

**LEARNER-CENTERED APPROACH IN THE TEACHING OF
MATHEMATICS: A CONSIDERATION OF TEACHERS'
PERCEPTIONS**

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**LEARNER-CENTERED APPROACH IN THE TEACHING OF MATHEMATICS: A
CONSIDERATION OF TEACHERS' PERCEPTIONS**

By

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Degree of Doctor of Education in the Department of Mathematics, Science and Technology
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DECLARATION

I, Jaime da Costa Alipio hereby declare that “*Learner-centred approach in the teaching of mathematics: A consideration of teachers’ perceptions*” is my own work both in conception and execution and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

Signed by _____
on the _____ day of _____ 2014.

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ABSTRACT

This research was designed to ascertain teachers' perceptions on learner-centered teaching in the discipline of mathematics in basic education. The first aim of the study was to determine the extent to which teachers background training contributes to perception of learner-centred approach in the teaching of mathematics. The second aim sought to determine the extent to which teachers professional experience contributes to perception of learner centered approach in the teaching of mathematics. The third aim of the study was to determine the extent to which teachers background training contributes to learner-centred practices in the teaching of mathematics. Lastly, the fourth aim was to determine the extent to which teachers professional experience contributes to practices of learner-centred approach in the teaching of mathematics.

To achieve the aims, a questionnaire and observation schedule were designed to collect the data. The questionnaire was primarily subjected to validation by the researcher through Exploratory Factor Analysis (EFA). This instrument was first administrated to three hundred and nine primary school teachers of the provinces of Inhambane, Gaza and Maputo.

After the piloting was performed the final version of the questionnaire was then applied to four hundred eight six primary school teachers and from this sample three hundred seventy three completed and returned the questionnaires. The returned questionnaire were then correctly analyzed. Three of four aims were connected to four hypothesis.

To evaluate whether teacher background training and type of training have significant effects on teacher perceptions of learner-centred teaching approach an ordinal regression analysis was performed. To test whether would there be a relationship between teachers' professional experience and their approach to teaching mathematics and whether will there be a relationship between teachers' background training and their approach to teaching mathematics, a Chi-square

test of independence was used. To evaluate whether teachers use learner-centred teaching an observation schedule was also used.

The results show that teachers teaching experiences as well as type of training did not have significant effect on their perceptions of learner-centred teaching.

The results of this study have also shown that teachers' professional experience as well as the type of training teachers have received in teaching methods have no significant effects on the type of approach (teacher or learner-centred approach). Teachers of basic education prefer to use both approaches when they teach mathematics.

Results from observation schedule show that teachers do not use learner-centred approach. Instead, they use teacher-centred teaching.

Lastly, the results were discussed taking in account the literature reviewed within the framework of educational psychology applied to mathematics teaching. Finally suggestions were made on how to understand more deeply the question of teachers' perceptions of learner-centred teaching. The most important suggestion is that research should be done regarding teachers mathematics self-efficacy, how teachers perceive their own knowledge of learner-centred approach and how do they practice it.

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CHAPTER ONE

1. MOTIVATION FOR THE STUDY

1.1 INTRODUCTION

Despite efforts to bring new teaching methods in education, conventional methods such as lecturing still being the most used methods in classroom mathematics. Lecturing is a part of what is called conventional methods which includes Montessori methods, dramatization method, inquiry method, project and field trip among others (Adeyemi, 2008:695). Each individual has his own learning particularities. When teaching is based only in lecturing method without taking into account learners learning characteristics the effectiveness of such teaching can be questioned. Traditional approach also fails to take into consideration the idea that teaching and learning might best occur when learners' needs and experiences are considered.

However, certain factors such as culture, teachers' perceptions and beliefs could act as barriers for implementing new approaches to the teaching and learning of Mathematics. Other aspects, such as overcrowded classrooms, extra-curricular responsibilities after teaching hours and low background training affect quality teaching in Mathematics.

The departure to new teaching approaches is built on the belief that the traditional approaches are inefficient in helping students to learn school curricular content. The traditional approach explains learning in terms of behaviourism theories. Behaviourists consider learning as sequential and hierarchical – a process that takes place when bits of separated knowledge are accumulated. They believe that transfer of learning can only occur in a situation where there is a high degree of similarity. Instruction based on this type of teaching tends to focus on low-level skills, especially for learners with poor achievement.

These beliefs promote a curriculum with clearly specified instructional objectives and control of each learning step (Shepard, 2000). Essentially, traditional curriculum focuses on programme content and discipline with sequentially described methods (Niquice 2002: 97), rather than focusing on the process that leads to an effective learning.

Assessment in traditional curriculum is perceived as a sequence of testing aimed at accomplishing what is written in the programme. Testing is, therefore, given an important role since it is aimed at verifying whether learners have correctly mastered each learning step before proceeding to the next objective. In such a learning environment, students are not keen to risk themselves, and are inflexible in demonstrating their skills and intellectual competences (Shepard, 2000:23).

A learner-centred approach is a teaching and learning approach based on a constructivist theory of learning, which advocates the inclusion of learner experiences in teaching and learning. Imasiku (2006) maintains that, in a learner-centred approach, teachers involve learners in the learning process. The constructivist model of learning is based on the assumption that knowledge and understanding are constructed within a social context and learning occurs when deep understanding and support is observed. Constructivism addresses learning processes, as well as learning outcomes, and considers that learners may have the same opportunity to learn.

Contrary to the traditional curriculum, the learner-centred curriculum (the curriculum which is based on constructivism) is based on the fact that in the learning process, learners contribute their experiences from their own environment. These experiences are used to acquire new concepts in the classroom. Those experiences may be the subject of analysis by the teacher during the teaching and learning process. Assessment in this type of curriculum is meant to develop students' higher order thinking.

Shifting from one teaching approach to another is an intricate process. It involves changes in attitude, perception and in the beliefs of those who are directly connected to the education process (teachers, learners, and education policymakers). It also involves the training of teachers, as being the main force that is going to act in the classroom. Less confident teachers will not take risks as to implementing new approaches.

However, most teachers are trained in a teacher-centred environment and, as this approach was dominant in the past, they might probably continue acting within this default framework and thereby affecting current teaching practices. Teachers may feel professionally pressurised, and therefore continue using teacher-centred teaching.

On the other hand, the terminology that is used to describe the learner-centred approach seems to be vast, and sometimes less accurate to describe the learner-centred approach. Learner-centred teaching can sometimes refer to process that is organised by teachers to help a learners acquiring knowledge (acquisition of knowledge), the learner activity in the classroom or the role of teacher in learning and teaching process. This confusing meaning of what learner-centred education is about can contribute or hinder the acceptance of use of these approaches by teachers (Blumberg, 2009:4) in classroom Mathematics.

Another factor that is due to influence learner-centred approach is that of teachers' beliefs. Teachers' system beliefs towards teaching practices can emanate from personal experience and extend to popular culture (Shepard 2000:4). Once they have become part of daily teaching practices, the beliefs may implicitly influence teachers' teaching strategies. Consequently, teachers who are influenced by a teacher-centred approach may resist applying new teaching approaches.

Abusive use of the teacher-centred approach to teaching may exacerbate students' problems in acquiring learning concepts in many school subjects. Research results suggest that learners are

often incapable of reaching a required level of comprehension and cognitive skills development due to excessive use of the teacher-centred approach. Such learners tend to demonstrate a low level of comprehension and cognitive skills in Mathematics, Portuguese Language and Social Sciences (The Strategic Plan of Education and Culture, 2006:22-23).

1.2 STATEMENT OF THE PROBLEM

In 1999, the educational authorities drew the first strategic plan for education after democratic elections in 1994. This strategic plan was due to be implemented during six years from 1999. The implementation of the education strategic plan was in parallel with curriculum reforms in basic education, the second major curriculum reform at this level after the country became independent in 1975. After 2005, more and other strategic plans were designed (2006-2011 and 2012-2016) and in all of them, an emphasis on improvement of the quality of education was declared. To reach the objective of quality education, the government committed itself to review the curriculum, to improve teacher training college infrastructures and to train and develop teachers' teaching skills through various professional development programmes (Ministry of Education, 2006; 20012). In line with this policy, twenty six, state owned teacher training colleges were built to cover the needs of training teachers in basic education.

Despite the effort made by the government in building new training colleges and revising the teacher training curriculum, as well as basic education curriculum, educational authorities acknowledge that teacher training colleges' curriculum still emphasises the use of methods that favour prescription (the teacher-centred approach) to the detriment of student-oriented teaching, and on the other hand teacher lack of teaching experience and knowledge to implement new teaching approaches (Ministry of Education, 2004). This aspect may afterwards affect in-service teachers' teaching practices in Classroom Mathematics.

The new curriculum of basic education introduced in 2003 orient that teaching in all disciplines must be based on constructivist theory of learning (Ministry of Education, 2003). This

curriculum urges teachers to be more creative in using approaches that facilitate students' learning of subject content in the classroom. The same curriculum emphasises the importance of assessment as part of teacher's daily activity and the notion that it accompanies the teaching and the learning process.

Although in the last two decades, efforts to achieve quality in basic education were made, especially in terms of building new schools or new teacher training infrastructures, the level of knowledge in teaching methods teachers possess still represent challenges to meet the demands of the new curriculum. The teacher training strategy drawn by the Ministry of Education focuses mainly on basic and medium training. Candidates are recruited among grade ten graduates from secondary schools and spend one to two years of training in teaching methods with little or no teaching experience whatsoever. Teachers who participate in one year postgraduate mathematic courses have little time to develop mathematical subject knowledge and the mathematics experience brought by them may impede the acquisition of new knowledge (Witt, Goode & Ibbett, 2013).

Statistics from the Ministry of Education (2013) reveal that there are 24,223 teachers employed in basic education in Mozambique. From this total, 2,371 have no training in teaching methods at all, while only 1,167 from this total have a university degree in teaching. About 8,700 teachers are trained at medium level and the remaining 12,779 are trained at basic level. This shows that teacher preparation to meet the demands of constructivism curriculum is still a challenge since the greater majority of teachers are not well prepared.

Despite the effort of bringing in a new teaching approach to the curriculum to enhance students' learning, the achievement results of those students who terminate grade five are not very encouraging. Although results from the annual schools' survey published by the Ministry of Education of Mozambique indicate a higher percentage of pass rates (83%) from grade one to five in 2012, in the whole country, the failure rates in some provinces, namely Gaza province (12.3%), Maputo province (14,8%) Maputo City (14%) and Sofala Province (10, 4%), continues

to be higher (Ministry of Education, 2012:9). It is also acknowledged that the mathematics achievement of Mozambican students in grade six, when compared with their counterpart of Southern Africa Development Community (SADC) region, show a decrease of their performance. Magaia, Nahara and Passos (2007) have found that the level of achievement of grade six pupils in reading (476) and mathematics (484) was below average when compared to the overall average of SACMEQ countries, with 512 and 510 respectively.

Contrarily, mathematics students' achievement in some OECD countries and partners has been continuously increasing. Countries such as China, Singapore, Japan, Korea, China-Hong Kong and China-Taipei are among those whose students reach high level of mathematics proficiency (PISA, 2009). Results from TIMSS indicate also that over the past 16 years, since 1995, twelve countries have experienced an increase of fourth grade students' achievement in mathematics (Mullis, Martin, Foy and Arora, 2012:7). The reasons for the increase or decrease of mathematics students' achievement has been linked to various factors. For instance, the GDP per capita accounts for 6% of difference of students' performance, while public policies account for 94% (PISA, 2009). Mullis, Martin, Foy and Arora, 2012, have found that teacher preparation and high confidence in teaching mathematics was also related to higher mathematics achievement in fourth and eighth grades.

