Chapter 1

Introduction and contextualisation

1.1 Introduction

When referring to mathematical literacy[1] a clear distinction is required between the international and national perspectives. Internationally mathematical literacy refers to *the competence of individuals* (Christiansen, 2006, p. 6), which ranges from a competence demonstrated in word problems to a critical or democratic competence and whose purpose may be *mathematics as a tool in gaining insights into oppression, inequalities, and exploitation; … to become aware of the effects of applying mathematical models in society … and a third component has to do with mathematics as a 'gate-keeper', i.e., access to further education* (p. 6). In South Africa, according to the Department of Education (DoE, 2005) mathematical literacy on national level refers to a fundamental subject where learners are provided with learning opportunities to consolidate and extend their basic mathematical skills.

South Africa is the first country in the world to have Mathematical Literacy (ML)[2] as a school subject (Christiansen, 2007). This subject was introduced in 2006 as an alternative to Mathematics in the Further Education and Training band (FET)[3]. The purpose of this subject is to provide learners with an *awareness and understanding of the role that mathematics plays in the modern world*, but also with *opportunities to engage in real-life problems in different contexts* (DoE, 2003a, p. 9). The DoE (2003a) defined ML as follows:

> *Mathematical Literacy provides learners with an awareness and understanding of the role that mathematics plays in the modern world. Mathematical Literacy is a subject driven by life-related applications of mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems* (p. 9).

In the implementation of this relatively new subject teachers are crucial as agents of change. Bearing this in mind, it is essential to plumb the depths of their knowledge and beliefs regarding the subject in

[1] The words mathematical literacy (no capital letters) refer to a competency in applying mathematical knowledge.
[2] Mathematical Literacy (ML) refers to the South African school subject.
[3] The FET band includes Grade 10 through to Grade 12.

order to understand their instructional practices. An overview of the international and national perspectives on mathematical literacy, the experiences of ML teachers and the existing paucity in the literature now follows.

1.1.1 International perspective on mathematical literacy

With the emphasis on globalisation and the information explosion in mind, mathematical literacy should imply the empowerment of learners to meet the demands of living in the 21st century (Gellert, Jablonka & Keitel, 2001; Queensland Government, 2007b; Skovsmose, 2007). Although different terminology such as 'numeracy' and 'quantitative literacy' is also used internationally, Jablonka (2003) prefers to use the term "mathematical literacy" to focus attention on *its connection to mathematics and to being literate*, in other words it refers to *a mathematically educated and well-informed individual* (p. 77). International comparative studies such as the Organisation for Economic Co-operation and Development's (OECD) programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) have heightened international awareness of the value and significance of mathematical literacy. It is not just internationally, but also at national level that there is a growing concern about learners' mathematical literacy skills (DoE, 2003a). PISA's purpose is to measure *how well students can apply their knowledge and skills to problems within real-life contexts* while the purpose of TIMSS is to *measure the mathematics and science knowledge and skills broadly aligned with curricula of the participating countries* (National Centre for Education Statistics, 2008). At national level there is also a growing concern about learners' mathematical literacy skills (DoE, 2003a).

Jablonka (2003) investigated different international perspectives on mathematical literacy and found that the perspectives basically differ according to the stakeholders' underlying principles and values. On the one hand there are researchers who accentuate the formal application of mathematics by mathematicians to real-world contexts, demanding a high level of mathematical knowledge and the competence to use and apply that knowledge (Gellert et al., 2001; Hope, 2007; Jablonka, 2003; Skovsmose, 2007). Other researchers are persuaded that everyone needs some basic level of literacy to empower them to make well informed decisions in their daily lives, whether personally, to care for their families or to contribute meaningfully in their workplace or society (McCrone & Dossey, 2007; McCrone, Dossey, Turner & Lindquest, 2008; Powell & Anderson, 2007; Skovsmose, 2007). Internationally mathematical literacy in schools refers to a competency or skill to apply mathematical knowledge and is embedded in the subject Mathematics.

1.1.2 National perspective on mathematical literacy

The results of TIMSS 2003 show how poorly mathematics is understood and conceptualised by learners in South Africa (Bloch, 2009; De Meyer, Pauly & Van de Poele, 2005). In the past learners who could not perform well in Mathematics in the General Education and Training (GET)[4] band *usually stopped studying Mathematics, thus contributing to a perpetuation of high levels of innumeracy* (DoE, 2003a, p. 9). With that in mind ML for Grades 10-12 was introduced in 2003 and implemented for the first time in 2006.

