.

4.4.3.2 Mary's lesson planning

During the initial interview Mary submitted a form with the date, learning outcome, assessment standard and content as an example of her planning. From this template one cannot picture how these lessons were taught. This template does not make provision for assessment, how the plan is linked to learners' learning of concepts and the ability of the

teacher to teach effectively. The needs of the learners are also not addressed. However, for the Grade 8 lesson on equations that I observed Mary provided a detailed lesson plan. In her lesson plan she reflected on her learners' understanding of equations as follows: *from their participation the teacher is able to draw feedback of their understanding*. I asked her what she meant with this statement and she replied:

> *As the one person is in front, is working on behalf of the class, and then ... I will see the level of the class ... of his understanding ... what ... through their participation, as you could see they participated more, and then they were trying to tell her how to do it, even though she was nervous, but they knew what should be done ...*

Although Mary explained to me in the post-observation interview that she tried to cater for the needs of all her learners there was no evidence of that in her lesson plan. However, in her written reflection on the lesson she reflected on the time she had wasted trying to mark all of the 54 learners' work and felt she should have rather given them a *fully-fleshed activity of maybe ten equations.*

4.4.3.3 Morgan's lesson planning

Morgan submitted a lesson plan template of Calculus lessons that he had taught for Grade 12 during the week of 21 June to 25 June. The lesson plan made provision for reflection, but he left that space open. The template did not make provision for teaching methodology or special needs of learners. From the template it was difficult to picture what had happened in the classroom during that week. Morgan's lesson plan for the observation lesson did not reveal much more than the template he submitted during the initial interview. However, he wrote out the examples he planned to do, as well as the class work in more detail. He provided no details of his expectations of his learners but in his final written reflection he reflected on their lack of understanding of solving equations and how he could help them:

> *I need to do everything in detail like writing in explanation each and every step because ... if ... I assume that the learner have pre-knowledge but they do stupid mistakes.*

Morgan's deviations from his lesson plan will be discussed when dealing with the theme *Reflection-in-action.*

4.4.3.4 Sipho's lesson planning

Sipho did not bring a lesson plan for discussion during the initial interview, but he provided a detailed lesson plan before the classroom observation. His lesson plan dealt with the product of two binomials. In his plan he provided an introduction to the lesson and three examples. During his teaching of the lesson he also deviated from his lesson plan and this will be discussed when dealing with the theme *Reflection-in-action.* His lesson plan did not make provision for special needs of learners and he did not explain his teaching methodology in his plan. As teacher activity he wrote *Facilitation.*

In his written reflection on his observation lesson he mentioned that he should have placed more emphasis on the application of the distributive law when finding the products of binomials, the addition and subtraction of like terms after multiplication of binomials, and the use of the number line for guiding the learners to add and subtract integers.

4.4.3.5 Vicky's lesson planning

During the initial interview Vicky provided me with a lesson plan template for six days, from 4 May to 11 May. No grade was written down and the content column revealed that the learners were doing revision of simple and compound interest, wrote a test, and then started with the Cartesian plane, drawing $y = mx + c$ and plotting points on the plane using the table method. Vicky's lesson plan for the observation lesson had a good introduction and her three examples were written down. However, the rest of the plan was done cryptically with no reflection on her expectations of her learners or how she would teach the content.

In her written reflection of her observation lesson Vicky wrote that she learned from her colleagues to involve her learners more in the lesson.

To sum up, it appears that hardly any reflection on planning to teach the content to increase learners' understanding of the concepts was evident in the participants' lesson plans. The lesson plans they submitted for the observation lessons were slightly more informative because they used a template that I provided, but none of them revealed any reflections on their expectations of the learners (although provision for this was made on the template). In their post-lesson written reflections the participants reflected only on Jay and Johnson's (2002) descriptive level (describing what happened in class). No evidence of critical reflection was found in the participants' lesson plans. This finding contrasts with the study by Luwango (2008) who investigated three mathematics teachers' critical reflective teaching in Namibia. She found evidence of reflection in the three teachers' lesson plans and concluded that critical reflection directs planning in terms of future actions (Luwango, 2008).

4.4.4 Theme 4: Reflection-in-action

Schön (1987) describes reflection-in-action as becoming surprised, interpreting it as a problem, and inventing procedures to solve the problem.

To determine each participant's reflection-in-action I used the lesson plan provided to me before the observation lesson and, during the observed lesson, I made notes on the lesson plan whenever the participant deviated from it. In the post-observation interview I asked each participant to explain the deviation and their explanations reflected that they were thinking on their feet. Reflection-in-action involves simultaneously reflecting and doing, and this implies that the professional has reached a level of competence, where he or she is able to think consciously about what is taking place, and modify actions instantaneously (Hatton & Smith, 2006).

Three of the participants in this study deviated from their lesson plans. Morgan planned to do eight examples but only did seven, including the eighth example as part of the homework. I asked him why and he said he was thinking of the time factor, and also that he needed to rather do one example that was on a higher level: $4(3x + 1) - 15 = 5(3x - 1)$, because he anticipated that the learners would not know what to do with the negative 15.

Sipho also deviated from his lesson plan. He introduced the product of two binomials on the board using a rectangle that was divided into four sections (a square and three rectangles) and explained to the learners how to find the area of the big rectangle by adding the areas of the four shapes. The learners struggled to find the correct area. He then deviated from his lesson plan and wrote the following on the board: If $p = x + 3$, find $p(x + 2)$. He explained this deviation as follows:

> *That is where ... I realised thereafter ... before I do this* (he refers to his planned examples)*, I should have got to show them the distributive, before I do this ... I should have done this after I have shown them this ... and that is when I realised that I've made a mistake ...*

Vicky deviated from her lesson plan by including the mathematical problem $(-3x + 2)(4x - 1)$ during the lesson while all the binomial products in her original lesson plan had positive x-coefficients. She explained this deviation to me by saying that she included it due to the common exam that all the Grade 9 learners would write the next week: *I decided let me challenge them and come with something that is different, that is why I have added this one with the negative.*

Although a number of theorists and researchers (Artzt, Armour-Thomas & Curcio, 2008; Butke, 2003; Jaworski, 2004; Nyaumwe, 2005; Pedro, 2001; Schön, 1983) believe that reflection-in-action is an active process in which doing and thinking are complementary, not all believe that reflection-in-action is possible[11] (e.g. Court, 1988; Van Manen, 1995). However, there is evidence in the literature that teachers do reflect-in-action (Artzt, Armour-Thomas & Curcio, 2008; Leikin & Dinur, 2003; Pedro, 2001; Ross & Bruce, 2005). Reed, Davis and Nyabanyaba (2003) argue that it is difficult to trace teachers' reflection-in-action if the researcher does not speak the main or primary language of the teacher whom she interviews and they stress that classroom observation is essential to capture these reflections. In my research study the teachers' reflection-in-action was captured using the teacher's lesson plan in conjunction with the classroom observation.

4.4.5 Theme 5: Content of reflection

The participants' content and depth of reflection relates to the level of their reflections. Different levels of reflection have been discussed in Chapter 2.3. Some researchers use the level of reflection interchangeably with depth of reflection (e.g. Lee, 2005; Jay & Johnson, 2002) and others relate the level of reflection to the content of reflection (e.g. Van Manen, 1977). In my study I considered both depth and content as the level of reflection, and I base my rationale to consider both on Lee's (2005, p. 712) argument that *one can reflect in depth on technical/practical issues and be considered at a lower level; as long as one considers moral and ethical issues even without justification, one can be considered reflecting at a high level*. In other words a teacher can be considered to reflect critically on a technical aspect of his/her teaching if there is a moral or ethical justification for it.

In Table 4.8 I summarise my view of the participants' levels of reflection, based on their revelations during the two interviews, also keeping in mind my observation of each participant. I used Lee's (2005) levels of reflections to determine the level of reflection of each participant[12]. Lee's (2005) levels of reflections consist of a recall level (R1), a rationalisation level (R2) and a reflective level (R3).

[11] See Sections 2.2.2.1
[12] See Section 2.3.5

Table 4.8 Participants' level (content) of reflection

Participants	Content of reflection	Level of reflection (Lee, 2005)
Dianne	Needs of learners; her poor command of English; relating mathematics to the real world; time management and her teaching style	R1 (recall level of reflection) R2 (rationalisation level of reflection)
Mary	Learners' lack of interest in mathematics, time management; teaching style and curriculum	R1 (Recall level of reflection)
Morgan	Learners' understanding of concepts; linking new knowledge to pre-knowledge; teaching style	R1 (recall level of reflection) R2 (rationalisation level of reflection)
Sipho	Learners' lack of language skills; learners' understanding of concepts; learners' lack of basic skills; learners thinking	R1 (recall level of reflection) R2 (rationalisation level of reflection)
Vicky	Needs of learners; own shortcomings as a teacher; impatience with learners' lack of understanding	R1 (recall level of reflection) R2 (rationalisation level of reflection)

From the table it appears as if none of the participants were able to reflect critically on their teaching. In my attempt to evaluate the level of each participant's reflection (during the interviews, in their lesson plans and reflective writings, and while watching the video recordings of their teaching) I had to consult the literature repeatedly, trying to capture the essence of what critical reflection is. According to Van Manen (1977) critical reflection entails the questioning of moral, ethical, and other types of normative criteria related directly and indirectly to the classroom. On Lee's (2005) reflectivity level one approaches experiences with the intention of changing/ improving in the future, analyses experiences from various perspectives, and is able to see the influence of cooperating teachers on students' values/behaviour/achievement. Critical reflection for Valli (1992) focuses on social, moral and political dimensions of education and involves making judgements based on ethical criteria. On Jay and Johnson's (2002) critical reflective level the teacher will consider all the different perspectives of a situation or problem and all the players involved: teachers, students, the school, and the community.