In Mozambique, most teachers have lack of sufficient training and most of them are trained in a teacher-centred environment. Teachers may feel professionally pressurised, and therefore continue using teacher-centred teaching. On the other hand, the shift from one approach to another involves attitude changes as well as perceptions and beliefs towards teaching. Thus, it also requires well trained, experienced and confident teachers. Less confident teachers will not take risks as to experiencing new approaches. This study will add a new understanding of what numerous researchers have found towards teaching and learning of mathematics.

Mathematics is a science that is based on numbers and mostly it requires that learners should be able to think and work by using logic. One of the most difficult aspects on teaching this

discipline is how to transmit and develop logical thinking in learners. Yet, the most difficult task would be to assure that learners' logical thinking is developed.

The objectives of the learner-centred approach to Mathematics is to develop learners' problem-solving abilities, such as acquiring a variety of methods of computation by solving problems; of communicating with each other about the ways in which they solved mathematical problems and; by developing good attitudes towards learning Mathematics as well as in developing a positive self-image.

The Mathematics curriculum in the 5th grade of basic education in Mozambique sets three levels of knowledge that have to be attained by learners, namely:

- a) Understanding: the learner is required to understand the concept of numbers, space, measurement, logic and relations;
- b) Interpretation: the learner is required to interpret, read, speak and write using mathematic language; and
- c) Application: the learner is required to use his or her knowledge in daily problem solving.

To attain these goals, teachers of basic education are urged to use learner-centred approaches. The position taken by curriculum designers, therefore, seems to be ambiguous because, to a certain extent, such an approach creates a contradiction between the current level of training and the teaching experience teachers possess and their practices in the classroom.

The current situation in teacher education shows that:

- a) A great number of teachers in basic education have no further training in learner-centred teaching methods;

- b) Teacher training programmes, especially at teacher training institutions, still emphasise traditional teaching methods as the main pedagogic approach; and
- c) Most of those who have received training in those institutions are employed in teacher-centred environments.

This situation may affect teachers' beliefs or perception about learner-centred teaching and somehow confusing them whether to apply a learner-centred approach in mathematics classrooms.

The research questions are:

- 1.2.1 Does teachers' background training contribute to their perception of the learner-centred approach in the discipline of mathematics?
- 1.2.2 Does teachers' professional experience contribute to their perception of learner-centred teaching in the discipline of mathematics?
- 1.2.3 Is there a relationship between teachers' background training and their teaching approach in mathematics classrooms?
- 1.2.4 Is there a relationship between teachers' professional experience and their teaching approach in mathematics?
- 1.2.5 Do teachers use a learner-centred approach in the teaching of mathematics?

1.3 THE AIMS OF THE STUDY

- 1.3.1 To determine the extent to which teachers' background training contributes to their perception of a learner-centred approach in the teaching of Mathematics.
- 1.3.2 To determine the extent to which teachers' professional experience contributes to their perception of a learner-centred approach in the teaching of mathematics.

- 1.3.3 To determine the extent to which teachers' background training contributes to learner-centred practices in the teaching of mathematics.
- 1.3.4 To determine the extent to which teachers' professional experience contributes to practices of learner-centred approach in the teaching of mathematics.
- 1.3.5 To conduct classroom observations on the use of the learner-centred approach.

1.4 FORMULATION OF HYPOTHESIS

- 1.4.1 H1= There is a relationship between teachers' background training and their perceptions of the learner-centred approach in the teaching of mathematics.

Ho= There is no relationship between teachers' background training and their perceptions of the learner-centred approach in the teaching of mathematics.

- 1.4.2 H1= There is a relationship between teachers' professional experience and their perception of the learner-centred approach in the teaching mathematics.

Ho= There is no relationship between teachers' professional experience and their perception of the learner-centred approach in the teaching of mathematics.

- 1.4.3 H1=There is a relationship between teachers' background training and the approach they use in the teaching of mathematics.

Ho= There is no relationship between teachers' background training and the approach they use in the teaching of mathematics.

- 1.4.4 H1=There is a relationship between teachers' professional experience and the approach they use in the teaching of mathematics.

Ho= There is no relationship between teachers' professional experience and the approach they use in the teaching of mathematics.

The study also sought to find out whether teachers practise a learner-centred approach in the classroom.

1.5 DEFINITION OF TERMS

This study is based on Piaget and Vygotsky's constructivist theory of learning and the concepts related to this study are selected from these theories.

1.5.1 CONSTRUCTIVISM THEORY

Constructivism is a theory that asserts that learners' knowledge and understanding is a process of construction on which content is highly iterative, subjective and requires the use of a multiple systems or mental constructs (Leonard, 2002). It is a philosophical approach about how learners come to know and understand and think, and it is based on the assumption that during learning learners interact with environment, and their cognitive structures are placed in conflict and the knowledge is negotiated (Savery and Duffie, 1996). In constructivism learning environment learners are urged to work together, use different tools (Wilson, 1996) and are supplied by information that can enable them to confront what they learn. In Mathematics teaching, learners are encouraged to engage themselves in activities that enhance the construction of knowledge.

The Learner-Centred Model (LCM)) is a theoretical model which focuses on the process of learning by learners. Learner-centred education is a learning that considers the learner as an active, inquisitive being who strives to acquire knowledge about his or her surrounding world. According to McCombs (2009:35), the "Learner-Centred Model consists of a variety of materials, guided reflection and assessment tools that support teachers and administrators' effectiveness and change at the individual and school levels". Concomitantly, LCM evidences which factors impact learners and learning.

The starting point of LCM is to know who the learners are, their characteristics and their needs. The knowledge of the learners includes their social characteristics, as well as the individual ones. However, the knowledge of learners' characteristics will not per se be enough to carry out the educational process. The LCM also emphasises the understanding of learning, as well as the strategy of how this learning can be supported in order to embrace all people in the system. Lastly, the decisions which practices should be taken in the school, or in the classroom, depend upon what sort of knowledge learners should possess. Teaching Mathematics by means of the learner-centred approach facilitates the learning process by allowing learners to develop logical thinking and helps them to discuss mathematical problems through questioning and making conjectures.

The word 'teachers' will be used to cover primary school teachers, teacher trainees and other personnel. The word learner will refer to pupils.

1.6 PLAN OF THE STUDY

The research is organised as follows:

1.6.1 CHAPTER ONE

This chapter includes: motivation of investigation, statement of the problem, aims of the study, the hypothesis and the plan of the scientific report.

1.6.2 CHAPTER TWO

This chapter focuses on the theoretical background of the study and discusses the main theories of learning focused on constructivism and behaviourism.

1.6.3 CHAPTER THREE

This chapter is concerned with literature review and presents the studies carried out in the discipline of mathematics taking in account the learner-centred approach.

1.6.4 CHAPTER FOUR

This chapter discusses the research design and methodology of the study in detail. It also describes how the data collection instruments were designed, the data collection process and the sampling method and data analysis.

1.6.5 CHAPTER FIVE

This chapter focuses on the analysis and interpretation of data and on hypothesis testing.

1.6.6 CHAPTER SIX

This chapter focuses on the findings of the research study.

1.6.7 CHAPTER SEVEN

Chapter six contains the conclusion and recommendations.

CHAPTER TWO

2.0 GENERAL THEORIES OF LEARNING

2.1 INTRODUCTION

The core of this chapter is to discuss the nature of learning in the light of different psychological theories namely associationism, behaviourism, and constructivism and analyse their implication in classroom mathematics. From the centuries past, learning has been viewed and treated in different perspectives. These differences can be attributed, on one hand, to the lack of solid foundations of educational sciences, but on the other, to claim that every educational movement has its own theoretical foundations. Since then, the concept of learning has been drawn from two main pre-scientific views; associationism and rationalism.

2.2 THE ASSOCIATIONISM AND BEHAVIOURISM THEORY OF LEARNING

In the past century, human learning was dominated by the influence of traditional theories based on behavioural psychology. These theories are based on associationism philosophy which basically considers complex behaviour as emerging from combination of small simple behaviours. Therefore, learning will rise from association of small bits that associate themselves and form a concept. The Behaviourism, it can be considered as the extreme version of associationism, since it focuses on the association between human behaviour and environment. Behaviourism considers that human thinking, as a whole, can only be understandable through analysis of external behaviour based on a/the stimulus response (S-R) mechanism.

The philosophy of associationism and behaviourism shaped the education system in America through the rise of the so called social efficiency theory (Shepard, 2000). The movement,

supported by sociologists, psychologists, business leaders, as well as politicians, defended that principles of scientific management applied to maximise the efficiency of the factors can also be applied with success to improve students' achievement in schools (Shepard 2000:6). These principles in education gave rise to the so called technocentrist pedagogy, the pedagogy that is based on rationalisation of educative act.

To maximise the process of teaching and learning, technocentrist pedagogy appealed to the use of a rigorous, systematic, scientific approach when dealing with educational issues. This approach to learning found its basis in pedagogy, by objectives defended by Bloom and Guilford. These scientists argued that to promote the student as an active learner, teaching should be programmed and oriented towards discovery and reconstruction (Altet, 1997:27). Programmed learning or learning by objectives creates such situations on which a learner would act by him or herself at his or her own pace, however students' tasks should be organised by the pedagogue. According to Altet (1997:27), the role of the teacher in programmed learning would be to manage all situations that are related to the process of teaching and learning and evaluate the products and processes in accordance to objectives previously stated.

Technocentrist pedagogy constituted the fundamentals of aspiration of the social efficiency movement, which had its support from associationism philosophy. The tenet of the social efficiency movement, concerning curriculum, was that instructional objectives be specified in details and people be taught according to everyone's vocation (Shepard, 2000). Such type of curriculum proposed to eliminate useless contents and keep what is strictly necessary for the learners. Teachers need only to teach students the association they need to learn (Anderson, Reder, & Simon, 1998:227) or that is they should tell the content so that learners can memorise it.

Because teaching every step would lead to a bulky curriculum, there was a need for establishing precise standards of measurement to determine who is best suited in each profession. Thus, teaching objectives were highly specified and tracked by ability. The technocentrist view of

learning is based upon the idea that learning is built in blocks and during teaching all steps must be taught specifically (Sheperd, 2000).

Associationist and behaviourist theories of learning dominated the school curriculum during the greater part of 20th century and have influenced teaching. Some of the learning principles defended by associationists and behaviourists can be found in table 2.1. The associationism of Thorndike and behaviourism of Hull, Skinner and Gagne were the most prominent theories of learning. Thorndike's view of learning is that it occurs following the principle of elemental building blocks (Shepard, 2000:9). Physical and mental events are formed, associated and then perceived by the individual. During the process of learning, the learners select the physical and mental units and perceive them. This process is somehow mechanic and passive. Trial and error learning rises from this process.

Thorndike's experiments with animals elucidate how successive attempts in animals to get food in a cage can lead to learning. He showed that animal can gradually build a connection or association between the useful movements in consequence of which the perception of the situation is immediately translated into appropriate activities (Koffka, 2000:172). That means that the animal will conduct several responses until the correct one is found. This almost happens automatically. In teaching process such as problem solving, similar trials occurs until the correct answer is achieved.

The association of facts can happen when teacher asks a learner to respond to a stimulus such as "2x3=?". The learner responds with the correct answer "6". She or he establishes a connection between the stimulus 2x3 and the response "6" through the symbol "=" (Calderon, 1998:47).

