DECLARATION

As the principal author of this mini dissertation, I, Janice Peters, wish to declare that during the process of conducting this inquiry I:

- adhered to the highest possible technical and ethical standards;
- did not under any circumstances fabricate nor falsify any data;
- rejected any form of plagiarism by referring to any source that was consulted either directly or indirectly, and that made a significant contribution to my work.

In addition, I wish to confirm the originality of the revised research assignment.
ACKNOWLEDGEMENTS

I am grateful to many people whose timely and generous assistance and comments have made this mini dissertation a possibility.

- First and foremost, I want to give GOD all the praise and glory for giving me the strength and courage and ability to complete this task.
- To, my awesome husband, Uzendt, for urging me to fulfil my dreams, for pushing me forward with much love and support when I felt like giving up, for understanding when I chose the cold study to a warm bed.
- To my children, Liam, Zoe and Brett who have been badly neglected. Thank you for your support and understanding the importance that this journey held for me.
- A special thank you, to my supervisor, Professor Gert Van der Westhuizen, for all your patience, guidance and support.
- I am especially grateful to the research participants who welcomed me into their school and classroom to conduct this study.

Thank you all – thank you so much!
DEDICATION

This study is dedicated in memory of my eldest daughter, Ashleigh Erin Peters.

(Written by a dear friend – M.N. Jackson – 26-08-2000)

Ashleigh

In the morning light, in the morning light
   My special angel’s soul took flight.
In the morning light, in the morning light
   Heaven’s portals beckoned oh! so bright.

Whisper soft was your final sigh,
   Whisper soft was your hand in mine.
OH! What utter sadness, when the day drew nigh.
OH! What utter sadness, for my special child.

How can I ever say goodbye,
   Or control the water from my eye.
How can I ever say goodbye,
   When you’re very presence floods my mind.
Sleep my darling angel, sleep my darling child
   On the wings of glory, to eternal life
ABSTRACT

There are many concerns about the state of mathematics education, globally. Concern about learners’ poor levels of performance in mathematics in South Africa is therefore not a unique phenomenon. In an era of globalization, with its increasing rapid social, cultural and economic change, enhancing an individual’s capacity to apply their knowledge in “real world” situations through problem-solving is one of the key challenges facing the education system today. Understanding forms the foundation for application and therefore if the problems in the classroom relate to the learners’ experience in their environment, the mathematics becomes meaningful to them and in turn becomes usable. The influence of teacher beliefs and teacher knowledge on their pedagogical decisions and classroom practice has also been highlighted in many studies. In this regard, it is believed that to improve mathematics results, classroom practices must reflect reform recommendations. This study investigated mathematics teachers’ beliefs and knowledge in a Grade 7 mathematics class. Additionally, the study examined how teacher beliefs and teacher knowledge was used to incorporate word problem-solving and problem-solving strategies in a given task.

The theoretical framework, which underpins my research, includes an integration of theories however I use the Social Constructivist Theory (Vygotsky, 1978) as a basis for my qualitative theoretical framework. Vygotsky indicates that children are able to solve practical tasks by means of talking, suggesting that discussion between the educator and the learners or the learners and their peers leads to social exchanges which is necessary for the internalization of learning and the construction of knowledge. Thus, suggesting that the discussions and sharing of ideas develop skills that can be used later in life to solve problems in the world. Social Constructivism therefore offers a view that helps me to understand the social construction of knowledge and it directed me in exploring how the participants’ knowledge and beliefs were constructed and what influenced their knowledge and beliefs. For the purpose of this study, a qualitative approach was chosen as the key concern was to explore and understand teacher beliefs and teacher knowledge from the participants’ perspective. A case study design was utilized to provide an in-
depth understanding of a Grade 7 mathematics teacher’s knowledge of her learners’ ability to use problem-solving strategies when doing word sums. The participants were one educator and her class of 40 learners. The data collection methods included in this study are a semi-structured interview with the teacher, a focus group discussion, self-reflection tool used by the learners, observation of a lesson presentation and an analysis of an activity completed by the learners. Data was analysed using the constant comparative method to determine the common themes and sub-themes. Themes that emerged during the data analysis process included: learners’ attitude towards word problem-solving varies; learners find word problem-solving difficult; teacher experience influences teaching and learner performance; the teaching strategies used in the classroom are not assisting learners; and learners have a backlog in word problem-solving strategies.

The study concludes with a discussion of recommendations for future research and limitations and strengths of the research.
GLOSSARY

**Association:** In a learning context, association is the purposeful linking of one concept or thought with another. We remember things if we associate them with previous experience or with something we know already.

**Attitude:** Attitude have been defined as mental predispositions to act in a certain way in a particular situation

**Beliefs:** Whatever you believe with feelings becomes your reality. Beliefs shape attitudes and so create tendencies for people to behave in certain ways.

**Emotions and learning:** Learning is a very emotional process. To learn we must see, feel, experience and do. The seat of the emotions is the limbic system of the brain. It is connected to the frontal lobes, which have an important role in learning. Learning can therefore be enhanced or speeded up if there is an emotional involvement with the subject to be learned.

**Learning-to-learn skills:** Learning-to-learn skills are those skills required to learn effectively in any learning situation, the skills required for life-long learning. They include concentration, creativity, problem-solving, memory, mnemonic strategies, effective reading, time management, researching ability and the ability to produce learning maps.

**Understanding:** Understanding implies more than mere knowledge: it implies knowledge plus the ability to use the knowledge and to relate it to other knowledge in a useful way.
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CHAPTER ONE

OVERVIEW AND RATIONALE OF THE STUDY

1.1 INTRODUCTION

This introductory chapter serves to contextualize and orientate the research. It will firstly provide an overview of the background to the study followed by the problem statement. Next, the research question will be formulated and from this the aim of the study is derived. Next, I provide a brief description of the theoretical framework which underpins this research. This is followed by an explication of relevant terminology. The research methodologies used in this research will be briefly explained and ethical considerations that lay the foundation of trustworthiness will be discussed. The chapter concludes with a brief overview of the structure and sequence of the study.

1.2 BACKGROUND TO THE STUDY

The South African economy is currently experiencing deep skills shortages in many important forms of employment, such as science and technology, medicine, engineering, information and telecommunication, leadership and management and in public decision-making. These are the direct cause of widespread unemployment and the resultant poverty experienced by many. The latest statistics indicate that approximately 41 percent of the country’s youth are unemployed and are considered to have skills that are not in line with the requirements needed to address these shortages in. The government has attempted to address them with many interventions over the last decade; however success would require the beneficiaries (youth and young adults) to have a
sound background in mathematical skills. The reality is that the schooling system is currently failing to produce learners with the necessary mathematical acumen to address the skills shortages. Too many learners without essential mathematical ability are moving through the schooling system and because of this shortcoming they cannot be fast tracked through skills development intervention strategies planned to address the skills shortages. Focus is required on addressing learners’ mathematical ability so that the learners can be equipped with the necessary tools to understand and bring change to their circumstances, thus impacting the economy of South Africa and the world at large.

Currently, the subject of mathematics transcends human boundaries and its importance is universally recognized. Haylock and Thangata (2007:3) suggest that the aim of mathematics teaching can be categorized under five headings:

- **Utilitarian**: Equipping learners with the basic numerical skills and knowledge demanded in everyday lives.
- **Application**: Furnishing learners with the necessary knowledge and skills to function effectively in a range of other subjects, i.e., being able to use data handling skills in history, biology and other subjects.
- **Transferable skills**: Developing learners’ thinking skills that can be transferred in a range of circumstances and problem-solving situations.
- **Aesthetic**: Promoting the pleasure and wonder that learners can experience by engaging in mathematics. This aim of teaching mathematics is likened to the teaching of subjects such as music and literature, thus suggesting that it is teachers’ responsibility to open up the world of delight and beauty in mathematics.
- **Epistemological**: Mathematics teaching is a distinctive and universal field of human knowledge derived from many different cultures, therefore learners must be made aware of these contributions.

### 1.3 PROBLEM STATEMENT

The new curriculum in South African schools calls for learners to participate in mathematics lessons and to express their mathematical ideas. This study is thus relevant to the South African context in that the focus will be to create a richer learning environment for learners and teachers so that the latter can be guided to address the poor performance in mathematics from a lower
grade and not just focus on learners’ mathematics performance in Grade 12. Dednam (2005:202) substantiates this opinion by stating that many learners’ difficulties start in their first year at school. According to Sarah Howie, (2004:151), a number of reports and articles have been written on the status of mathematics education in South Africa (e.g., Arnott & Kubeka, 1997; Khan. 1993; Taylor & Vinjevold, 1999); with many have criticising the poor results achieved in the mathematics matriculation examinations as well as the performance of South African learners in comparison to those in other countries. The focus of this study is also directed at addressing one of the aims suggested by Haylock and Thangata, namely developing learners’ thinking skills so that their knowledge and skills can be transferred to a range of circumstances and problem-solving situations (transferable skills).

According to Jonassen et al. (2003), word problems pose difficulties for many learners because of the complexity of the solution process. Providing classroom opportunities that emphasize mathematical thinking and reasoning is critical for successful problem-solving, while strategy instruction in mathematics is a powerful approach to helping learners learn and retain problem-solving skills (Griffen & Jittendra, 2008:187). This study therefore provides insight into the strengths and weaknesses concerning methodology and makes recommendations for improving teaching methods so that learners can form the link between mathematics and the external world.

In the pedagogic process, the role of the teacher requires that he or she follow the progress of learners and ensures adequate teaching responses. According to Mayer and Marland (1997) and Butler and Winne (1995), teacher knowledge of learners is important as it is the basis of directed feedback from and interaction with them, however little has been published in this field.

Banks, Leach & Moon (1999:94) suggest that teacher’s professional knowledge can be divided into four areas: personal subject construct (which includes past knowledge and experience); subject content knowledge (which includes vocabulary and symbols); school knowledge (which includes curricular knowledge, however this model excludes any context knowledge); and pedagogic knowledge (which includes teaching strategies such as analogies, illustrations and explanations). Missing from this model of teacher’s knowledge, however, is the knowledge that the teacher should have of the learner’s context and knowledge about the learner’s learning. Such knowledge begs the following theoretical conceptual questions: What is the knowledge base and beliefs base that teachers have of the learning questions asked by the students, and what problems do they face in approaching learning tasks in a content domain? Is the knowledge base and beliefs of the teacher of his or her students congruent with the factual available knowledge in the
learning task of a particular learner? Are the support actions teachers offer based on their learner knowledge during class interactions more effective, in the sense of leading to improved learner performance, when there is congruence between teachers’ learner knowledge and the actual knowledge of the learner?

As outlined above, previous research has identified the importance of teacher thinking, beliefs and knowledge about teaching, learning and students. Initial studies about teacher thinking and teacher beliefs were mostly conducted at a tertiary level and the focus was mainly directed at the psychological context of how the teacher plans and makes decisions. The findings in the initial research were that teacher theories about teaching, learning and students are to a great extent influenced in their goals in teaching and classroom behaviour.

Since 1986 (Hativa & Goodyear, 2002), almost 200 publications have appeared that are concerned with teacher knowledge, teacher thinking and teacher beliefs. Subsequent studies, since 1985, have concurred that thinking and beliefs do indeed affect the modification of the teacher’s thinking and beliefs, and can result in effective teaching. Additional studies have also indicated a strong link between teacher thinking and teacher beliefs and how teachers’ experiences in teaching can alter their beliefs and knowledge.

Current thinking about goals in teaching suggest that the emphasis in teaching should move away from transmission of knowledge towards in-depth teaching of fewer topics, and focus on developing learners as self-directed, with the promotion of thinking skills and understanding. This focuses on capacity to apply new knowledge to a variety of tasks and situations, such as solving problems, and thus suggests that the new goals for education should change from knowledge transmission to student development. This view in itself is not entirely new, having been expressed by Polya (1965):

“I have an old fashioned idea about the aim of teaching. I believe the aim, first and foremost, is to teach young people to think…Teaching to think means that the …teacher should not merely impart information, but should try to develop the ability of the students to use the information”.
Teaching for conceptual change thus requires that teachers have a deep understanding of the subject and deep content knowledge.

Further studies relating to teacher interviews and classroom observations support the consistency of the relationship between teachers’ thinking, beliefs and knowledge and their classroom practices. Gardner (2004) suggested that the capacity for and the importance of analytical and creative thinking, and problem-solving within and across disciplinary boundaries, are essential for education in this era of globalization.

1.4 AIM OF STUDY AND RESEARCH QUESTION

Word problems have long been the nemesis of learners of mathematics. When one considers studying mathematics the first image that comes to mind may be that of a person working to solve a problem or to find an answer to a question, and it is reasonable to presume that problem-solving is at the heart of the subject. Many kinds of mathematics problems exist and the type of problem-solving strategy used depends on the skills of the person solving the problem.

The aim of this research is to explore and describe a mathematics teacher’s beliefs and knowledge about her learners and their learning of word problem-solving in a mathematics classroom setting. In the process, it will aim to identify some of the reasons for the poor performance of learners when doing word problems. In addition, it will attempt to suggest guidelines and make recommendations for ways in which such knowledge may be further developed by the Grade 7 mathematics educator in such a way that she will be able to support the learners in her class in better understanding word problems and being able to successfully solve them.

The problem gives rise to the following research question:

- What are the teacher’s knowledge and beliefs about the learners’ problem-solving strategies that they use when doing word problems and how do these beliefs shape her teaching and influence the learners’ outcomes?

The above question has the following three sub-questions:
• What is the mathematics teacher’s beliefs and knowledge of the learning strategies that learners use when solving word sums?

• What are the beliefs of the Grade 7 learners about their own ability to solve word sums?

• What are the outcomes of the learners when doing a word sum activity?

The implication of this study is that educators need to understand how to help students to think mathematically and to understand deeply the development process of learning mathematics. For educators to teach in this way they need professional development opportunities so that they can engage in the very practices that a new teaching for thinking curriculum requires. The curriculum needs to be replaced by a push to develop learning environments where students are set tasks that develop their problem-solving skills and self-regulatory skills.

1.5 THEORETICAL FRAMEWORK

The theoretical framework, which underpins this research, influenced the empirical research strongly. Although my theoretical framework is an integration of various theories, I used social constructivist theory (Vygotsky, 1978) as a basis for my qualitative theoretical framework. It posits that all humans are continually engaged in the construction and re-construction of meaning (Engelbrecht & Green, 2001), and offers a view that helps in understanding the social construction of knowledge, looking at how learners used mathematics when given a problem-solving task that required creative thinking in groups or individually. The process of cognitive development is seen as taking place through the process of social interaction (Donald, Lazarus & Lolwana, 2002). Whereas Piaget claimed that all learners follow the same developmental stages independently of context, Vygotsky believed that cognitive development relates more to the culture and context in which it unfolds. Sierpinska et al. (1998:498) suggest that all learning should be viewed as a process of active construction whereby the child’s culture, the role of language and social interaction are emphasized, a standpoint shared by this researcher.
I further base my theoretical framework on the eco-systemic perspective, derived from a blend of ecological and systems theory, which provides a comprehensive way of understanding human development. Landsberg et al. (2005) makes the point that a key component of Bronfenbrenner’s model is the understanding that people are also active participants in their own understanding and development, and that the environment therefore does not simply impact on the person. In light of this research inquiry, educators should have an understanding of the learners’ context as this is central to understanding how they interact with their environments and the support structure that learners have at their disposal.

1.6 CONCEPT CLARIFICATION

The following are the definitions of some key concepts that are used during this study. These definitions are presented in order to ensure that the reader of this study has the same understanding of concepts as the author.

‘Barrier to learning’ refers to any factor, either internal or external to the learner, which causes a hindrance or barrier to that person’s ability to benefit from schooling.

‘Mathematics’ is an ordered field of knowledge with many branches such as arithmetic, algebra, geometry, trigonometry, statistics and analysis that are related and dependent on each other. It is a universal language that uses carefully defined terms and symbols that enable human beings to think about, record and communicate ideas concerning the elements and the relationship of quantity.

The term ‘social context’ implies all aspects of the position that a person, group, or organization occupies in the social structure as a whole.

A word problem/sum is a verbal description of a problem situation wherein one or more questions are posed, the answers to which can be obtained by the application of mathematical operations to information available in the text.
1.7 METHODOLOGICAL OVERVIEW

In this section a brief introductory outline of the research methodology will be presented, prior to a more detailed description in Chapter Three.

1.7.1 Research design

A qualitative approach with a literature review was used in this inquiry. A qualitative approach can be described as an interpretive and naturalistic research design which involves the use of interviews, observations, written questions and artefacts (e.g., documents and collages). Mouton (2004:179-180) describe a literature review as a study that provides “an overview of scholarship in a certain discipline, through an analysis of trends and debates”. He further suggests that it is an account of what has been published on a topic by accredited scholars and researchers.

A case study design was further utilised in this inquiry, differentiated from other types of qualitative research in that it includes intensive descriptions of a ‘single entity’, a unit around which there are boundaries (Merriam, 1998:18-19). Merriam (p.27) further indicates that the case study design lends itself to investigating a selected phenomenon as it reveals itself within its natural setting, and will further inform the researcher and reader how the research is to be conceptualized and executed (Henning, van Rensburg & Smit, 2004:30). The case study design has become the design of choice for researchers who aim to gain an in-depth understanding of a particular phenomenon and was therefore a suitable research design as it allowed me to investigate an educational phenomenon in such a way that educators reading this study may realize that effective education is required to maintain relevance in a changing society. They may further develop a better understanding of the importance of preparing the learners to be part of a global community.

Merriam (1998:60) indicates the importance of selecting a single unit of analysis to meet the specific qualitative standards, after identifying the research problem. She further suggests that selecting this unit of analysis directs the researcher’s attention to considering where, who and what to observe. Since this inquiry is underpinned by a qualitative case study design, purposive sampling is appropriate.
1.7.2 Data collection

A variety of qualitative data collection techniques were utilized in the research process, in three stages: (A) before, (B) during and (C) after a teaching intervention. At each stage, information was gathered from either the teacher or the learners. Methods before (A) included one semi-structured interview conducted with the educator, the aim of which was to gain insight into the perceptions of the educator’s teacher knowledge and beliefs of mathematics as a learning area in Grade 7. Further data collection methods included observations during the lesson presentation (B) and whilst learners were completing an individual activity. Observations which are qualitative in nature enable the researcher to pay specific attention to things that would normally receive attention (Merriam, 1998:95). In relation to this study the researcher acted more as a participant observer, seeing things firsthand and then interpreting what was observed. I also made use of a focus group interview after the completion of the homework activity (C). The analysis of the learners’ performance, such as their individual activities completed as part of the lesson presentation, formed part of data collection. Merriam (1998) suggests that the analysis of documents such as reports should form part of data collection. Evidence of data collection can be found in the Addendums and will be discussed later in the research document in Chapter 3, section 3.4.

1.7.3 Data analysis

Merriam (1998:178) describes data analysis as the “process of making sense out of the data”. Content analysis, one of the most commonly used data analysis techniques, will be used to analyze the collected data (semi-structured interview, observations and the focus group discussion) that has\(^1\) been transcribed into written text. The constant comparative method was used qualitatively to constantly compare and construct meaning from data that was being collected (Merriam, 1998:197). Merriam (p.162) suggests that ongoing data analysis takes place simultaneously with data collection, meaning that the interviews and observations were analyzed thematically in order to obtain an in-depth understanding of the teacher’s and learners’

\(^1\) Although ‘data’ is a Latin plural of datum, it may also be treated as an uncountable entity, thus acting grammatically as a singular noun, as is the case in this paper.
perspectives on the latter’s needs and problems. To improve the reliability of the constant comparative method, content analysis was used to analyze the themes and recurring patterns of meaning (Merriam p.160). Henning et al. (2004) suggest that content analysis allows the researcher to generate codes directly from the data which works on one level of meaning, namely the meaning of content. With this method themes can be used to highlight the resemblance between core and shared stories. This is in order to gain a “rich description” (Henning et al., 2004: 6) of the phenomenon under investigation.