In contrast to my study's results, where none of the participants reflected on a critical level at this stage of the data analysis, Nyaumwe (2005) found that three of the four pre-service teachers' post-lesson reflective texts attained deliberate reflection (Level 2) and one of them reached the systematic reflection (Level 3) on the third visit. He used Hall's proposed three levels of reflection (Hall, cited in Nyaumwe, 2005): The first level (**fleeting**) involves random or everyday reflection (reflection at this level does not go deeper than thinking, remembering

or narrating one's practice); Level 2 (committed or **deliberate reflection**) involves an evaluation of the effectiveness of pedagogical decisions and actions without using the results to improve practice (reflection at this level is focused on action and it may or may not directly contribute to the improvement of practice); and programmatic, deliberate or systematic reflection at Level 3 (takes place when reflection results in **designing actions** that improve subsequent practice).

4.4.6 Theme 6: Contextual factors that influence reflection

Lee and Tan (2004) identified personal dispositions as a crucial contextual factor that influences student teachers' practice of reflection. If they are confident and competent they are more inclined to practice reflection in their classrooms. The other contextual factor that plays a role is, according to Lee and Tan (2004), interpersonal contexts (in the case of the student teachers the quality of the mentoring they received was crucial).

In this study the crucial contextual factor that emerged from the interviews with the participants was the opportunity that was created for reflection by the research project. Vicky reflected on the value her participation in the research project had on her classroom management:

> *Because everything was planned, (laughs) ... even if, I have changed, when you come, I decided I'm letting them sit in pairs, normally I use individual, and it was big class, when you enter my class from last term ... because, normally I don't resort to group lesson, because I want everybody to do it on their own, but this time I decided that, let me pair them in pairs, maybe they can help one another, and then, I think it works, because I could see that when I said ... do it for yourself ... then you come ... then the other turns to the one they know that could assist them, they do not turn to the neighbour, but they could turn to another one, which they know that they will understand better than themselves ...*

During the initial interview with Dianne when we discussed her lesson plan on data handling she said she would not change anything in the lesson if she had to teach it again. However, during the post-observation interview she was able to think of two alternative ways of teaching the lesson on BMI. She also reflected that she had learned to plan better because of the research project.

Morgan reflected on the value of being observed while teaching as follows:

> *I think ... what I maybe need to add is ... the sessions like this one are very important where you teach ... someone is watching you ... is giving you feedback because in that way you ... as a teacher you can be able to improve ... to be able to improve ... because the person who is observing you ... eh ... is maybe going to advise you,*

because in the session if you did something like this, like this ... then is going to improve your lessons ...

Another contextual factor that appeared to influence the reflections of the participants of this study was **language**. On numerous occasions the issue of language was raised by three of the participants (Dianne, Mary and Sipho), either complaining about their own command of English or referring to their learners' language proficiency. My findings provide some evidence in favour of Reed, Davis and Nyabanyaba (2003) in their investigations on teachers' reflective practice in under-resourced multilingual contexts. They suspected that those teachers who were more fluent in English found it easier to speak reflectively. However, the one researcher who was able to switch to the main language of some of the teachers in the least reflective band reported that switching to this language did not promote reflective discourse (Reed, Davis & Nyabanyaba, 2003). This finding suggests that in order to become a member of reflective practitioners, teachers may need to be apprenticed into reflective discourses, and further research is needed on this issue (Reed, Davis & Nyabanyaba, 2003).

The contextual factors that seem to influence the participants' reflections are summarised in Table 4.9.

Table 4.9 Contextual factors that influence participants' reflections

	Dianne	Mary	Morgan	Sipho	Vicky
Contextual factors	• Language • Lesson study experience		Lesson study experience	Language	Lesson study experience

From the table it seems as if Mary is the only participant who did not reveal any contextual factors that might influence her reflective practice, although she reflected on external factors that influence learners' understanding of mathematics. The rest of the participants mentioned the value of the lesson study experience and language as contextual factors influencing their reflective practice.

In the next section I discuss the interpretation of the lesson study group reflections and the final group reflection.

4.5 Results of lesson study group reflections

In this section I discuss the results of the lesson study group reflections.

4.5.1 Discussion of lesson study group reflections on lessons observed

After each classroom observation the lesson study group met in the afternoon, observed the video-recording of a lesson and then reflected on their observations. According to Taylor *et al.* (2005) observing a lesson enables teachers to shift their thinking from a teaching focus to a learning focus while puzzling over their learners' mathematical thinking. As observers, they are free to focus on the actual work the learners are doing and the learners' thought processes. During the lesson study group discussions I took fieldnotes and focused mainly on hearing the participants' individual voices while they were reflecting on the observed lesson as a group. I searched the literature for similar research but there seemed to be a lack thereof. Most of the research (e.g. Cerbin & Kopp, 2006; Coe, Carl & Frick, 2010; Fernandez, Cannon & Chokshi, 2003; Friedman, 2005; Hix, 2008) on lesson study report in general on the process and not in detail on the content of the individual teachers' reflections in the group (as I have done below) during the evaluation cycle.

4.5.1.1 Lesson study group reflection on Mary's lesson

Mary's lesson was the first that the group watched and discussed. Morgan, Mary and Dianne were present during the lesson discussion. Sipho and Vicky had to attend a labour meeting.

Morgan reflected on Mary's **introduction**, which he thought was *good because it relates to the learners' world*. He also reflected on her **lack of helping learners to understand** addition of integers and suggested that she should show learners how to add integers using the number line. He expressed **concern about treating the learners fairly** and catering for all learners' needs. Morgan's reflection on Mary's lessons is on a critical level (Jay & Johnson, 2002; Lee, 2005).

> *We should cater for all learners ... sometimes you plan a worksheet for your class, and after one or two examples you see they don't understand, and then only a few sums are done ...*

Dianne reflected on the **class size** (more than 50 learners in the class) and the fact that the learners do not have **textbooks**. Here she is still reflecting only on a technical level (Van Manen, 1977) or descriptive level/recall level (Jay & Johnson, 2002; Lee, 2005).

Mary reflected on the **time** she had wasted with the examples as well as the fact that she tried to mark every single learner's book. She is reflecting on her own actions while teaching

and thinking about what she could have changed to help her learners to gain the concepts, which, according to Jay and Johnson (2002), is on a descriptive and comparative level of reflection. However, she is not reflecting critically about how she should change her teaching to ensure that learners gain a deeper understanding of mathematics.

The group reflected on Mary's **lesson plan** and agreed that it could be improved. They suggested that in each lesson plan the grade should be mentioned and teachers should plan according to the level of their learners (e.g. Mary planned to divide or multiply by the coefficient of the variable, but this did not happen during the lesson because her learners struggled to transpose the constant term in an equation to the other side). The lesson plan should reflect the teacher's expectations of the learners and should include how the lesson would be wrapped up and what homework would be given.

4.5.1.2 Lesson study group reflection on Morgan's lesson

All the participants were present at the post-observation discussion. Dianne and Vicky criticised Morgan for not using the additive inverse to solve equations when he did the examples on the board (reflecting on his **teaching of the concepts**). They were reflecting on Level 2 of Jay and Johnson's (2002) taxonomy, in a comparative way (comparing Morgan's lesson with Mary's, who used the additive inverse in her examples of linear equations). Mary commented on his **teaching style**, which was learner-centred, also reflecting in a comparative way (her own lesson was not learner-centred). Vicky compared her own teaching style to Morgan's and reflected that she would have to prepare well for her observation lesson. The group reacted positively to the way Morgan conducted his class.

They reflected on Morgan's **lesson plan** and agreed that it could still be improved. They observed that the goals for the lesson should be clear. Morgan wrote as one of his goals that learners would be able to convert problems into linear equation form. This did not materialise in the lesson. Morgan deviated from his plan by omitting two examples. His reason was that the one example was easier than the previous one and he included that in the homework. He also asked the learners to do only one of the four planned activities, due to the fact that the learners did the examples on the board and that took up too much time.

4.5.1.3 Lesson study group reflection on Vicky's lesson

All the participants were present during the observation of the video and a fruitful reflection on her lesson was held afterwards. I found that the group was getting more fluent in their discussions. They seemed to reflect more openly and talk more freely during the

discussions. They were also less careful of each other's feelings and as a result they criticised some aspects of the lesson but also praised where this was due.

The group reflected mainly on how to **help learners to gain basic concepts**, like adding and multiplying integers. Vicky addressed the basics while doing the examples by writing the rules for addition and multiplication of integers down. Morgan suggested that she should use the number line to help learners to understand addition of negative and positive numbers, Sipho suggested that all learners should have the multiplication tables in the back of their books and Mary showed the group how to use their fingers when multiplying 7 by 7. Dianne said:

> *What I liked, she knew that they are going to struggle with the signs and the first 3 examples she gives them everything, how to multiply, after that she gives them the more difficult examples ...*

The group also reflected on her **class arrangement and discipline**. She paired the learners according to their performance, so that they could help each other. Vicky admitted that she became impatient with the learners when they struggled to understand the content. Morgan stressed the **importance of being patient with learners**, reflecting on a critical level (Lee, 2005):

> *We need to be very patient with the learners. When you teach them, we need to make sure that you motivate the learners.*

The group discussed Vicky's **lesson plan** and concluded that it could still be improved by writing down the teacher's expectations of her learners.