Calderon (1998) stresses three main laws of learning, stated by Thorndike: (1) The *law of readiness*, (2) the *law of exercise*, and (3) the *law of effect*. The *law of readiness* argues that when an organism is ready to act, action is satisfying; inaction is annoying. That means that if a particular learner is sure about a certain question, she or he will be ready to answer the question

and that situation creates a satisfaction within her or him. If she or he fails to answer the question, he or she will be annoyed. In that situation, a teacher may assign tasks with low level of difficulty to less mentally able learners, and more difficult task to those with superior mental ability. The *law of exercise* is concerned with repetition of a task. The more the learner repeats the task, the more the learning is reinforced. According to this law, teachers who wish to teach their learners multiplication, division, sum, or subtraction, may ask their learners to repeat the multiplication table.

The *law of exercise* establishes that when a certain task gives satisfaction to a learner it strengthens the learning. This would be in that sense that the teacher makes the lessons enjoyable by praising learners who perform well.

Table 2.1 Curriculum and learning in traditional teaching. Adapted from Shepard (2000)

Curriculum	Learning
<p>Use of scientific approach for school management.</p> <p>Educational objectives must be set in conjunction with careers.</p> <p>Practical school content.</p> <p>Use of exact and scientific tools to measure learners' knowledge.</p> <p>Separated curriculum for each social status.</p>	<p>Use of hereditarianism theories to characterise intelligence.</p> <p>Learning is based on Associationist and behaviourist theories.</p> <p>Concept of mind replaced by stimulus-response associations.</p> <p>Knowledge is a result of successive accumulation of atomic bits.</p> <p>Learning is sequential and hierarchical.</p> <p>Each learning objective is clearly taught.</p> <p>To guarantee that students are learning teacher must test-teach-test.</p> <p>Tests isomorphic with learning.</p> <p>Motivation is based on positive reinforcement of each learning steps.</p>

Thorndike's theory is based on the fact that both animal and human solve problems through the process of trial and error ((Kein & Mowrer, 1989:7). Although Thorndike's theory seeks to explain the sequence of learning, there are some other processes that occur for learning to take place rather than mere repetition of movements.

Weiten, Lloyd, Dunn and Hammer (2009:46), and Bustus and Espiritu (1996:34) assert that even Pavlov also recognised that his theory of classical conditioning was not the only one that explain conditioning. There are other forms of conditioning. While Pavlov's classical conditioning centred on how reflexive responses are controlled by stimulus, Skinner's operant conditioning seeks to explain learning as a process on which voluntary responses are controlled by their consequences (Weiten et al., 2009:46).

In his experiments with rats, Skinner tried to show that responses that are followed by favourable consequences tend to be repeated, while those with negative consequences will not. This occurs when positive responses are strengthened when followed by pleasant stimulus, while the negative ones are punished. Skinnerian theory views learning as depending on the contingent factors. Teachers should previously prepare contingencies to turn learning more efficient. That is, they should arrange situations that allow learners to learn.

Another behaviourist who was interested about learning process was Gagne. Gagne's theory focused on learning capabilities and the internal and external conditions required for these capabilities to be learned (Zimmerman & Schunk 2003: 305). His research was directed to problem solving, conceptual learning, learning hierarchies and learning outcomes of intellectual skills.

Gagne's theory of cumulative learning is based on the fact that learning depends primarily on combining previously acquired and recalled learned entities, as well as on their potential of the transfer of learning (Zimmerman & Schunk 2003:311). That is, learners acquire knowledge as they progress from low to high level (Klausmeier & Goodwin, 1977:38-39) and learning of simple to complex is sequential (Johri, 2005:168). He related the development of aptitude to eight hierarchical types of learning that range from learning of a signal to problem solving (figure 2.1)

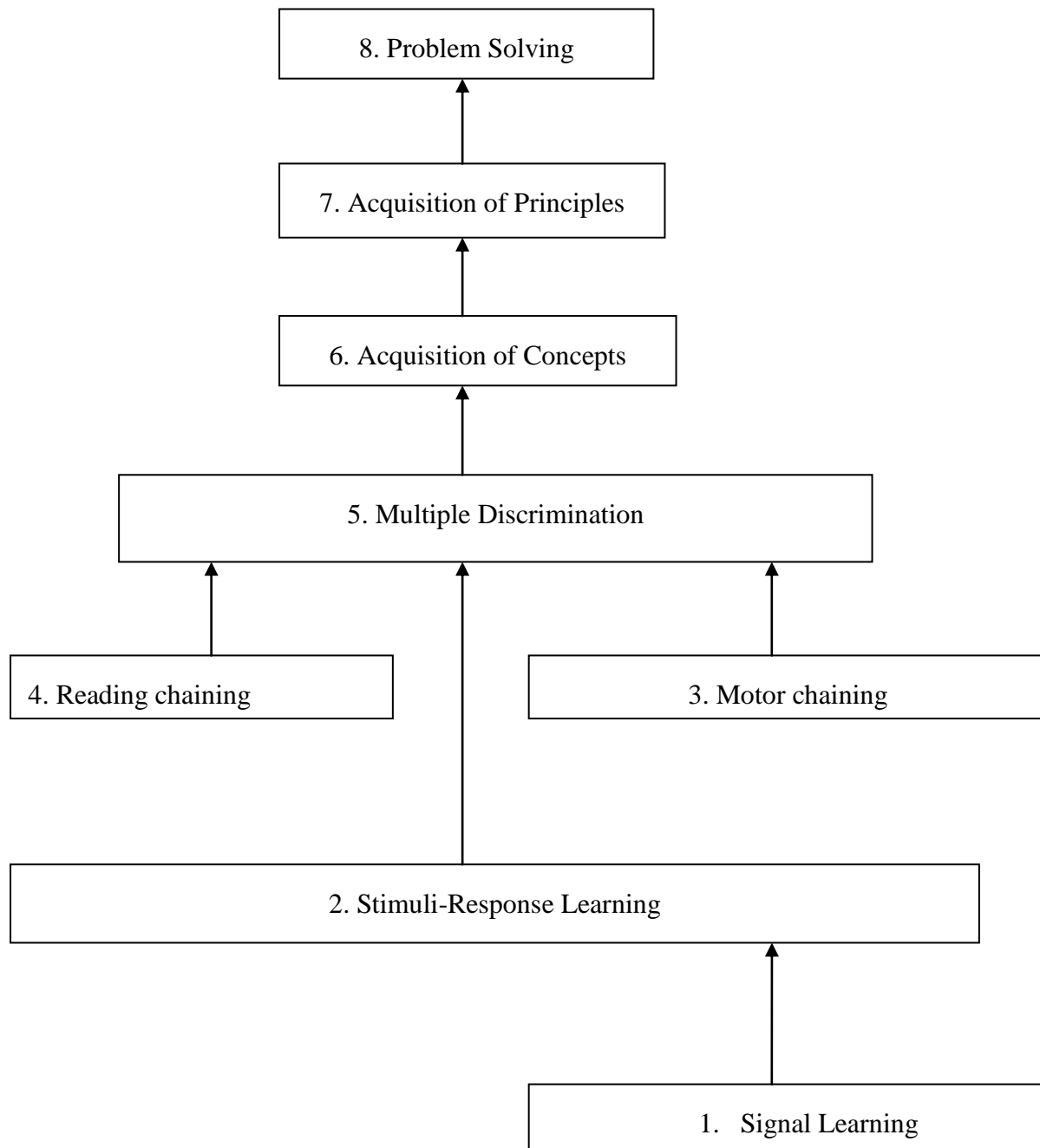


Figure 2.1 Types of learning. (Adapted from Klausmeier and Goodwin, 1977:39)

Signal Learning is learning that is based on classical conditioning theory. As mentioned above, classical conditioning learning follows the S-R process stated by Pavlov. Thus *signal learning* occurs when two (conditioned and unconditioned) stimuli are matched together. In this case, the

learner will respond in the same way to the conditioned one. These two stimuli are temporary contiguous which results in association of the both. Individual preferences and dislikes can also be acquired through signal learning. This kind of learning is involuntary, emotional and diffuse (Johri, 2005:163).

The *S-R learning* consists of applying certain movements from muscles in response to some specific stimuli. Verbal responses such as seating, turning or walking are related to S-R learning and are performed by learners in their first year of schooling.

Motor and verbal chaining consists of combining two or more separate responses in order to develop complex abilities. For instance, two words can be combined to form an association of words. Teachers use this type of learning when they ask learners to write the alphabet, and memorise numbers or formulae. To develop such type of learning rehearsals and contiguity are essential.

Discrimination learning is characterised by discrimination of responses that the learner has already mastered. The process is similar to learning through a signal. A learner acquires knowledge of a certain type of concept numbering, for example, odd numbers and consecutively the even numbers. She or he must be able to discriminate between the two concepts. Multiple discriminations can occur when the learner is able to distinguish several responses mastered through the S-R process and connect them to new learned words. Although chains of known words is not seen as prerequisite for learning, to accomplish multiple discrimination requires learner to distinguish chain of words, for instance, the learning of the alphabet or successive numbering. Before schooling, learners learn to distinguish properties of objects (liquids, words). Each time they encounter a new word they have to associate it to a chain of words they have learned.

2.2.1 Concept learning

For Gagne, the learning of concepts is also based on the S-R process. From a known concept a learner could be able to give more examples without additional learning. However, to acquire a new concept, the learner should be able to discriminate one concept from the other, highlighting the common and different characteristics. The process of learning new concepts also requires repetition.

2.2.2 Rule Learning

The acquisition of rules on Gagne's view also follows the S-R process. If a learner answers correctly a given question posed by teacher, for instance that equilateral triangles have similar form, it is assumed that the learner has mastered the rules. However, to avoid mechanic responses, the answers given by learner might be consistent.

2.2.3 Problem Solving

Gagne sees problem solving as learning of higher order rules, in which higher order rules are combined and used for understanding the situation (Johri, 2005:171) and it involves the use of individual inner events such as thinking. Problem solving requires the use of rules.

Gagne's hierarchy is important for teaching since teaching complex skills requires that one concentrates on the subordinate skills to ensure that learners have mastered them. Subordinate skills are a precondition for learning new material.

Associationism and behaviourism seek to explain all the aspects of how learning is processed and translated to human behaviour. Thorndike explains how reinforcement and S-R bonds are

processed, and Skinner is concerned with reinforcement schedule. Gagne explains the process how in cumulative learning individuals develop high level abilities or acquire high level knowledge building successively their aptitudes in blocks. These theories all give important insights of how learning should occur.

Behavioural theories emphasise the role of the teacher in the teaching process. The teacher is seen as the transmitter of the knowledge to the learner. She or he prepares learning contingencies, plans the teaching steps and determine the objectives and the learning behaviour that must be shown by learners. A learner is a passive, waiting for the teacher, to be taught.

2.3 THE RATIONALIST AND LEARNING

The doctrine of rationalism was first propelled by Plato when he first considered the live world as intelligible and the knowledge we have from it as a projection of our innate ideas. Later on, this doctrine has nourished the thoughts of Kant, Descartes and Leibniz, and was revised by current cognitivist psychologist movement followers such as Fodor, Chomsky, Piaget, Ausubel, Bruner and Vigotsky, also known as interactionists or constructivists. Rationalism is opposite to associationism, since it builds and maintains the view of mental structures and defends that learners should be allowed to build their own knowledge and discover what they really need to learn (Anderson, Reder, & Simon 1998:228). Contrary to behaviourists, who seek to explain learning on the basis of stimulus and response, and also on the role of environment in learning, cognitivists view learning on the basis of individual internal processes that interact with the surrounding environment. Altet (1997:30) states that constructivists can be interpreted as an individual personal appropriation or a process in which an individual constructs by himself the sense of things.

