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.

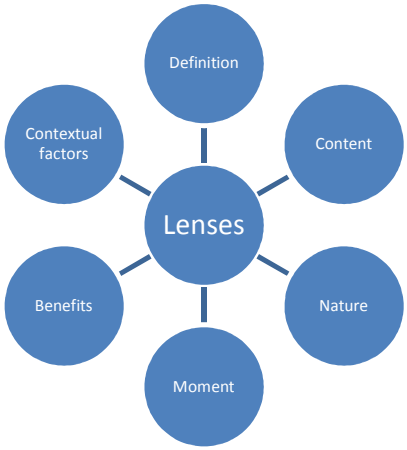

Figure 2.1 Lenses used to explore studies dealing with preservice teachers' reflections

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).

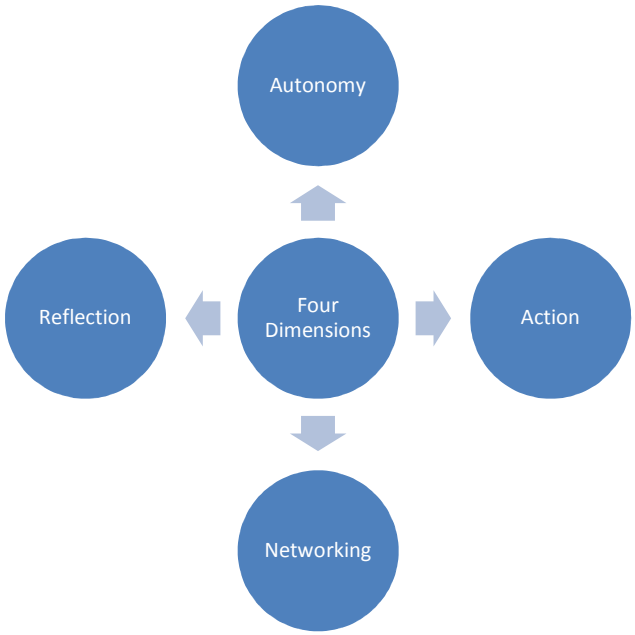

Figure 2.2 Four dimensions of teachers' professional practice (Adapted from Source: Krainer, 2001, p. 288)

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).