The Constitution of the Republic of South Africa speaks of human rights, social justice and provides a basis for transformation and development in South Africa (DoE, 2003a). Mathematics as a discipline, with its inherent potential to develop critical thinking, is a significant role player in the realisation of the DoE's (2003a) vision to create internationally competitive and creative learners and thinkers. Guided by these statements the DoE's (2003a) purpose with ML was to introduce a subject that would bring mathematics to all people and to ensure that *citizens of the future are highly numerate consumers of mathematics* (p. 9). The emphasis is on the knowledge needed to be a self-managing person, a contributing worker and a participating citizen. It is clear from the definition of ML on p. 1 that the focus of ML is on the applicability of mathematics in everyday life situations.

Teachers play a valuable and important role in ensuring the success of a newly introduced subject such as ML which depends largely on the teachers' training, experience, knowledge and perceptions of the subject. In the DoE's (2009) **Report of the task team for the review of the implementation of the National Curriculum Statement** (NCS), it is emphasised that *teachers need absolute clarity on what they are required to teach* (p. 16). Teachers need to *regain confidence in their practice, and authority as subject specialists in the classroom* (p. 16). Teachers and schools reported that *newly qualified teachers have deficiencies in respect to their subject or learning area specialisations and it would appear that they often have not been adequately prepared in respect to appropriate methodologies* (p. 55).

1.1.3 The experiences of ML teachers

The intentions and purpose of the DoE (2003a) are admirable, but due to implementation problems, among other things, not all ML teachers share the DoE's sentiments. In Sidiropolous' (2008) study on the implementation of ML in South African schools, she found that the threat experienced by qualified mathematics teachers regarding their 'status identity' undermines the proper implementation of the

[4] The GET band includes Grade R through to Grade 9.

subject. She also found that teachers do not understand and value this new curriculum which involves understanding not only the concept of mathematical literacy but also the nature of mathematics, *its transformative purpose and possibilities* (p. 254). Teachers need to understand *the sudden shift from content, to context and content as a process* (p. 254).

ML requires a different teaching approach to that of Mathematics as the nature of ML is contextualised and de-compartmentalised (De Villiers, 2007; North, 2005; Venkat & Graven, 2007; Graven & Venkat, 2007). Researchers are concerned about teachers' knowledge and competency to use and apply an approach based on mathematical modelling (Brown & Schäfer, 2006; Glover & King, 2009; Vermeulen, 2007). The focus in research on the issue of teachers' knowledge and competency in ML should therefore be on teacher education. ML student teachers should experience practically what it means to develop an understanding of mathematics in context through, for example, an activity and investigation-based approach (Brown & Schäfer, 2006; Vithal & Bishop, 2006). Glover and King (2009) regard teacher professional development as an important component of curriculum reform and draw attention to issues that need to be addressed such as teachers' beliefs, self-efficacy and knowledge. They refer to subject knowledge, pedagogical content knowledge (PCK) and curriculum knowledge that need to be improved.

1.1.4 Silence in the literature addressed in this study

We have a unique situation in South Africa in that ML refers to a subject and not a skill or competency per se, as is the case internationally. Although the literature informs this study regarding international views, purposes and definitions of mathematical literacy as competency or skill, there is a gap in the literature regarding ML teachers' knowledge and beliefs. Existing literature on national level mainly focuses on the vision and purpose of the subject, the curriculum implementation process, curriculum issues such as the relevancy of the outcomes and assessment criteria, the content-context debate and which approaches to use. The silence in the literature this study attempts to address concerns ML teachers' knowledge and beliefs but also the relationship between their knowledge and beliefs and their instructional practices. It is this gap that this study aims to fill.

1.2 Rationale for the study

A rationale firstly addresses how the researcher developed an interest in the topic and secondly why the study is worth doing (Vithal & Jansen, 1997). As far as my personal interest is concerned, I have been involved in teacher training for the past twenty years, teaching Mathematics to undergraduate student

teachers. I took a particular interest in the introduction of ML as subject because I value and appreciate the subject's vision, purpose and content. As I am interested in how people in and outside the school environment experience and view ML, I make a point of talking to people about the topic. Through my involvement in Teaching Practice which forms part of the undergraduate students' curricula at the University of Pretoria (UP) and being a member of the data collection team for the FET Implementation Project, I have been required to visit many local schools where I also have had the opportunity to talk to principals, teachers and learners. What I learnt and experienced is not at all what I had anticipated.

As far as the possible value of the study is concerned, I regard it as imperative to conduct a study which focuses on ML teachers' instructional practices, as the findings from the study will suggest ways to improve current teachers' practices and will also inform and enrich my own teacher training practice. Koellner et al. (2007) believe that to achieve the vision for school mathematics, no factor is more important than the teacher. A teacher requires a sound knowledge of subject content, principles and strategies, needs to believe in the potential of the subject and the learners, and should maintain a positive attitude. It is also the teacher who is to enthuse and motivate the learners about mathematics and the role it plays in their lives. Through the study I purpose to contribute to our understanding of how the subject is currently taught in South African schools and what the nature of the ML teachers' knowledge and beliefs is, as well as to help people gain insight into the value of ML. Awareness needs to be created of ML as an important subject and the necessity of having knowledgeable and positive teachers teaching this subject. As long as negative perceptions prevail regarding any subject, that subject will not be taken seriously and will not fulfil its purpose. Through the findings of the study I endeavour to show that ML is not a subject with a lower status, but is a different subject with a different emphasis and different requirements compared with Mathematics.