Rationalism gave origin to what is known as cognitive psychology. Cognitive science is also considered as the science of mind and it is concerned with how people acquire knowledge and

how they use this knowledge. It involves mental processes such as perception, memory, problem solving, reasoning, and decision making.

Cognitive science is based on two principles: the *information processing*, and *knowledge types and knowledge representation*. Information processing theory asserts that humans are much like computers and they process their information. McGilly (1998:4) states that information, in the form of symbols or symbolic representation, enters and activates particular cognitive processes that result in physical and mental actions. Thus, information processing theory is concerned with how the information is encoded in symbols or represented.

The second principle of cognitive science is related to the types of knowledge and knowledge representation: the cognitive and metacognitive knowledge. Metacognitive knowledge is a formal knowledge that is kept in the memory which also includes different models of cognitive processes, the information about people and about tasks, and strategies and goals (Vanderswalmen, Vrijders & Desoete, 2010; Flavell, 1981). Vanderswalmen et al., (2010) argues that metacognitive tasks involve how an individual makes relations between tasks, their categories and features and how are they processed, while metacognitive strategy-knowledge is related to the use of multiple strategies and the condition under which those strategies may be applied. They added that in metacognitive strategy, in goal-knowledge, the individual is aware about what kind of goals he or she can chase when performing certain task or facing a situation of some kind.

Metacognitive skills may include strategies used to monitor and regulate one's own learning such as planning strategies or which strategies to be used during learning (McGilly, 1998:5). Knowledge is represented, or stored, in memory as isolated and disconnected pieces of information, or in large and interconnected bodies where pieces of knowledge are conceptually linked to other pieces.

Impelled by recent developments in cognitive psychology recently, a new rationalist movement called constructivism has influenced mathematics education. There are several versions of constructivism schools, namely, simple constructivism, radical constructivism, and social constructivism. The different versions of constructivism converge in the way they view knowledge. Beside the fact that they consider knowledge as a process subject to construction, they also emphasise that understanding is a building of mental structures. This is different to the view of behaviourists who consider understanding as building up from received pieces of knowledge. For constructivists the construction process comes first.

Simple constructivism is based solely on one constructivism principle alone which asserts that knowledge is not received passively, instead it is an active process which is constructed through cognizance. Compared with the behaviourism view of knowledge, simple constructivism represents a shift towards recognition that knowledge is active, individual and personal, and based on previously constructed knowledge (Sriraman & English, 2010:40). This is a principle that is also defended by other types of constructivism. In terms of implications for educational practices, simple constructivism is sensitive and pays more attention to learners' previous learning and constructions, as well as with identification of learners' errors and misconceptions and the use of diagnostic teaching and cognitive conflict techniques in attempt to overcome them (Sriraman & English, 2010:45).

Radical constructivism has its strong hold in mathematics education and emphasises discovery learning, learning in complex situations, and learning in social contexts (Anderson, Reder & Simon 1998:229). It also shares positions from general rationalism, as well as two other movements, that vividly influenced the modern schools of education. Such movements are: situated learning and deconstructionist critical theory.

According to Joworski (1994:15), radical constructivism has its foundation in two principles: (1) knowledge is not passively received but actively builds up by the cognising subject and, (2) the

function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality.

Radical constructivism sees learning as an active process in which students attempt to resolve problems that arise as they participate in the mathematical practices of the classroom (Anderson, Reder & Simon 1998:230). It emphasises the role of individual characteristics on what is to be perceived and known (Carr, 2006:116).

Constructivism can be described as a theory of learning and knowledge since it attempts to approach how people get to know things from the Nature and what is in fact knowledge and how is it constructed. It is also considered as a theory of teaching, because it approaches education in a different way to those conceived by traditional teaching approaches.

Having nourished its experiences from other sciences such as psychology, anthropology and philosophy, constructivism describes learning as temporary, developmental and socially constructed and culturally intermediated. This theory describes knowledge as temporary, internally constructed, developmental, non-objective, social and culturally intermediated (Fosnot, 1998: xxi). Educational practices for radical constructivism is that it takes in to account learners' perceptions as a whole, i.e. of their overall experiential world, the problematic nature of mathematical knowledge as a whole not just the learner's subjective knowledge, as well as the fragility of all research methodologies (Sriraman & English, 2010:45).

2.3.1 Theoretical basis for radical constructivism

Radical constructivism has its roots in modern cognitive psychology, and the Piaget' ideas about learning, the situated learning and Vygotsky's social constructivism.

2.3.2 Modern cognitive psychology

The discussion about the influence of modern cognitive psychology over radical constructivism is based on the distinction of views about learning processes between behaviourism and cognitivism, as well as the views within constructivism itself. While the distinction of how learning should process between behaviourism and cognitivism is clear, the distinction between radical constructivism and modern constructivism seems contradictory.

The contradiction between behaviourists, connectionist and cognitive science lies in the fact that while cognitivists recognise that human learning involves symbolic representation of knowledge, connectionists argue that knowledge can only happen through synaptic connections among neural elements.

In behaviourism, the learner is considered passive and learning occurs when the teacher focuses teaching directly over what learners should know. In other words, that means that the teacher prescribes what learners have to know. In behaviourism, the information students get is recorded passively while in constructivism learners are active and interpret new information with help of prior knowledge.

The argument presented by modern constructivists, or human constructivism, that human cognition involves knowledge that is represented symbolically, does not find similar interpretation by radical constructivists. Beside their opposition to the idea of direct instruction propelled by connectionists, they also disagree with the claim made by information processing psychology which argues that knowledge is a product of symbolic representation of mind.

For radical constructivists, symbolic representation only happens at verbal or logical expressions, and it is found inadequate for nonlinear, nonverbal, and intuitive form of thinking (Anderson,

Reder & Simon 1998:233). However, the symbolic mental representation can give an incomplete and distorted picture of environment. This picture later on it has to match individual's thoughts with sensorial information received by him and with acts at motor level. Anderson, Reder, & Simon, (1998:34-233) points out that in the case of mathematics, "cognitive competence depends on the availability of symbolic structures (mental patterns or mental images) that are created in response to experience."

In the later 1980s, most researchers agree that hybrid positions may be taken when dealing with learning issues. It is worthwhile to recognise that through some aspects of cognition learners will require symbolic representation to understand them, while others will need help in terms of neural connections.

2.3.3 The construction of knowledge in Piaget

Piaget had a profound influence on cognitive psychology and he was concerned with the cognitive development of a child. Piaget builds his concept of knowledge from the influence he had from biology. Many of concepts he used in psychology were borrowed from biology and simultaneously used in psychology. Piaget's theory of knowledge has its basis in the biological process of adaptation and organisation of live organisms. To sustain their existence, organisms constantly interact with the environment and adapt themselves to the conditions posed by this environment. In teaching and learning process, there are different types of interactions: the learner-teacher, learner-content, and learner-learner. Fundamentally, education is based on learner-content interaction (Vrasidas, 2000:2). In this type of interaction, a learner interacts with content to modify his or her behaviour, or construction of cognitive structures, or to construct concepts. For that he or she uses books, abstract ideas, objects from the environment and so on. The learner-teacher interaction occurs when the teacher delivers instruction, provides feedback, and encourages the learner to learn more. The opposite occurs when the learner asks questions, discusses problems with the teacher, or submits his or her homework. The learner-learner

interaction is when learners collaborate with each other on a project, and when they exchange ideas, discuss, and collaborate on an assignment.

Piaget discusses interaction, taking in account the influence of environment on live organism. The environment imposes demands, and in the presence of those demands, the organism reacts. This process was viewed by Piaget as *adaptation*. In his theory, the biological structures of the individual are continuously subject to change due to constant interaction between him and the environment. This dual interaction process (individual-environment) originates changes in the structure of the organism.

This process was called *progressive equilibration* by Piaget, in which development proceeds progressively from a low state to a high one (Montagero & Naville, 1998:151).

Adaptation encompasses two main stages, namely assimilation and accommodation. Assimilation occurs when the organism infuses into the pre-existing biological structure's new experiences. When the child plays with new objects, he or she infuses these objects schemes to the pre-existing ones (Haydt, 1998: 33).

The individual seeks to interpret the surrounding world taking as base his own constructs. In accommodation process, the pre-existing schemes of the individual are adjusted in order to fit into every new experience. New experiences create sometimes contradictions in what the individual already knows. To suppress these contradictions, he or she uses reflexive thinking to analyse and to change his own view towards the object.

In this case, assimilation process is the stage where the individual seeks to know the characteristics of the object. In the presence of unknown object, the individual may perform different movements such as tossing, shaking of, scrubbing, or squeezing the object in order to know what this object is about. In this case, manipulation and apprehension are part of

assimilation process (Haydt, 1998: 33). During this process, schemes of new object are gradually incorporated into the pre-existing ones.

In accommodation, in the presence of an unknown object, the individual organises actions that are already planted in his or her mental schemes in order to get the desired solution. That can be accomplished by organising the pre-existing schemes such as using reflection, trial and error, or re-elaboration of data (Haydt, 1998: 33). In this sense, assimilation and accommodation occur simultaneously.

While the individual apprehends characteristics of the new object, the new experiences got from that interaction are accommodated into pre-existing mental structures. Thus, changes in the individual occur when there is a constant interaction between the individual and the environment, where new experiences are absorbed and accommodated into the pre-existing ones. As stated by Montangero and Naville (1998:97), assimilation and accommodation constitute the two points where the organism and the environment interact. This enables the organism to function and progressively achieve new equilibrium.

Progressive equilibration occurs when the organism seek to adjust himself to the demands of a new situation. In the sight of new challenging situation, the individual activates assimilatory schemes (Haydt, 1998: 34) that demand him to organise and mobilise all accommodated data to give appropriate response to the situation. Hence, progressive equilibration is a continuous crossing from a low state to a high one. Equilibration is viewed as a self-regulated and dynamic process of behaviour that equilibrates two main types of behaviour, the assimilation and accommodation (Fosnot, 1996:30).

According to Piaget's theory, the development of mental processes also proceeds from adaptation and organisation. Adaptation constitutes a process of assimilation and accommodation. In accommodation process, the existing cognitive structures replace the old

ones, while in assimilation process, new events are incorporated into pre-existing cognitive structures. For this process to take place, a child needs to be allowed to explore, manipulate, question and to discover things by him or herself. That is, she or he constructs his knowledge. Fosnot (1996:20) asserts that knowledge cannot be viewed as an accurate representation of reality, but the set of actions attempted by an individual that are proved to be valid within his experience.

Piaget's theory finds its roots in biology. When he approaches the problem of cognitive structures, he does it from the biological perspective, and then transfers it to the development of cognition. Cognitive structures refer to mental cognitive systems with laws that are applicable to the system as a whole (Fosnot, 1996:34), and that is how reasoning can inhibit, or less inhibit, inferences (Frawley 1997:38). A common example that can elucidate the notion of structure is that of numbers. A single number can only get meaning when it is integrated in a whole system.

Fosnot (1996:34), and Montagero and Naville (1998:177) characterise the structure into three properties: totality, transformation, and self-regulation. In totality, the parts are integrated within the whole and they cannot be separated from it. Transformation explains how the relationship among the parts occurs in the system as well as their transmutation. Self-regulation refers to the fact that each structure seeks self-maintenance, organisation and closeness. Mental structures also are constituted by such patterns as grouping, classification, establishment of correspondences and relations, reversibility, and so on. In fact, individual growth depends on the development of cognitive structures and the structures are in constant construction.