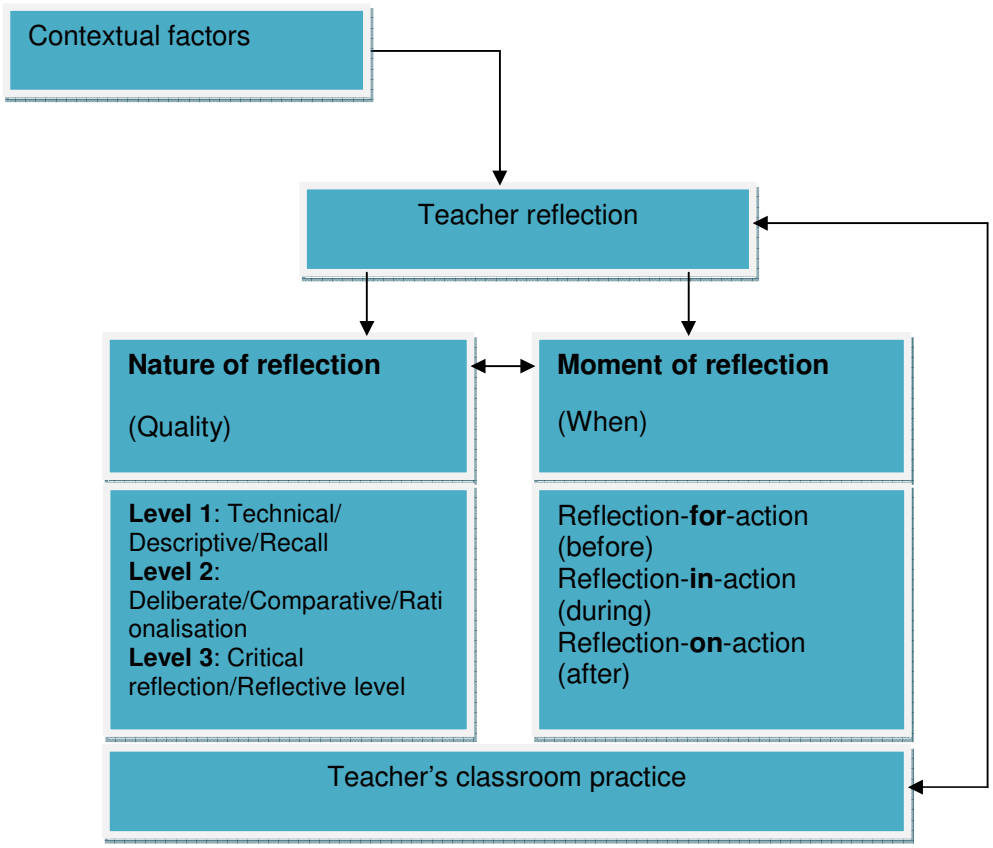

Figure 2.3 Framework for reflective teaching of mathematics

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.

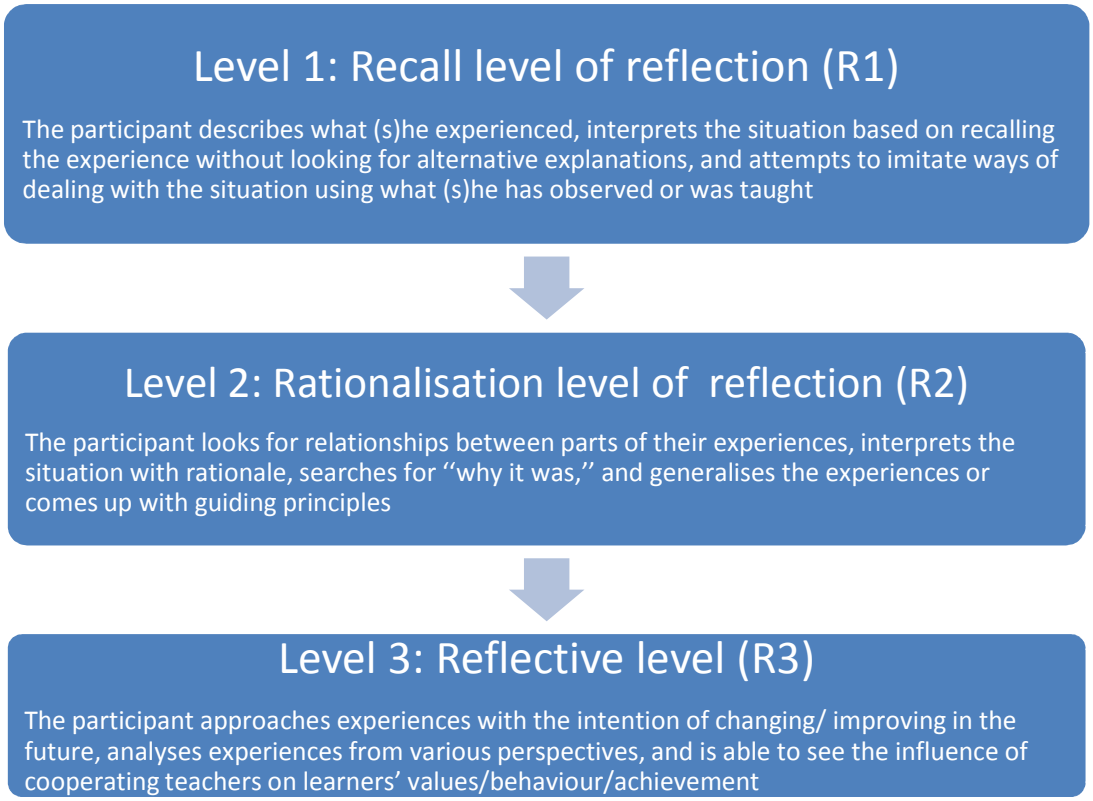

Figure 2.4 Lee's reflection levels (2005)

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.