4.5.1.4 Lesson study group reflection on Sipho's lesson

Sipho's lesson was observed by all the participants and the lesson was discussed briefly because Morgan and Sipho had other obligations. The group reflected on his **introduction**, which they felt was good and they also felt positively about his **interaction with his learners** and the way he conducted his class. Once again, they all reflected on the **learners' lack of understanding of basic concepts**, for example, the learners struggled to add $3x$ to $6x$.

4.5.1.5 Lesson study group reflection on Dianne's lesson

Only Vicky and Mary were present to watch Dianne's lesson on video. The rest of the lesson study group were in a meeting with the principal and Sipho had to attend to his soccer team.

Vicky reflected on Dianne's **teaching style**, which she believed was too teacher-centred with little learner involvement. Mary reflected on Dianne's **topic** which she considered to be very interesting and also commented on the fact that **Mathematical Literacy learners** were actually using mathematics formula and doing mathematical calculations.

Dianne reflected on her own **poor command of English** and her nervousness being video-taped. She also commented on the fact that she could see on the video that the learners actually understood English well. She said that she was going to do less code-switching in future.

In Table 4.10 I summarise the content and level of reflection revealed in the group discussions on each lesson.

Table 4.10 Summary of content and level of reflection revealed during the lesson study group reflections after each lesson

Lesson study group reflections	**Mary's lesson on 2011-02-24**	**Morgan's lesson on 2011-03-04**	**Vicky's lesson on 2011-03-10**	**Sipho's lesson on 2011-05-05**	**Dianne's lesson on 2011-05-05**
Content of reflection	The introduction; her teaching style; learners' understanding ; class size and lack of textbooks; her lesson plan	Teaching of the content; teaching style (learner-centred); lesson plan	Her methodology; learners' understanding of concepts; her expectations of her learners; teaching style; class arrangement and management; learners' needs	His introduction; his teaching style; learners' understanding of concepts	Her teaching style; the topic; language
Level of lesson study group reflection (Jay & Johnson, 2002; Lee, 2005)	R3 (Critical reflection / Reflective level: Considering the implications of her teaching for learners)	R2 (Comparative level / Rationalisation level: Thinking about his teaching from different perspectives)	R3 (Critical reflection / Reflective level: Considering the implications of her teaching for learners)	R1 (Descriptive reflection / Recall level: Describing his actions in class)	R2 (Comparative level / Rationalisation level: Thinking about her teaching from different perspectives)

Table 4.10 illustrates two dimensions of this research study, namely content of reflection and level of reflection. The content of the group reflections was measured using Jay and

Johnson's (2002) and Lee's (2005) levels of reflection (see Section 2.3). From the table it seems that, during the group reflections, the individual participants reflected on all three levels: Descriptive/Recall (describing the actions of the teacher observed), Comparative/Rationalisation level (comparing individual reflections on the lesson with each other's perceptions) and Critical reflection/Reflective level (considering the implications of the teacher's actions on learners' understanding of mathematics). This was in contrast with the individual participant's reflections during the two interviews, in which none of them revealed critical reflectivity on their practice. However, during the group reflections, while reflecting cooperatively on a lesson that they observed, they reflected critically (R3) on Mary and Vicky's lessons, considering the implications of each teacher's actions on their learners' understanding of mathematics. This finding is mirrored in the literature by Yoon and Kim (2009) who found that when reflection was done at a collaborative level by their participants, the dynamics of reflection among group members was greater than individual reflection.

4.5.2 Final group reflection on being part of the lesson study group

Initially I planned a focus group interview to determine how the participants experienced being part of the lesson study group. Due to unforeseen circumstances at the school the scheduled focus group interview could not take place. One of the participants was called for a meeting with the school management just before the start of the focus group interview and another participant excused himself in order to attend to his soccer team. Only three participants remained and I conducted a general discussion with the three participants and asked them to talk freely and openly about their experiences in the lesson study group. Dianne and Mary conversed in their home language (Sesotho) and Vicky translated their conversation for me. Afterwards I asked each participant individually to tell me about their experiences and to elaborate on Vicky's translation of their conversation. During the same afternoon I conducted a telephonic interview with Morgan and Sipho to ascertain their opinions on being part of the lesson study group.

The participants reported that they had gained a lot from being part of the lesson study group. A summary of their reflections appear in Figure 4.7. They mentioned the following aspects:

4.5.2.1 Lesson planning

Dianne and Mary discussed the influence of the lesson study group on their planning as follows: *Previously we did not spend much time on lesson plans, and now, because of what we have done, it is much easier for us ...*

4.5.2.2 Teaching mathematics

Dianne and Mary felt that their learners had also gained from their teachers' being in the lesson study group because

> *I was lazy and slow ... now I'm more determined to ... whatever we have learned, to transfer it to the learners. I see learners as differently from the first ... we gained that when you are teaching you must start from simple to complex, and we gained that you must question the learners a lot and involve the learners ... yes, we gained a lot and we have improved a lot ...*

Dianne also reflected that she would, after the lesson study group experience, use more English in her class: *I now realise that the learners are able to do the work in English. I thought that learners do not understand but now I want to uplift the learners ...*

4.5.2.3 Self-observation

The participants all reflected on the value of self-observation. Mary said:

> *You can see yourself and what you are doing now ... you take yourself out, out, and you are looking at yourself as if you are looking at another person who is performing ... you see another part of you that you haven't noticed, then you feel very bad when you see I'm not doing what I think I'm doing ...*

Vicky said:

> *After seeing myself in the video, it was as if I was researching myself, it was research that was done for me. I gained a lot, and everybody has gained a lot from this, because after seeing yourself you could see the mistakes that you are doing and you are able to rectify them, therefore I'm not looking at this as your research, we are looking at this as comprehensive maths research ...*

Morgan said he appreciated the opportunity that the lesson study group provided to watch his colleagues and himself and saw how he dealt with the learners. *This leads to introspection so that you can improve when you go back into the class.*

4.5.2.4 Observation of colleagues

Morgan reflected that he had learned a lot from the classroom observations. Watching his other colleagues helped him to make his own lessons more learner-centred and to focus more on learners and their needs rather than on finishing the syllabus. He also realised that he had to be more patient with the learners and their lack of understanding and help them to master the basics so that they did not become discouraged. Vicky said:

> *We have learned of so many approaches for teaching, each one of the educators here, and really that benefits the school a lot, even you yourself, it's not only the school that will benefit but also the learners, but even yourself is going to benefit so much, the approach, the style ...*

Dianne reflected on the value of observation her colleagues as follows:

> *We learned from each other, like in Morgan's lesson. Most of the time he talk to the learners, ask them questions, give learners time to think and ask them to write answers on the board. From Mary I learned that she gives learners examples first and then let them solve ... and then, they waste time but learners understand, they understand. From Sipho I learned that he facilitates, not facilitating but checking every learner's book, and give learners chance to write on the board ... from Vicky ... she gives learners lots of examples for them to understand ...*

4.5.2.5 Group discussions

Sipho appreciated the positive feedback that he received from his colleagues in the lesson study group. Morgan also commented on the fact that during the group discussions, criticism was done in a positive way, indicating the teacher's strong points and providing suggestions for improvement. Mary reflected that from the group discussions

> *I learned more about our educators as teachers because when we are here ... we talk about ourselves and how we experience the learners.*

I summarise the benefits of lesson study reported by the participants in Section 4.5.2 in the Figure4.7. I use a circular diagram to illustrate the influence of the lesson study cycle on the participants' reflective journeys. They reported that they improved their lesson planning as a result of the lesson study group planning sessions. They were more confident about their teaching after seeing themselves on video. They expressed a deeper awareness of their learners' needs. They learned from watching their fellow participants on video to change their teaching to become more learner-centred; and they felt as if they were doing self-research by being part of this research study.

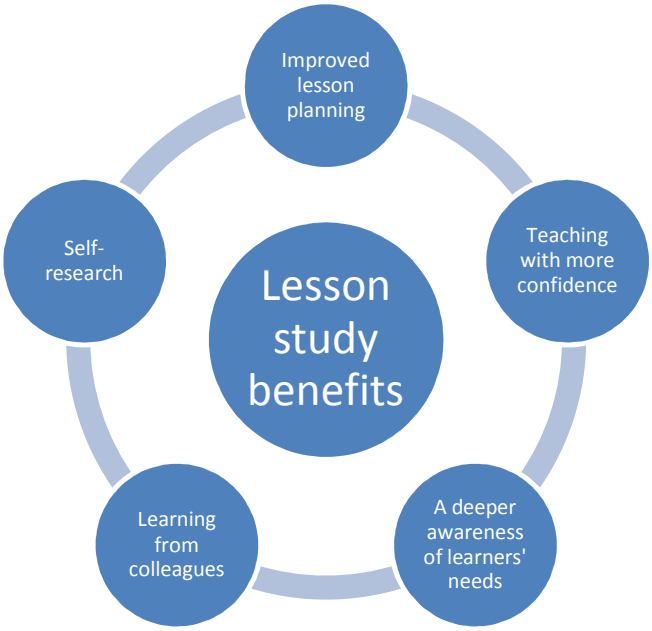


Figure 4.7 Benefits of lesson study reported by the participants

In the literature there is confirmation of the benefits of lesson study as reported by my research study's participants. Lewis (2000) mentions that research lessons impact on teachers' individual professional development, their view of learners (they *learn to see children*), new content and approaches are acquired, competing views of teaching emerge, and a demand for improvement is created. Hix (2008) confirms that the sum of planning collaboratively, anticipating student responses, creating evaluation questions for observers, observing the public teaching, and discussing and reflecting on the observations are beneficial to teachers' reflective practice. Friedman (2005) reports that the major advantage of lesson study for teachers is the collaboration factor which supports the findings of this study.