Piaget's view of constructivism is markedly epistemological and is aimed at reaffirming the role of subject active learning in the construction of new knowledge. On the other side emphasises the genetic perspective, and evidences the role of different sciences such as logical mathematics and physics in constructing new knowledge. However, according to Fosnot (1996:35), the concept of cognitive structures may also be applied in the development of writing and social sciences.

Piaget's theory is related to child activity and asserts that interaction between environment and the individual is a key issue to the development of cognitive structures. That is, knowledge is constructed. On the basis of this assumption, Piaget's view leads to some pedagogical consequences in teaching and learning in the classroom. Based on Piaget's view, Haydt (1998: 48) suggests different pedagogical actions in the classroom to enhance learner's cognitive structures. He proposes that to organise thinking schemes, teachers should pose problems to learners. That would allow them to think more reflexively and discover the solutions by themselves. Reflexive thinking constitute the fundamentals of learner-centred education since in this type of education learners become more critical thinkers and active in the construction of knowledge. Challenging situations stimulate and mobilise cognitive schemes so that learners can learn to observe, compare, describe, synthesise, and explain situations. This can only be achieved when teachers use active methods, especially those that emphasise problem solution, experiment, manipulation of objects, and group work where learners can talk, exchanging their ideas. That would stimulate the development of learners' mental schemes. These learning situations are related to learner-centred teaching, and are consequence of Piaget's theory of cognitive development.

Piaget's view of mental development is placed upon the genesis of cognitive structures and the conditions that generate knowledge. For instance, the idea that a child possesses genetic structures that enable him to develop concepts through interaction with environment was taken from biological influences that involve Piaget's theory.

2.3.4 The Vygotsky's social-cultural theory in the construction of knowledge

Piaget's approach to knowledge is constructivist because in constructing knowledge he prioritised the child's activity upon the objects that encircle him. Although he does mention the concept of social in the construction of knowledge, he considers the collective intellect constitutes a social equilibration, which is a result of cooperative actions among individuals in the group (Fosnot, 1996:35). Equilibration can be used both to explain individual and social

processes. This argument of Piaget shows the little importance that he gave to socio-cultural aspects issues in the construction of knowledge.

Trying to overcome these gaps, educational researchers began to conduct studies on which they focused more on the content of current learners' ideas developed in the social context to understand and explain how knowledge and learning is processed. This approach emphasizes socio-cultural factors in the development of cognitive structures that is how cultural experiences account for development of mental process. The socio-cultural approach for learning is concerned on how learners' ideas brought from their own environment can influence the way they acquire new concepts in the classroom settings. Social-cultural constructivism is opposed to Piaget's radical construction of knowledge because consider human nature as product of the environment which include social rather than being influenced by biological factors.

For socio-cultural constructivism the historical and cultural relations have a greater impact on the way people learn and build their concepts about surrounding objects. Knowledge is not derived directly from the reality but from different perspective (Burr, 2003:6).

In terms of educational practices, socio-cultural constructivism gives more importance to all aspects of the social context and of interpersonal relations, especially teacher-learner and learner-learner interactions in learning situations including negotiation, collaboration and discussion. It also emphasises the role of language, texts and symbiosis in the teaching and learning of mathematics (Sriraman & English, 2010:45).

Vygotsky was one of prominent defender of socio-cultural constructivism. The starting point of Vygotsky's thought was that the development of mental process in human being is based on social interactions. Vygotsky did not totally disagree with Piaget's view of construction of knowledge. Like Piaget, he considers learning as a developmental process. However, in his

theory, he focused more on the effect of social interaction, language and culture in learning process (Fosnot, 1998:35).

Vygotsky detaches two types of concepts that can be built by an individual. One occurs when a child in his daily activity interacts with his surroundings. In the process, she builds her own concepts as result of her own reflection over experiences that she takes from the environment. Vygotsky called these concepts spontaneous concepts because they spontaneously emerge as result of child's permanent contact with the objects in the surrounding.

Similarly, Piaget's notion of learning is built under the argument that knowledge as a whole is constructed under the relation object-subject, and social-cultural factors may have little influence on how child gets to know about his or her surroundings.

The second types of concepts are the so called scientific concepts. Contrary to spontaneous concepts, the scientific ones are formally and logically defined as results of cultural agreement and they are acquired in the process of instruction in classroom settings using language (Fosnot, 1998:35). Classroom environment imposes on a child's formal thinking, and well-defined concepts as a result of cultural agreement.

That means that for a child to acquire scientific concepts, the spontaneous one must attain a certain level of development. The concept of number, for instance, can be acquired only if a child has gained the concept of quantity. That is, first in her interaction with objects she can construct her concept of quantity or mass, building her own concept towards the object. This would be the actual development level. In the school, with guidance of teachers and interaction with peers, she can acquire the concept of number. That would be the level of potential development. The distance between the two constitute what is called by Vygotsky the *zone of potential development*.

The zone of proximal development is an explanation given by Vigotsky to emphasise the role of social and cultural environment in learning concepts. It is defined as “the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or with collaboration with more capable peers” (Shepard, 2000:19).

To develop spontaneous and scientific concepts, both need the use of language. The interest of Vigotsky around the development of language involves the fact that the child uses language when he or she interacts with adult and peers.. Most of the time, a child talks to herself or himself when playing with toys. This internal language is described by Piaget as egocentric language and it do not have any influence for social communication. Instead, Vygostky considers egocentric language a prelude of internal language, which will further be used to build knowledge (Fosnot, 1996:36), and it is also a very important tool for building spontaneous concepts.

For instance, when a mother interacts with her baby asking questions or instigating the baby to talk, she simultaneously builds concepts and meanings with him or her. Similarly, the child interacts with his peers using language built concepts and meanings. The interaction with a child occurs in social spheres. The role of the teacher in the classroom is to stimulate learners to construct their meanings and concepts about the surrounding world.

Language is an important tool to appropriate the whole spring of knowledge the child needs. The child uses the language of his or her social environment as way of understanding the reality in a given space or time. In that sense, language is viewed as having a communicative function or as an organiser and mediator of conduct. On the other hand, it is viewed as a means of expressing his or her thoughts. Vygotsky and Luria have found strict connection between language, thinking and the situational context among small farmers (Fosnot, 1998:38-39), which suggests that the way an individual constructs knowledge is affected by how he or she represents the phenomena or object in the context the individual lives. Luria’s experiments seem to conclude that when the

small farmer is confronted with a problem, he or she activates similar mental schemes as those described in books for problem solving (Frewley, 2000:23). He or she starts by constructing a mental scheme and then follows all the procedures as an expert does. That means that he or she is also able to represent Mathematical quantities mentally.

While in some areas, the effect of language over abstract thinking seems to be round-about; in such areas as music, dance, and drawing the relation seems to be straightforward. In each of these areas, the symbolic representation of the same object can occur differently. For example, if we ask someone to represent an object using drawing symbolically, he or she would emphasise certain characteristics, while in language he or she would describe it according to the use.

Movements that led to the reform of curriculum in the 1980s have considered the teaching of mathematics in the classroom as an inquisitive and problem solving process on which the development of thinking must be valued rather than memorisation of algorithms. Current vision of curriculum has its base from constructivism theory in which learning is viewed as having a social and cultural link.

Table 2.2 Constructivism view of curriculum and learning. Adapted from Shepard, (2000)

Curriculum	Learning
<p>All students can learn.</p> <p>In order to develop learners higher order thinking and problem solving subject matter must be challenging.</p> <p>Learners have identical chance for learning.</p> <p>Academic disciplines should be related with practice.</p> <p>Connecting school learning with outside context.</p> <p>Encourage and develop learners' habits for thinking.</p> <p>Develop democratic practices and kind attitudes towards community.</p>	<p>Learning is based on cognitive and constructivism theories of learning</p> <p>Intellectual abilities are developed within social and cultural context.</p> <p>Learners' concepts and understanding are built within a social environment.</p> <p>Learners' new learning is formed on the basis of previous knowledge and culture perspectives.</p> <p>Intelligent thinking involves knowledge of self.</p> <p>Defends a principle of deep understanding and supports transfer.</p> <p>Learners' cognitive performance vary from one individual to another.</p>

According to Shepard (2000), when learners construct their knowledge and understanding they use as base the context of social environment. In learning new concepts and abilities, the experiences brought from the community are due to influence students' understanding, therefore a teacher may take in account these aspects. Experiments over influences of constructivism on teaching have been conducted. Fosnot (1998), for example, reported a number of examples that used constructivism in the classroom to enhance learning in different subjects. He reported two experiences held by two different teachers while teaching mathematics. The content taught was

related to measurement scales. The teacher started his lesson by putting a question to learners. The example was then compared with a class in which the teacher, instead of confronting learners with a problem, he explained in a straightforward manner the concept of measurement and urged learners to practice it. Although the learners of the two examples were able to practice measurement, using a tape-measure, learners from the first example were more capable of building their own concepts from successive experiments they had performed, than those of second example.

The results have shown that learners are more able to understand and apply concepts when are urged to think on a problem.

This example shows that individuals interpret new situations on the basis of experiences they have built before. As Fosnot (1998:96) asserts, the construction of new concepts takes place when previous experiences do not allow the accommodation of new ones. The construction activity takes place in two contexts: the individual and social.

2.4 SUMMARY

Piaget's cognitive theory and Vygotsky's socio-cultural theory provided basis for the psychological learning theory named constructivism. However, Piaget emphasised more the activity of the child in the construction of knowledge, while Vygotsky placed more emphasis on the role of socio-cultural relations. The fact that construction of knowledge is more effective in highly social environments is based on the idea that all human activity is social in its nature and learning is associated with social context.

Classroom context is in its nature a social activity. Learners interact each other, and work together in groups to enhance their individual acquisition of knowledge, as well as to enhance

their skills. Piaget and Vygotsky agree that knowledge is constructed and is developmental. The difference between the two is that while Piaget considers that knowledge is constructed in the head of the learner, Vygotsky consider knowledge as a product of social interaction. Learners build their concepts while they work together and exchange their views. That means that concept is somehow a product of social negotiation. However, Piaget's and Vygotsky's theory of knowledge is that they complement each other. For instance, mathematical learning encompasses both active individual construction and the process of how mathematical knowledge takes place in the community.

The constructivist assumptions of construction of knowledge have significant implications on the nature of learning and instruction. The reality is diverse and education should take in account such multiple diversity, allowing learners to interpret their own world. The role of the teacher is to focus teaching and learning to learners (learner-centred teaching) and guide learners' apprenticeship, helping them to interpret the world.

2.5 CHARACTERISTICS OF RADICAL CONSTRUCTIVIST APPROACH TO MATHEMATICS

Mathematics education is the strongest host of radical constructivism. Focusing on the learner, its approach to mathematics relies on discovery learning, learning in complex or authentic situations, learning in social contexts and distrust of empirical evaluations (Anderson, Reder & Simon (1998:237), and problem based learning, inquiry learning and problem solving (Casas, 2011:215). According to Casas (2011), although all these types of learning vary in essence, the core of learning is through experience in the environment that involves: (1) real-world and meaningful challenges, (2) active learning, (3) opportunity to solve problems, answer questions or address real needs, (4) the idea of ownership, responsibility and choices, and (5) opportunity for the students to feel empowered.

2.5.1 Discovery learning

Constructivists and behaviourists differ with each other in the way they view learning. While behaviourism advocates direct instruction, constructivists see learning as active and centred on learners.