1.3 Statement of the problem

Many learners, teachers and parents have negative attitudes towards ML and regard it as an inferior subject. According to Mbekwa (2007) some teachers regard the subject as a dumping ground for mathematics underperformers. ML learners are ridiculed for having to take a subject that is considered a waste of time. ML is a relatively new subject in which an entirely different teaching approach is required: mathematical content should be taught in terms of real-life situations. For this to occur successfully, specific skills are required of the ML teacher. This study aims to address the problem concerning ML teachers' instructional practices. There are three groups of ML teachers: a) Mathematics teachers who teach ML in the same way that they teach Mathematics; b) non-Mathematics teachers

who in many cases lack the necessary mathematical knowledge, skills and beliefs to teach ML competently; and c) Mathematics teachers who adapted their practices to teach ML using different approaches than those required for teaching Mathematics.

1.4 The purpose of the study

Curriculum developers and teachers are still in the process of addressing implementation problems and determining the required standard of the subject. Limited in-depth research has been done concerning the ML teachers, what they believe and what knowledge is required to teach this subject effectively and proficiently. The purpose of this study is to investigate the way in which ML is taught in a limited number of classrooms with the view to establishing the relationship between ML teachers' knowledge and beliefs and their instructional practices. To accomplish this aim, an in-depth study will be conducted to explore the nature of teachers' knowledge and beliefs of mathematics and ML as manifested in their instructional practices. These findings will then be used to investigate the possible implications thereof for teacher training and theory building.

1.5 Research questions

With the rationale, statement of the problem and purpose as background, the following research questions were formulated:

Main question:

What is the relationship between Mathematical Literacy teachers' knowledge and beliefs and their instructional practices?

Subquestions:

1. How can ML teachers' instructional practices be described?
2. What is the nature of ML teachers' knowledge and beliefs?
3. How do ML teachers' knowledge and beliefs relate to their instructional practices?
4. What are the possible implications of the findings from Questions 1, 2 and 3 for teacher training?
5. What is the value of the study's findings for theory building in teaching and learning ML?

1.6 Methodological considerations

This study was initiated by my interest in the relationship between teachers' knowledge and beliefs and their instructional practices. To answer the research questions a qualitative research approach will be

used as it concerns *specific meanings, emotions and practices that emerge through the interactions and interdependencies between people* (Hogan, Dolan & Donnelly, 2009, p. 4). The research design is a case study as it observes *effects in real contexts, recognising that context is a powerful determinant of both cause and effect* (Cohen, Manion & Morrison, 2001, p. 181). My research paradigm is social constructivism[5] and is based on the epistemological assumptions that *social life is a distinctly human product* and that *human behaviour is affected by knowledge of the social world* (Nieuwenhuis, 2007, p. 59-60). This study is subjective in nature with the nominalist position as ontological assumption: reality is understood through words and is the product of individual consciousness (Cohen et al., 2001). Observations and interviews serve as data collection techniques to enable me to interpret the reality by becoming part of the lives of the teachers. The data are analysed according to the categories identified in the conceptual framework.

1.7 Definition of terms

The following are operational definitions of terms used in this study:

- Beliefs: This term refers to a viewpoint or a way of thinking, or even a preconceived idea a person holds. Beliefs can be interpreted as *mental constructs that represent the codification of people's experiences and understandings* (Schoenfeld, 1998, p. 19). Beliefs about teaching and learning can be located on a perspective continuum from traditional (instrumentalist view), to formalist (Platonist view), to a constructivist perspective (problem solving) (Dionne 1984; Ernest, 1988).
- Contextualised mathematics: This term is similar to realistic mathematics education (RME) where mathematics is seen as a human activity that is connected to reality and relevant to society. RME is founded upon the principles of using real-world contexts, bridging the gap between abstract and applied mathematics, allowing learners to develop their own problem-solving strategies, and making connections to other disciplines (Freudenthal as cited in Van den Heuvel-Panhuizen, 1998).
- Instructional practice: This term refers to the qualitative dimensions of teacher behaviour regarding their teaching. These dimensions involve *teachers' abilities to model cognitive strategies in meaningful and purposive activities, promote classroom dialogues, adjust instruction as required and establish classroom communities in which students collaboratively and cooperatively participate in enquiry-related activities* (Englert, Tarrant & Mariage, 1992, p. 62). A framework used to observe and describe teachers' instructional practices is built on three observable aspects of mathematical lessons namely tasks, discourse and the learning environment (Artzt, Armour-Thomas & Curcio, 2008).
- Learners: This term refers to school learners.