4.6 The reflective journey of each individual participant

The developmental process of the participants' reflective practice was analysed with a focus on the content, moment and the depth of their reflection. In this section I discuss the reflective journey of each of the five participants from the initial interviews up to the last group reflections. This journey is illustrated in Figure 4.8.

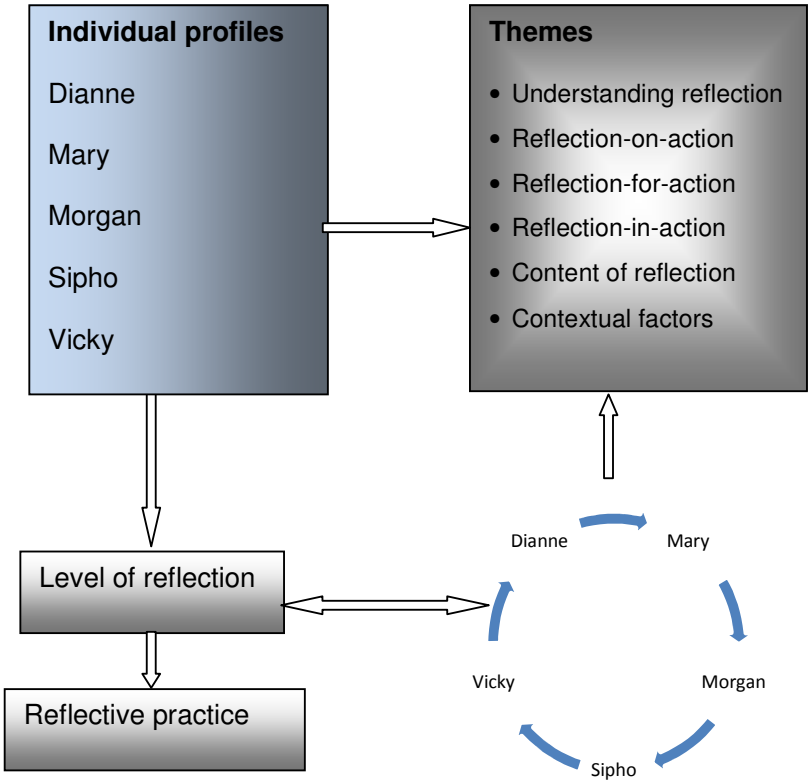


Figure 4.8 The reflective journey of individual participants

In the figure the individual profiles of the five participants are linked to the six themes of this research study. The participants' levels of reflection were established during the interviews and in their lesson study group reflections (the circular diagram). The arrows in the figure indicate a possible relationship between the individual participant's level of reflection and his/her reflective practice. A possible relationship between the lesson study group and the individual participant's reflection is also portrayed in the figure.

4.6.1 Dianne

During the initial interview Dianne could not explain her understanding of the term reflection, and she was unable to give an example of how she reflected in her classroom. She told me about a lesson on data handling that she taught to Grade 10 mathematics learners and said she experienced no problems in class. She could not think of any other way to teach the lesson she was telling me about in the interview, saying *Change? ... nothing ... nothing to change.* Her lesson plan for this lesson did not contain any evidence of reflection. However, during the post-observation interview she reflected on what she liked about her lesson, her

own inability to use English fluently, as well as on her misinterpretation of her learners' command of English. She was also able to provide two alternative ways of teaching her lesson, and expressed surprise that her learners were eager to work on the board during this lesson.

During the lesson study group reflections Dianne (who was the youngest participant and teaching Mathematical Literacy, unlike the rest of the group who were all mathematics teachers) talked freely about what she considered worthy aspects of the lessons observed (for example Vicky's class arrangement and her examples that were structured from simple to complex). She also criticised Morgan for teaching the learners to solve linear equations without formally transferring the constant term to the right-hand side of the equation. During the final group reflection she admitted that her view of learners had changed because of the lesson study experience. She revealed that she was using questioning more effectively and tried to involve the learners more in her lessons.

In my view Dianne has grown as a reflective practitioner. Although she was unable to reveal her understanding of reflection, she reflected-on-action and her reflections most often occurred at Level R1 (recall level) and then slowly extended to the R2 level (rationalisation level) (Lee, 2005). She is not yet reflecting critically on the impact of her teaching on her learners' understanding of mathematics and how she should change to achieve this, but I believe that the lesson study experience helped her to view her own teaching from a different angle (through the eyes of her colleagues). The contextual factor that seems to influence her reflections is language.

4.6.2 Mary

During the initial interview Mary could not explain her understanding of the term reflection, and she was unable to give an example of how she reflected in her classroom. However, Mary regarded herself highly as a mathematics teacher during this interview, explaining to me in detail how she related mathematics to the learners' real-life experiences. When asked whether she would teach the lesson she was describing in any other way, she replied: *I ... I ... I would, but I did it this way, I also give them other strategies, but I think this one was the simplest to them.* This reply indicated that she was not thinking of changing her teaching method to develop her learners' understanding of the concepts, and her reflections during this interview were only on a recall level (R1 level of reflection) (Lee, 2005).

During the post-observation interview Mary was able to reflect on how to introduce linear equations to Grade 8 learners:

> *but when you are breaking the ice ... you want to talk about ... maybe twins ... how am I going to ... you want to create that set-up where the left-hand side and the right-hand side are being balanced, you see ...*

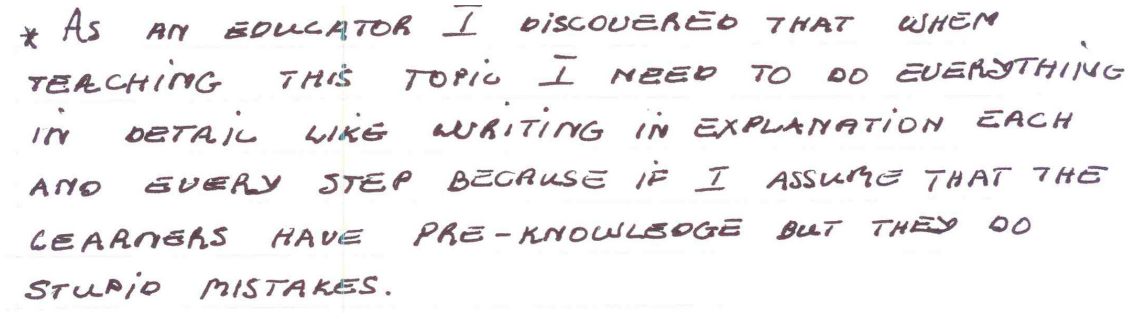
She reflected more deeply on her own actions during this interview, thinking back on her time management and the fact that she was unable to wrap-up her lesson or give the learners homework to do. However, during the interview she still blamed external factors for her lack of time management, revealing that she was only reflecting on a technical level (Level R1, recall level) (Lee, 2005). During the group reflections Mary's reflections were still only on Level R1 (recall) (Lee, 2005). She reflected on Dianne's topic, Morgan and Sipho's learner-centred teaching style, and Vicky's examples, ordered from simple to complex.

However, in her written reflection on her observation lesson, she attributed her poor time management to her own actions (the fact that she tried to mark all the learners' class work during the lesson, and the time wasted by calling one learner to the board who wasted time doing the example). When asked what she would change about the observation lesson, she admitted that she had not planned the lesson with her learners in mind: *you know, I did not now think of them ... grasping gradually* ... To me, this acknowledgement as well as her final reflective writing revealed that she was reflecting on a deeper level than during the initial interview, progressing to Level R2 (rationalisation level of reflection) (Lee, 2005).

4.6.3 Morgan

Morgan explained the term "reflection" as *looking back* on actions taken in class. During the post-observation interview Morgan revealed his knowledge about his learners' level of mathematics when he explained to me why he clarified terminology before he started with his Grade 10 lesson on linear equations: *you do not need to frustrate them ... you take them from the easiest one, eh ... from what do they know from other grades, then you take it step by step ...* Morgan knew his learners and his teaching approach actively involved the learners in the lesson. Based on the interview I had with him I considered him to reflect on Level R2 of Lee's (2005) reflection levels (a rationalising level), but during the group reflections on each other's lessons, I realised that he was reflecting on a critical level (Level R3 of Lee's (2005) reflection levels), thinking about how each teacher could change their lesson in order to improve the learners' understanding of mathematics.

In his final reflection on his observation lesson he wrote:


* As an educator I discovered that when teaching this topic I need to do everything in detail like writing in explanation each and every step because if I assume that the learners have pre-knowledge but they do stupid mistakes.