1.7.4 Trustworthiness

Lincoln and Guba (1985, as cited in Pillay, 2006:30) identify four strategic principles with which to establish trustworthiness relevant to qualitative studies, namely credibility, transferability, dependability and confirmability. These were considered in this research process in order to ensure reliability and validity of the data gathered and with Guba’s (1981) model of trustworthiness will be discussed in more depth in Chapter Three. Merriam (2002:30) declares that for a study to be viewed as trustworthy, reliable and valid, it has to be carried out in an ethical manner. The research results must thus represent the congruence of research findings with reality. In this study, the reliability and validity of our measures (e.g., questions-data) will be ensured by using instruments that other researchers have used previously.

The trustworthiness and validity of this study is promoted by the use of triangulation, which involves using different methods to collect data to be compared when cross-checking the findings and interpretation (Merriam, 2002:31). Also, data is collected from both teacher and learners so that both perspectives can be obtained.

Trustworthiness, triangulation and verification of data are also discussed in detail in Chapter 3, section 3.5
1.8 ETHICAL CONSIDERATIONS

Before this study commenced, clearance from both the University’s Higher Degrees Committee and the Research Ethics Committee was obtained. Thereafter, written permission and consent was obtained from the necessary role-players before data collection began. Written permission was obtained from the School Governing Body (SGB) at the school where the research is to be conducted. I fully informed the parents about the research goals, process and outcomes and then asked them to give written permission in order for their son/daughter to participate. The participants’ parents voluntarily signed a consent form which gave me permission to video-record the lesson presentation (Addendum A). The teacher and learners were asked to sign an informed letter of consent (Henning et al., 2004) to participate, which included a description of the research process and purpose. The letters explained the voluntary nature of the involvement in the study and that the participants might withdraw from the study at any time without negative consequences. They were assured that all information would and shall continue to be kept confidential and that the research findings would be presented in such a way that their anonymity is assured. Participants records were kept anonymously and they were not referred to by name during the course of the research or in the written report on the research results. All data collected was to be stored safely at the University to secure the anonymity and confidentiality of the participants. Safekeeping of records and any research data was ensured for a period of two years following completion of the research, after which the data is to be destroyed. The participants and the SGB were promised feedback on the findings of the study and permission to read the final document once the study is completed.

1.9 COURSE OF THE STUDY

The chapters for this study have been arranged as follows:

Chapter One serves as the background and contextualization of the study, orientating the reader to the research. It also explored the researcher’s theoretical framework that leads to the formulation of the research question. A brief discussion of the research paradigm, design and methodology are included. A discussion of trustworthiness and ethics was included.

Chapter Two reviews the literature, which grounds this study academically.
Chapter Three elaborates on the reasons for choosing the research design and methods. The ethical considerations used during this study are explained as well as the credibility of the research process.

Chapter Four includes a discussion of the themes and subsequent findings drawn from the research conducted.

Chapter Five provides a summary of the study. Recommendations for further research within a similar context are made.

1.10 CONCLUSION

Chapter one provided an overview of the research study, as well as a background to the study, contextualizing the aim and research question. Thereafter a brief discussion of the research design and methodology used, along with the qualitative framework within which this inquiry was conducted is given. Key concepts were clarified and the chapter concluded with ethical procedures that were considered during this inquiry in order to obtain trustworthiness. Lastly, a demarcation of the inquiry is provided as an organizational framework for the reader.
CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the literature relevant to this study and begins with a brief discussion of the theoretical framework which underpins it. I provide an in-depth analysis of literature related to the nature of teacher knowledge and teacher beliefs and discuss mathematics teachers’ knowledge and beliefs and how this knowledge is developed and learned. Next I discuss mathematics learning with an overview of the nature of mathematics and how it is learned, with reference to mathematics learning strategies and word problem-solving. The last section will address teachers’ knowledge of mathematics learning. In this section I will provide a summary of the theoretical perspectives on teacher knowledge and beliefs of mathematics learning.

2.2 THEORETICAL FRAMEWORK

The theoretical framework which underpins my research includes an integration of theories, in particular constructivism (Piaget, 1965), social constructivism (Vygotsky, 1978) and ecosystems theory (Bronfenbrenner, 1979).

2.2.1 Constructivism and social constructivism

Piaget (1965) referred to ‘making-up’ knowledge as ‘constructing knowledge’ and postulated that knowledge was what one makes up in one’s mind rather than the objective observation of the individual. This theory, which guided mathematics education for many years, was based on his theory of learning and has had the greatest single influence on education in general and on mathematics education in particular. Piaget suggested that the individual organises his or her
world through the process of accommodation, assimilation and equilibration, indicating that individuals continually construct new knowledge from their experiences and in so doing form schemas. Schemas are segments of interrelated ideas in a child’s mind which build complex ‘maps’. Learning is thus seen as the interaction between a child’s existing schemes and new ideas (Donald et al., 2002:63-64). Piaget’s theory of learning therefore suggests that children’s capacity for understanding is determined by the ‘cognitive’ level that they have reached as individuals. The strength of the Piagetian approach includes a focus on the child’s thinking or the process, and not just the answer. It requires self-initiated active involvement in a rich environment and an avoidance of pushing the child to be adult-like, while viewing the role of the teacher as a guide (Gomes, 2006).

Piaget’s model of cognitive development indicates that the highest stage of cognitive development is the formal operations stage. This study focuses on learners in the fourth stage of Piaget’s hierarchical model, i.e., the formal operational stage. At this level the reasoning is no longer dependent on concrete reality as in the concrete operational stage. The formal operational stage (11 years and above) can also be referred to as ‘middle childhood’, a period marked by a great increase in sociability and emotional control. At this stage children begin to form mental pictures of objects and think in terms of the whole rather than the parts.

Social constructivism is a branch of constructivism, owing its origins to Vygotsky. According to Donald et al. (2002), it is a theoretical perspective that is currently of considerable importance in the field of psychology. Vygotsky believed that cognitive development relates more to the culture and context in which it unfolds, thus the process is seen as taking place through social interaction (Donald et al., 2002). The major theme of Vygotsky’s theory is that social interaction plays a fundamental role in the development of cognition, with an important aspect being that of ‘scaffolding’ Or support, needed at in the early stages of learning in order to grasp a task. According to Vygotsky (1978), “Every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level”. This socio-cultural approach refers mainly to thought, reasoning processes and language, all of which are conceptualized as formed in and through mediated social interaction. The emergence of socio-cultural perspectives in mathematics education reflects a wider social turn in understanding learning in education.

Vygotsky further indicates that children are able to solve practical tasks by means of talking, suggesting that discussion between the educator and the learners, or the learners and their peers
leads to activity that takes place in the classroom, emphasising that social exchange is necessary to the internalisation of learning and knowledge. The discussions and sharing of ideas therefore develop skills that can be used later in life to solve problems in the real world. Vygotsky’s “Zone of Proximal Development (ZPD)” delineates the difference between what learners can do by themselves and what they can do with assistance of another person or tool, and is key to my study as it alludes to the role, importance and relevance of cooperative learning when doing mathematics. Social constructivism as the basis for my theoretical study was thus relevant as it offers a view that helps me to understand the social construction of the knowledge and beliefs of the participants in this study.

2.2.2 Eco-system theory

Systems theory has its relevance in developing understanding of families, classrooms, and schools and the relationships within them, as well as between them and their social context. Ecological theory is based on the interdependence and relationships between different organisms and their physical environment (Donald et al., 2002). Bronfenbrenner’s ecological model (1979), and the more recently revised bio-ecological model of development (1992), as discussed in Landsberg (2005), have much relevance to emphasising the interaction between an individual’s development and the systems within the social context. Swart and Pettipher (as cited in Landsberg et al., 2005) see this model as valuable because it offers insight into understanding the ‘causal’ processes underlying a phenomenon, and thus highlights that people actively participate in their own development and that the environment does not simply impact on the person.
2.3 LITERATURE REVIEW

The following literature review is broken down into a number of key topics and discussed to provide a theoretical background for the research study.

2.3.1 The nature of teacher knowledge and teacher beliefs

In this section I will clarify the theory of teacher knowledge and teacher beliefs.

2.3.1.1 Teacher knowledge

‘Knowledge’ according to the Concise Oxford Dictionary (1990:656) can be described as information that comes with insights, framed experiences, intuition, judgement and values. It can also be described as representation of facts and concepts to help one plan for the future and solve problems. Knowledge can further be defined as the body of understanding and skills constructed mentally by people, and that increases through reflection and interaction with others. Knowledge has also been described as the lowest type of learning because it focuses on the recall of information (Vogel, cited by Eloff & Ebersohn, 2004).

In an educational setting, teacher knowledge can be described as the link between teaching and learning, suggesting that the teacher has knowledge about the learner, classroom management and learning theories. Researchers have gone so far as to refer to the concept as ‘the DNA of the classroom’, suggesting that teacher knowledge acts in a complex, non-linear manner to create and foster student actions and learning. Rosiek and Atkinson (2005, as cited by Voorhies, 2009), describe teacher knowledge as “seeking to bridge the gap between educational theory and practice by taking seriously the intellectual dimension of the practical work of teaching.” In defining teacher knowledge further, Grossman (1990) refers to the contributions of the researchers at Stanford (Shulman, 1986a, 1987; Wilson, Shulman, & Richert, 1987) who proposed seven categories of teacher knowledge, i.e., knowledge of content; knowledge of pedagogy; knowledge of curriculum; knowledge of learners and learning; knowledge of contexts of schooling; pedagogical content knowledge; knowledge of educational philosophies, goals, and objectives. Leinhardt and Smith (1985) categorize teacher knowledge as subject matter knowledge and knowledge of lesson structure, while Lampert (1984, as cited by Grossman, 1990)
suggests that in order for a teacher’s knowledge to be of use for classroom practices it must be context-specific. Martin, et al. (1997:666) contends that “teacher knowledge and knowing affects every aspect of the teaching acts” and that “what teachers know and how they express their knowledge”, is central to student learning.

2.3.1.2 The development of teacher knowledge

Grossman (1990:6) suggests that Shulman identified four areas that can be seen as the cornerstones of the professional knowledge for teaching, namely general pedagogical knowledge; subject matter knowledge; pedagogical content knowledge and knowledge of context. Shulman (1986, 1987, as cited by Peterson, 1989:559) was one of the first to point to the importance of pedagogical knowledge or “knowledge of the learner”, as well as the importance of content knowledge (“teacher’s knowledge”) in the performance of teaching. He argued that a combination of content knowledge and pedagogical knowledge plays a crucial role in teacher thinking, since not only did a teacher have to know what to teach but also how to teach in ways that facilitate student learning (Gess-Newsome & Lederman, 1999). Shulman (1986:93) and his colleagues proposed that this domain of teacher knowledge be termed ‘pedagogical content knowledge’ (PCK). According to Hativa and Goodyear (2002:67), Shulman described this domain as including knowledge of the conceptions and preconceptions that students of different ages and backgrounds bring to most frequently taught topics. This suggests that PCK is a teacher’s understanding of how to help learners understand specific subject matter and knowing what to do when students encounter difficulties in learning. Knowledge of learners includes knowledge of the characteristics that students of different ages and backgrounds bring to the situation (Hativa & Goodyear, 2002:67).

Central to Schulman and his colleagues’ contributions was the reframing of the study of teacher knowledge in ways that attend to the role of content in teaching thus suggesting that little attention has been given to examining content and its roles in instruction therefore Shulman has referred to the absence of focus on subject matter as the “missing paradigm” problem. He explains that the missing paradigm refers to a blind spot with respect to content that now characterises most research on teaching. Ball et al. (2008:390) also suggests that Shulman and his colleagues’ second contribution were to present content understanding as a special kind of
technical knowledge that is key to the profession of teaching. Ball et al. (2008:393) ascribe the
effects that Shulman’s proposals brought about in teaching to the following:

- Teachers’ orientations to content influenced the ways in which they taught content

- Grossman (1990) found that teachers’ orientations to literature shaped the way they
approached texts with their students

- Wilson and Wineburg (1988) indicate that social sciences teachers presented historical
knowledge to their students differently

- Ball (1990) introduced the phrase “knowledge about mathematics” to contrast with
“knowledge of mathematics” and further highlighted the nature of knowledge in
discipline, i.e., where it comes from, how it changes, and how truth is established.

2.3.1.3 Teacher beliefs

There is no common description for beliefs upon which researchers can agree. In as much as they
originate from personal experience some beliefs may derive from other personal experiences,
such as family traditions and values, social encounters, community participation, popular culture,
teacher preparation, professional development, and scholarly literature. Grootenboer (2008:480)
indicates that after Richardson (1996) reviewed the definition of beliefs of anthropologists, social
psychologists and philosophers, he noted that the findings revealed considerable congruence of
the definitions of these disciplines, in that beliefs are thought of as “psychologically held
understandings, premises or propositions about the world that are felt to be true”.

According to Cross (2009:326), early research on beliefs revealed two major findings. Firstly,
beliefs were organized according to gender differences in how epistemological beliefs were
organized and, secondly, beliefs were influenced by educational experiences. More recently the
thinking around beliefs has been different and the focus directed more on how knowledge is
conceptualized. This new thinking is suggestive of the significance of how content is taught and
how it can influence a person’s belief about knowledge. Cross (2009:326) defines ‘beliefs’ as
embodied conscious and unconscious ideas and thoughts about oneself, the world, and one’s
position in it. She further suggests that beliefs are personal, stable and often reside at a level
beyond the individual’s control or knowledge, and that one’s beliefs can have an influence in determining how one frames problems and structures behaviour. Turner (2009:361) concurs with this and suggests that beliefs represent the individual’s subjective knowledge, and so have an influence on his or her actions.

Cross further indicates that, according to Green (1971), beliefs tend to be highly resistant to change. Pajares (1992) concurs with this as he writes that “Once formed, beliefs are difficult to change…” Teachers’ beliefs exist on a global or a personal level and can be described as a part of their identities. Lortie (1975, as cited by Grootenboer, 2008:481) argues that teachers learn many of their beliefs about teaching through their years of experience in classrooms, as learners, and refers to this experience as “an apprenticeship of observation” that usually explains the primary central beliefs that many teachers hold. Clarke and Peterson (1986) concur with this and further propose that the most resilient or core teachers’ beliefs are formed on the basis of their own schooling as young students while observing teachers who taught them. The study of teacher beliefs forms part of the process of understanding how they conceptualize their work, and in order to understand how they approach their work it is necessary to understand the beliefs and principles on which they operate.

Teacher beliefs can therefore be associated with student learning mediated by the teacher, suggesting that they drive instructional pedagogy (Pajares et al., 1992). Hampton (1994) notes that teacher beliefs or personal constructs determine how they approach their teaching and therefore strongly affect those materials and activities they choose for the classroom that are geared to improving educational processes. Furthermore, beliefs are thought to influence teachers’ perceptions and judgments and, in turn, affect their behaviour in the classroom, suggesting that teacher beliefs also affect innovations in learning and teaching and thus influence the introduction and development of SRL practices. Another important characteristic is the teacher’s capacity to stimulate and guide SRL processes (Tillema & Kremer-Haydon, 2002, as cited by Lombaerts at al., 2008:163).

In summary, this section found that teacher knowledge and teacher beliefs differ over a period of time however the significant impact on the teaching act has also been highlighted. What teachers know and how they impart that knowledge has also been clarified with reference to how teacher knowledge can further be influenced by their beliefs. The importance of teachers’ content
knowledge and pedagogical knowledge was also discussed highlighting the need for educators to have an understanding of structured content knowledge in order to meet the demands in the classroom.

The next section looks at mathematics learning where the nature of mathematics and how mathematics is learned is discussed with reference to mathematics learning strategies and problem-solving.

2.3.2 Mathematics learning

2.3.2.1 The nature of mathematics

Naude (2004:121, as cited by Eloff & Ebersohn, 2004) describes mathematics as the logical study of shape, arrangement and quantity, and as a communication tool that uses mathematical symbolism to describe quantified relationships in the universe. Gates (2001:281) defines mathematics as cultural knowledge that derives from humans engaging in the six universal activities of counting, locating, measuring, designing, playing and explaining in a sustained and conscious manner. Mathematics, however, is much more than counting and simple arithmetic, and is essentially an effort to search for, specify, and use relationships (Baroody, 1987:15). Mathematics can further be defined as the science of discovering patterns and defining order, suggesting that it is very much an ongoing problem-solving process. Orton (1994:11) claims that:

mathematics is an organized body of knowledge, an abstract system of ideas, a useful tool, and a key to understanding the world, a way of thinking, a deductive system, an intellectual challenge, a language, the purest logic possible, an aesthetic experience, and a creation of the human mind.

Paul Ernest (1989, as cited by Webb & Webb, 2004:14) distinguishes between three philosophies that underlie the nature of mathematics. He presented a descriptive model that outlined the different types of knowledge, beliefs and attitudes of a mathematics teacher and how these three components relate to teachers’ models of teaching mathematics. Teacher knowledge represents
the cognitive components of this model, which are (a) mathematics; (b) other subject matter; (c) pedagogy and curriculum; (d) classroom management; (e) context of teaching; and (f) education. Teacher beliefs represent the affective component of the model and include (a) the conception of the nature of mathematics; (b) models of teaching and learning mathematics; and (c) principles of education. From the model, knowledge and beliefs are all posited to have a direct influence on teachers’ instructional practices. However, teachers’ beliefs were found to have the strongest effect on teacher’s practice.

The three philosophies will now be briefly discussed. Firstly, the instrumentalist view posits that mathematics is an accumulation of facts, rules and skills to be used in the pursuit of some external end. Secondly, the Platonist view of mathematics is of a static but unified body of certain knowledge suggesting that mathematics is discovered, not created. Thirdly, the problem-solving view regards mathematics as a dynamic, continually expanding field of human creation and invention. Figure 2.1 (below) depicts the three philosophies of mathematics as a hierarchy.

![Figure 2.1 Three philosophies of mathematics as a hierarchy](image-url)
Within this hierarchy the problem-solving view is at the highest level, and thus sees mathematics as a dynamically organized structure located in a social and cultural context. This view supports the establishment of a learner focused environment. The Platonist view is at the next level, with a global understanding of mathematics as a consistent, connected and objective structure. It supports the idea that mathematics is a static body of knowledge that is there to be discovered not created. At the lowest level of the hierarchy is the instrumentalist view involving knowledge of mathematical facts, rules and methods as separate entities. This supports a style of teacher-centred teaching in which the teacher explains and the learners follow the rules and procedures instead of constructing knowledge.

Ernest (1989) argues that mathematics teachers’ beliefs have a great influence on teaching, suggesting that their beliefs are affected by the constraints and opportunities of the social context of teaching and the level of the their thought. He further theorizes that the teacher who views the nature of mathematics as a problem-solving activity should act as a facilitator in the classroom, regard learning as an active construction of understanding, and possibly even see learning as an autonomous problem-posing and problem-solving activity.