[5] Social constructivism is discussed under Section 3.2.1: Research paradigm.

- Pedagogical content knowledge: This term refers to the knowledge teachers need in the teaching profession that goes beyond having mathematical content knowledge (MCK) only. PCK includes knowledge of what learners do not understand, why they do not understand it and what can be done to rectify the situation. It is the knowledge needed to notice, predict and understand learners' misunderstandings and to assist and guide them to better understanding (Ball, Thames & Phelps, 2005; Shulman, 1986).
- Productive practice: A practice where the teacher listens to learners' mathematical thinking and aims to use it to encourage conversation that revolves around the mathematical ideas in the sequenced problems (Franke, Kazemi & Battey, 2007, p. 226).

1.8 Possible contribution of the study

Although workshops have been offered by the DoE and papers have been published and presented by national academics on various issues concerning the implementation of ML, there is no evidence of in-depth empirical research that has been conducted on ML teachers' knowledge and beliefs and the relationship between ML teachers' knowledge and beliefs and their instructional practices. This study will thus contribute to this new field and fill the gap in literature. The study further contributes to ML theory and practice as the findings will be implemented in undergraduate teacher training programmes at the University of Pretoria. Furthermore it is important to contribute to the vision and success of the DoE's (2003) endeavour to change the current situation where South Africa's adult population has a very low level of literacy and mathematical proficiency. To accomplish this, teachers as well as the community need to realise the place and value of ML in the school curriculum as well as the need for ML teachers to build their own 'status identity'. On a more personal level, this study will also contribute to the development and enrichment of my own practice of preparing ML student teachers. The personal experiences and findings will provide me with a broader and deeper knowledge and understanding of the subject ML, of ML teachers' knowledge and beliefs, and to what extent these knowledge and beliefs relate to their instructional practices.

1.9 Limitations of the study

The case study, like any other research method, has its weaknesses. In this study a limitation is that the primary data are gathered from a relatively small number of teachers who will be observed on three different occasions and will be interviewed three times. Cohen et al. (2001) mentioned that *results may not be generalisable except where other readers/researchers see their application* (p. 184). It will therefore not be possible to generalise the findings, but one may still acknowledge the value of the findings obtained

from rich in-depth involvement in specific cases as *they provide insights into other, similar situations and cases* (p. 184).

During the data gathering process the Hawthorne effect will be taken into account as teachers naturally try to impress an observer in class or an interviewer during the time of observation and interviewing. To a certain extent they may even feel threatened by being observed during their lesson presentations, despite my reassurances. As they do have busy schedules, some may experience it as extra work and an intrusion into their privacy and they may not be as dedicated to the project as would be ideal. Despite the normal human preconceived ideas and perceptions, I will try to guard against being biased and selective and try to be objective during the data gathering and analysis stages in an effort to avoid the halo effect during the data analysis. Cohen et al. (2001) describe the halo effect as a cognitive bias in which the researcher's knowledge or perception of the person or situation exerts an influence on subsequent judgement. The fact that more than one data collection technique will be used minimises this problem. Another way these limitations are minimised is to properly prepare the teachers before the commencement of the data collection process and the establishment of a positive relationship with them, emphasising the value of honest and true data and their anonymity during the whole process.

1.10 Summary

This chapter provides an overview of the problem and rationale for the study, the research questions, methodological considerations and the possible contribution and limitations of the study. The different meanings attached to mathematical literacy both internationally and nationally have been discussed. Internationally mathematical literacy refers to *the competence of individuals* (Christiansen, 2006, p. 6) whereas nationally mathematical literacy mainly refers to a subject involving mathematical skills for solving contextual problems. The subject was introduced in 2006 and schools are experiencing a lack of qualified teachers. The purpose of this study is to investigate, by means of a case study, the way in which ML is taught with the view to determining the relationship between ML teachers' knowledge and beliefs and their instructional practices.

1.11 The structure of the thesis

The thesis consists of five chapters. Chapter 1 is summarised above. Chapter 2 provides an in-depth analysis of the findings in the relevant literature and also explains the conceptual framework on which the study is based. In Chapter 3 details regarding the methodology of the study are given. The data analysis strategies are discussed as well as the trustworthiness and ethical considerations of the study.

Chapter 4 includes the presentation of findings from the data obtained through class observations and interviews conducted with the ML teachers. The findings are also analysed and discussed according to the research questions based on the conceptual framework and the literature and trends are identified and explained. Chapter 5 contains the conclusion and implications and comprises a chapter summary, verification of the research questions, a reflection on the study, the conclusions, recommendations and limitations of the study.