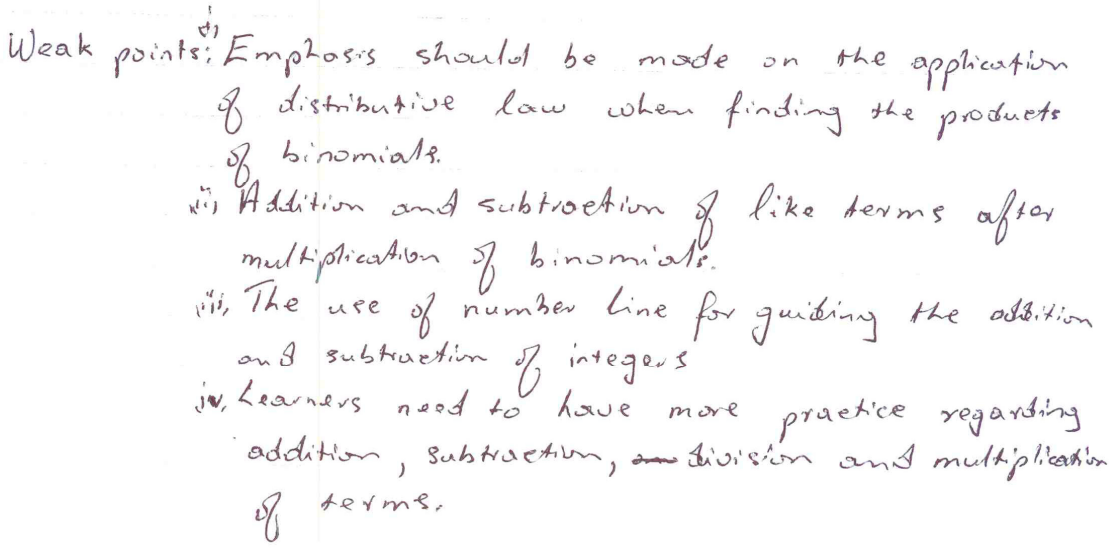
I consider his reflective writing to be only on a rationalisation level of reflection (Level R2) (Lee, 2005).

4.6.4 Sipho

Sipho could not explain his understanding of the term “reflection” to me during the initial interview. However, during this interview he said he would change the way he taught a lesson depending on the challenges he experienced emanating from the learners. He was concerned about the learners’ understanding of trigonometric problems due to their poor command of English. During this interview he reflected on his actions in relation to the learners’ lack of basic knowledge: *it seems as if you are not doing enough ... or something like that ... but as you can see they lack background ... that is, they lack foundation, that is the basic knowledge ...* At this stage Sipho was still reflecting on Level R2 of Lee’s (2005) levels of reflection, rationalising about his learners’ lack of understanding, but not with the intention of changing his actions in the future.

Sipho attended only two group reflections during the course of the research project. He reflected on learners’ lack of basic computational skills during the discussion on Vicky’s lesson, but his reflections were on a technical level only, (Level R1) of Lee’s (2005) reflection levels.

In his final reflective writing he wrote the following, which indicated that he was reflecting on his learners’ understanding of the concepts, as well as his presentation of the content, once again not reflecting on a critical level of reflection (Level R3, reflective level) (Lee, 2005).


Weak points: i) Emphasis should be made on the application of distributive law when finding the products of binomials.
ii) Addition and subtraction of like terms after multiplication of binomials.
iii) The use of number line for guiding the addition and subtraction of integers
iv) Learners need to have more practice regarding addition, subtraction, ~~and~~ division and multiplication of terms.

4.6.5 Vicky

Vicky revealed her understanding of the term "reflection" as *looking forward.* She reflected on her concern for her learners during both interviews, describing herself as a counsellor in the initial interview. However, during the second interview she revealed that through reflection she was able to change the way she was teaching. She was reflecting on a critical level (Level R3 reflective level) (Lee, 2005):

> *I think that is through reflection that I've changed the way of teaching. I have tried to come closer to them and see their own problem and how can I help them. What is it that they are lacking? Like I said, they don't have anything. Financial background is allowing them that they cannot participate* ...

However, Vicky's written reflection after her observation lesson was only on a R1 level (recall level) (Lee, 2005). It seems as if she was able to reflect verbally on a deeper level than with written reflections. This finding supports Lee's (2005) observation that each participant in his study indicated different preferences and abilities in the various communication modes: written reflections and oral format.

4.7 Conclusion

In this chapter I discussed the coding of the data, which was done inductively using the programme Atlas.ti 6. Twenty-six codes were created from the *verbatim* transcriptions of the two interviews with participants of this study. These codes were assigned to the six themes that were created deductively from the research questions and conceptual framework for this study, namely, 1) understanding of reflection; 2) reflection-on-action; 3) reflection-for-action;

4) reflection-in-action; 5) content of reflection; and 6) contextual factors influencing participants' reflective practice.

I then gave the ethnographic profiles of each of the five participants of the study, followed by each participant's reflection in relation to the six themes of the study (see the summary in the Table 4.11).

Table 4.11 Participants' reflections in relation to the themes of this study

Themes	Dianne	Mary	Morgan	Sipho	Vicky
Understanding of reflection			*		*
Reflection-on-action	*	*	*	*	*
Reflection-for-action					
Reflection-in-action			*	*	*
Content of reflection	*	*	*	*	*
Contextual factors	*		*	*	*

From the table it appears that two participants seem to understand the concept of reflection; all reflected-on-action during the interviews; none of the participants reflected-for-action in their lesson plans or in their reflective writings after the observation lesson; three participants reflected-in-action by explaining their deviations from their lesson plans; all the participants revealed the content of their reflections during the interviews and four participants revealed contextual factors that influenced their reflective abilities, namely language and the value of being in the lesson study group.

In this chapter I also reported the results of the lesson study group reflections on each participant's observation lesson. In the lesson study group the individual participants reflected on Level 3 of Jay and Johnson's (2002) and Lee's (2005) levels of reflection, which means that their reflections were on a critical reflective level. This is in contrast to the individual participant's reflections during the initial and post-observation interviews, where none of them seem to be able to reflect critically on their practice.

Finally I reported the benefits of the lesson study experience that the participants revealed in the final group reflection. These are: 1) improved lesson planning; 2) gaining confidence in

their teaching of mathematics; 3) obtaining a deeper awareness of their learners' needs; 4) reporting learning from their colleagues; 5) doing self-research.

In the next chapter I provide the final conclusions and implications of this study.

Chapter 5

Conclusions and implications

5.1 Introduction

In Chapter 4 the results of the data analysis of this research study were discussed. In this chapter I provide the conclusions and implications of the study. After summarising the chapters the research questions are verified, followed by a discussion of my own reflections on the procedure I followed to conduct the study as revealed in my researcher diary. I also make provision in this chapter for the fact that I may have been wrong in my interpretation of the participants' reflective practice. This is followed by conclusions, recommendations and final reflections on the research study.

5.2 Chapter summary

In Chapter 1 I introduced and contextualised the research study. This study aimed to explore mathematics teachers' reflections before, during and after teaching a lesson. I situated my investigation in the context of lesson study, mainly because I believed that teachers would reveal their reflections more openly in a setting where they jointly discuss their teaching experiences. In this chapter I also formulated three research questions to guide the inquiry. I briefly discussed methodological considerations, as well as possible contributions and limitations of the study.

In Chapter 2 I reviewed the theoretical underpinnings of teacher reflection and reflective practice as found in the literature. Research studies dealing with the reflective practice of pre-service and practising teachers were investigated. I focused on teacher reflection in general and mathematics teachers' reflective practice in particular. The content and depth of teacher reflection are measured at different levels and in this chapter I discussed various categories of reflection as depicted by different researchers and theorists. I also explored the different meanings of reflection found in the literature and developed a tentative definition of reflection and conceptual framework for this study, based on this review and exploration.

Chapter 3 described the research design that guided this case study. An in-depth exploration of five mathematics teachers' reflection before, during and after teaching a lesson was qualitatively conducted through interviews, classroom observations and lesson study group reflections on the lesson observed. The teachers' lesson plans and reflective writings were

also analysed. The strategies for data analysis were discussed, and measures of quality assurance were provided. Ethical considerations were presented and the possible limitations of the study were indicated.

In Chapter 4 I discussed the results of the analysis of this research study. The data were analysed qualitatively using the computer programme Atlas.ti 6. The interview transcripts were coded and six themes, related to the conceptual framework of the study and the research questions that guided the study, were created. The voices of the five mathematics teachers were heard, explaining their understanding of reflection, their reflection-for-action, reflection-in-action and reflection-on-action, as well as the contextual factors perceived to influence their reflections. Each teacher's level of reflection was established by using Lee's (2005) and Jay and Johnson's (2002) levels of reflection.

5.3 Verification of research questions

In this section I discuss the interpretations of the participants' reflective practice as they relate to the research questions.

The research questions that guided the study were the following:

Question 1: What is the nature of mathematics teachers' reflective practice?

To address this main question, the following subquestions guided the enquiry:

a) How do mathematics teachers understand the concept of reflection?
b) How do mathematics teachers reflect before, during and after teaching?
c) What is the possible relationship between mathematics teachers' reflection and their classroom practice?

Question 2: How do contextual factors influence mathematics teachers' reflective practice?

Question 3: What is the potential significance of mathematics teachers' reflective practice for the science and art of mathematics teaching?

5.3.1 Research question 1

To understand the nature of mathematics teachers' reflective practice the study attempted to answer three subquestions. The first subquestion deals with mathematics teachers' **understanding of reflection**.