2.3.2.2 How mathematics is learned

Knowing how and to what extent children can learn mathematics is very important; however it is not sufficient in itself as one must also know something of the psychological environment that surrounds the classroom. Baroody (1993:2) writes of the traditional view and the reflective view on children’s mathematical thinking, suggesting that traditionally children are viewed as uninformed and learning is viewed as a process of absorbing needed information. The role of children is to listen carefully and practice diligently what has been taught. The reflective view suggests that meaningful and usable knowledge is not merely absorbed but must be actively constructed. The implications for instruction are that children need to be actively engaged in problem-solving, reasoning, and communication so as to promote self-regulated learning and thinking. Experiencing failure in the early stages of mathematics instruction can severely limit future development and may result in students not even attempting to solve story problems when they encounter them in class tests or examinations. These students are likely to pay less attention
in class, which may hamper their learning severely. The beliefs students hold about mathematics is therefore an important factor in the learning process.

### 2.3.2.2.1 Mathematics learning strategies

According to Schumaker and Deshler (1984), learning strategies can be described as an individual’s approach to a task, i.e., how a student organizes and uses a set of skills to learn content or to accomplish a particular task more effectively and efficiently. When used in a problem-solving context it could refer to the use of a plan, step or conscious action toward achievement of an objective. Learning strategies can also be described as specific actions taken by the learners to make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferrable to new situations.

Korthagen and Kessels (1999, as cited by Kroll, 2004:203) explain that for many children and teachers, mathematics causes many problems, thus implying that there is a need to find productive ways of helping children acquire necessary knowledge and skills in a manner that helps them to apply what they are learning. Leiken and Levav-Waynburg (2007:369) suggest that, despite reform-oriented recommendations for solving problems in multiple ways in order to develop the students’ understanding, teachers find it difficult to teach multiple solutions to problems. Stiegler and Herbert (1999, as cited by Leiken & Levav-Waynburg, 2007:350) however found that encouraging the idea that there are multiple solutions to a problem actually enhances the quality of lessons. They further suggest that when problems are solved in different ways the construction of mathematical knowledge is supported by shifting between representations, comparing strategies, and connecting different concepts and ideas. They add that an awareness of the possibility of solving a problem in different ways helps students not to give up searching for the solution.

According to Griffin and Jitendra (2009:187), providing classroom opportunities that emphasize mathematical thinking and reasoning is critical for successful problem-solving, but that these skills are not well addressed in traditional mathematics textbooks. They argue that a powerful approach to helping students learn and retain basic mathematical concepts is through strategy instruction. The need to use learning strategies and explicit strategy instruction in the teaching and learning of mathematics is supported by Zimmerman (2000), while Griffen and Jitendra
advocate effective instructional strategies that allow learners to visually and graphically depict problem areas; the use of explicit instruction to teach mathematical concepts; and the use of peer-assisted learning activities. These have been identified as factors that develop a variety of strategies for improving learner progress in mathematics.

Polya (as cited by Griffen & Jitenda, 2009:188) writes that there are many ways to solve problems and that students should learn how to choose appropriate strategies, such as working backwards, using a formula, and looking for a pattern. Leiken and Waynberg (2007:349) however suggest that mathematics teachers are reluctant to solve problems in different ways in the classroom and find it difficult to teach multiple solutions to problems. According to Montague (1998), students with mathematical disabilities often do not use learning strategies naturally, rather switching from strategy to strategy because they are unable to use them effectively. Within a mathematics context there are various types of cognitive learning strategies available, ranging from simple to complex, such as the use of mnemonics, understanding that two times any whole number will be even, or that five times any whole number will end in a zero or a 5. The use of manipulatives, i.e., sight, touch, and hearing, is also an excellent way of encouraging students to develop self-verbalizing learning strategies, especially since it encourages them to talk their way through each problem, either with peers or to themselves. The use of manipulatives further encourages more abstract thinking. Modelling learning strategies to students is also an effective way that can be used by teachers to increase their thinking processes and should be part of every lesson. Witrock (1986) and Weinstein and Mayer describe learning strategies as “behaviours and thoughts that a learner engages in during learning and that are intended to influence the learner’s encoding process”

Nisbet and Shuchsmith (1986) define learning strategies as “the processes that underlie performance on thinking tasks.” They elaborate further on this theory by explaining that “strategies are more than simple sequences or agglomerations of skills; they go beyond the strings or routines advocated in some study manuals. According to Nisbet and Schuchsmith learning strategies are almost always purposeful and goal- oriented, but they are perhaps not always carried out at a conscious or deliberate level. They can be lengthy or so rapid in execution that it is impossible to recapture, recall, or even be aware that one has used a strategy”.

Masters, Mori, and Mori (1993) refer to ‘learning strategies’ as cognitive strategies that encapsulate techniques, principles, or rules that will facilitate the acquisition, manipulation,
integration, storage, and retrieval of information across situations and settings. Alley & Deshler as cited by Masters, Mori, and Mori further expand on this theory by stating that cognitive strategies are a fundamental part of the process of acquiring knowledge as well as the skills of reading, writing, speaking, listening, note taking, questioning, vocabulary acquisition, time management, reasoning, problem-solving, and memorization.

### 2.3.2.2.2 Mathematics problem-solving

A word problem or sum is a verbal description of a problem situation wherein one or more questions are posed, the answers to which can be obtained by the application of mathematical operations to information available in the text. In its most typical form, word problem describes the essentials of a situation assumed to be familiar to the solver. Within the text, certain quantities are explicitly given while others are not. The student is required to give a numerical answer to a stated question by making exclusive use of the quantities given, and of the mathematical relationships between these quantities.

The terms ‘problem’ and ‘problem-solving’ occur in many disciplines but are perhaps more closely related to mathematics than any other. Many kinds of mathematical problems exist, and the type of problem-solving strategy used depends on the skills of the person solving the problem. In mathematics education, problem-solving has been examined since Polya’s work in the 1940s. Polya, often considered “the father of problem-solving”, describes it as:

> Solving a problem is finding the unknown means to a distinctly conceived end… to find a way where no way is known off-hand. For a question to be a problem, it must present a challenge that cannot be resolved by some routine procedure. Problem-solving is a process of accepting a challenge and striving to resolve it.

Polya offers a model for problem-solving (Fig.2.2. below), in which suggests the learners must be encouraged to recall and use information and strategies previously taught. They must learn (through instruction and practice) to construct and implement new strategies. Commonly taught strategies include working backwards; trying a simpler but similar problem; diagramming the
situation; and looking for patterns. These and other strategies can help students develop a positive attitude toward problem-solving (Dossey et al., 2002).

![Polya's problem-solving framework](image)

**Figure 2.2 Polya's problem-solving framework.**

Killen (2000:128) refers to problem-solving as a process of applying one’s old knowledge to situations that are new in order to learn new knowledge through this process. The process of problem-solving thus involves using prior knowledge in new or different ways. Problem-solving includes investigation, but in some cases one will apply certain strategies to search for a specific solution which does not involve an investigation. Problem-solving therefore builds new mathematical knowledge. In Cagne’s view of learning, problem-solving is the highest level at which people can function. In its broadest sense, it occurs when children employ principles to achieve a goal and should be the central focus of the mathematics curriculum since all branches of mathematics involve it. As such, it should form the primary goal of all mathematics instruction and an integral part of all mathematical study throughout the learners’ schooling career. Current research suggests that a problem-solving approach to teaching and learning mathematics helps students develop both conceptual understanding and skill proficiency (Lester, 1994).

Most of the problems children attempt to solve are called word problems, verbal problems, or story problems, whereby the situation is conveyed to the child in written form. A word problem or sum is a thus a verbal description of a problem situation wherein one or more questions are posed, the answers to which can be obtained by the application of mathematical operations to information available in the text. All word problems are centred on a unique theme. Solving a word problem is about determining what the problem is asking as much as it is about determining
and solving the equation hidden in the words. Within each word problem is an equation. In its most typical form word-problem describes the essentials of some situation assumed to be familiar to the solver. Within the text certain quantities are explicitly given, while others are not. The student is required to give a numerical answer to a stated question by making exclusive use of the quantities given, and of the mathematical relationships between these quantities.

Thus in summary, mathematics is described as being more than just about counting and adding totals. Mathematics must be applied suggesting that it must be of use to the learner in his/her everyday life especially since problem-solving is central to understanding the real world. The next section will look at the role of teacher knowledge and beliefs in the mathematics learning process.

2.3.3 Teachers’ knowledge and beliefs of mathematics learning

2.3.3.1 Teachers’ mathematical knowledge

Cognitive theory suggests that all mathematical knowledge is a socially agreed upon interpretation or mental invention (Baroody, 1987:14-15), and posits that mathematical knowledge is not simply a storehouse of facts and skills that can be readily imposed upon a passive learner. Ball et al. (2008:395) describe mathematical knowledge for teaching as that needed to carry out the work of teaching mathematics. The emphasis is thus with the tasks involved in teaching and answering students’ questions and checking their work. These tasks demands an understanding of the school curriculum, however, according to Kilpatrick, Swafford and Findell, (2001, as cited by Ball et al., 2008:395), it mostly involves knowledge of mathematical ideas, skills of mathematical reasoning, fluency with examples and terms, and thoughtfulness about the nature of mathematical proficiency. Hill et al. (2004, as cited by Ball, 2008:396) write that the mathematical knowledge needed for teaching is multidimensional and that general mathematical ability does not fully account for the knowledge and skills entailed in teaching. This statement supports the earlier view of Shulman (1986), suggesting that teachers might need to know how to analyze and remedy student errors and be able to explain or represent particular ideas and procedures.

Silver et al. (2005, as cited by Leiken & Levav-Waynberg, 2007:351) speculate that limitations in the teachers’ mathematical knowledge may obstruct use of multiple solutions in the classroom.
This hypothesis is consistent with the cyclic models of teaching (Simon 1997; Steinbring 1998) that demonstrate the importance of teacher knowledge for creating a teaching-learning process in the classroom. According to both Simon (1997) and Steinbring (1998, as cited by Leiken & Levav-Waynberg, 2007:351), teachers’ knowledge of subject matter and of their students determines the mathematical tasks they assign to the students, the learning setting, the teachers’ perception of the learning process, and their ability to learn from interactions with students and to adjust initial plans to reality.

Ball et al. (2008:396) conclude their analysis by suggesting that mathematical knowledge needed for teaching is not less than that needed by other adults, and that ultimately a teacher needs to know more and different mathematics and not less. According to Hill and Lubiensky (2007:753), researchers in mathematics education began in recent years to pay close attention to the special ways mathematics is used in teaching. According to Ball et al. (2005, as cited by Leikin & Levav-Waynberg, 2007:352), research in mathematics education has shown that deep and connected teacher knowledge of content is a necessary condition for teaching that develops mathematical connections in student’s minds. Researchers in mathematics have also included a third category within subject matter knowledge, referred to as ‘horizon knowledge’ (Ball et al., 2008:403).

2.3.3.2 Teachers’ mathematical beliefs

Teacher beliefs vary and there is a strong reason to believe that in mathematics their conceptions (beliefs, views, and performances) about the subject matter and its teaching play an important role in their effectiveness as the primary mediators between the subject and the learners (Thompson, 1984). Researchers tend to classify teachers’ mathematical beliefs into those concerning the nature of mathematic, mathematics teaching, and beliefs about student learning (Cross, 2009:329). Similarly, Thompson (1992) has maintained that teachers differ a great deal in their beliefs about both the nature of mathematics and how they view the teaching and learning of it. Ultimately, these beliefs reflect on the teacher’s role and choice of activity within the classroom situation, as well as the manner in which the activities will be presented to the learners. These beliefs are therefore integral to any efforts to improving student learning. Thompson (1992, as cited by Webb & Webb, 2004:13) concur that teachers differ a great deal in their beliefs about both the nature of mathematics and how they view the teaching and learning of it, while
Grootenboer, (2009:361) writes that teacher beliefs vary, as they hold contradictory beliefs in different contexts.

Assing (1988, as cited by Turner et al., 2009:362) argues that teachers hold ‘common sense’ notions or theories about children’s learning. The ‘common sense’ notions focus on the importance of active involvement in the classroom, which reflects their longstanding attitudes and their experiences in education rather than research-based knowledge about learning. She highlights a few types of beliefs that teachers experience: firstly, they believe that learners have a need to learn in a secure environment, that is a positive learning environment that may not necessarily involve beliefs about what is effective learning. Secondly, some teachers believe that what is taught should be learned (Nuthall, 2004). Thirdly, some teachers have a ‘hands on’ rather than a ‘minds on’ approach to assigning activities to learners. Such teacher beliefs are focused on enjoying the mathematics and not on demonstrating an understanding.

Researchers agree that teachers’ mathematical beliefs are not conducive to quality mathematics education, and it is evident that teachers’ mathematical beliefs are influenced by their own beliefs about teaching and learning mathematics. As Turner writes, “Sadly our system of Education is largely built upon beliefs and practices on the negative side resulting in our teaching methods minimizing effort, and failing to overcome gaps in learning, and limits what can be learnt”.

In summary, mathematical knowledge is described as the measure needed to carry out the teaching of mathematics. Mathematical knowledge can represent a good understanding of the curriculum needed at a specific level for a specific grade however it can also refer to mathematical skills that must be acquired, ideas around mathematical concepts etc. The literature further suggests that a lack of mathematical knowledge can obstruct mathematics teaching. The literature further indicates that mathematical beliefs vary from person to person and is usually determined by a person’s own learning experiences of mathematics. How the mathematics was modelled has an effect on the individual person’s beliefs of mathematics.
2.4 CONCLUSION

In this chapter I have developed the theoretical framework that underpins this study. Among the key issue raised in this chapter were teacher knowledge and teacher beliefs, which have become prominent in influencing teacher training. I have attempted to highlight that most researchers describe knowledge as evidential, dynamic, emotionally-neutral, internally structured, and developing with age and experience. Teacher knowledge has also been referred to as the link between teaching and learning, and involves the teachers’ planned classroom interactions, student learning, and attitudes and beliefs of the students they teach. The research further revealed that Shulman (1986) refocused the attention of researchers onto the importance of teachers’ subject matter understandings. Initially the areas of expertise used to describe teacher knowledge were subject matter knowledge, pedagogical knowledge and curricular knowledge. Shulman expanded on teacher knowledge by adding the new sub-category Pedagogical Content Knowledge (PCK). The various studies on teacher knowledge suggest that differences in a teacher’s disciplinary knowledge, background knowledge, experiences, and orientations have a significant impact on how he or she organises instruction and represents the substance of the curriculum to students.

Beliefs have both affective and evaluative functions, acting as information filters and impacting on how knowledge is used, organized and retrieved. The thinking around beliefs is that it is personal and has an influence on how teachers approach their work. Some researchers propose that teacher beliefs are formed on the basis of their own schooling experiences. Throughout the literature, the profound impact from teachers on classroom life has been highlighted.

In view of the discussion above, it is difficult to distinguish between teacher knowledge and teacher beliefs. As Petersen, Fennema and Carpenter (1991) note:

We were struck both by the influences of teachers’ knowledge on their thinking about instruction, learning, and assessment, as well as by the pervasive influence of teachers’ beliefs about students’ knowledge; by the way in which teachers’ thinking was influenced both by their beliefs and by their knowledge; and by the interconnections that seem to
exist between knowledge and beliefs in teachers’ minds (They follow with the question, “Where does knowledge end and belief begin?”

There is much debate around teacher beliefs and teacher knowledge, with one view, held by Pajares (1992) that beliefs and knowledge are concepts that interweave along a spectrum of meaning. In this view, beliefs are often thought of as being a type of knowledge, and knowledge as a component of beliefs. This leaves me with the understanding that mathematics teachers’ knowledge and beliefs might have an immeasurable impact on all aspects of educators’ teaching, as well as on how and what their learners learn.
CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter presents a background to the research process followed so as to orientate the reader to how the research was conducted. The research paradigm that had an influence on this research inquiry will be briefly described and thereafter the research design will be discussed. Next, the method of research and means of gathering data will be outlined, followed by a description of how I analysed the data. Finally, the way that precision was built into the design and the ethical considerations will be explained.

3.2 RESEARCH PARADIGM

The research paradigm, according to Merriam (2002), is suggestive of the orientation or standpoint that the researcher employs in the study. The paradigm therefore defines and guides the content and end result of research. As discussed in Chapter One, the research paradigm and design of this study fall within the interpretive and social constructivist paradigm, which assumes that people are in pursuit of understanding the world in which they live and work by developing personal meaning of their experiences. I therefore support the view that all human action is meaningful and has to be interpreted and understood in the context of social practice, and based my research on the belief that I can gain a deeper understanding of the teaching of word problem-solving in a Grade 7 class. As Giordano and Weir (2002) argue, mathematics learning takes place as teachers and learners jointly search for meaning in the situations they encounter.

For the purpose of this research study I decided to use a qualitative research approach, within which personal experiences are explored. Qualitative research is explained by Macmillan and Schumacher (1993:372) as naturalistic inquiry, the use of non-interfering data collection strategies to discover the natural flow of events and processes and how participants interpret
them. They add that most qualitative research describes and analyses people’s individual and collective social actions, beliefs, thoughts and perceptions. Henning et al. (2004:5) explain that qualitative research examines the qualities, characteristics or properties of a phenomenon for better understanding and explanation, while Merriam (1989:6) concurs with Macmillan and Schumacher that it is an interpretive and naturalistic research method that is most effective for the gathering of information for the purpose of improving the practice of education. Mertens (2010:225) describes qualitative research as a situated activity that locates the observer in the world, suggesting that the study is carried out in natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them. In a qualitative study the process of making meaning is emergent, and as Willis (2007:202) maintains, qualitative research is an approach to understanding human and social behaviour that emphasizes the collection of ‘thick’ data, that is data collected from various research sources such as observations, interviews and tests. For Merriam (1998:6), essential characteristics of qualitative research cut across all forms of qualitative research, some of which related to this inquiry are as follows:

The key philosophical assumption upon which all types of qualitative research is based is the view that “reality is constructed by individuals interacting with their social worlds “Merriam, 1998:6). Gaining an understanding of the phenomenon being researched from the participant’s ‘insider’ perspective is essential, in what Merriam refers to as the ‘emic’ view. Neuman (1994:324) explains that in qualitative research, data is interpreted by giving it meaning, translating it or making it understandable, however, the meaning is given from the point of view of the participants. For this reason I collected data directly from the participants, who in the case of this inquiry were the learners and their teacher. This was done by gaining information from them through an individual semi-structured interview with the teacher and a focus group interview with a group of six learners.

A second characteristic Merriam (2002) highlights is that the researcher is the primary instrument for data collection and analysis. Henning et al. (2004:7) concurs with Merriam that the researcher is unequivocally the main instrument of research in making meaning from involvement in the project. In this research I personally interviewed the educator and conducted the focus group interview. I also made the classroom observation myself, which assisted me in making the transcriptions of the interviews and the lesson presentation. Observing the lesson presentation first-hand assisted me in writing copious notes during the classroom observation.
A third characteristic is that the research involves fieldwork, which demands that the researcher physically go to the people, setting, site, and/or institution (the field) in order to observe the behaviour in its natural setting. In this study, as stated above, I visited the school on several occasions, initially to introduce myself to the principal and the mathematics teacher. I further visited the school to conduct the interview, focus group study and make the classroom observations.

The fourth characteristic is that qualitative research employs an inductive research strategy. I therefore undertook to build towards theory from observations and intuitive understandings gained in the field. Theory develops during the data collection process, and this inductive method means that theory is built from data or grounded in the data (Neuman, 1994:322).