The concept of *discovery learning* was introduced by Bruner in an attempt to explain how learners acquire concepts and ideas. He was concerned with how learners could continuously learn about a certain topic on the basis of what they know. As a unique way of resolving this problem, Bruner advocated the *discovery learning*. According to him, *discovery learning* occurs when a teacher rearranges or transforms evidences that enable learner to go beyond the evidences and bring new insights (Siddiqui, 2008:96), or students are encouraged to learn by their own and to discover principles for themselves (Linn & Walmsley, 2003:23), and it is influenced by student's prior knowledge and his or her ability to learn. Since experience is the basis of discovery, learners are stimulated to work with materials so that they can construct their concepts. These processes transform learning to a more meaningful activity.

In mathematics learning, a teacher uses discovery learning when he, for example, urges learners to discover geometrical figures in a given object, or when in a function he asks additional questions that may lead him to discover other patterns that may be used as a solution to a problem. For instance, the function below:

Consider the function f defined by $f(x) = x^6 - 2x - 1$

- a) If you try to substitute the function f by evaluating it successively at $x = 3.8, 3.9, 3.999$, and 3.9999 , what sort of values of f would you get as x increases to 4?
- b) What would happen if you do the same experiment with values that are bigger than 3? Give your comments to the results.

In discovery learning, the learner is induced to understand mathematical ideas following certain guidelines. Lynn and Walmsley (2003:25) describe the guidelines as follows:

- a) When a student solves a problem, she or he develops a pattern of thinking through the problem rather than searching only for answer;
- b) The teacher gives guidance where necessary while allowing the learner to discover on his or her own when possible;
- c) When the learner search for patterns she or he describes relations as she or he sees and forms a generalisation based on the mathematics problem she or he is facing, always taking an active role in learning, and
- d) Each topic is understood more when it is revised later or in the year or in the other grades.

This allows a learner to achieve a permanent understanding and to develop a sense of freedom and confidence to learn.

In spite of numerous successes that discovery learning brings to learners in terms of acquiring a desired construct, this approach to learning has been some times subject to question. For instance, Anderson, Reder and Simon (1998:240) refer to interference of time spent in acquiring a construct when using discovery learning teaching. They argue that since learning only takes place after the construct has been discovery, the time required to perform a task is long, or the search is unsuccessful, and this may affect the individual's motivation.

2.5.2 Emphasis on complex learning situations

Radical constructivists also assert that learning of any other subject, including mathematics, should take place in the context of complex problems. Complex learning environments consist of learning in which learners are required to solve complex problems. This is based on the constructivist assumption that complex and genuine learning tasks stimulate curiosity, creativity

and higher-order thinking, and that the real world does not offer enough situations that can lead learners to deal with complex situations. Therefore, it is of extreme importance that learners practice complex problems. Complex problems enable students to make a choice of what sort of learning should they go on. For instance, if learners are given different ways of solving a problem they are likely to attain the goals of advanced knowledge acquisition. Vygotski asserts that higher order thinking can only be achieved through social interaction.

The idea that complex learning situations may develop high-order-thinking led radical constructivists to recommend that learning should occur in the context of complex problems. Anderson, Reder and Simon (1998:241) acknowledge the existence of two problems in this approach. Firstly, if a child is experiencing difficulties with many of the components, he or she could be confused by the process demands of a complex task. Secondly, in a situation in which all the components of task are mastered by the learner, she or he will be wasting a good amount of time practicing all those components that have already been mastered in order to get to those that still need additional practice. On the other hand, it is acknowledged that part training is often more effective when the part component is independent (Anderson et al., 1998:241).

2.5.3 Problem solving

Constructivist approaches to mathematics also emphasise problem solving as one of learning type. One way of dealing with the nature of problem solving is to describe what a problem is about. According to Robertson (2005:2), a problem arises when someone is confronted with something she or he does not know what to do. That means that if a person already knows the process to a problem solution then there is no problem.

In a daily life, people are confronted with different types of problems. They face a problem when, for instance, they try to fix an electronic device, or when they are in the presence of a

mathematic equation whose solution is not known. When a person faces a certain type of problem, she or he unchains different mechanisms to solve it.

One important issue that has to be distinguished in a problem is the existence of a goal towards which a person acts to accomplish it. Acting includes thinking whose process is composed of devised actions that mediate the solution. The mediated actions include steps that should be taken, leading to a solution, and those that will make the solution easier. Problem solving can be viewed as a sequence of cognitive actions directed to a goal. These actions include the known and the unknown procedures. The known procedures result from individual experience and the unknown emanate from the situation. The National Council of Teachers of Mathematics (2007:782) defines problem-solving in mathematics as a ‘process of interpreting a situation mathematically, which usually involves several interactive cycles of expressing, testing and revising mathematical interpretations’.

Robertson (2005:18) points out some characteristics of problem solving. The first one relates to the fact that the solver knows in advance all the possible paths that she or he can take to solve the problem. For instance, she or he can concentrate on the strategies people use rather on the nature of the problem or can examine how people improve after repeated attempts at solving the problem.

The second characteristic refers to the fact that the solver generally knows nothing in advance about the process that involves a particular problem especially when it comes to well-defined puzzle problems. From this characteristic, it is possible to examine the representations built up by the solver.

The third concerns the possibility of examining the generalisation of transfer of learning from one problem to another by representing two problems with identical structures but a different

cover story. This allows comparing how people differ in their understanding about problems with different cover stories.

According to Glasersfeld (1991:115), problem solving approaches call for an explicit instruction in the solving of mathematical problems and it uses heuristic and metacognitive strategies such as understanding the problem, devising a plan, carrying out the plan, and looking back. Problem solving approaches share some assumptions with constructivists namely, 1) the value of the problem as a means of finding a way out of a difficulty; 2) the importance of problem clarification; 3) the significance of elucidating strategies that are typically tacit but effective and; 4) the value of reflecting on one's solution path.

2.6 CONSTRUCTIVISM AND LEARNER-CENTREDNESS

The last quarter of the 20th century have witnessed a growing interest in the school curriculum based on different pedagogical approaches. One of these interests is related to the need of transforming teaching, as well as assessment, taking as base the learners' sentiments or needs, their spontaneity in knowledge production and their individual differences. This approach was called learner-centred teaching.

Learner-centred education is an approach in which teachers in teaching process take into account learners' cultural live experiences and create conditions in order to make these experiences happen in the classroom.

In a learner-centred environment, learners construct their own knowledge. They use their own ideas as tools to build new ones. These ideas can be interpreted as the knowledge the learners already have concerning certain facts. When someone construct new facts, the pre-existing ideas or knowledge are important for the establishment of connectivity between the pre-existing ideas

and the new ones. The wealth of connectivity depends on how many ideas or how much knowledge an individual has accumulated. Walle and Lovin (2006:2) assert that the more ideas an individual has accumulated, the more connectivity can be established. Such individualised type of teaching and learning is based on constructivist theory. Constructivism is a theory that describes knowledge as temporary, internally constructed, developmental, no-objective, social and culturally intermediated (Fosnot 1998: xxi).

The constructivist view of leaning is based on the assumption that learners carry individual significant experiences, developed in their environment, that may serve as a base to help them understand new concepts. Consequently, learning works as a self-calibrator of conflicts that arise between individual internal models and the new insights, allowing new ideas to take place on the base of cultural experience. Thus, teaching should allow learners to raise their own questions and build their own concepts and strategies (Fosnot 1998: xxi). Contrarily, in the teacher-centred approach, concepts are transmitted and are taught out of learners' experiences.

Constructivism can be described as a theory of learning and knowledge since it attempts to approach how people get to know things from nature, and what knowledge is, and how is it constructed. It is also considered as a theory of teaching because it approaches education in a different way as it conceived by traditional teaching approaches. Having nourished its experiences from other sciences such as psychology, anthropology and philosophy, constructivism describes learning as temporary, developmental and socially constructed and culturally intermediated.

Contradicting the idea of traditional pedagogy that concepts and symbols can be learned out of the context, constructivists assert that learning may occur in an environment in which learners can contextualise their own experiences, turning them expressive. Thus, in learning process, learners may be able to question, construct their patterns, strategies, models and concepts (Fosnot, 1998). The classroom may be seen as a micro society where the community of learners engage themselves in discussion, and reflection, of what they have learned.

These ideas are opposite to traditional teaching where teachers assume an autocratic position and continuously control the learners' learning activities.

Fosnot (1998) argues that the teaching of mathematics in a constructivism environment may lead learners to engage themselves in 1) solving significant problems; 2) debating and searching for appropriate solutions, and 3) constructing their own algorithm and formulas.

2.6.1 The development of learner-centred approaches

The learner-centred approach is markedly connected to recent developments in modern psychology such as existential humanism psychology, and constructivism. The recent approach to knowledge is dominated by existential humanism psychology brought by Abraham Maslow, Gordon Allport, Carl Rogers, Henry Murray and others (Brito, 1989:41), Baldwin and Wallon (Haydt, 1998:53), as well as the Piaget and Vigotskys' ideas in respect to how knowledge is constructed and developed.

In this research, we will not discuss in detail the contribution brought by each one of those psychologists and philosophers. We will briefly present some theoretical analysis of human existentialism towards knowledge. Learner-centred approach in our research will be supported by Piaget and Vigotskys' theory of knowledge and present each one's view of learner-centeredness, as well as the influence of each view in the teaching and learning of mathematics.

Human existentialism seeks to determine the quality of the reality, as well as the phenomena, that human beings experience and observe. Knowledge, according to humanist psychologists, is developed when the individual takes an immediate experience of *self* and the *other* as result of participative interaction between himself and the surroundings (Brito, 1989: 45). The *self* is

thought of as a cognitive structure that contains an organised and stable content about what a person is, including his experiences (Horowitz & Bordens, 1995:47).

The person's ideas, his personal history and characteristics, constitute the *self* concept. In the view of Human existentialists, learning is processed when teacher and learner interact with each other. Interaction in the process of learning means that both teacher and learner play an important role. This interaction exalts self-esteem and generates new experiences in learners, as well as consciousness in the relationship not only among learners themselves but also in the community context (Britto, 1989:74-75). In its turn, learning provokes modifications in learners' behaviours and leads them to choose what is beneficial to them in each stage of their existence (Britto, 1989:74-75). The existentialists advocate the involvement of learners in all learning situations that can enhance the development of attitudes and self-consciousness. That means that learning should be significant and be guided by instructional objectives.

Learner-centeredness, as result of humanist psychology, as well as constructivism, dates from pedagogues such as John Dewey (1859-1952), Edouard Claparède (1873-1940), and Roger Cousinet (1881-1973) to name a few, who designed a pedagogic approach to learning that is centred in child activities.

Dewey's ideas about education were driven by his ethical theory of human kind. He believed that ethical code on human kind should base their system on human experience in the natural world. Current approaches to education share Dewey's philosophy about education. He valued learner activity in the learning process through the establishment of what he called the "learning by doing" method. This method concentrated more on activities that could enhance a learner's cognitive experiences. This was the starting point of the teacher's role for learning process in Dewey's approach.

The teacher, instead of being a transmitter of learning in the classroom, turns into the facilitator of learning. He or she could organise different classroom activities that capture learners' interest

and motivation. To enhance learners' reflective thinking, the teacher may create activities which demand learners' emotional activity such as interaction. Dewey's educational action focused on helping learners to develop the ability to examine their beliefs, to understand and test their ground and consequences, and their reliability (Fishman, & McCarthy, 1998:25) because this will permit action with foresight.

Dewey valued more significant learning because he thought that would be the only way learners could progressively integrate their knowledge. Activity, experience, interaction and object sense are the key elements of Dewey's pedagogy (Altet, 1997:33).