The findings of the study indicate that only two of the five mathematics teachers understood the concept of reflection, as measured by the working definition of reflection defined in Chapter 2.7. Morgan stated that he *looked back on his actions* to think about what he could have done differently to help the learners gain a better understanding of the concepts he taught. Vicky said that because of her reflection on her learners' circumstances she was able to change her way of teaching. For her reflection meant *looking forward to transform her actions.* This finding is very much in line with findings in the literature that suggest that there is no single definition of reflective practice (Osterman & Kottkamp, 1993; Sparks-Langer, 1992; Zeichner & Liston, 1987).

The second subquestion asked **how mathematics teachers reflect before, during and after teaching a lesson**. This subquestion relates to teachers' reflection-for-action, reflection-on-action and reflection-in-action. The findings of the study indicate that none of the teachers involved in the study completed the sections in the lesson plan that relate to reflection on their expectations of their learners. They did not tailor their planning with the idiosyncratic needs of their learners. According to Butke (2003) a teacher's lesson plan formulates the concrete, tangible product of **reflection-for-action**. In this research study the planning, teaching and reflection on the lesson observed formed a cycle in which the reflection-for-action dimension was an extension of the reflection-on-action where certain understandings had been reached concerning the previous teaching episode, and how the next teaching episode would be affected. However, the five teachers' lesson plans did show an improvement from the original lesson plans presented at the initial interview to the final lesson plans submitted for the observation lesson.

The five teachers all reflected on their actions during the initial interviews and the post-observation interviews (**reflection-on-action**). They reflected on various aspects of their teaching, their time management, their classroom arrangement, their learners' lack of understanding of basic concepts and understanding of mathematics amongst other things. One teacher, Mary, reflected on the curriculum that does not allow question papers to be set in such a way that most of the learners will pass the papers. She also reflected on the learners' use of calculators and obsession with cell phones and blamed these for the learners' lack of interest in mathematics. Only one teacher, Sipho, reflected on his learners' thinking while they were busy doing mathematics. The five teachers' reflection-on-action are in line with the understandings of Dewey (1933) and Schön (1983, 1987) who focused on reflection as a method of thinking about experience that leads to inquiry and problem solving[13]. The finding also confirms Hatton and Smith's (2006) argument that as

[13] Discussed in Chapter 2, Sections 2.2.1 and 2.2.2

professionals, teachers should frame and reframe complex and ambiguous problems that they face, test out various interpretations and modify their actions as a result.

Three teachers displayed moments of **reflection-in-action** while teaching their observation lessons. All three explained the deviations from their lesson plans in terms of reflection while teaching the lesson. By reflection-in-action they solved problems that had emerged from their planning. Morgan realised while teaching that he should expose his learners to a more difficult example, Sipho said he realised that he should have revised the distributive property in more detail and Vicky wanted to prepare her class for more challenging binomial products because they were to write a general Grade 9 exam. By reflection-in-action they found a way to re-appreciate a problematic situation. Schön (1987) described reflection-in-action as that moment when a teacher becomes surprised, interprets something in the teaching-learning situation as a problem and invents procedures to solve the problem.

To answer the third subquestion (**What is the possible relationship between mathematics teachers' reflection and their classroom practice?**) the study considered each participant's reflection in relation to his/her observation lesson. Mary, who reflected mostly on Level R1 (recall) (Lee, 2005) did not involve her learners actively in her lesson. My impression was that she did not understand her learners' thinking and did not encourage the learners to clearly explain and justify their reasoning. She also frequently interfered with her learners' thinking. According to Warfield, Wood and Lehman (2003) such teachers base instructional decisions on the expectations of external voices rather than on their learners' thinking. They do not reflect deeply about either their learners' mathematics or about their own teaching (Warfield, Wood & Lehman, 2003).

Morgan however, reflected critically (Level R3) (Lee, 2005) on his learners' understanding of mathematics concepts and how to possibly transform his own practice to improve their understanding. In his observation lesson he allowed learners to solve problems in their own ways and expected them to both explain and justify their reasoning and to listen to and question the reasoning of other learners, actively involving all learners in class.

To sum up, the first question deals with the nature of mathematics teachers' reflective practice. From my investigation I found that only two of the five mathematics teachers understood the concept of reflection (based on the working definition of reflection for this research study) before the onset of the research. Although the lesson plan template made provision for reflection-for-action (with space provided for writing about expectations of how the content will be received by the learners), none of the teachers completed these sections. Three teachers reflected in-action while they were teaching and changed their lesson plans

to adapt to unexpected happenings in the classroom; and all five teachers reflected on-action during the interviews and in their lesson study group discussions. They reflected on pedagogical matters (classroom management, time management, teaching style, learners' understanding of mathematics), personal issues (language, shortcomings as a teacher), external factors (curriculum, interferences while teaching, class size), and critical issues (learners' needs, learners' thinking). Their reflections were rated on Lee's (2005) levels of reflection and ranged from R1 (recall level of reflection which is descriptive in nature), R2 (rationalisation level of reflection) and R3 (reflective level, thinking critically about their own teaching and the impact of their actions on their learners' understanding of mathematics). Furthermore, by relating each teacher's level of reflective thinking to his/her observation lesson, it seems that a possible relationship might exist between a teacher's reflection and his/her instructional decisions. Teachers who were reflecting on a critical level of reflection seemed to pay more attention to their learners' thinking about mathematics and how their own instruction of mathematics might influence their learners' understanding of mathematics.

5.3.2 Research question 2

To answer the second research question (**How do contextual factors influence mathematics teachers' reflective practice?**), the participants' reflections during the interviews as well as during the lesson study group reflections were analysed. Contextual factors that emerged through these reflections were 1) the opportunity created for reflection by the lesson study group experience and 2) language. Support for the first contextual factor, the lesson study group experience is provided by Coe, Carl and Frick (2010), who mention that 1) lesson study can act as an agent of change in a culture of isolation; 2) participants become comfortable with having colleagues observe them teach; 3) an increase in content knowledge is realised by participating members; and 4) lesson study provides an approach that is continuously effective in meeting the needs of learners. Language as a possible contextual factor is confirmed by Reed, Davis and Nyabanyaba's (2003) who suggest that teachers may need to be apprenticed into reflective discourses, whether in their main language or an additional one.

To sum up, the second question deals with how contextual factors influence mathematics teachers' reflective practice and from my investigation I found that teachers reflect on their practice when granted the opportunity to do so (through interviews and within the context of lesson study). In addition language seemed to influence the teachers' ability to reflect on their practice.

5.3.3 Research question 3

The third research question, **What is the potential significance of mathematics teachers' reflective practice for the science and art of mathematics teaching?** encapsulates the other two main questions. The results of this study indicate that not all teachers are reflective practitioners, but by creating an opportunity for reflection, through lesson study, the participants of this study did reflect-on and in-action. Their individual reflections were descriptive, rationalising their actions and not directed to transformation of their classroom practice. However, in the lesson study group reflections the individual participants achieved a critical reflective level, and this finding can be utilised to bring teachers out of isolation by way of meaningful collaboration. The findings highlight that a lesson study model has potential for effective continuous professional teacher development (CPTD) within the South African context (Coe, Carl & Frick, 2010).

To sum up, the third question deals with the significance of mathematics teachers' reflective practice and I found that through the lesson study experience the teachers in my study were able to reflect on their classroom practice, reporting that they had gained a lot from observing themselves and their colleagues' teaching.

5.3.4 Summary of verification of research questions

In Table 5.1 a summary of the findings of this research study to verify the research questions of the study is provided.

Table 5.1 Summary of verification of research questions

Research questions	Verification
What is the nature of mathematics teachers' reflective practice?	Mathematics teachers reflect in-action and on-action, but not for-action. The content of their reflections indicate that they reflect mainly on pedagogical matters, personal issues, external factors and critical matters. The level (depth) of their reflections range from Level 1 (recall/descriptive), Level 2 (rationalisation/comparative) to Level 3 (reflective level/critical reflection). They reflect whenever they are given the opportunity to do so (during interviews and in the context of the lesson study group). Furthermore, a number of contextual factors influence their reflective practice. In the current study, the lesson study experience seemed to have a positive influence on their reflective practice. In addition, inadequate language and verbalisation skills seemed to hamper reflective abilities.
How do mathematics teachers understand the concept of reflection?	Whereas one teacher understood the concept of reflection as *looking back on action*, another teacher understood the concept of reflection as *looking forward to guide action.* The other three teachers were unable to explain their understanding of the concept of reflection.
How do mathematics teachers reflect before, during and after teaching?	No evidence was found in this study that mathematics teachers reflect **before** their teaching of a lesson, even though the lesson plan template made provision for such reflection. Three teachers reflected **during** their teaching by deviating from their written lesson plans and adapting their examples and classroom arrangements to cater for unexpected events or responses from learners. All five teachers reflected **after** their teaching by recalling or describing certain incidents (R1 level of reflection). Moreover, all teachers increasingly rationalised or generalised their experiences as the research study progressed (R2 level of reflection). However, only two of the teachers were able to eventually reflect critically on their action (R3 reflective level) during the lesson study group reflections (Lee, 2005). Individually, teachers reflected verbally on their actions during the interviews and cooperative participation during the lesson study group reflections. Their post-observation written reflections on their actions in class were at a recall level only (describing what had happened in class).
What is the possible relationship between mathematics teachers'	Evidence was found that a relationship between the teachers' reflection and their classroom practice exist. Teachers who reflected on a lower level (R1 level of reflection) neglected to allow learners to solve problems using their own methods and communicate their findings to their fellow learners in contrast with