The fifth characteristic is that the product of a qualitative study is richly descriptive. Words and pictures rather than numbers are used to convey what the researcher has learned about a phenomenon. In this study an individual semi-structured interview with the teacher and a learner focus group interview were conducted. A lesson was observed, while a learning task, audio and video recordings, and an adapted self-reflection tool that was completed by the learners assisted me in this aspect of qualitative research.

Having drawn a brief review of the paradigm of this study, I now discuss the research design used in this inquiry in greater detail.

3.3 RESEARCH DESIGN

Mouton (2005:55) describes the research design as a plan or blueprint of how the researcher intends to conduct the research. The research design thus outlines the research methodology by specifying how the researcher intends to conduct the fieldwork and gives a description of the data collection process, methods and procedures used. A qualitative case study research design was chosen, since the aim of this study was “employed to gain an in-depth understanding of a situation and meaning for those involved” (Merriam, 1998:19). In a case study design, the interest is in process rather than outcomes, in context rather than a specific variable, and in discovery rather than confirmation (Merriam, 1998:19). Henning et al. (2004:2) agree with the above, adding that compared to quantitative studies, which focus on control of all the components or variables in the actions and representations of the participants, case study design usually aim
for depth and breadth, rather than quantity of understanding. Case studies often rely on the use of several data sources, as I have done, using an individual semi-structured interview, focus group interview, observations an adapted self-reflective tool as well as an individual task carried out by the learners. The methods used within this context are therefore strongly associated with a qualitative approach.

According to Giordana and Weir (2002), much of the information on learner problem-solving competence comes from large-scale assessments or interviews with individual learners, hence my decision to use a case study design. In the research conducted, my aim was to explore how the Grade 7 learners approach word problem sums whilst working in groups and whilst doing an individual word problem sum. The ultimate goal was to further formulate significant knowledge that could be useful to the teacher when teaching word problem-solving skills and strategies to her learners in the future.

This qualitative case study design thus correlated well with the interpretive and constructivist theoretical framework in which this research was conducted.

**Sampling**

In qualitative research, samples tend to be relatively small because of the depth of information sought from each individual. Rubin and Babbie (1989:233) state that the chief criterion of a sample is the degree to which it is representative, and the extent to which the characteristics of a sample are the same as those of the population from which it was selected. The type of sampling used in the study is known as ‘purposive’, used to ensure that the sample selected had adequate information and knowledge. For this study I further decided to engage a Grade 7 mathematics teacher with her 40 learners from a school in Gauteng. The participants were Grade 7 learners from a government school in Johannesburg where the language of learning and teaching (LOLT) is English. The approximate ages of the learners varied from 12 years 6 months to 13 years 10 months. Ideally, participants should include both male and female learners, which in this study was the case as the school was co-educational and multi-racial, and typically represented the cultural and economic diversity of an urban school in a South African context.
The educator and all the students in her class agreed to participate in the study (see Addendum A). The educator, Mrs J. Botha (pseudonym) was a white female and the majority of the learners were of mixed racial and cultural groups. Mrs Botha (pseudonym) had started teaching in 1981 however she only taught mathematics since 1990. In total, she has over 20 years of mathematics teaching experience.

3.4 RESEARCH METHODS
As discussed before, I chose to use a qualitative case study research design, which allows for the use of multiple research methods or data collection procedures. In this section the research methods used in this study will be discussed.

3.4.1 Data collection methods
Data in qualitative research captures the core elements of the phenomenon, person, object or situation, providing elaborate accounts of people’s behaviour, thoughts, feelings, opinions, experiences, knowledge and activities (Merriam, 1998:69). Many authors advocate the use of multiple methods of data collection as this enhances the trustworthiness of the data.
Table 3.1. A classification of data sources

<table>
<thead>
<tr>
<th>DATA COLLECTION METHOD</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-structured interview</td>
<td>Transcription</td>
</tr>
<tr>
<td>Focus group interview</td>
<td>Transcription</td>
</tr>
<tr>
<td>Documents</td>
<td>Lesson preparation</td>
</tr>
<tr>
<td></td>
<td>Learner’s work</td>
</tr>
<tr>
<td></td>
<td>Adapted learner’s self-reflection tool</td>
</tr>
<tr>
<td>Observation</td>
<td>Field Notes</td>
</tr>
<tr>
<td>Visual representation</td>
<td>Transcription</td>
</tr>
</tbody>
</table>

As indicated in Table 3.1 (above), the methods of data collection used in this study were an individual semi-structured interview; a focus group discussion, an adapted self-reflective tool completed by the learners; samples of a learner activity and participant observation with supporting field-notes; as well as a task completed by the learners. I utilized multiple sources of information because as researcher I wished to pursue some form of methodological triangulation to corroborate and “substantiate the findings” (Merriam, 1998:96).

Through the process of data collection the interviews were transcribed, field notes revised and then typed from the handwritten notes and the documents were reviewed. The raw data was then stored in a file to facilitate the process of sorting it according to the research questions.

3.4.1.1 Interviews

Swartz et al. (2008:28) describe interviewing as a situation in which the researcher asks questions, listens and analyses the responses. Interviews have been defined as a conversation with a purpose (Merriam, 1998:71), typically characterized by person to person encounters, in which one person elicits information from the other (Merriam, 1998:71). Interviews are a very powerful tool and those that have been designed correctly should allow full exploration of the
subject at hand, including follow-up questions (Salkind, 2003:211). The purpose of interviews is to find out what is in and on a person’s mind in order to elicit their other subjective realities and perspectives (Henning et al., 2004:52). According to Salkind (2003:190), interviews offer great flexibility by allowing the researcher to explore any direction within the scope of the study.

### 3.4.1.1 The Semi-structured Interview

A semi-structured interview is a flexible data collection instrument, as it allows the researcher and participant to engage in dialogue. It allows the researcher to respond to the situation as it unfolds, to investigate the worldview emerging from questions and highlight new ideas on the phenomenon of study (Merriam, 1998:74). Semi-structured interviews also tend to provide more valid data as opportunities for reflection, probing and clarifying ambiguity (Churton, 2000).

For the purpose of this study, a semi-structured interview was conducted with the Grade 7 mathematics educator. The educator was expected to answer a set of predetermined questions (see Addendum B), however, even though I had a definite direction that I wished the interviews to follow I did not want the educator to feel interrogated or placed on the spot. The interview structure was therefore sufficiently flexible to allow me to respond to whatever ideas the participant raised at any given time (Merriam, 1998:75).

The reason I used a semi-structured interview when interviewing the teacher was to encourage her to speak freely about her own experiences regarding the teaching of word problem sums and mathematics teaching in general. My aim was to explore further whether she was aware of any difficulties the learners might have experienced when doing word problems and whether she was aware of any learning strategies that they might have been using when tackling word problems.

The interview was planned to last for approximately 45 minutes and was conducted in English. For the purposes of this study I gained permission from the educator to audio-record the interview as this tool captured verbal and non-verbal behaviour and would assist me in analysing the interview in a meticulous manner. The interview was then transcribed verbatim to provide me with a record of the naturally occurring interaction. I also took notes during the interview to assist me in reviewing the educator’s answers and to help set down additional questions for the end of the interview.
3.4.1.2 Focus Group Interview

A focus group interview could be described as a purposive discussion of a specific topic or related topics taking place between similar background and common interest. Salkind (2003:210) described a focus group as an interview of a group of respondents by the researcher. A focus group interview aims to explore concerns relating to a topic by obtaining information from respondents or by observations made. Salkind (2003:210) states that the setting in the focus group should provide an encouraging environment that will promote frank and open communication amongst members. One of the main functions it is to encourage group interaction and allow the participants to talk through their thought processes so that their motivations can be determined. The interactions bring various viewpoints together in a way that individual interviews do not. Swartz et al. (2008:29) support this thought by indicating that an advantage of a focus group is that it offers a researcher the opportunity to gather information from a situation in which participants are interacting with one another. They further suggest that interactive settings may offer a wider perspective on the topic under discussion. According to Jan Nieuwenhuis (as cited in Maree, 2009:90), the distinguishing features of a focus group are that the discussion is focused on a particular topic, that debate and even conflict are encouraged, and that group dynamics assist in data generation.

A focus group interview with six of the learners was favoured for this study above conducting interviews on an individual basis. The main reason for deciding on this method was based on time constraints experienced by myself. A further reason for using a focus group interview was determined by the research question addressing the learners’ experiences, beliefs and understanding of solving word problems. I would also be able to explore their help-seeking tendencies and determine whether they were aware of any learning strategies that they used when tackling word problems. It further aided me in conserving time as the respondents were interviewed at the same time.

I managed the focus group interview by asking questions so as to give each learner a chance to speak and at the same time ensured that everyone participated. The focus group lasted for approximately an hour and all participants had an opportunity to express their views. Focus group discussion questions appear in (Addendum B). For the purpose of my inquiry, the focus group interview was tape-recorded and transcribed, a method, which ensures that whatever is said is
preserved for analysis. My observations, field notes and personal reflections made before and after the interviews were also used.

3.4.1.2 Observations

According to Swartz et al. (2008:28), observations involve a researcher observing people without interacting with them, while for Jan Nieuwenhuis (in Maree, 2009:82) it is the systemic process of recording the behavioural patterns of participants, objects and occurrences without necessarily questioning or communicating with them. He further explains that during this process the researcher uses not only the senses (sight, hearing, touch, smell, taste), but also intuition to gather bits of data. Data obtained from observations represents firsthand encounters with the particular phenomenon under study, such as human behaviour and events as they would naturally occur in their routine settings (Merriam, 1998:94). The reason for using observations rests in the desire to notice those aspects that are routine for the participants, so that windows can be created for better understanding the context of this study. Observations are further utilized to triangulate findings between what was observed, what was said in the interviews and what was documented (Merriam, 998:96).

For this study, documenting the observations during the interviews and the lesson presentation will be important as the details pertaining to the teacher and learners’ behaviour, actions and comments and body language would assist me in better clarifying and understanding the participant better. Direct observation was included as a research tool, because I wanted to gather data from the natural setting, i.e., the classroom. Merriam (1998:94) stipulates that “observations are deliberately planned, systematically recorded and subject to checks and control validity and reliability”. My reason for entering the classroom was to observe the behavioural and emotional responses of the teacher and her learners within the context. This would enable me to develop a deeper understanding of what was happening in the classroom (Patton, 2002). Observations, according to Willis (2007:233), are at the core of what qualitative research is, and therefore require that the researcher become involved in the analysis and interpretation of the data.
My observations were loosely guided by Merriam’s (1998:94) five elements of observation:

1. **The physical setting:** The physical environment, in this case is the classroom setting.

2. **The participants:** A description of the educator and the learners in the classroom is given.

3. **Activities and interactions:** The activities happening within the classroom are described with special reference to how the participants were connected or interrelated.

4. **Conversation:** The content of the conversations in the classroom setting is described, such as who speaks to whom and who listens.

5. **Subtle factors:** These are the activities that are less obvious but perhaps as important to the observations.

My initial observation (element 1) was focused on the classroom physical setting. My second observation (element 2) was directed at the participants. During my observation of activities and interactions (element 3) I noted how the lesson was presented, what resource material was used, how the learners responded and the learners’ involvement during the practical activities. My next observation (element 4) was to determine who spoke to whom and who listened. The last observation (element 5) describes subtle factors such as the interactions between learners during the lesson presentation and during the group work and individual activity.

### Table 3.2 Excerpt of the field notes made during my visit to the classroom

<table>
<thead>
<tr>
<th>Classroom Visit</th>
<th>Observation of lesson presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element 1:</strong></td>
<td>- There are 20 desks and 40 chairs in the classroom</td>
</tr>
<tr>
<td></td>
<td>- The classroom setting is based on group work – desk are placed in groups accommodating 6 learners</td>
</tr>
<tr>
<td></td>
<td>- Pictures and charts reflect that this is a classroom where mathematics is being taught</td>
</tr>
</tbody>
</table>
| Element 2: | - Educator makes use of an overhead projector to present the lesson  
- There are 40 learners in the classroom  
- There are 9 groups in the class – 6 groups consist of 6 learners and 1 group consists of 4 learners  
- Pictures and charts reflect that this is a classroom where mathematics is being taught |
| --- | --- |
| Element 3: | - The educator explains the work to the learners whilst they listen attentive  
- Time is allocated for questions  
- Learners are allowed to complete the first activity as a group  
- Learners must complete the next activity on their own – each group member has been given their own word sum to complete  
- Working out paper is supplied |
| Element 4: | - The learners are allowed to speak in their groups  
- Learners are encouraged to ask for assistance |
| Element 5: | - The group of 4 learners is placed closes to the teacher and according to the teacher they are the weakest group  
- The other groups are formed according to mixed abilities |

### 3.4.1.3 Visual representations in collecting data

Qualitative researchers record their research as a way of creating unobserved and unexamined perceptions. The use of video recordings creates another tool for data collection (Flick et al.,
2005:236), and assist the researcher in integrating what is observed with the theory of the research (Flick et al., 2005:235). They provide a glimpse of reality captured in that moment and give access to interpretations that cannot be reproduced. In this research study, audio-recording of the data were taken during the semi-structured interview and the focus group discussion. Observations during the lesson presentation were video-recorded and the researcher looked at the tapes when answering the particular research questions.

3.4.1.4 Documents

Documents may be in any text form and may include written activities completed by the learners, lesson preparations by the educator and educator notes. According to Yin (1994), documents are a valuable source for supporting findings made through other research methods such as interviews and direct observation.

For this study I have identified the teacher’s lesson preparation, the learners’ adapted reflection tool and the learners’ individual word sum task as documents for use in this study. The educator provided me with succinct notes of the lesson preparation, copies of the opening word sum and the individual activities that needed to be completed by the learners as well as the homework activity that the whole class had to complete.

These documents provided me with insight into understanding the teaching style and knowledge and beliefs of the educator as she taught her Grade 7 class.

3.4.2 Data analysis

To analyze means to break into bits and pieces or to break down data. Henning et al. (2004) describe data analysis as taking apart words, sentences and paragraphs in order to make sense, interpret and theorise the data. There are various methods of analyzing qualitative data, with the purpose of making meaning of the phenomenon under study. Bassey (1999:84) regards the process of data analysis as an “intellectual struggle” with the raw data collected. Data collection and data analysis, according to Merriam (1998:178), are simultaneous activities in qualitative research, as emerging insights in one phase of the data collection lead to refinement or
reformulation in the next phase. The aim of data analysis is to find significant and valid answers to the research question.

Data analysis in this study was conducted in terms of the constant comparative method, chosen because of its relevance to the type of research undertaken (qualitative survey), and also because of the data collection methods that were used.

### 3.4.2.1 The constant comparison method of analysis

The constant comparative method is described by DuPoy and Gitlin (1994) as one in which data is constantly compared and contrasted with successive segments of data, to determine similarities and differences and subsequently to categorize them. All new data is compared to the existing categories to determine similarities between new and previously obtained information. Data that fits the existing categories is classified accordingly, but new categories are developed in cases where it does not readily fit. Maykut and Morehouse’s (1994:126) coherent step-by-step description of the constant comparative method of analysis based on Glaser and Strauss’ (1967) work was chosen for this study since they have incorporated the work of other authors to refine this method for rigorous analysis. According to Dana and Yendol-Silva (2003:92), analyzing data involves the following four-step process, which the researcher followed:

- **Step 1**: The entire data set is read and reread in order to get a ‘descriptive sense’ of what has been collected.

- **Step 2**: Thereafter ‘sense making’ begins, with the researcher beginning to notice which data stands out and which different pieces of data fit together.

- **Step 3**: Interpretation of the data.

- **Step 4**: Analysis of the data.

I chose this method of analysis as it involved searching across data to find repeated patterns of meaning, a method that further assisted in writing up my findings, as related in Chapter 4.
When analyzing the data from the semi-structured interview, focus group discussion and the adapted learner reflection tool conducted, I charted the following data analysis protocol: I made a conscious effort to ignore all the pre-conceived ideas about the study when analysing the data for the highest form of reliability. In this research inquiry basic raw data was processed by transcribing (word for word as far as possible) from the audiotapes the interviews and typing up the rough field notes (Miles & Huberman, 1994). During preparation of the analysis process, each page of transcriptions and field notes was coded in the upper right-hand corner to ensure a simple way of quickly identifying the various sources. The codes were developed according to the guidelines of Maykut and Morehouse (1994).

Figure 3.1 (below) provides an example illustrating this coding procedure.

<table>
<thead>
<tr>
<th>Example of coding procedure: 1/2–3</th>
<th>Example of codes for transcripts:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. = Type of data</td>
<td>I/E – 3 = Interview/ Educator/ Page 3</td>
</tr>
<tr>
<td>(Interview transcript/ observation/learners work/reflective note/focus group)</td>
<td></td>
</tr>
<tr>
<td>2. = Source of data (Participants /Initials)</td>
<td>Example of codes for field notes:</td>
</tr>
<tr>
<td>3. = Page Number</td>
<td>F/O/I-4=Field notes/Observations/Interview/ Page 4</td>
</tr>
</tbody>
</table>
Other codes used:

<table>
<thead>
<tr>
<th>Type of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>T = Transcripts from lesson presentation</td>
</tr>
<tr>
<td>O = Observation</td>
</tr>
<tr>
<td>D = Documents</td>
</tr>
<tr>
<td>ART = Adapted Reflective Tool</td>
</tr>
<tr>
<td>LP = Lesson Presentation</td>
</tr>
<tr>
<td>LW = Learners Work</td>
</tr>
<tr>
<td>I = Interview</td>
</tr>
<tr>
<td>F = Field notes</td>
</tr>
<tr>
<td>W = Word</td>
</tr>
</tbody>
</table>

**Figure 3.1 Coding data**

After reading and reviewing the “raw data”, line-by-line, I aimed to underline the important words and phrases in order to search broadly for important themes and categories. This process of reading and re-reading the data helped familiarise me with the content, followed by searching...
across the data to find repeated patterns of meaning. Following this first reading the transcripts were re-read and units of meaning allocated as I made up tentative codes. Next, I manually provided codes in order to organise my data into meaningful groups. In this process the data was broken into its constituent parts in order to isolate distinctive features and structures (Henning et al., 2004). Common themes were identified and re-reading the transcriptions refreshed my memory regarding what was said during the interviews, and as a completed piece of information it helped me gain a holistic overview of the interview (a sample of the transcripts appears in Addendum C). I then noted how the codes related to each other and categorized them accordingly. Instead of calling the final groups ‘categories’, I arranged the code families or categories described into emerging themes (Merriam, 2002). This was done through an inductive process, whereby the data is used as a guide to deciding what the various categories should be called (Henning et al., 2004:105). Each category and code was then be given different category names, based on themes, concepts or common features, thereby providing labels of units of meaning. Next, themes bearing the research questions in mind were identified.

After the completion of coding and categorizing, my next task was to see how the data provided answers to the research questions. I wished to illustrate the relationships between the meanings of the various categories and themes, what they said together or about each other. The aim was to find out how all these answers contributed toward addressing the research question and how the categories and themes could be linked to expand upon the existing knowledge of the topic.

3.5 BUILDING PRECISION INTO THE DESIGN

In this section, I describe methods to ensure trustworthiness and validity of the data. It is necessary to describe how trustworthiness and validity were maintained throughout the collection and analysis of data.