Claparède was in his turn influenced by Dewey's readings and considered learning as intimately related to a child's needs and interests. What moves a learner to learn is his or her interests or needs. The child's needs and interests constitute the source of his or her activity. According to Claparède, the role of teacher is to stir up learners' interest in solving a problem through appropriate exercises (Altet, 1997:34). Claparède gave importance to learner's cognitive strategies, as well as his or her commitment to solving a given problem.

The development of psychology gave birth to experimental pedagogy, the approach that is concerned with pedagogic methods that could enhance a learner's activity. This type of approach was backed by Gaston Mialaret, Jean Vial, and Louis Legrand. These pedagogues constitute the representative of contemporary learner-centred pedagogy.

The core of their approach was related to the development of teaching strategies that would enhance learning activity, and on the other to seek understanding of learner activity as an individual, his or her interest, motivation and engagement in learning. This aim could be achieved by what they called the pedagogy of project. The pedagogy of a project was defined by Jean Vial as a chain of mental attitudes or behaviour that authorises the definition, accomplishment and exploration of a project (Altet, 1997:41).

The pedagogy of a project is in its essence the attempt to link learning with learners' interest, motivations, initiatives, and needs. The project would help learners to choose the learning goals, and the teacher's role is to negotiate with them according to everyone individual characteristics. Both learner and teacher in this approach plan together the contents to be learned, as well as the time needed to accomplish every task. That is, they work together in the accomplishment of learning tasks. In a project the learner has to be active, persistent, concerned and self-conscious.

Among the pedagogues whose approach to learning was student-centred were those concerned with the teaching that emphasised the development of learners' cognitive and metacognitive strategies. Britt-Mari Barth's approach to learning, for instance, favoured the use of a teaching strategy that could allow an understanding of learners' mental processes, prepare them to be aware about their cognitive strategies in order to be successful in their tasks (Altet, 1997:50).

Barth puts emphasis on teacher-learner interaction, and the understanding of his or her culture and motivation in order to build positive expectations and self-awareness which would help learners to construct the concepts. Metacognition (self-awareness) has to do with how a learner is able to understand himself or herself, or which strategies can he or she use to solve a certain problem. The role of teacher would be to guide him or her and show the mechanisms that would allow acting. In this sense, teaching is viewed as a process that seeks to develop higher order structures such as planning, anticipation and problem solving.

The pedagogies of learning which are centred on the learner emanate from cognitive theories since their approaches aim at developing learners' cognitive structures. These theories also put more emphasis on the internal aspect of learners such as motivation, interests, learners' initiatives and needs.

Brito (1989:82) argues that "any kind of new knowledge and information can be significantly perceived and brought into conscience only if students' motivational strengths are oriented to his

or her experiences, objectives and ideas”. It is under this belief that these pedagogues focus more on learners’ internal aspects in learning process.

The concern with learners’ success is one of the core aspects defended by learner-centred pedagogues since they give priority to learning strategies and methods that are oriented to achieving success. Learning strategies and techniques are the core aspects of learner-centred teaching. A teacher in his or her teaching would focus more on content and processes that involve learning rather than simply delivering content.

Contrary to behaviourists, who consider the teacher as centre of the process, learner-centred pedagogues view the teacher as being a person who takes in account the relationship between learners and knowledge, their cognitive strategies and devotion to learning. She or he acts as a facilitator or mediator of processes that involve learners’ construction of knowledge.

2.6.2 The Learner-Centred Education Model (LCEM)

The Learner-Centred Educational Model is a theoretical model which focuses on the process of learning by learners. According to McCombs (2009:35), “Learner-Centred Model consists of a variety of materials, guided reflection and assessment tools that support teachers and administrators’ effectiveness and change at the individual and school levels”. Concomitantly, LCEM evidences which factors impact learners and learning.

The starting point of LCEM is to know who the learners are - their characteristics and their needs. The knowledge of the learners includes their social characteristics, as well as the individual ones. However, the knowledge of learners’ characteristics will not per se be enough to carry out the educational process. The LCEM also emphasises the understanding of learning, as well as the strategy of how this learning can be supported in order to embrace all people in the

system. Lastly, the decisions which practices should be taken in the school or in the classroom depend upon what sort of knowledge learners should possess.

Learner-centred teaching as a teaching strategy is guided by psychological principles that principles involve complex individual internal aspects or factors. These aspects or factors relate to motivation and affectivity, cognition and metacognition, individual differences, and developmental and social factors (American Psychological Association, 1997). These principles are psychological since they involve complex individual internal aspects that stimulate learning.

The cognitive and metacognitive factors are some of the learner-centred principles and based on rationalism theory of learning. Vanderswalmen, Vrijders and Desoete (2010) see metacognitive knowledge as formal knowledge that is kept in the memory, which also includes different models of cognitive processes, the information about people and about tasks, and strategies and goals. Vanderswalmen et al., (2010) argue that metacognitive tasks involve how individuals make relations between tasks, their categories and features and how are they processed, while metacognitive strategy-knowledge is related to the use of multiple strategies and the condition those strategies may be applied. They add that in metacognitive strategy and goal-knowledge, the individual is aware of what kind of goals he she chase when performing certain tasks or facing a situation of some kind.

The development of metacognitive skills may include strategies used to monitor and regulate one's own learning such as planning strategies or which strategies to be used during learning (McGilly, 1998:5). For instance, Sete, Tachibana, Umano and Ikeda (2005) argue that for a novice to solve a problem well, he she requires an excellent performance of metacognition.

Different models for developing learners metacognition were developed and discussed (Ayala, 2005; Seta, Tachibana, Umano and Ikeda, 2005) however, it is important to note that to develop metacognitive system is an intricate process and depends on how metacognitive experiences are

transmitted to the learner. In learner-centred strategies, the use collaborative learning has also been seen as adequate to develop learners' metacognition (Chelmers & Nason, 2005). Strategies such as planning strategies or monitoring by commenting about group progress or the contribution of each member in the group help the group to focus their attention on what is important (Chelmers & Nason, 2005). Teaching with a wider range of activities drives learners to pay more attention when solving problems than those with fewer activities (Seta et al, 2005). Therefore, the teachers' challenge in learner-centred teaching is how to plan and organise a diversity of strategies that help learners developing metacognitive structure.

2.6.3 Motivational and affective factors

Motivation and affective factors also play an important role in learner-centred teaching. Students' interests, sentiments, beliefs and habits (McCombs and Miller, 2009; Mishan, 2005) are the major factors that influence learning. These aspects are termed motivation for learning. Well organised teaching can spark students' interest in learning, making them more committed to classroom activities. The motivation that emanates from inner individual interest is known as intrinsic motivation, while the one that arises from external forces is known as extrinsic motivation (Mishan, 2005). To get learners intrinsically motivated, learning activities or subject matters should be of interest to learners and concomitantly, as the individual interests increases, so does the value of the subject (Sansone & Harackiewicz, 2000). Hativa (2000) argues that good teaching is a teaching in which the teacher organises an enjoyable atmosphere and learning activities, and in which confidence to learn is transmitted, students are more motivated to come to class and learn, contrarily to teacher who is less committed to students' motivation. That means that motivation can be stimulated through activities that stimulate interests in the learner and are also relevant, meaningful, and appropriate in complexity and difficulty to their abilities.

2.6.4 Developmental and social factors

Another factor which is important to learner-centred teaching is that of development and social influence. The relationship between construction of knowledge and social environment is linked to Vigotsky's idea that all human activity is social in its nature, and learning is associated with social context. The development of the child can only be understood within his or her interaction with other people (Lacasa, Del Campo and Reina, 2001). Within the classroom context to attract pupils' attention during learning, a teacher may use small groups in which the members interact with each other. This situation reinforces the idea that classroom context is in its nature a social activity in which learners interact each other, and work together in groups to enhance their individual acquisition of knowledge, as well as to enhance their skills. The importance of social and developmental factors in learning is underlined in Vigotsky's theory in which social context is taken as a prior factor for learning. This theory emphasises that the development of child's mental processes also happens under the guidance of an mediator in the process of interaction (Kozulin, 2003). In a learner-centred environment, the learner is actively engaged in constructing knowledge by setting himself goals and searching for the means to achieve them (Zuckerman, 2003), and the development of learners' mental process depends on the presence of an adult in the interaction of environment.

In terms of educational practices, social constructivism give more importance to all aspects of the social context and of interpersonal relations, especially teacher-learner and learner-learner interactions in learning situations including negotiation, collaboration and discussion. It also emphasises the role of language, texts and symbiosis in the teaching and learning of mathematics (Sriraman & English, 2010:45). As Zins, Weissberg, Wang and Walberg (2004:24) assert, "Social and emotional skills are essential for the successful development of cognitive thinking and learning skills." A school represents a community where learners interact with peers and teachers. Thus, a school is a social place and learning is social process. Academic achievement is influenced by how much a child is socially integrated in the school, as well as her level of emotion for learning. Empirical data have linked academic success with pro-social behaviour.

Conversely, it was also found that antisocial behaviour could be linked to academic failure. In that sense, education process should focus on activities that enhance responsibility and moral character.

One of the factors that influence learning in teacher-centred teaching is that of individual differences. Each individual has his or her own way of learning, and these differences are important mediators of learning process (Jonassen & Grabowski, 2011). Individuals can show traits that represent a presence of abilities to a certain degree, but can also show weakness indicating that the same individuals lack certain learning abilities. Jonassen & Grabowski (2011) argue that the aptitudes and traits the individual possess can be reflected in what is called cognitive styles, personality and learning styles.

Researchers attempting to probe the influence of individual differences (Berch, 1979; Gholson and Beilin, 1979; Kendler; 1979) acknowledge that in learning process, learners respond to a task demand differently. While some differ in terms of type of response mode, others differ in terms of the nature of the presentation mode employed (Berch, 1979). These differences can be found whether at gender level or among learners themselves. In learner-centred environments, it is very important to acknowledge that different other factors such as culture, learners' linguistic, beliefs, ethnicity, and social background may influence how learners learn. These aspects they have to be carefully handled so those do not negatively affect learners' learning in the classroom.

In summary, we could say that the centrality of LCEM is in the link between instructional decisions and the knowledge of learners' characteristics and needs. That is, all decisions that should be taken in the instructional arena must begin with profound knowledge of the learners. This process does not end only with knowledge of learners' characteristics and needs, but also the knowledge of learning and how could it support all people in the system. LCEM focuses on the person himself. Also, LCEM is supported by different tools, such as surveys, that can be used to facilitate reflections by teachers, administrators and students.

CHAPTER THREE

3.0 EMPIRICAL STUDIES ON THE RELATIONSHIP BETWEEN TEACHERS' BACKGROUND TRAINING, TEACHING EXPERIENCE AND LEARNER-CENTRED APPROACH

3.1 INTRODUCTION

For any curriculum, including mathematics, to be successful requires that teachers be professionally well-prepared to satisfy the demands of the curriculum. In other words, educational administrators must be sure that teachers, prior to engaging themselves in teaching, possess sufficient pedagogical skills knowledge, as well as content knowledge, as to how to transform classroom into a place where learners can learn effectively. The core of the present chapter of literature review is to analyse the contribution of teachers' professional preparation, whether in pedagogical or mathematical content knowledge, and their perception of learner-centred teaching in the mathematics' classroom, as well as the influence of professional experience on teachers' perceptions of learner-centred teaching in the mathematics' classroom. In this chapter we will also discuss the contribution of teachers' professional experience and teachers' background training on their practices of learner-centred teaching in the mathematics' classroom.