reflection and their classroom practice?	teachers who reflected on a more critical level (R3 level of reflection) about their learners' understanding of concepts and their own classroom practice.
How do contextual factors influence mathematics teachers' reflective practice?	The lesson study context experience proved to be a positive influence on all the teachers' reflective practice. All teachers reported positively on the cooperative planning of a lesson, revealing that they learned much from the experience of planning with the goal to improve learners' understanding of concepts. Additionally, they reported that they were teaching with more confidence as a result of watching themselves as teachers and learning from watching their colleagues. They also reported a sense of increased and deeper awareness of their learners' needs and the importance of involving learners in their lessons. Lastly, two of the teachers regarded the lesson study experience as self-research that enabled them to compare themselves with their colleagues and observe their own actions critically while watching the post-observation videos. Teachers' inadequate linguistic skills and inability to verbalise basic mathematical concepts properly seemed to influence mathematics teachers' reflective practice negatively. One teacher constantly reflected on her poor command of English and the fact that she code-switched to Sesotho to explain content to her learners. As the research project progressed, the teachers increasingly talked more openly and freely during the group reflections in English, in contrast to their first planning session when they all wanted to talk in Sesotho. A plausible explanation for this phenomenon seems to be that teachers' lack of experience ion teaching Mathematics in English impacted their self-confidence negatively.
What is the potential significance of mathematics teachers' reflective practice for the science and art of mathematics teaching?	The results of this study show that when mathematics teachers' are made aware of their reflections on their practice in a context of working cooperatively, they are encouraged to reflect at a more critical level. This finding has some potential value for planning professional learning programmes, where teachers can be encouraged to talk about their classroom experiences, share their joys and challenges with each other and strive to build a community of reflective practitioners to enhance their learners' understanding of mathematics.

5.4 What would I have done differently?

As a novice researcher I learned a lot during the course of this research study. My own reflective capabilities grew and I am now more able to reflect on my own role as researcher and teacher educator. I also learned more about the reality of teaching in a rural school using a language of instruction that is not your home language, teaching mathematics without resources, and trying to deal with the pressure from the school management and district office to increase the pass rate of the learners. This caused me to expand my thinking about the development of mathematics teachers. I now realise that effective professional learning programmes need to establish supportive and interactive communities that use reflection as a means for growth.

What would I have done differently? I would have liked to extend the opportunities for participant reflection, but due to time constraints this was not possible since I could only meet the participants once a week on a Thursday afternoon.

In addition, I initially wanted the participants to complete a daily reflective diary, so that I could follow their teaching lives during the week, but they were reluctant to submit their diaries as arranged. Lee (2005) argues that it is important to create various opportunities and climates where reflective thinking about their practice can flourish rather than to limit teachers to a particular approach. With this view in mind, I then asked the participants in my study to write a one-page reflection on the observation lesson, so that I had at least some form of reflective writing from each participant. I agree with Russell (1993) who suggests that some teachers need support in learning how to reflect. If I were to repeat this study, I would provide for reflection on critical incidents and ask the teachers to write reflectively about these incidents on a weekly basis.

When I originally planned this research study, I proposed to invite teachers teaching the same grade (e.g. Grade 10) from neighbouring schools to become participants to this study. However, the district official suggested that I use only one school, with the result that the participants of my study were teaching mathematics to learners ranging from Grade 8 – 11. This turned out to be a beneficial arrangement as I realised that the teachers learned more about learners' understanding and misunderstanding of concepts by observing each other's video-recorded lessons, than they would have if the group had remained homogenous as originally planned.

Finally, when I coded the data I realised that language emerged as a possible contextual factor that influences teachers' reflection. There is a possibility that the participants in my study might have reflected more openly and freely in their own language if an interpreter was available from the start of the research project.

5.5 Providing for errors in my conclusions

I engaged with five mathematics teachers who opened their classrooms to me and revealed themselves as teachers and human beings in the context of my study. I have made some decisions on their reflective capabilities as teachers, and I have to provide for the fact that I may have been wrong in my conclusions. I have tried to ensure that the results of this study are trustworthy. I have used interviews, video recordings of lessons, reflective writings and group reflections to gather data. I have also asked two experienced colleagues to verify my coding of the data and the families I created from the coding of the data, in order to enhance the trustworthiness of the data analysis process. The emerging reality I described in my results chapter (Chapter 4) was a crystallised reality obtained from different perspectives that *all reflected the unique reality and identity of the participants of this research study* (Nieuwenhuis, p. 81, 2010).

However, I often struggled to make sense of the abundance of data, frequently consulting with my supervisor and co-supervisor to share my feelings of disequilibrium. Although I sometimes became confused, I persevered and with time succeeded to piece together a picture of each participant's reflective journey. I have learned that teachers, once they are aware of their reflective capabilities, realise the value that reflection can add to their classroom practice. I am convinced that reflection created opportunities for the participants in my study to grow as teachers, as professionals and personally.

5.6 Conclusions

This research study focused on mathematics teachers' understanding of reflection, the content and level of their reflections before, during and after teaching a lesson, and the contextual factors that influenced their reflections. The findings indicate that the participants of this study experienced growth in their reflective practice as the research study progressed. Although their lesson planning improved, they still neglected to reflect on their expectations of learners in their planning and their final reflective writings were on a descriptive/recall level (Level 1) only. All the participants reflected on their actions in class during the interviews and lesson study group reflection sessions. The content of their

reflections differed, ranging from pedagogical issues, curricular matters, personal issues and critical issues. The level of their reflection-on-action (Jay & Johnson, 2002; Lee, 2005) during the interviews ranged from Level 1 (descriptive/recall) to Level 2 (comparative/rationalisation), but during the lesson study group reflections they reflected on Level 3 (critical/reflective) on each other's lessons as well as on their own teaching. Three of the participants reflected in-action, as indicated by their deviations of their lesson plans. The contextual factors that seemed to influence the participants' reflections are the opportunity the lesson study group provided for collaborative reflection and language. The participants reflected positively on the lesson study experience, and mentioned the following benefits: 1) They felt that they improved their lesson planning; 2) They gained confidence as mathematics teachers; 3) They reported a deeper awareness of learners' needs; 4) They learned from colleagues, watching each others' video recordings and discussing their own and each others' lessons after observation of the video; and 5) They felt that the lesson study experience helped them to research themselves as teachers, seeing themselves in their classrooms, becoming aware of not only their mistakes, but also the positive aspects of their teaching.

5.7 Recommendations

Additional questions have been generated by this research study. For example, it would be worthwhile to undertake a follow-up study with the participants of this study to understand the long-term effects of reflective process.

Furthermore, I believe that there might be other contextual factors that influence mathematics teachers' reflective practice that need to be researched further, for example gender, personality characteristics and culture. The reason why I consider gender to possibly influence the reflective process is because the male participants in my study were very reluctant to write about their reflections in a reflective diary. Personality characteristics might play a role in a teachers' reflective practice and I base this belief on Dewey's (1933) three attitudes that he considered to be integral to reflection: openmindedness, responsibility and wholeheartedness. Reflection might also be culturally bound, for example Lee and Tan (2004) investigated student teachers' reflective practice in Malaysia and found that their private reflections were on a deeper level than their public reflections. An intercultural study, for example comparing South African mathematics teachers' reflective practice to that of a different culture will provide for a more comprehensive body of knowledge on reflective practice.

Lastly, the results of this study can be used in the planning of future CPTD programmes. The positive feedback of the participants on the lesson study process suggests that lesson study should be initiated in other settings. Further research should explore lesson study as a model in South Africa for successful CPTD programmes.

5.8 Limitations of the study

As already stated in Chapter 3 Section 3.9, the small number of participants (five) makes it impossible to generalise the data from this research study. However, within the qualitative paradigm I tried to study the reflective practice of these five participants from multiple perspectives, using various methodologies.

Another limitation of this research study pertains to the researcher's inability to speak the home language of the participants. Language emerged as a contextual factor that possibly influences the participants' of this study's reflective practice, although I allowed for an interpreter during the last group reflection. I evaluated the participants' verbal and written reflections as they struggled to express themselves in English, and I have to make provision for the fact that I may have misinterpreted their understanding of reflection.

5.9 Last reflections

As much as any qualitative study can draw any conclusions, this research study represented not only the professional and personal development of the five teachers who were so willing and eager to share their stories with me, but also the personal and professional culmination of three years of hard work. During this time I gained new insight into mathematics teachers' classroom practice, as well as the realities which these teachers have to deal with every day. The lesson study context of my research offered an effective strategy to bring teachers out of isolation, allowing them to experience meaningful collaboration with their fellow teachers, observing and criticising their own and each other's lessons and planning lessons together. All five of these teachers proved to be reflective practitioners to a greater or lesser degree. However, these teachers need ongoing support if they are going to continue to develop as reflective practitioners and they need professional learning opportunities to help them to develop their reflective capabilities.