3.5.1 Establishing trustworthiness

All research should be conducted to produce valid and reliable knowledge in an ethical manner (Merriam, 1998). According to Merriam (1998:198-199), the degree to which research results are considered trustworthy depends on the extent to which an investigation is conducted in an ethical
manner, in addition to how issues of reliability and validity have been addressed according to qualitative interpretations and implications. Guba and Lincoln’s, (1994) trustworthiness model as described by Bryman (2001:272) and Pillay (1996:31) was used to establish the validity and reliability of the qualitative research, the criteria being:

- Credibility, which parallels internal validity
- Transferability, which parallels external validity
- Dependability, which parallels reliability
- Conformability which parallels objectivity.

3.5.1.1 Credibility

Credibility has to do with something that is believable and has truth. According to Wiseman (1999:33), it is contrary to worthy use of time to conduct research that, when completed, lacks credibility. He further suggests that the research problem must have conceptual soundness and be capable of being investigated.

To further ensure credibility, I made sure that the research methodologies, i.e., the data collection and analyzing strategies, as discussed in the research methodology section, were appropriate for the topic being investigated. Throughout the research process, an attempt was made to ensure that the findings were comprehensive, holistic, expansive, and richly descriptive (Merriam, 1998:9). To further ensure credibility of this study, transcripts were made from audiotaped interviews. I further kept notes of “off the record” conversations, held with participants however I ensured that the evidence collected was first hand from the participants, and not hearsay. Credibility was increased further by ensuring that inconsistent data was checked and examined carefully however the idea was not to illuminate any inconsistencies or exceptions, but to understand the reason for them occurring (Paton, 2002:554). To further convince the reader of the credibility of the findings, I quoted generously directly from the transcripts so that the participant’s voices could be clearly heard in context (Rubin & Rubin, 1995:90-92)
3.5.1.2 **Transferability**

Guba and Lincoln (1989, as cited in Martens, 2010:259) suggest that readers of the research should be able to make judgments based on similarities and differences when comparing the research situation to their own.

To obtain transferability, I provided detailed descriptions of methods used in the data collection and analysis process, to allow for comparison by other researchers so that similar studies could be conducted. I attempted to ensure that data was supported by sufficient evidence and theory (Henning et al, 2004). To ensure transferability, a Grade 7 Mathematics teacher and her learners were chosen as participants. Thus if transferability of the study were to be tested, it would have to be conducted with the same learners and teacher, from the same school.

3.5.1.3 **Dependability**

In the constructivist paradigm, change is expected, but it should be tracked and publicly capable of being inspected. Guba (as cited by Mertens, 2010), states that dependability can be established if the sources of variability can be identified. I aimed to obtain dependability by ensuring that changes that occurred during the research process were documented in my field notes. I further provided a detailed description of the research methods and data analysis used in the study so that a step-by-step replication of the study could be conducted by another researcher. Dependability was further enhanced through triangulation to ensure that the weaknesses of one data-collection method are compensated by the use of other data-gathering methods.
3.5.1.4 **Confirmability**

Confirmability means that the data and interpretation are not figments of the researchers’ imagination (Mertens, 2010:260). Guba and Lincoln (as cited in Mertens, 2010) recommend a confirmability audit to attest that the data can be traced to original sources and that the process of synthesizing it to research conclusions can be confirmed. In this inquiry the data was viewed by my supervisor in order to verify the legitimacy of the findings.

3.5.2 Validation Methods

3.5.2.1 **Validity**

Validity, according to Babbie (1995:129), “… refers to the extent which a specific measurement provides data that relate to commonly accepted meanings of a particular concept”. For Henning et al. (2004:148), to validate is to check for bias, neglect and lack of precision, to question all procedures and decisions critically, to theorise (addressing theoretical questions that arise throughout the process) and to discuss and share research actions with peers, and they (p.150) write of pragmatic validity, as “the usability of the findings and also the empowerment of research participation”. The validity of an instrument is thus reflected by the degree to which it evaluates what it proposed to evaluate.

To ensure validity of the findings in this inquiry, I attempted to provide a “rich, thick description” (Merriam, 1998:211) of information by using various data collection methods.

3.5.2.2 **Triangulation**

In field research, there is a special need for multiple types of evidence gathered from different sources, often using different data collection methods, and known as ‘triangulation’ (Baker, 1994:244). This is a strategy of casting out broadly for diverse evidence so as to more effectively focus on the study question at hand. In this study I collected evidence and material from multiple sources in order to address the question at hand from different points of view. Ultimately, I narrowed down and focused on the main themes that emerged once the analysis had been completed. I then made use of triangulation to determine and confirm that the main themes that
emerged were accurate and had emerged as mutual themes from the various data collection methods used. I made use of observational and field notes in order to enhance validation (see Addendum B).

### 3.6 ETHICAL CONSIDERATIONS

This research was conducted according to the ethical measures and guidelines as stipulated by the Research Ethics Committee of the University. In accordance with the guidelines the ethical considerations in this regard were that every author was acknowledged both in the text and in the references. Where the original source was used the text was quoted to avoid plagiarism. Issues of confidentiality, anonymity, explanation of the purpose of the study and voluntary participation were considered from an educational psychology perspective. I requested the necessary permission, in writing, to conduct the study from the principal of the school, the Grade 7 Mathematics educator and the parents and guardians of the learners. Vargas and Montoya (2009, as cited by Mertens, 2010:341) suggest that parents are usually the people who have legal authority to give permission for research participation for their children under the age of 18. However, according to them ethical practice calls for getting “assent” from the child by explaining the study to the young person in language that is understandable to them and getting their agreement to participate. The learners were thus requested to complete an assent form that clearly indicated my intention to observe them and conduct a focus group interview. I confirmed that the interview would be treated in the strictest confidence and that the participants’ identities would be protected, and to this end it was agreed that pseudonyms were to be used. No harm would come to any human being as a result of the research. During the informal interviews the purpose of the interview was explained to the interviewees as I informed them about my inquiry and therefore requested permission to talk to them. I did not ask or deal with any emotionally laden or personal questions or issues; therefore they were not left with any unresolved emotional issues. One of the conditions set out by the Ethics Committee was that I give feedback to the participants to ensure trustworthiness. I promised the participants that I would give them feedback on the findings once the study was complete.

For the interviews and classroom observation I asked for and received permission to audio- and video-record the sessions.
3.7 CONCLUSION

This is a qualitative study using the descriptive research method. In this chapter, the researcher’s aim was to present a detailed description of the research design, methods of data collection, analysis of data, trustworthiness, reliability, validity and ethical strategies that were considered. Sampling was done through purposive sampling and data collected through a semi-structured interview, focus group discussion and observations. Analysis was carried out through content analysis, data was coded and themes formulated to facilitate the analysis.

The following chapter gives a detailed description of the analysis of the data obtained and analyzed in the research process. The findings will be discussed in the next chapter.
CHAPTER FOUR

RESEARCH RESULTS AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

In Chapter Three, I provided a description of the research methodology and data analysis procedures. This Chapter begins with an overview of the data collection and analysis that took place. Next I present the findings obtained through the data analysis described in Chapter 3 (see 3.4.2) followed by a detailed discussion of the findings according to common themes which emerged from the collected data. Excerpts from the data collected were used to illustrate the findings.

The findings from the data will be presented here, guided by the research questions:

- What are the beliefs and knowledge of the Grade 7 mathematics teacher about her learner’s ability to solve word problems?

- What is the teacher’s belief of her practice?

- What are the beliefs that the Grade 7 learners’ have of their own ability to solve word problems?

- What are the results of the learners when doing a word problem activity?

The second way, by means of a comparative nature, is firstly to compare the teacher’s and the learners’ beliefs regarding word problems, and secondly to compare the teacher’s beliefs and her practice in order to highlight how these beliefs are reflected in practice and how they affect learner performance.

In order to achieve this I used the following sub research questions:
What are the teacher’s and learners’ beliefs regarding word problems? How congruent are these?

How are teacher’s beliefs related to practices and to learners’ performance?

4.2 OVERVIEW OF DATA COLLECTION AND ANALYSIS

4.2.1 Data collection methods

Based on my planning of the empirical study, as summarized in Chapter 3 paragraph 3.4.5, the data gathering involved a phase of preparation, gathering and organizing of data. As indicated in Chapter 3, I made use of an array of data collection methods in order to provide me with the much needed data to answer my research question. Accordingly, I made use of a semi-structured interview with the Grade 7 mathematics educator (Addendum C contains excerpts) and a focus group discussion with 6 of the Grade 7 class learners (Addendum C, contains excerpts). ‘Semi-structured’ in this specific research structure implies that predetermined questions were posed while still allowing the participant sufficient opportunity to elaborate before continuing to the next question.

After the interview with the educator and the focus group discussion with the learners, I transcribed the data.

4.2.2 Data analysis methods

Next, after reading through the transcripts, the constant comparative method of data analysis was used to analyse the data collected during the interview and focus group discussion. The aforementioned method was described in detail in Chapter 3, but a brief summary is given before the findings are discussed.

I engaged in a process of constant comparative method of data analysis to look for similarities, differences, patterns, themes, and ideas in the collected data. In analyzing the data collected from the interview and focus group discussion I set about looking for codes and then proceeded to record these codes under broader categories. From there I identified common themes. I began
fitting each of the categories into the dominant themes that emerged during the analysis of the data. The content analysis was also extended to the learners’ activity and the completion of the self-reflection tool. These were grouped by codes into categories that gave light to an array of re-emerging themes and patterns, to be discussed in the section that follow (Addendum C, contains an example of the content analyses made).

I also made use of a video recording of the lesson taught by the educator and this was accordingly transcribed into a textual document (Addendum C, contains excerpts). The lesson topic was: ‘The use of learning strategies during a word problem-solving activity’. I also made use of observations of the educator and the learners during the lesson presentation. All observation notes were documented in writing and an example may be viewed in addendum C. The observation data was also analysed in using a content analysis approach. The two sets of analysis were combined to search for main themes and in an attempt to see enveloping patterns in the information. All the above data gathering techniques successfully provided a rich qualitative data source from which evidence could be selected to effectively answer the posed research questions in this section.

After the analysis of the collected data was completed the final data was interpreted, using the literature that has been reviewed. Recommendations will be made on the grounds of the interpretation.

**4.3 FINDINGS**

In this section I present the findings gathered during the process of analysis of the data. The findings will be presented according to a descriptive and a comparative approach as discussed in the aforementioned section. The descriptive presentation of the findings will involve the first four research questions.
4.3.1 What are the beliefs of the Grade 7 mathematics teacher about her learner's ability to solve word problems?

To answer this question I drew on data from the teacher’s interview, (addendum B contains excerpts thereof). Data for this question was coded and the codes were further categorized. Three main categories emerged during the analysis process and these are:

- The learner’s attitude towards problem-solving vary
- The learner’s find problem-solving difficult
- Teacher experience has an effect on teaching and learner performance

I now give a description of each of these categories using excerpts from the transcriptions:

4.3.1.1 The learner’s attitude towards word problem solving vary

The main categories which were identified are that the learners’ attitudes towards problem-solving fluctuate. The teacher indicated that ‘the learners’ attitude towards mathematics in general varies’ (I/E-1; line 8). She indicated that ‘some learners live for mathematics whilst others avoid mathematics by wanting to be anywhere else rather than in the maths class’ (I/E-1; lines 9-11). The teacher elaborated ‘that some learners merely tolerate mathematics’ (I/E-1; 11), and predicted that ‘in a class of forty you will probably have four to five learners that would look forward to and enjoy word problems’ (I/E-10; 165-168). The teacher indicated that learners ‘seldom ask questions, that they generalize problem areas that they don’t understand and that they have an inability to be specific about what they are struggling with’ (I/E-3; 38-39) as reasons they were unable to ask for help. The teacher also suggested that ‘generally speaking, learners are unmotivated when doing word problems’ (I/E-9; 147). She predicted that ‘one or two learners are excited about word problems; however they are in the minority’ (I-E-9; 148). The teacher cited ‘a lack of comprehension, ongoing failure, experiencing no success, a negative reaction to word problems, getting to Grade Seven after experiencing four to five years of negativity as attributing factors for learners’ negativity’ (I/E-10; 150-156). She also felt that in view of the above ‘teachers are fighting a losing battle’ (I/E-10; 158).
4.3.1.2. The learners find word problem solving difficult

The teacher suggested that ‘the learners generally find problem-solving activities difficult’ (I/E-2; 20) and that ‘they usually complain when given such activities’ (I/E-2; 22). She also said that ‘the change in a learner’s facial expression during a lesson presentation’ (I/E-2; 30) was an indication to her that such a learner was having difficulty in completing a word problem activity. She further noted that they ‘react negatively in some way’ (I/E-3; 31) when faced with word problems. The teacher predicted that ‘only a few learners were actually using learning strategies’ (I/E-3; 47) when doing word problem activities. The teacher suggested that learners ‘do not have much knowledge of problem-solving strategies even though strategies are mentioned throughout the year’ (I/E-3; 48). She further indicated that ‘it is difficult to explain word problems to the learners since the learners’ knowledge is such that they don’t fully understand the strategies’ (I/E-15; 244) and that in trying to apply problem-solving strategies they do not have the background to do this. The teacher cited them as ‘grasping at the first thing that comes to mind, trying to follow their own strategies, sticking to the first strategy that comes to mind and following this’ (I/E-16; 252), as reasons learners did not show an awareness of learning strategies.

4.3.1.3. Teacher experience has an effect on teaching and learner performance

The teacher indicated that ‘experience and educators who themselves struggled with mathematics at school’ (I/E-18; 285-286), tend to make the best mathematics educators because ‘... they know what it feels like and know the problems they had themselves.’ The teacher said that ‘mixing learners according to mixed ability groups’ (I/E-4; 56-59) assisted weaker learners in coping with mathematics, especially since they learn from each other. The teacher indicated that ‘setting up a word problem is usually done in anticipation of what the expected learner performance will be’ (I/E-7; 104-106) when doing word problem activities. She cited ‘experience’ (line 106) as a reason for being able to predict where learner errors are going to come from, and indicated that ‘allowing learners to make errors first, knowingly’ (I/E-7; 114) could result in a class discussion, which may result in further discussions as to why errors were made and what would have been
the correct approach. The teacher cited ‘approaching word problem activities in their own way first through trial and error, using whatever strategies they feel comfortable with, emphasizing that there’s no right way to solve a problem and that there’s always more than one strategy which you can use, allowing them to find the answers, using diagrams or specific strategies, i.e., sister numbers, repeating the question and understanding the question, giving them the answers and discussing it in detail and showing how it works’ (I/E-11; 178-182), as possible strategies that could be used to address learners’ anticipated errors when doing word problems. The teacher reported that ‘learners are not exposed to enough learning strategies and that it depends on the experience of the math’s... the more experience you get, the more you understand the problems, you can anticipate the problems the children are going to have’ (I/E-17; 268-271) will assist the learners in understanding word problems.

In summary, the categories indicate that the teacher believed that the learners’ attitudes towards word problems were inconsistent. This inconsistency resulted in learners not being able to verbalize the actual difficulties they experienced when tackling word problems, hence their reluctance to ask questions in class. The teacher also believed that they had the ability to use strategies, however because they had a negative attitude towards word problems they were unable to use the strategies taught to them. According to the teacher’s beliefs, learners mostly benefitted from teachers with years of experience as mathematics teachers, as they had an understanding of how to assist the learners when they were experiencing difficulty with word sums.

4.3.2 What is the teacher’s belief of her practice?

To answer this question I provide a description of the teacher’s beliefs and how these were reflected during the actual lesson presentation. Addendum B contains examples of the observations made during the video-recording of the lesson presentation.

As mentioned above, I use the three main categories that emerged from the individual teacher interview and report on how these beliefs were confirmed and further extended during the lesson presentation.
The categories are:

- The learner’s attitude towards problem-solving vary
- The learners find problem-solving difficult
- Teacher experience has an effect on teaching and learner performance.

### 4.3.2.1 The learners’ attitudes towards word problem solving vary

During the introduction of the lesson the teacher instructed the learners to ‘focus’ their attention on the overhead projector and to ‘constantly think’ about what she was going to talk about. My observations reflect that most of the learners were instantly focused on the content that was going to be presented, however some learners had not completely settled down and occasionally fidgeted and looked around the class to see what their friends were doing. A further observation was that some learners did not participate in the group activity as they seemed to be reliant on other group members to solve the problem (see addendum xxx). The teacher encouraged the learners to ‘approach problems with a relaxed and a positive attitude’ (O/LP-1; 14), suggesting that they would ‘enjoy it and develop many skills’ (O/LP-1; 14-15). During the lesson presentation I clearly observed the relevance of the teacher’s request for the learners to approach the problems with a relaxed and a positive attitude, since some, when faced with the word problem activity presented with symptoms related to stress and anxiety, such as feverishly erasing ‘incorrect’ answers or operations, and nervously looking around to see what other learners were doing. She encouraged them to ‘jump right in and try to solve it’ (O/LP-1; 15). My observation of the lesson presentation correlates with this advice that the teacher gave to the learners. Again, some were motivated to start whilst others took their time. This observation confirmed and is suggestive that not all the learners shared the same attitude towards word problems.

### 4.3.2.2 The learner’s find word problem-solving difficult

The teacher indicated to the learners that they ‘would need to be able to think of methods’ (O/LP-1; 10) to solve problems and to ‘be able to apply these methods’ (O/LP-1; 10-11) when doing
word problem sums and afterwards be able to ‘check’ their answers. During the group work activity my observations were that not all the learners were able to solve the problem without intervention from the educator, thus suggesting that they found it difficult to think of possible solutions to the problems. They also interpreted the questions incorrectly, resulting in them giving the wrong answers. My observation further correlates with the teacher’s comment that they found word problems difficult, as I had observed their inability to work independently during the completion of the group work and the individual activities (see observation notes addendum B). Some learners seemed to struggle to move to a more abstract level of thinking when doing a word problem activity, while others were relying on the help from the stronger learners in the group and others were waiting on the teacher to assist them by giving more guidance and support. The level of word problems selected for this lesson is an indication of the teacher’s believes that the learners find word problems difficult. She had selected six problems for the class group activity and they were all basic problems that required that the learners work out the problems without much difficulty. However, most interpreted the questions incorrectly, resulting in wrong operations being carried out, which further resulted in incorrect answers being presented.

4.3.2.3 Teacher experience has an effect on teaching and learner performance

In my observation notes (Addendum B), I indicated that the teacher’s experience was reflected in how she handled the learners. She reminded them that ‘word problem-solving develops logical thinking’ (O/LP-1; 19) and that the ability to solve word problems could ‘help’ them in many other situations. The application of mathematics to real-life problems is one key purpose for learning the subject. My observations reflect the teacher’s view that the mathematics that she was teaching should be able to enhance their development in being able to deal with real-life situations. Through her experience it is evident that she was trying to motivate and encourage the learners to understand the value that word problems have in mathematics in other spheres of their lives. The idea of ‘sharing information’ was further explained to the learners by suggesting ‘this is your opportunity to explain in a logical way both your solution and the methods you used to reach it’ (O/LP-1; 21-22). The teacher realized the importance of being able to verbalize the methods used to get to the answer as well as to be able to explain to others how the answer was
determined. She then suggested that the learners would further ‘develop their skills in communication and logical thinking’ (O/LP-1; 22). A skill is something that a learner learns to do with the objective being to have such a degree of proficiency that they are able to perform it repeatedly, accurately, efficiently and whenever required. This means that when the learner is engaged in some mathematical problem-solving, they are able to call on the skills they have mastered without being distracted from the real mathematical task in front of them.

In summary, the categories indicate that the teacher believed that mathematics was important in everyday life and in many forms of employment. During her lesson she gave the learners a step-by-step breakdown of how they should solve the problems and explained the words that the learners might possibly not understand. This was an indication that she realized that the learners’ attitudes varied and that they found word problems difficult. Although some learners could deal with the problems without any assistance and guidance she still provided support to those learners who usually complained and gave up easily. The teacher realized that the learners found word problems difficult; therefore she encouraged them throughout the lesson to relax and to be positive when doing the activity. Her experience was also reflected here in that she informed the learners of the importance of not becoming anxious as this would affect their thinking. The teacher’s experience was further reflected by her suggesting to the learners that once they had an answer they should be able to explain to the group members and the class how they arrived at it. She reminded them that by doing this they would develop their communication and logical thinking skills. My observations further reveal that through her experience the teacher had her own purpose for choosing the activities that she used during the lesson presentation. Some of the reasons for choosing the particular word problems could be related to promoting learning, reinforcing learning, and developing various kinds of mathematical thinking.

4.3.3 What are the beliefs that the Grade 7 learners have of their own ability to solve word problems?

The intention of this research question was to determine what the learners’ beliefs were of their own ability when solving word problems. To answer this question I firstly report the findings of the focus group interview then report the findings of the learners’ reflection tool.
4.3.3.1 Focus group interview (Addendum B)

After carefully reading the transcribed focus group interview, codes that seemed to answer the research question were highlighted. From these codes, categories were formed in order to cluster all the codes. An excerpt from the analysis of the focus group interview appears in Chapter 3. The analysis of this excerpt illustrates which phase or group of words led to the formation of categories as established. The main categories that emerged were:

1. Word problems are difficult to do
2. Problem-solving strategies
3. Help seeking.

4.3.3.1.1 Word problems are difficult

One learner indicated that ‘I honestly struggle with word problems’ (I/F-4P2; 45). This was confirmed by participant 4 (I/F-4P4; 52), who also indicated that ‘problem-solving is difficult’, whilst another suggested that ‘Ohm, for me uh, multiplication tables of big numbers is difficult’ (I/F-4P3; 46). One learner stated that his difficulty with word problems could be ascribed to ‘mainly the methods and to understand the question’ (I/F-8P1; 121) whilst another learner suggested that ‘...finding new ways to solve the problem... you try to perfect certain methods but they still um, don’t work’ (I/F-8P3; 125). This learner’s suggestion is an indication that trying new methods eventually leads one to realize that certain methods do not always work. One learner indicated that ‘...analyzing and checking ohm, how you’re going to work it out’ (I/F-8P2; 122-123), as a difficulty which he experiences when doing word problems. Another learner said ‘Ma’am when the problem has fractions in it then it is difficult’ (I/F-8P4; 127). The challenge that working with fractions in word problems poses was further supported by another learner stating ‘Ma’am ohm, working out problems solving is, is easy but the fractions, when it’s a problem... when it’s a problem with fractions in it, it’s kind of difficult because, then I get lost’ (I/F-9P5; 134-135). The only difference for the two learners is that the one (P5) does not generally find word problems difficult; it is only when the problem contains fractional parts in it that he ‘get’s lost’. One learner very confidently stated that ‘I never find anything difficult’ (I/F-9P4; 131).
4.3.3.1.2 Problem-solving strategies

The majority of learners suggested that they used strategies when they tackled word problems, one indicating that ‘I write down all the numbers in the story, then I try working it out and I read the story again ...’ (I/F-9P1; 141). Participants 2, 3, 5 and 6 concurred with this strategy of taking out the numbers and then working out the problem, however P 2 (line 143) also indicated that ‘I analyse the sentence of the story... and see if, if that works. If not I’ll re-read the story and try again’, while P3 stated that ‘... try the same problem...using my own simpler numbers...or simpler fractions’ (lines 146/153). Participant 6 (line 160) indicated ‘... be creative with the numbers...’, which is a further indication that these learners seemed to value the importance of manipulating the numbers in a word problem.

4.3.3.1.3 Help-seeking

A number of learners indicated that they asked for help when they were not able to solve the word problems. They said, ‘I ask someone that knows how to do... to help me and to help me understand what to do’ (I/F-5P1; 66); ‘I do ask for help, mostly’ (I/F-5P2; 69); ‘I read it over and over then I ask my brother to do it for me.’ (I/F-6P5; 86); ‘... I try it over and over again and if it doesn’t come right I ask someone that knows how.’ (I/F-5P3; 73); and ‘Ma’am I do it until I give up then I ask ohm, misses Grassman or someone that knows Maths ya.’ (I/E-6P6; 89). Some learners however suggested that they did not rely on others’ assistance when tackling word problems ‘... I really try... look within the numbers... I do my own problem-solving... or practice. Maybe it will get better.’ (I/F-6P4; 81-82). This statement by the learner was an indication that the she concurred with her peers that word problems were difficult, but it is an indication of her ability to persevere until she arrives at the answer. This learner seems motivated to explore problem-solving by herself.

In summary, the findings reveal that learners generally find word problems difficult, with the exception of one or two who felt very confident when working with them. From the findings it is clear that learners struggle with word problems when fractional parts are included in the problem.
One learner suggested that if he understood the story this would help him cope better. The findings also reveal that most learners used strategies of their own to assist them in doing word problems.

Most of the learners mentioned that when a word problem was difficult they asked for help, either from their family members or the teacher. The learners also indicated that understanding the question was imperative to being able to provide the correct answers. One learner implied that she could work on her own and that she was confident in using her own problem-solving strategies, whilst another learner also seemed to have this quality. However, this learner (Participant 6) did indicate that when she has exhausted all her own efforts she would only then ask for help.

4.3.3.2. The Reflection Tool (Addendum B)

Following the analysis of the data from the adapted self reflection tool, I started with a list of tentative categories. Initially five major categories emerged during the analysis process. I then re-read the learners reflections and by this time I had worked through the data collected and re-categorized it in a manner that I believed would contribute to answering my research question and meeting my aims. Once I was pleased with the revised category names I could work through the data again, re-reading it and placing relevant data where it fitted best. The categories that emerged were:

1. Problem-solving strategies used during an activity
2. Difficulties experienced during an activity
3. Help-seeking during an activity.

4.3.3.2.1 Difficulties experienced during a word problem activity

A common challenge that most learners cited as a difficulty regarding word problem solving was that they did not always understand the questions posed, resulting in them not knowing which operations to use in finding the answer.
‘I read the question... but if it is a bit tricky, confusing...’ (Participant 2, verification of themes).

A few learners suggested that at times they did not even know where to start with the problem, and another indicated that he wrote down the first thing that came to mind.

‘How am I gonna answer it... ’ (Participant 10, verification of themes).

‘... I hate problem-solving because it is complicated and very very hard... ’ (Participant 15, verification of themes).

‘I thought of how am I going to answer the question of the word sums?’ (Participant 12, verification of themes).

‘Just wrote what came first to my mind’ (Participant 32, verification of themes).

Some learners related feeling helpless and having thoughts of ‘giving up’ after difficulties they struggled with when doing word problems.

‘I struggle a lot with this problem-solving and maths is not my subject...’ (Participant 5, verification of themes).

Others clearly indicated that they felt stress and panic when doing word problems.

‘... I was just holding my head and stressed... ’ (Participant 6, verification of themes).

‘...started panicking and all that stuff” (Participant 33, verification of themes).

4.3.3.2.2 problem-solving strategies used during a word problem activity

Most learners clearly indicated that they read through the problem carefully, trying to analyse, i.e. read, check and look for other options so that they were able to understand the question posed before answering.

‘I look and read the question before writing anything on the paper... ’ (Participant 11, verification of themes).
Some learners suggested that simplifying, i.e. substituting large numbers with smaller numbers worked for them, whilst other used alternative methods to find the answer.

‘I think about different steps to solve the sums’ (Participant 16, verification of themes).

A few learners indicated that working out the problem on scrap paper helped them to understand what they were doing.

‘...worked out the answer on a scrap paper and read the question again’ (Participant 24, verification of themes).

### 4.3.3.2.3 Help-seeking during a word problem activity

The majority of the learners indicated that they asked for help when doing word problems because they often did not know how to do the problems. Some learners indicated that they asked their parents or friends; whilst others said they asked the teacher for help.

‘I call my teacher to explain more about the activity so I can understand’ (Participant 11, verification of themes).

A few learners reflected on previous work done in the class by looking in the books at old activities.

‘I looked back in my book... what Mrs. Grassman taught us’ (Participant 3, verification of themes).

A number also indicated that they would persevere until they got it right, however these learners were in the minority, suggesting that they were not reliant on the help of others.

‘I tried and tried till I got the right answer... ’ (Participant 16, verification of themes).

In summary, the findings reveal that learners do find word problems difficult and that they cited a lack of understanding the questions as the most prominent difficulty. They acknowledged the importance of reading through the problem with understanding and reported that when they struggled with word problems they panicked and become stressed about finding the correct
strategies to use. Knowing which operation to use has also been highlighted as a difficulty by the learners, some indicating that their way of coping was just to write down the first thing that came to mind.

4.3.4 What are the learners’ actual performances when doing a word problem activity?

In order to study the link between teacher and learner knowledge and practice, it was necessary to summarize how well learners performed in a word problem solving task. In answering this question I drew on data received from an individual activity carried out by the learners. During this activity the learners were given an individual sum to complete on their own.

The classroom setting accommodated nine groups of six learners and one group of four learners, which according to the educator was the group in need of more support and intervention than the rest of the class. The teacher selected six different word problems that were suited for the Grade 7 learners. The problems consisted of sub questions, however the aim of these questions were not directed at highlighting the ‘product’ or answers only, but rather the focus was on allowing learners to determine the ‘how’ or the process of getting to the answer. Both of these measures formed part of the assessment criteria I used to determine the commonalities and differences in the learners answers. I also looked at whether learners provided the working out of their problems and whether any miscalculations were made.

In order to present each learner with an individual problem within the group context the educator colour coded the questions, i.e., blue, purple, yellow, pink, green and orange. The problems were divided amongst group members so that each had a different word problem to work on.

Below is an example of one of the questions posed to the learners (see Table 4.1). A sample of the rest of the questions can be found in addendum B. The codes used to describe the marking criteria used by the researcher have been tabulated in the previous chapter. The learners’ results are presented in a table format (Table 4.2) and these results will be followed by a descriptive summary of the learners’ performance during this activity.
**Example of a word problem:**

**Orange Problem:** A man wishes to purchase a refrigerator that costs R2400. He must pay \( \frac{1}{4} \) of the price in cash.

i.) How much must he pay in cash?

ii.) The balance must be paid over 18 months plus R30 interest every month. How much will his monthly payment be?

<table>
<thead>
<tr>
<th>Colour coded problems</th>
<th>Number of participants</th>
<th>Total correct answers C/A</th>
<th>Total wrong answers W/A</th>
<th>No working out shown N/W</th>
<th>Use of correct interpretation C/I</th>
<th>Miscalculations M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blue</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2. Purple</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>3. Yellow</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>4. Pink</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5. Orange</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>6. Green</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>16</td>
<td>20</td>
<td>20</td>
<td>19</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table 4.2 Results of the word problem activity**

In summary, the findings revealed that most learners got the answers wrong and that 19 interpreted the questions incorrectly. These totals support the theme ‘that learner’s find word problem-solving difficult’. This is a reflection of the learner’s overall poor performance since most of them got the answers wrong. The findings further reveal that some ‘learners used their
own strategies when doing word problems as some of them showed their basic working out on a scrap page whilst others, according to my observation notes (see addendum B), used their fingers while doing the calculations.’ This observation corresponds with the findings in 4.3 where learners have indicated that they do try to use some strategies when doing word problem-solving however their difficulty is in using it successfully. The purpose of this activity was to study the link between the teacher’s and the learners’ knowledge and practice.

The next section represents the second level of reporting and analysis, in which I compare the teacher’s and the learners’ beliefs when doing word problems and how these influences the teacher’s teaching and the learners’ performance when faced with word problems. Next I compare the link between the teacher’s beliefs, her practice and the learners’ performance during an activity.

**4.3.5 What are the perceptions of the learners and the teacher regarding their beliefs of word problems?**

In answering this question the data will be presented by indicating three main categories and their sub-categories. The findings of the learners and educators were similar and therefore will be grouped together. Differences will however be indicated where applicable.

The categories that emerged were:

1. Learners’ attitudes toward word problems varies
2. Learners find word problems difficult
3. Teacher experience has an effect on teaching and learning.

**4.3.5.1 Learners’ attitudes toward word problems varies**

Based on the points raised in the presentation of the findings it is evident that the learners and the teacher agree with the assumption that the learners attitudes toward word problems vary.

‘… some learners will rather be anywhere else than in the math’s class...’ (I/E-1; line 10). Verification of themes.
The teacher also indicated that not all of the learners looked forward to the maths class.

‘... in a class of forty learners... five to six learners would look forward to and enjoy problems...’ (I/E-10; 10). Verification of themes.

She further stated that they were not motivated to tackle word problems.

‘Generally speaking they're unmotivated... ’ (I/E-9; 146-147). Verification of themes.

The learners also reported their reliance on others to motivate and encourage them.

‘... I ask someone that knows how ...’ (I/F-5; 66).

‘... they are often not motivated when faced with word problems and that a negative reaction to word problems just compounds itself as the years go by so when they get to Grade Seven they have four or five years of negative feelings towards word problems’.

4.3.5.2 Learners find word problems difficult

The teacher’s and the learners’ responses suggested that finding the answer to a word problem was too difficult for the majority.

‘I honestly struggle with word problems ’ (I/F-4; 45).

‘difficulty... problem-solving ’ (I/F-4; 52).

‘... skip difficult questions... ’ (SL/L6).

Some learners suggested that word problems that included fractions were difficult.

‘... word problems with fractions in it very difficult ... ’ (I/F-4).

‘Generally speaking the class would complain about doing word problems... ’ (I/E-2; 22)

‘... sometime give up... ’ (SL/L6).

‘...they see that word, problem or they hear that word, problem, you can see on their faces the expression changes rather than say ‘oh no’ the reaction is negative... ’ (I/E-2-3; 30-31).
Another learner suggested that ‘concentrating helps him to understand and then to solve the problem’ (SL/L20).

‘... holds his head ...’ (SL/L6).

One learner indicated that:

‘...writes down the first thing that comes to mind ...’ (SL/L32).

‘... I try it over and over again...’ (I/F-5; 73).

Whilst another learner indicated her independence from others and her ability to work alone:

‘... I do my own problem-solving...’ (I/F-6; 81).

‘... stress when faced with word problems... through positive self-talk I can overcome the stresses’ (S/L-L15 and L33).

‘... writes down the first thing that comes to mind...’ (SL/L32).

4.3.5.3 Teacher experience has an effect on teaching and learning

The teacher further cited the following reasons, based on teacher experience, as examples of how it can benefit the teacher and improve teaching and learning.

‘... lack of comprehension, ongoing failure and experiencing no success...’ (I/E-10).

‘... with experience you do know where the errors are going to come...’ (I/E-7; 106).

‘... very few learners... use learning strategies...’ (I/E-3; 47).

The teacher suggested that experience had taught her that the learners would not often ask for help, because they might be embarrassed about not understanding and would not want their peers to know about this.

‘... children shy away from making it known that they have a problem...’ (I/E-14; 219).

‘... they’d rather fly under the radar and not be noticed...’ (I/E-14; 226).
The teacher seemed to be aware of the learners’ emotional needs and was able to assist them with sensitivity. Hence, she dealt with their difficulties in the following manner:

‘... I would very often work one-one... ’; ‘... I never stand over them and help in groups... I take them out of the group and take them to me desk’; ‘...sometimes they come during a break... ’; ‘... Thursday afternoons ... extra maths... ’ (I/E-13; 209-216).

The teacher’s and the learners’ responses suggest that finding the answer to a word problem was too difficult for the majority. This reveals the learners’ inability to use appropriate learning strategies to deal with the word problem. It is therefore my view that, in the absence of these strategies, learners tend to develop negative attitudes towards word problems, which may explain the lack of comprehension and success to which the teacher alludes. The teacher’s statement that the learners’ negative reaction to word problems had compounded over the years suggests that if learners are not equipped with learning strategies to deal with word problems in the earlier stages of their primary schooling, these problems can escalate and follow the learner throughout his or her schooling career. This can possibly be related to the current poor learner performances in mathematics at a high school level in South Africa.

The teacher reported that ‘the learners facial expression indicate that they are finding the activity difficult’ (I/E-2). She also reported that ‘children shy away from making it known that they have a problem’ (I/E-14) and that ‘they’d rather fly under the radar and not be noticed’ (I/E-14). Some learners reported that they do ‘stress when faced with word problems however through positive self-talk they can overcome the stresses’ (S/L-L15 and L33). They also reported that they ‘skip difficult questions’ (I/F-3) and sometimes ‘gave up’ on certain word problems. One learner indicated that he sometimes ‘holds his head’ (SL/L6) when faced with word problems.

Based on the abovementioned responses from the learners, it is clear that they become anxious and stressed when faced with word problems. The teacher’s response concerning the facial expressions of certain learners while they were busy with word problems is in my view a further reflection of the anxiety that these learners were experiencing The teacher further reported that learners ‘seldom ask specific questions related to the difficulty they are experiencing and that very few of the learners actually use learning strategies’ (I/E-3). She reported that they were not sufficiently motivated to successfully complete word problem activities and indicated that ‘they do not have the necessary knowledge and background in order to complete a word problem...’
activity’ (I/E-9). She cited ‘...a lack of comprehension... ongoing failure since they (learners) can remember’ (I/E-10) as reasons learners struggled with word problems.

The learners reported that at times they found ‘word problems with fractions in it very difficult and that getting the answer can be a challenge’ (I/F-4). One learner reported that ‘only when he understands the word problem is he able to find an answer’ (SL/L3), whilst another indicated that he ‘writes down the first thing that comes to mind’ (SL/L32). The literature discussed in this enquiry suggests the teachers’ beliefs strongly affect the materials and activities they choose for the classroom (chapter 2). According to the teacher: ‘… experience, and educators who themselves struggled with mathematics at school, tends to be the best mathematics educators’. Clarke and Peterson (1986) have proposed that the most resilient or core teachers’ beliefs are formed on the basis of teachers’ own schooling as young students while observing teachers who taught them.

The teacher reported that ‘teachers are fighting a losing battle because learners do not have knowledge of learning strategies that they can use to solve word problems’ ((VE-10). The educator cited the following: ‘using sister numbers, trying to repeat the question more than once and understanding what the question is asking’ (VE-13) as possible learning strategies that the learners could use. The learners reported that ‘at times not knowing which operation to use causes difficulty in understanding word problems’. They also cited the following as strategies that they use: ‘the strategy of writing down numbers in the story, re-reading the story again, analyzing the sentence, simplifying the numbers and working with simpler fractions, etcetera’ (I/F-9).

In summary, the match between teacher and learner beliefs reveals that both the teacher and some learners agree that the learners’ attitude towards word problems vary and that most learners find word problem solving difficult. In linking the teacher’s beliefs and the learners ‘beliefs related to problem-solving the same themes have emerged during the analysis process and these are; ‘learners find word problem-solving difficult, ’learners ‘attitudes towards word problem-solving vary; ‘and teacher experience does impacts learner performance when doing word problem-solving.’ Some learners specifically stated that it was more difficult when fractions were included in the problem.
4.3.6 What are the links between the teacher's beliefs and her practice with the learners’ actual performance?