In Chapter 1 I mentioned that the importance of this research study rests on its unique connection of reflective practice with mathematics teaching. I am convinced that through engaging in the lesson study experience the five participants of this study improved their

reflective practice, reporting an increase in self-knowledge and finding new ways of teaching mathematics to learners. As for myself, my own reflective journey and involvement with mathematics teachers' professional learning will continue. In the words of Carl Friedrich Gauss (cited in Fleming & Varberg, 1992)

> *Does the pursuit of truth give you as much pleasure as before? Surely it is not the knowing but the learning, not the possessing but the acquiring, not the being-there but the getting-there, that afford the greatest satisfaction. If I have clarified and exhausted something, I leave it in order to go again into the dark. Thus is that insatiable man so strange: when he has completed a structure it is not in order to dwell in it comfortably, but to start another.*

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APPENDICES

Appendix A: Lesson plan template

Lesson Study: Lesson Plan

Date:

Educator:

Lesson duration:

Pre-active stage of the lesson:	
Topic: Understanding this topic is important because …..	
What are your goals for this lesson? What will learners understand as a result of this Lesson? (what do you want learners to know and be able to do?) What evidence will show learners understand? (what performance tasks, products, projects, etc. will demonstrate understanding?)	
What materials will you need?	
Prior knowledge of learners	
Future knowledge (following the lesson)	

Interactive stage of the lesson:		
Introduction (How will you introduce the lesson? Give full details)	(Please provide full details of your expectations)	Reflection (after the lesson)
Learner Activity (provide full details of the activity, as well as your expectations of learners' responses) • class arrangement • assessment • teacher activity (role) • learner activity (role)		
Post-active stage of the lesson		
Class discussion (how do you plan to wrap up the lesson)		
Your feedback to the learners about the activity and learning that took place		
Final reflections on the lesson (complete this part as soon as you have taught the lesson)		

Appendix B: Letter of consent

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Mrs AB Posthuma
Groenkloof campus
barbara.posthuma@up.ac.za
Tel: 082 293 5533

13 May 2010

Dear Ms/Mr ……..……

Letter of consent to the mathematics teacher

I am conducting a research study for my doctoral degree in mathematics education at the University of Pretoria. This letter is written to invite you to be a participant in this study. The Free State Department of Education granted permission to allow you to participate in the study.

The study seeks to investigate the nature of mathematics teachers' reflective practice. In order to do this, the following techniques will be employed: 1) I will interview you before the onset of the research study. Please bring one of your lesson plans to the interview for discussion. The purpose of this interview is to help me to understand the nature of your reflections in your classroom practice. 2) You will form part of a lesson study group with other mathematics teachers. In this group you will collaboratively plan a mathematics lesson. One teacher in the group will teach the planned lesson to his/her class. This lesson will be video-recorded and this video recording will be shown to the group afterwards so that they can discuss the teaching of the lesson and reflect on ways to improve the lesson plan. The revised lesson will then be taught by another member of the group and the cycle will continue. 3) You will be asked to keep a reflective journal and share experiences related to your teaching. 4) You will be asked to participate in a final group interview with your fellow teachers of the lesson study group in order to reflect upon your teaching practice and the experience of planning and teaching lessons collaboratively. Audiotapes of the interviews will be made so that each teacher's verbal reflections can be used as data. Participation is entirely voluntary and you may withdraw from the study at any time if you so choose.

Should you declare yourself willing to participate in this study, confidentiality will be guaranteed. You will be asked to read the transcripts of the interviews to ensure the trustworthiness of the data. Your decision to accept/decline involvement in this research will not influence your teaching career in any way, nor will your participation be reflected in your performance appraisal.

If you are willing to participate in this study, please sign this letter as a declaration of your consent.

Yours sincerely

…… Date: ……
Mrs AB Posthuma

…… Date: ……
Supervisor: Prof JG Maree

Participant's signature..... Date:……

E-mail address …… Contact number ……..

Appendix C: Letter of permission to department

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs AB Posthuma

Aldoel Building F235
Groenkloof Campus
barbara.posthuma@up.ac.za
Tel: 082 293 5533

13 May 2010

Free State Department of Education

Dear Sir/ Madam

Request from FDE for permission to do classroom observations and to conduct interviews

I am currently enrolled as a doctoral student at the University of Pretoria, where I am also a lecturer in the Department of Science, Mathematics and Technology Education. The title of my proposed thesis is as follows: **The nature of mathematics teachers' reflective practice.** The importance of this research rests on its unique connection of reflective practice relating to teaching, specifically in the field of mathematics. The rationale for this study stems from the premise that mathematics teachers need to find a vehicle for growth and improvement. The development of a reflective process can serve as an important technique in increasing self-knowledge and seeking new ways of educating learners in mathematics. The study can add to research findings concerning reflective practice and contribute to the discussion on the usefulness of reflective practice as a reform effort in teacher education.

In order to collect data for this project, I would like to invite mathematics teachers of at least two neighbouring schools in the Thabo Mofutsanyana district to participate in forming a lesson study group. In lesson study the focus is on the concrete examination of practice and the testing of new ideas in actual classrooms. This examination of practice is a collaborative exercise in which a group of teachers design, reflect on, and deliver mathematics lessons to enhance student achievement.

I will interview the teachers individually and observe them in the lesson study group while they are planning lessons and reflecting on their classroom practice. The teacher who teaches the lesson will also be observed and video-recorded. My observations will be unobtrusive and confidentiality of both participants and the institutions will be ensured.

I hereby formally request your permission to observe and interview mathematics teachers at schools in the Thabo Mofutsanyana district in the second term of this year. I trust that my request will meet with a favourable response.

Yours faithfully

……..

Mrs AB Posthuma

Appendix D: Interview and group reflection schedules

INTERVIEW SCHEDULE 1
Individual semi-structured interview

Name of school	
Name of researcher	Barbara Posthuma
Name of teacher	
Male/ female	
Date of interview	
Teacher's qualification	
Level of Mathematics education	
No of years teaching Mathematics	
Home language	

Thank you for taking part in my study. As you are aware I am working on my thesis. The topic is the nature of mathematics teachers' reflective practice. I want to get your perspective of reflection and have some questions that I want to ask you. Please feel free to elaborate on your answers, the more you can tell me, the more I will be able to represent your views in the thesis.

1. What do you understand by the term reflection?

2. Do you reflect on your classroom practice in mathematics?

3. Can you give me an example of when you reflected on your classroom practice?

   i. **How** do you reflect on your practice?

   ii. **When** do you reflect on your practice?

   iii. **What** do you reflect on after teaching a lesson?

   iv. Do any particular **factors influence** your reflections?

   v. Have you **gained** anything by reflecting on your practice? If the answer is "yes", how? If the answer is "no", why not?

Discussion of the lesson in lesson plan provided during initial interview:

- What did you like best about this lesson?
- What, in your opinion, were essential strengths of the lesson?
- What, in your opinion, were essential challenges experienced during the lesson?
- Suppose you had to teach the lesson again, what aspects, if anything, would you change about the lesson?
- Did your learners achieve the lesson outcomes? Why do you say so?
- What, if any, unanticipated learning outcomes resulted from the lesson?
- Can you think of another way you might have taught this lesson?
- Can you think of alternative approaches to teaching this lesson that might improve the learning process?
- Do you think the content covered was meaningful to the learners? Why?
- Is there anything else that you would like to add to what has already been said in this regard?

INTERVIEW SCHEDULE 2

Post-observation interview

- What, in your opinion, were essential strengths of the lesson?
- What, in your opinion, were essential challenges experienced during the lesson?
- What, if anything, would you change about the lesson?
- Do you think the lesson was successful? Why?
- Should you feel that the lesson was not successful, please elaborate?
- What conditions were important to achieving the outcomes?
- What, if any, unanticipated learning outcomes resulted from the lesson?
- Can you think of other ways in which you might have taught this lesson?
- Can you think of alternative approaches to teaching this lesson that might improve the learning process?
- Do you think the content covered was meaningful to learners? Why?
- What, if any, moral or ethical concerns occurred as a result of the lesson?
- Is there anything else that you would like to add to what has already been said in this regard?

Final group Interview

Name of school	
Name of researcher	
Name of teacher	
Gender	
Date of interview	

- In which ways, if at all, did participation in the lesson study group alter your teaching practice?
- What are your thoughts about the lesson study group?
- What are your feelings about the lesson study group?
- How did you experience working collaboratively with colleagues in the lesson study group?
- Did you gain anything from this experience? If the answer is “yes”, in which ways and what did you gain?
- Were there any negative experiences in the lesson study group? If the answer is “yes”, please elaborate?
- As a result of your lesson study group experience, describe a specific instance(s) in which you have been reflective or specific instance(s) in which your teacher thinking was changed in some way

Appendix E: Ethical clearance certificate

UNIVERSITY OF PRETORIA

FACULTY OF EDUCATION

RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**CLEARANCE NUMBER :** SM 10/06/01
DEGREE AND PROJECT	PhD The nature of mathematics teachers' reflective practice.
INVESTIGATOR(S)	Anna Barbara Posthuma
DEPARTMENT	Department of Science, Mathematics and Technology Education
DATE CONSIDERED	15 June 2011
DECISION OF THE COMMITTEE	APPROVED

Please note:

For Masters applications, ethical clearance is valid for 2 years
For PhD applications, ethical clearnace is valid for 3 years.

CHAIRPERSON OF ETHICS COMMITTEE Prof L Ebersohn

DATE 15 June 2011

CC Jeannie Beukes
Ms A.B Posthuma
Prof J.G Maree

This ethical clearance certificate is issued subject to the following conditions:

1. A signed personal declaration of responsibility
2. If the research question changes significantly so as to alter the nature of the study, a new application for ethical clearance must be submitted
3. It remains the students' responsibility to ensure that all the necessary forms for informed consent are kept for future queries.

Please quote the clearance number in all enquiries.