In answering this question my aim was to compare the findings of the teacher’s beliefs (4.3.1) and the observations made of the teacher’s practice (4.3.2) with the learners’ performance as was reported in 4.3.4. The themes that emerged during this comparative exercise are:

- Learners have a negative attitude towards word problems which negatively affects their performance when doing such activities
- The teaching strategies used in the class are not assisting learners in improved performance
- Learners have a backlog in problem-solving strategies therefore their performance is poor.

4.3.6.1 Learners have a negative attitude towards word problems which negatively affect their performance when doing such activities

The overarching theme that emerged during the content analysis process is that the teacher believes that the learners have a negative attitude towards word problem solving in general. The teacher’s beliefs can be supported by my observations which revealed that some learners laughed at each other when getting the answers wrong and some did not show an interest in participating in the activities. However, the findings gathered from the learners’ adapted reflection tool reveal that some panicked, experienced stress and anxiety or skipped difficult questions when faced with word problems. According to the teacher, teachers in general are fighting a losing battle in trying to change the learners’ attitudes. This statement correlates with the teacher’s actions during the lesson presentation as she continually encouraged the learners by emphasizing the importance of word problems and their significance in everyday life.

With regards to learner performance, the findings revealed that most learners provided only answers without showing any calculations, and that most of them got the activity wrong. My assumption is therefore that the learners either did not know how to do the calculations or they calculated the answers mentally. This would mean that they had actually used their own
strategies in answering the questions posed by the word problem. The teacher suggested that experience allows teachers to pick up on negative behaviour and attitudes, and that through these experiences learners’ difficulties can be anticipated and remedied at the same time. This belief of the teacher was evident in practice as she reminded the learners to relax and to be positive in their approach to word problems, thus encouraging them to find more than one possible solution to the word problem.

4.3.6.2 The teaching strategies used in the class are not assisting learners in improved performance

The teacher believes in having a mixed ability class setting, suggesting that learners learn from each other. This was supported by the teacher’s practice as she encouraged learners to discuss and work together when solving the word problem (see observation sheet). The teacher believed that the learners learned from each other, however the findings reveal that the learners were still very dependent on the teacher’s opinion and support within the classroom. This suggests that the teacher might not have been allowing sufficient space for personal development and growth. The findings from the teacher’s beliefs and the observations of the lesson presentation reveal that although the teacher was focused on motivating the learners to handle word problems with confidence, this was not evident in the learners’ performance or in their reflection regarding their performance. The learners cited division and knowing when to use the correct operations as reasons for experiencing difficulties when doing word problems. This was evident in the presentation of their work when they completed an activity. The findings revealed that some learners did not interpret the questions correctly, while other used the wrong operations or miscalculated the totals and others simply did not write down an answer. It is thus my assumption that the teacher might need to focus more on teaching concepts and principles through concrete representations and then gradually progress to symbolic representations. Opportunities for learning concepts, principles, and problem-solving levels occur when teacher have children work with objects, talk about what they observe, and then record the relationship they discover.
4.3.6.3 Learners have a backlog in problem-solving strategies, therefore their performance is poor

The teacher believed that learners had a backlog in problem-solving strategies and suggested that it emanated from past negative experiences. Based on this belief, the teacher, in her lesson presentation, read through the opening problem with the learners, explained difficult words and worked through all five sub-questions with the learners. She also discussed the learners’ various methods that could be used to answer the questions. Much time was thus spent on guiding the learners on how to approach the word problem, which is a skill the learners should have learnt in the lower grades. This corroborates the teacher’s belief that the learners did not have knowledge of learning strategies and that they had no background knowledge to tap into so as to successfully complete the word problem. This is evident in practice as the findings reveal that learners were unsure of what learning strategies to use when faced with different types of word problems. They were unable to use a variety of strategies as they did not have the necessary background, as indicated by the teacher.

The teacher indicated that the learners seldom asked questions and that generally they were unable to ask specific questions that would highlight their actual difficulty. During the lesson presentation she indicated to the learners that word problems would develop their skills in communication and logical thinking. This is suggestive that the teacher’s beliefs were grounded and that in order to overcome this lack she motivated and encouraged them to develop the skills so that they could cope better when doing word problems. The learners’ performance reflected their inability to communicate effectively. Whilst completing the activity the researcher observed that they did not ask clarifying questions, but simply wrote down an answer without interacting with the problems.

In summary, it is evident that there is a link between the teacher’s beliefs, her practice and the learners’ performance. The teacher’s beliefs about the learners and how they perceived word problems were reflected in her teaching approach. She attempted to teach the learners strategies to use however this was not her main focus as her concern was to ensure that the learners understood the words used in the worded problems. Much time was spent on explaining new and possibly foreign words to the learners and not enough time was spent on emphasising learning strategies. She combined her beliefs with her experience as a mathematics teacher, evident in the way she taught word problems to her learners. By this I am suggesting that her belief is that the
leaners must have a good understanding of the words used in the problem sum. The teacher was very much aware of the learners’ cues, i.e., facial expressions and body language however the focus was on making sure that they understood what was asked and not on providing the learners with strategies that they could use to answer the questions.

4.4 DISCUSSION OF FINDINGS

In this section the findings of the research will be interpreted, revisiting the research questions as well as the aims of this study as a point of departure. This will assist me in exploring the respective categories to be discussed in relation to the overarching focus of the study.

4.4.1 Themes identified during the data analysis

Following the data analysis process, it was found that 3 major themes emerged during the study namely: “learner attitudes towards word problem-solving vary”; ‘teacher experience influences teacher and learner performance’; ‘the teaching and learning strategies used in the classroom are not effective.’ The themes will be interpreted from the theoretical framework presented in the literature search. As an overview, I will illustrate the main themes of the results schematically (see figure 4.1)
4.4.2 Discussion of themes identified

4.4.2.1 Learners attitude towards problem-solving vary

According to the teacher, one of the reasons the learners’ attitudes towards word problems vary was that the learners seldom asked questions in class and that they usually generalized problem areas that they did not understand. The teacher ascribed this to the learners’ inability to be specific about what they were struggling with. She further cited a lack of comprehension as a factor contributing to learners’ negativity in the mathematics class. The findings suggest awareness by the teacher of the significance of language in learning mathematics. In South African schools there are many learners who are taught through the medium of English, which is not their home language (Landsberg, 2005:150). According to Perry and Dockett (2002:101, as cited in Key Concepts in Teaching Primary Mathematics, 2007:100), “without sufficient language to communicate the ideas being developed, children will be at a loss to interact with their peers and their teachers and therefore will have their mathematical development seriously
curtailed”. This perspective accords well with Vygotsky’s view that language is a means of gaining knowledge but, more importantly, it is a tool that permits the restructuring and refinement of experience and thought. Vygotsky adds that words direct and control mental operations (Engelbrecht & Green, 2001:83). I concur with the above findings, based on my assumption that the importance of language in learning mathematics cannot be overstated, especially since a word problem can be described as a verbal description of a problem wherein one or more questions is or are composed.

The teacher further cited experiencing no success, on-going failure, and getting to Grade 7 after experiencing four to five years of negativity as factors that affect the learners’ attitudes towards word problems. From the teacher’s statements above, one can conclude that continuous failure leads to learners developing a negative attitude towards word problem solving. They experience no success, for example having all their activities marked and checked for errors only, without teachers providing positive comments and specific guidelines on how to improve on an activity exasperates this negative feeling. Experiencing failure in the early stages of mathematics instruction can severely limit future development. Too often, learners experience conflict, frustration, and alienation in the mathematics classroom, conditions that destroy their commitment to learn and usually lead to feelings of inadequacy, resulting in negative attitudes towards word problems. This results in them believing that responding negatively and avoiding mathematics can become rewarding in a negative sense. This is backed up by my own experience in the classroom, where I have found that mathematics is a favourite subject of learners in Grade 1 but by the time they reach Grade 9 it has developed into a subject that they fear and hope never to encounter again. It is evident that something must have happened during this period to cause this negative attitude. The teacher also refers to learners experiencing four to five years of negativity that affects their attitudes at a Grade 7 level. It is thus my assumption that the cause can either be ascribed to poor teaching methods or a lack of teaching learners learning strategies, or it can be a result of learners not being able to master the move from the concrete operational phase to a more formal phase, as Piaget’s theory of cognitive development posits. The teacher indicated that the learners usually complained when given word problem activities to complete in class, and that their facial expression was a further indication that they found word problems difficult. This statement by the teacher correlates with the findings of the learners’ performance when they tackled a word problem activity and with the comments when they did self-recording and self-monitoring using the adapted reflection tool. The results of this activity (see addendum
B) reveal that the learners performed poorly when given word problems to complete on their own, and the results gained from the reflection tool further indicated that they found word problem solving difficult because they did not always understand the questions being asked. The finding remains, however, that there are large, significant, and continuous differences among children as they progress through the mathematics curriculum in school. For this reason, it is important that teachers are reminded that children cannot absorb information that they are unable to understand.

The teacher also noted that the learners react negatively when faced with word problems and some do not use strategies when tackling word problems because they do not understand how to use the strategies taught in class throughout the year. In analyzing the learners’ results it was evident that they generally did not use strategies to calculate the answer to the problem. The teacher further indicated that ‘learners can only deal with certain types of questions’ (VE-5). Again, this was evident in the learners’ performance as discussed in the previous section. The teacher noted that some learners would simply write down the first thing that came to mind. The problem-solving level of learning is attained when a learner is able to accommodate skills, concepts and principles into a cognitive structure. To solve word problems learners need many subordinate capabilities. They must be able to read with understanding, identify the mathematical question and the necessary operation from the relevant data, and they must be able to construct a number sentence either mentally or on paper. Finally, they must compute with accuracy.

According to Perry and Docket, (2002:93, as cited by Haylock & Thangata, 2007:125) “mental calculations is an integral part of young children’s learning about number because it can contribute to children’s meaningful learning of mathematical concepts and promotes’ thinking, conjecturing and generalizing based on conceptual understanding”. The teacher suggested that experience allows teachers to pick up on negative behaviours and attitudes and that through these experiences learners’ difficulties can be anticipated and remedied at the same time. This belief of the teacher is evident in practice as she reminded the learners they should relax and be positive in their approach to word problems, thus encouraging them to find more than one possible solution to the word problem.
4.4.2.2 Teacher experience has an effect on learners and teachers performance

The teacher cited experience and educators who themselves struggled with mathematics at school as factors that influences teaching and learner performance. Hativa and Goodyear (2002:69) suggest that maths teachers frequently depend on experience as the basis for knowledge construction, which suggests thus that they develop knowledge through experience. This is in line with what the teacher was stating. Knowing how and to what extent children can learn mathematics is very important, however it is not enough. One must also know something of the psychological environment that surrounds the classroom. Recognizing, understanding, and responding to children’s feelings, motivations, emotions, curiosity, and attitudes will help see them off to a good start in mathematics.

The teacher further indicated that placing learners in mixed ability groups assisted weaker learners in coping with the work. I concur with this teaching strategy used by the teacher. Barooski and Coslick (1999:20-21, as cited by Landsberg, 2005:205) argues that it important to “encourage children to work in groups”. According to Engelbrecht and Green (2001:50), approaches to learning that involve learner-to-learner support can be effective in creating classrooms that encourage the participation and learning of all learners. Another finding that was revealed was that the teacher indicated that through her experience she was able to predict the errors that learners might make. Errors give an indication to teachers of aspects or steps in mathematics that learners or individuals do not fully understand (Landsberg, 2005:202). This is an important skill for a teacher to have as it assists in structuring the content during teaching and can help diagnose academic difficulty and further guide the establishment of individual learner support structures.

The teacher also indicated that learners are not sufficiently exposed to teachings on learning strategies. This view of the teacher is supported by Donald (2005:108), who indicates that teachers are often so concerned about getting across the content, the ‘what’ of learning, to their students that they neglect the process, the ‘how’ of learning. Donald stresses that both processes are equally important and require active engagement from the teacher and the learner. He further explains that in terms of content, with Bruner alleging that knowledge is not only about facts and information. In terms of process, According to Donald (p.108) Bruner suggests that learners can be helped to develop more effective and powerful strategies to learn. Donald maintains that there are always more effective strategies, appropriate to the child’s age and development, which can be scaffolded with any child at any stage (p.106).
4.4.2.3 Learning and teaching strategies are not effective

The teacher believed in having a mixed ability class setting, suggesting that learners learn from each other. This was supported in the teacher’s practice as she encouraged learners to discuss and work together when solving the word problem (see observation sheet). Although the teacher believed that the learners learn from each other, the findings reveal that they were still very dependent on the teacher’s opinion and support within the classroom suggesting, suggesting that the teacher might not have been allowing enough space for personal development and growth. The findings from the teacher’s beliefs and the observations of the lesson presentation reveal that the teacher was focused on motivating the learners to handle to word problems with confidence; however this was not evident in the learners’ performance or in their reflection regarding their performance. The learners cited division and not knowing when to use the correct operations as reasons for experiencing difficulties when doing word problems. This was evident in the presentation of their work when they completed an activity. The findings revealed that some learners did not interpret the questions correctly whilst others used the wrong operations or miscalculated the totals or simply did not write down an answer. It is thus my assumption that the teacher might need to focus more on teaching concepts and principles through concrete representations and then gradually progress to symbolic representations. Opportunities for learning concepts, principle, and problem-solving levels occur when teacher have children work with objects, talk about what they observe, and then record the relationship they discover. The teacher’s beliefs correlate with the developmental phase that the learners are in.

In summary it seems to be clear that there is a link between the teacher’s beliefs, her practice and the learners’ performance. The teacher’s beliefs about the learners and how they perceive word problems are reflected in her teaching approach. She combines her believes with her experience as a mathematics teacher and this is evident in how she teaches word problems to her learners. The teacher is very much aware of the learners’ cues, i.e. facial expressions and body language.
4.5 CONCLUSION

This chapter revealed the findings obtained through the data analysis process and discussed the themes that emerged, in as much detail as possible. It was difficult at times, for me to make clear distinctions between these categories in order to make the themes mutually inclusive as is the norm for qualitative research.

From the findings presented in this chapter, I am able to conclude that the beliefs that teachers and learners hold about mathematics in general and more specifically word problem-solving are important factors in the learning process.

The aim of the final chapter will be to draw this inquiry to a close by providing a summary, discussing the limitations as well as providing some recommendations. I conclude this chapter with recommendations for future research, training and practice.
CHAPTER FIVE

SUMMARY, LIMITATIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The purpose of this chapter is to summarise the study, following which I make recommendations that may enhance the teaching and learning of word problems. Further recommendations for future research in the field of word problem solving are discussed. Next, the strengths and limitations of the study are acknowledged and discussed. Finally, the dissertation is brought to a conclusion.

5.2 OVERVIEW OF THE STUDY

In Chapter One I launch my research study by discussing the theoretical framework that underpins my research and that provided me with a reference point from which I could work when I stated the problem statement pertaining. The theoretical framework included the epistemology of social constructivism as proposed by the various learning theories of Piaget (stage theory) and Vygotsky (theories of scaffolding and ZPD), Bronfenbrenner’s bio-ecological (systems) model as well as cognitive development theory. Next, I stated the rationale and motivation for the study and formulated the research question that guided this study. The research question was formulated as: “How Grade 7 mathematics teachers’ beliefs are reflected in practice and outcomes”. Following this I provided a brief overview of the research methodology, data collection and analysis employed in this research study.

In Chapter Two, I present the literature review and in Chapter Three discussed the research paradigm. I introduced the qualitative approach as a framework for the research with specific reference to the case study design that I decided to use as part of the research design. I chose the case study design to gain an in-depth, intensive, multifaceted investigation and understanding of teacher beliefs, teacher knowledge and how these relate to word problems (Denscomb, 2000; Merriam, 2002). I discussed the methods of data collection, namely a semi-structured interview,
focus group discussion, observations, documents and a self-reflection tool. I further discussed data analysis and interpretation methods that were used and highlighted the ethical considerations taken into account during this research study. In Chapter Four, I provided a rich description of teacher knowledge, teacher beliefs, word problems and strategies that learners use when doing word problems by discussing the research findings as they pertain to the research question.

5.3 SUMMARY OF THE STUDY

Problem-solving is at the heart of learning mathematics and therefore requires that learners are able to use their prior knowledge to formulate a plan or strategy to attain an answer. The Primary aim of this research was to explore a Grade 7 mathematics teacher’s beliefs and knowledge about her learners and their use of problem-solving strategies when tackling word problems. A second aim of the study was directed at exploring how teacher knowledge and beliefs impact on the teacher’s teaching and the learners’ learning during a problem-solving task. A further aim was to explore the teacher’s knowledge and beliefs regarding the learners’ use of problem-solving strategies when confronted with a word problem task. This was done during the semi-structured interview, whereby the teacher was asked to reflect on her beliefs and knowledge regarding the strategies that learners used when solving word problems. The next aim was to explore the learners’ beliefs and knowledge about the problem-solving strategies that they used, as well as their help-seeking needs when doing a word problem activity. This information was gained through the completion of the adapted self-reflection tool that the learners were asked to complete after doing an activity on their own.

The theoretical framework underpinning the research included social constructivism with the various learning theories proposed by Piaget, Vygotsky and others, as well as Bronfenbrenner’s bio-ecological model (Landsman, 2005) and cognitive development theory. These were explained in Chapter Two.

The literature study revealed that teacher knowledge and beliefs have become prominent in influencing teacher training, especially since teacher knowledge has been referred to as the link between teaching and learning and involves the teachers’ proposed classroom interactions, student learning, attitudes and beliefs of the students they teach. Next, the literature review focused on mathematics learning. Aspects that were addressed in Chapter Two include a
description of the nature of mathematics, how it is learned, mathematics learning strategies and problem-solving in mathematics. The third area of focus in the literature review was directed at teachers’ knowledge and beliefs of mathematics learning. In this section I attempt to summarise the theoretical perspectives on teacher knowledge and beliefs of mathematics learning.

In order to answer the research questions, I made use of a qualitative case study design. In Chapter Three the research design and methodology were explained. For the purpose of this study I used the case study research design in order to gain an in-depth investigation and understanding of the experiences of the participants. Data collection methods include a semi-structured interview, a focus group discussion, a self-reflection by the learners, a problem-solving task and observations of a lesson presentation. In order to improve the trustworthiness of the study I audio-taped the interviews and then transcribed these verbatim. All the data collected were viewed by my supervisor in order to verify the legitimacy of the findings. Data analysis included the constant comparative method. The common themes that were established after the data collection and data analysis process had been completed were discussed and elaborated on in Chapter Four.

The main findings revealed that:

- Learners’ attitudes towards word problem-solving vary
- Teacher experience influences teaching and learner performance
- The teaching and learning strategies used in the class are not assisting learners

Recommendations to address these findings are discussed in detail in Chapter 5.

This study revealed a need for learners to be encouraged and motivated to gaining a changed and positive attitude towards word problem-solving. The teaching strategies used in the classroom do not lend to improved learner performance since the learners have a backlog in applying word problem strategies effectively. This was confirmed by the teacher as she mentioned during the interview that this backlog may have been created three to four years prior to the learners reaching Grade 7. The teacher’s confirmation therefore suggests that not enough emphasis is placed on the use of problem-solving in the lower grades.
5.4 RECOMMENDATIONS

In corroboration with the findings presented in this research study, related recommendations are based on the findings that emerged from the data analysis process. These recommendations are, however, by no means exhaustive. The discussion of the recommendations will be divided in two sections which are divided into recommendations regarding the participants involved in this study (5.3.1), addressing both strategies for the teacher and the learners to improve the results in word problem solving and secondly recommendations for further study (5.3.2).

5.4.1 Recommendations regarding the participants involved in this study

The recommendations will be discussed under the most profound themes that emerged during the analysis process as described in chapter four. It is important at this point to remind the reader that the recommendations are directed at the participants involved in this particular study, i.e., the Grade 7 mathematics educator, Mrs Brown (Pseudonym) and her 40 learners.

5.4.1.1 Learners’ attitudes towards word problem solving vary

For many years, educational psychologists have studied the way students differ in their views and representations of concepts, and in their preferred ways of working with and organizing new ideas. Some learners attain low marks in mathematics and this affects their attitude towards mathematics, however it is not necessarily an indication that the learner lacks the capacity to learn mathematics. Giordano and Weir (2002:523) suggest that learners vary in their ability to learn mathematics as well as in their interest in studying mathematics. Therefore, my finding that learners’ attitudes toward word problem solving vary is by no means unique to the study of mathematics teaching. Keeping students involved in a lesson is only one step in involving them in learning mathematics (Giordano & Weir, 2002:506). Involved students are more motivated and more likely to ask questions or seek answers on their own and interest is higher when they experience success, when problems are related to topics of interest to them and further when they can make connections between the usefulness and beauty of mathematics. Low self-esteem is
frequently the result of years of attaining low marks, failure or lack of recognition for efforts made. Maths anxiety is one outcome of low self-esteem and fear of failure can cause problems in processing new information as well as in using learned information for problem-solving. Giordano and Weir add that such learners tend to avoid mathematics whenever possible. On the other hand, gifted learners thrive in a self-paced, self-learning environment, whilst also learning to communicate and work with others.

There exist many effective strategies for involving students in the process of learning mathematics; however for the purpose of this study my recommendation to address the varying attitudes that learners have towards word problems is the development of self-regulated learners. Most self-regulation theorists define self-regulated learning (SRL) as a multidimensional process involving personal (cognitive and emotional), contextual, and behavioural components (Lombaerts et al., 2008:163). Butler and Winne (1995) describe SRL as a meta-cognitive style of engaging in tasks in which learners exercise learning skills and select and apply tactics and strategies that generate products conducive to goal attainment (Kremer-Hayon & Tillema, 1999:507). According to Tillema and van der Westhuizen (2006), Claxton et al. (1996) and Zimmerman and Schunck (2001), SRL is a process by which an individual directs and controls learning to attain his or her goals by appropriate learning strategies as well as meta-cognitive monitoring in knowledge construction. They further suggest that SRL allows the person to become a manager of his or her own learning. The development of strategic, purposeful self-regulated learning (SRL) is essential and involves specific teaching skills such as motivating learners to actively participate in the teacher-learner process, and being able to engage learners in complex, open-ended activities. It offers choices and opportunities to control challenge, providing learners with the opportunity to acquire strategy knowledge and skills to implement cognitive and meta-cognitive strategies needed to operate independently, as well as self-monitoring. Teaching learners self-regulatory skills can be viewed as a steppingstone to promote lifelong learning.
According to Kremer-Hayon and Tillema (1999), the definitions of SRL generate a portrait of self-regulated learners such as:

- Self-regulated learners are confident in their strategies
- They set goals for extending their knowledge and sustaining their motivation
- The attribute failure or success to themselves rather than others
- They control learning outcomes from within, are intrinsically motivated and adapt easier to uncertain challenges in the classroom.

Students need to be assured that they can succeed in doing what will be asked of them (Giordano & Weir, 2002:512). In any mathematics classroom there is always a range of student abilities. Many learners find word problems difficult as word problems have long been the nemesis of learners with reading barriers. Almost everyone, and certainly everyone of average intelligence, can learn mathematics, although some people need less help than others. The teacher must therefore be aware that people learn mathematics in different ways. Some use diagrams and mental pictures to gain insight whilst others manipulate abstract ideas and symbols easily, or solve word problems differently. Polya’s (1957) four-step problem-solving model includes the following stages: understanding the problem; devising a plan; carrying out the plan; looking back. Each stage is further defined by the use of questions and explanations.

The recommendation is thus that learners be assisted to use more formal strategies, as highlighted by Polya’s model, to solve word problems. Learners should therefore be exposed to models such as designed by Polya and others to assist them in finding solutions to word problems. The most positive outcome of a successful experience of word problem solving for learners of all ages is the satisfying sense of closure that occurs when the problem is finally solved, which gives a boost to the learner’s self-confidence and contributes to a positive attitude towards word problems.

Textbooks rely heavily on the written word for processing problem situations which results in greater barriers for such learners.
5.4.1.2 Teacher experience influences teaching and learner performance

Even the most experienced teachers are only successful when they have carefully planned and effectively structured a mathematics lesson. The mathematics that learners learn stems from what they do and experience in the mathematics classroom. The decisions made by teachers, such as which topics to teach, when to teach them, and the depth to which to teach them, impact the quality of mathematics programmes and the learning of learners (Giordano & Weir, 2002:486). To know and understand mathematics, and to have a deep understanding of pedagogical strategies, assists teachers in making appropriate choices and decisions regarding the teaching of mathematics. Content knowledge as well as pedagogical content knowledge therefore plays an important role in teaching word problem-solving. The content knowledge is vital to planning. With an understanding of the content to be taught, the teacher has a sense of what needs to be done during a lesson and this is crucial in helping learners. Pedagogical content knowledge (PCK), i.e., knowing what to teach and how to teach it helps the educator to make informed choices.

In a study by Sabers, Cushing and Berliner (1991), the researchers concluded that teachers of varying levels of experience differ in the quality and level of perceptions, monitoring, and understanding of classroom events. These researchers concluded that classroom experience plays a significant role in teachers’ comprehension and interpretation of classroom organization and management. The research further suggests that novice teachers’ awareness of student cognitions as well as their interpretation of classroom management events may be expanded and deepened as they gain experience in classroom settings.

My recommendation is that mathematics teachers strive to find the balance between content knowledge and pedagogical content knowledge, as Shulman highlighted that these two concepts flow together and a teacher cannot implement pedagogical knowledge in the absence of content (5.3.1.4). The teaching strategies used in the class are not assisting learners.
5.4.1.3 The teaching strategies used in the class are not assisting learners

Learning how to solve word problems involves knowledge about semantic structure and numerical associations as well as knowledge of basic numerical skills and strategies. As related to the findings of this study it is recommended that approaches in the classroom should be altered or adjusted in order for the learners to learn the relevance of word problems in their everyday lives. For problem solving we ask learners questions that focus on their understanding of the problem, their ability to select and apply strategies for solving problems, their capabilities to implement and monitor a given strategy, or to communicate the meaning of a solution and reflect on that solution.

The first recommendation relates to ‘making word problems real’. ‘Real world’ problems challenges educators to think beyond the individual ability of learners and places emphasis on viewing mathematics within the context of activities, language and social and educational expectations that will affect the learner at some stage in his/her life. The wave of globalization has brought about an information and communication explosion, and has also exposed us to issues such as the HIV/Aids pandemic, global warming and the importance of establishing greener economies, recession, unemployment and currency volatility etc. thus requiring interdisciplinary knowledge and competence by learners in dealing with these non-routine problems.

Most learners learn nearly all their mathematics from other people rather than from books. Learning mathematics from other people means that you can engage in discussions and get immediate answers to questions. A further recommendation is that teachers should strive to create opportunities for learners’ to learn from each other by using peer-assisted learning activities during word problem teaching. A suggestion is that learners should not only be grouped in the classroom according to mixed ability groups with the sole purpose that the weaker learners will learn from the stronger learners. The purpose should be extended and this can be done by teachers starting their lessons daily by posing a complex written word problem on the writing board; telling students to think and consult with one another in solving the word problem. Afterwards the learners can be asked to share potential solutions with the whole class. This encourages learners to practice working on problem solving within a group.

Most learners that have trouble with word problems in mathematics either fail to read instructions or fail to understand the instructions they have read. The importance of language
in understanding word problems cannot be overstated especially because of the significance of language in learning mathematics. Teachers must therefore be made aware of the particular difficulties and complexities in the way language is used in word problems. One of the major language difficulties in word problems is the way in which learners will sometimes respond incorrectly to verbal cues in word problems. For example, (adapted from Key Concepts in Teaching Primary Mathematics) in a word problem that requires a subtraction but which contains the word ‘more’, the word ‘more’, because it is naturally associated with addition, will act as a miscue and prompt learners to add the numbers in the problem. The recommendation is thus that the teacher must teach correct, formal mathematical language in the mathematics class.

A further recommendation is that teachers explore the Theory of Multiple Intelligence, first described by Gardner (1983) and the Theory of Learning Styles. The theory of multiple intelligence views all individuals as intelligent beings. Gardner specified seven intelligences that enable the learner to solve problems and construct understanding. These intelligences include Linguistic intelligence, logical-mathematical intelligence, musical intelligence, spatial intelligence, bodily-kinesthetic intelligence, intrapersonal intelligence and interpersonal intelligence. The Theory of Learning Styles describes an individual’s preferred way of using his or her abilities or intelligences. Learners are typically described as either visual, tactile, or abstract, although other learning styles, such as auditory, and kinesthetic or a mix of the three already mentioned, are also found in the literature (Butler, 1987). Research on learning styles often centres on determining a person’s tendencies, which include the ways in which they see and interpret information as well as the tools they use when problem solving (Butler, 1987). Research further reveal that learners are more successful in learning mathematics when their learning styles are accommodated for in the classroom (Giordano and Weir, 2002:521). Taken together theories of multiple intelligence and learning styles inform the mathematics teacher with regard to (1) the nature of activities that will enhance the learning of all students, (2) the importance of addressing individual students, (3) the value of demonstrating various problem-solving strategies, and (4) the importance of encouraging students to develop problem-solving strategies that fit their learning styles (Giordano and Weir, 2002:520).
5.4.2 Recommendations for future research

The findings in this research study have confirmed to me, as a researcher, that teacher knowledge and teacher beliefs ultimately influence teacher practice. In discussing teacher knowledge, pedagogical content knowledge (PCK) was highlighted as an aspect of teacher knowledge identified by Shulman (1986). However, this study did not explore it as my focus was on providing a broad outline of teacher knowledge as directed by my research questions. Various definitions and discussions have emerged around PCK since Shulman highlighted this concept. My understanding is that it is directed at the content knowledge that an educator has of his or her subject, and secondly it refers to the teacher’s understanding of how the learner learns new concepts, and for the purposes of this study the focus is on mathematics teaching and learning. My recommendation is therefore that future research should be directed at exploring how PCK can be utilised in addressing teachers’ knowledge of the actual learning process with specific reference to learners in Grade 7 and how this knowledge can help to improve the learners’ progress in mastering word problem-solving.

A follow-up study should be conducted in order to explore new or alternative strategies that can be added to the already known standard list of problem-solving strategies as suggested by Polya (1945), which include working backwards, trying a simpler problem, diagramming the situation, and looking for patterns.

Research studies can be conducted with the purpose of monitoring student learning during problem-solving tasks. Such a study might be able to direct teachers on identifying backlogs in the learners’ learning process so that learners’ needs can be addressed immediately. Having knowledge of the learners’ progress on a daily basis will direct the teaching and the learning in the classroom.
5.5 STRENGTHS OF THE STUDY

The data collected during this study is not restricted to problem-solving pertaining to word sums only. The findings can be used by the teacher to address the general teaching methods and strategies that he or she practices in the mathematics class. Positive changes within the classroom and more especially in teaching word problems are now possible, as a concrete detailed proposal for change that is relevant and can be implemented has been made in the recommendations section in 5.3.

The findings raise awareness of difficulties that the learners in this study experienced when tackling word problems, therefore the study adds value to the educational context, as it can assist the mathematics teacher in planning learner specific learning support activities that can address individual learner needs. The findings and recommendations will further assist the teacher in making accommodations for individual learners’ specific barriers. Extra time can therefore be allotted to assist learners in exploring a variety of approaches to solve problems.

The study further informed the teacher on how to use a learner-reflection tool in order to determine the progress, backlogs and barriers that the learners experience in the mathematics class, allowing for the participants’ voices to be heard and for their difficulties to be acknowledged.

The study further highlighted the significance that teacher experience has on learner performance. This was evident during the lesson presentation and to some extent when analyzing the learners’ individual tasks. The teacher was able to indicate that she was able to anticipate learner errors based on the years of experience in teaching mathematics. Learners can therefore be assisted sooner and an intervention strategy can be implemented as soon as the learners’ needs are identified.
5.6 LIMITATIONS OF THE STUDY

A possible limitation of this study is that the scope of the fieldwork focused on the experience of one primary school teacher resulting in a very small sample. As such, not all readers will necessarily be able to relate the findings of this study to their own experiences.

A further limitation could be related to the limited experience I had in interviewing skills. I learnt through experience to maintain better control over the interview situation so that in future I will be able to guide the interviewee to stay focussed and not to drift from the point as was evident in the teacher interview. Knowing this prior to the interview would have provided me with more valuable information.

The focus group interview was conducted using semi-structured questions consisting of six learners. This proved to be a limitation as a second or third group discussion would have provided me with greater insight into how learners experience problem-solving tasks.

5.7 CONCLUSION

Chapter 5 was dedicated to drawing together the findings of this research. This chapter comprised a summary of the research inquiry and relevant findings indicated. Next I discussed possible recommendations, linked to the findings, which I believe may benefit participants from this study further. Lastly, I outlined the limitations that might have impacted negatively on the findings of this study and suggestions with regard to further research were detailed.

In conclusion the maths teacher must embody the belief that learners can succeed. This will lead to learners gaining confidence, however they need to hold these beliefs themselves. The researcher hopes that these research findings, and the recommendations given will make a difference not only to the participants in this study but also to transforming approaches to word problem-solving in mathematics teaching.
List of References


Vithal, R. 20005. Researching Mathematics Education In South Africa. HSRC Press. Cape Town


ADDITION A

- Sample: Informed consent/assent form

Informed Consent/Assent Form

*Project Title:

Mathematics teachers's knowledge of learner's and the learning strategies they use when confronted with word problems

*Investigator: Janice
Peters

*Date:

11 October 2010

I hereby:

D Agree to be involved in the above research project as a participant.

D Agree to be involved in the above research project as an observer to protect the rights of: D Children younger than 14 years of age;

D Children younger than 18 years of age that might be vulnerable*;

and/or D Children younger than 18 years of age that are part of a child-headed family.

D Agree that my child, ____ ____ _____ mav participate in the above research project.

D Agree that my staff may be involved in the above research project as participants.

I have read the research information sheet pertaining to this research project and understand the nature of the research and my role in it. In addition, I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested. I understand that I may withdraw from the study at any time.

D Please allow me to review the report prior to publication.

Name:
Phone or Cell number:
e-mail address:
Signature:

If applicable:
D I consent/assent to audio recording of my/the participant's contributions.
D I consent/assent to video recording of my/the participant's contributions.

Signature:

* Vulnerable children refer to individuals at risk of/exposed to harm (physical, mental, emotional and/or spiritual).

**Auckland Park Kingsway Campus**
Cnr Kingsway and University Road Auckland Park
Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have
been granted permission from the Gauteng Department of Education to conduct the research study.

2. The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.

3. A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.

4. A ‘errer / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.

5. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.

6. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.

7. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.

8. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.

9. It is the researcher’s responsibility to obtain written? Parental consent of all learners that are expected to participate in the study.

10. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes tariff telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.

11. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.

12. On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.

13. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the
14. Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

MIRMSA

[Member of the Institute of Risk Management South Africa]

CHIEF EDUCATION SPECIALIST: RESEARCH COORDINATION

The contents of this letter has been read and understood by the researcher.

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ADDENDUM B

- Excerpts of transcription of semi-structured interview

  6. Mrs.... for the class as a whole what is their

  7. anticipated attitude towards Mathematics?

  8. Participant: The class as a whole. Uhm, oh it varies. If I just picture the class that,

  9. was thinking of 7... there are certain ones of them that basically live for Maths but

  others they would be anywhere else rather than Maths. But as a whole

  11. think most of the time they, they tolerate Math. Let's put it that way.

Teacher Individual Interview

QUESTION:

WHAT ARE THE BELIEFS OF THE TEACHER ABOUT THE LEARNERS ABILITY TO SOLVE WORD PROBLEMS

Question 1: For the class as a whole, what is their anticipated attitude towards Mathematics?

A. Anticipating learner attitude towards Mathematics varies

B. Living for Mathematics for some learners

C. Avoiding Mathematics by wanting to be anywhere else rather than in the Mathematics class

D. Tolerating of Mathematics by some learners
Question 2: What, in your opinion, is the purpose of word problems in the Mathematics Curriculum?

A. Developing lateral thinking skills

B. Developing an ability to apply their knowledge to areas outside the field of Mathematics

C. Developing various problem solving strategies to apply in fields other than Mathematics

• Excerpts of transcription of focus group discussion

What do you find difficult about Mathematics?

44. Participant 1: Uh, I honestly struggle with long division

Focus group Interview-Transcript

1. Researcher: Now guys, I'd like to ask you a few questions. We're going to start with

2. Diane and then we'll, we'll end off with Lelo.

3. Comment from the group... laughter

QUESTION 1:

4. Researcher: What do you think

5. Mathematics is about?
6. **Participant 1:** I think a lot about fractions and figures and mostly just adding and subtracting.

7. **Participant 3:** Uhm, I think maths is about uhm, finding a way to use numbers in our

8. **Participant 2:** I think it is all about numbers, adding, subtracting and mostly fraction.

9. . . .

10. **Participant 4:** I think maths is about bored-ness.

11. Laughter from the group.

12. Researcher: Bored-ness

13. Laughter

**What strategies, if any, did you use when doing the individual problem solving activity?**

A. Writing down all the numbers in the story

B. Seeing if taking out the numbers will work

C. Trying to work it out

D. Dividing and Multiplying
E. Reading the story again

F. Suggesting that re-reading the story helps

G. Analyzing the sentence of the story

H. Simplifying numbers to see how to solve the problem

I. Working with simpler fractions

G. Trying to be creative with the numbers

- Excerpts of transcript of learner self-reflection tool

Adapted Self Reflection Tool Questions

Describe:

What it is you did firstly?

What you had to think about while doing-the problem solving activity?

What strategies you had to use in order to be comfortable with the activity

What did you do when you struggled with the activity?
A gold bar is divided into 20 equal parts. Each of these 20 parts is now divided into 10 equal parts. A gold medal is made from each of these smaller pieces.

1. How many gold medals will be made?
   - Operation: multiplication
   - Calculation: \(20 \times 10 = 200\) gold medals

2. If the whole bar of gold is worth R120 000, how much is each gold medal worth?
   - Operation: division
   - Calculation: \(\frac{120000}{200} = 600\) R

3. What fraction of the whole gold bar is each gold medal?
   - Answer: \(\frac{1}{200}\)

Further Observations:
- 8 learners answered this problem
- 6 got all correct
- 4 showed no working out (answer only)
- 8 interpreted No. 5 correctly
ACKNOWLEDGMENT OF LANGUAGE EDITING

Date: Monday, 03 October 2011

This is to certify that Language Editing has been carried out on the following Master's Dissertation:

A Mathematics Teacher’s beliefs and knowledge of Grade 7 Learner’s problem solving strategies during a problem-solving task

by JANICE PETERS

Language Editing was carried out to appropriate academic standards, including syntax grammar and style.

Andrew Graham (BA, MA dp., PhD, University of Keele, UK)*

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