This study aims to: (1) to determine the extent to which teachers' background training contributes to perceptions of learner-centred approach in the teaching of mathematics; (2) to determine the extent to which teachers' professional experience contributes to perception of learner-centred approach in the teaching of mathematics; (3) to determine the extent to which teachers' background training contributes to learner-centred practices in the teaching of mathematics; (4) to determine the extent to which teachers' professional experience contributes

to practices of learner-centred approach in the teaching of mathematics, and (5) to determine whether teachers use learner-centred approach in classroom mathematics.

Several studies were conducted to assess the relationship between teachers' background training in teaching methodologies that emphasise the use of the constructivist approach in the teaching of mathematics and teachers' perception of learner-centred approach in the mathematics' classroom. Others studies are related with the relationship between teachers' teaching experience and teachers' perceptions of learner-centred approach in mathematics' classroom. Moreover, some studies attempted to verify whether different level of training would influence practices of learner-centred teaching in mathematics classroom. The present study attempts to verify whether those relationships also occur in the Mozambican context. Thus, the following section presents firstly the findings the researchers have reached concerning the above related issues, and then these findings are compared and discussed in the light of findings of present research.

3.2 THE CONTRIBUTION OF TEACHERS' TRAINING BACKGROUND TO THEIR PERCEPTION OF THE LEARNER-CENTRED APPROACH

When discussing teachers' education, two distinct concepts can emerge: the concept of training and the concept of professional development. Despite the differences, the objectives of the two are to provide teachers with the necessary tools to carry out their teaching duties in the classroom.

Before novice teachers commence their teaching activities in the classroom, they undergo a sort of specific training whether in methodology (pedagogical content knowledge) or in subject content (content knowledge). This type of training, also known as pre-service training, since the preparation of the individuals occurs before they commence their teaching activities, is aimed at enabling teachers to deal with the methodological aspects of teaching, and those related to the understanding of subject content such as theories, rules and facts. Teachers are also prepared in those psychological aspects that influences teaching and learning in the classroom.

To teach mathematics, a teacher needs not only to have a factual knowledge of mathematics, its structure and principles, but also the procedures that lead learners to comprehend mathematics' contents. Mathematics' teaching requires that teachers know mathematics as a subject, as well as the knowledge of pedagogy (Hodgen, 2011). The success of pedagogic approaches that focus on the learner depends largely on training received by teachers (Sall, Ndiaye, Diarra & Seck, 2009), as well as on their knowledge of subject contents.

With training, it is expected that the trainees be able to reach an acceptable pattern of behaviour (Hackett 2003:1) so that they can carry out, with efficiency, their teaching duties. Training a teacher involves knowledge about how to teach in the classroom and, in that sense, training also involves changing one person's behaviour.

Although mathematical knowledge of teaching (MKT) presents different models, there is a consensus that knowledge in teaching involves such categories as general pedagogical knowledge, knowledge of student's characteristics, knowledge of educational contents, knowledge of educational purposes and values, all known as general knowledge, and the knowledge that is related to the content dimension of teachers' knowledge, such as content knowledge, curriculum knowledge and pedagogical content knowledge (Petrou & Goulding, 2011).

Content knowledge is related to the knowledge of how the subject is structured, that is, the extent to which teachers know about mathematics as subject, that is, the theories, models, facts, concepts (substantive knowledge), while curriculum knowledge has to do with the knowledge of available instructional material and, the knowledge of the way how mathematics topics are organised (Petrou & Goulding, 2011). Pedagogical content knowledge is the representation of specific content (Petrou & Goulding, 2011), or teachers' 'know-how' about instruction and professional practical experience (Handal, Campbell, Cavanagh, Petocz & Kelly, 2013).

However, among all categories of MKT, the pedagogical content knowledge is the most researched category.

Once the trainees become teachers, and while they teach, they may also be guided to particular aspects of teaching such as the use of new approaches for teaching, or how to motivate students to learn or to improve their learning, how to conduct a discussion or to select an appropriate learning task. We refer to these activities as teachers' professional development, teacher development or in-service training (Organisation for Economic Co-operation and Development-OECD, 1998).

The word 'professional' can be regarded as the permanent activity a person does, and if he or she does it well to maintain his or her living status, and is obtained through long term rigorous academic learning (Wallace, Simon & Kau, 2001:5). Teachers' professional development is defined as a long term process where teachers acquire teaching methodology in order to accomplish students' learning needs (Maggioli, 2004:5). This process also encompasses the knowledge of curriculum, that is, the knowledge of how topics are structured within and across school years and the knowledge of curriculum material. In mathematics, teachers' knowledge includes the knowledge of pedagogy, the knowledge that is specific to the profession of teaching (Heritage & Vendlinski, 2006:2), the knowledge of the content of mathematics, knowledge of students' cognitions, context specific knowledge, and teachers' beliefs (Ann 2009:29). That is, what teachers will do in the classroom depends on the level of their professional competence. The more teachers are well-trained, the more professionally confident they would be to deal with the diversity of classroom learning situations (OECD, 2009:90). The development of teachers' mathematics knowledge has been linked to length of training (Witt, Goode and Ibbet, 2013), affective factors such as a teacher's appearance, and enthusiasm to predict students' achievement (Hill, Rowan and Ball, 2005), as well as to instructional, curricular and organisational factors (Handal, Campbell, Petocz & Kelly, 2013).

Teacher preparation and support have been two of the major concerns for governments. However, in some of the sub-Saharan countries, the recruitment for teacher training is not taken on a permanent basis. Recruitment for literacy teacher training programmes is voluntary-based. After training, no liability between teacher and the government is signed. For instance, in the Ghanaian National Functional Literacy Programme, teachers are recruited among local communities and they receive bicycles or sewing machines (Mooko, Tabulawa, Maruatona & Koosimile 2009:22).

In Mozambique, teacher trainees are recruited among high-school finalists. After being trained some change to another career without teaching even once. Cobbold, Gharthey, Mensah, and Oncasey (2009:69) argue that the attrition between the need for more qualified teachers and teacher preparation itself, is that most teachers who undertake further courses to upgrade their qualification tend not to return to their post. However, in Namibia, teachers, after being trained, sign a one year contract with the Namibian Ministry of Education.

Current reforms in teacher training curriculum emphasise learner-centred approaches for teaching. In South Africa, The National Curriculum Statement (NCS) emphasises a learner-centred, outcome-based approach to the teaching of mathematics (Maharajh, Brijlall & Govender, 2003:2). The Integrated Teacher Training and In-Service Training and Assistance to Namibia Teachers (Kapenda, 2007) and New Curriculum of Basic Education (MINED, 2003) in Mozambique also show a commitment towards the use of learner-centred approach in all subjects including mathematics. These approaches are based on constructivism, a theory that considers learning as an active process. According to constructivists, in a classroom situation, teachers should have a holistic understanding of their learners' approach to construct their mathematics knowledge and understanding. In learner-centred classroom, the teacher helps learners to construct their own ideas, to have a reflective thinking process and to interact with their peers (Walle & Lovin, 2006:4).

Curricula in teacher training institutions have been dominated by traditional approaches whose views advocate that learning is a sequenced and hierarchical process (Shepard, 2000). Mathematics teaching in such approaches as associationism and behaviourism is dominated by teachers' talk and learning based on memorisation of rules and formulas.

Changing the teaching paradigm that focuses on teacher-centred to those whose approach is learner-centred brings new challenges to teachers as to how to manage classroom situations. The more support the teachers are given, the more they can perceive, interpret and transform such approaches into teaching and learning practices in the classroom. That means the implementation of such a range of epistemological and pedagogical assumptions and behaviours in classroom mathematics need also to be aligned with more clear policy of teachers' professional development.

Mooko, Tabulawa, Maruatona and Koosimile (2009:22), from Botswana, have observed that the majority of teachers in Africa are under qualified, in spite of their motivation and dedication to teach. They still lack requisite skills and that could negatively impact on quality teaching. Pedagogical methods and teaching strategies can only be feasible when is supported by an adequate teacher professional development. Pedagogical methods also require systematic approaches as referred to by Sall, Ndiya, Diarra, and Seck (2009:55). Sall et al., (2009:55) advocate:

- a) A “child-centred pedagogy” rather than a “ teacher-focused approach”: active teaching methods gearing more towards learning than teaching;
- b) Intensive co-operation between highly qualified teachers and less qualified teachers, and
- c) Ongoing regular training of teachers and mechanisms for mutual training and monitoring (among peers).”

The merits and efficiency of the most common pedagogic methods and approaches, as outcome-oriented pedagogy, competency based approach, structured teaching, co-operative learning, collaborative learning, and open-ended and discovery-learning based education (Sall et al., 2009:55-110), depend on how professionally a teacher is prepared, and on his or her scholarly culture and personality.

The preparation of mathematics teachers includes not only the acquisition of foundations of teaching, which comprises the knowledge of pedagogy, but also the knowledge of contents of mathematics and the beliefs or perceptions, conceptions and attitudes teachers hold about mathematics as subject, their practices, as well as the beliefs, or perceptions about the teaching of mathematics. This aspect, in its turn, also influences students' learning outcomes.

The assumption that learning outcomes would be influenced by teachers' practices and beliefs about knowledge and understanding of mathematics and pedagogic content knowledge is reported in the work of Askew, Brown, Rhodes, Wiliam and Johnson (1997) and Philip (2007). Interaction between the teacher and learners in the classroom will involve amongst other things: the way teachers perceive how students know and understand mathematics and their behaviour. This will sustain teachers' beliefs or perceptions about teachers' practices in the classroom (Askew et al., 1997:21; Zalska, 2012:52). However, implicit and explicit beliefs held by teachers, as well as their knowledge in pedagogic content, will also determine what is going to happen in the classroom (Askew et al., 1997:21). That is, when a teacher holds deep knowledge in pedagogy, that knowledge is likely to influence his or her teaching practices and concomitantly, what happens in the classroom may also lead teacher to use a certain pedagogical approach that fits to the classroom environment.

From a psychological perspective, perception is the interpretation the individual gives to information gathered through the sense organs of the body. That involves sensory experiences of the individual. Perception varies from one individual to another. For an individual to perceive a certain object depends on his or her expectations, emotions, experiences, and motives (Davidof, 1983:210).

Another concept that is connected to perceptions is that of conceptualisation. This is a general term used to group and classify objects, as well as ideas, beliefs, meanings, concepts, propositions, rules mental images and preferences (Philip, 2007:259). Objects and ideas can be defined according to the features each object has. For instance, a definition of a car might be based on specific features such as the number of wheels or other characteristics. Thus, perceptions and conceptions reflect the cognitive sphere of the individual.

In mathematics, instruction concepts are perceived as the “personalised ideas and imaginations that are held by a teacher about the nature of mathematical knowledge and how it is mastered by learners” (Nyaumwe, 2007). The concepts in mathematics also involve teachers’ ideas about teaching strategies that can be used in classroom to enhance mathematics knowledge.

According to Kruger (1986:32), “beliefs are propositions that state or refute the relation between two real or abstract objects or between an object and some of its attributes”. Rokeach (1981:2) observes that beliefs cannot be seen or observed but can be inferred using appropriate psychological devices. Social psychologists place the beliefs into the cognitive sphere since such a process includes perception, thinking, and reasoning. However, beliefs can be the object of study in other subjects such as intercultural psychology, cognitive psychology, and psychoneurophysiology.

Belief, being an ancient term, has long been a subject of study in philosophy, especially in epistemology, but in recent times, it has been a focus of research in mathematics education (Mosvold & Fauskanger, 2013). On the other hand, the concept of beliefs intertwines with that of attitudes, and perceptions. However, beliefs are regarded as cognitive basis of attitudes (Weldeana & Abraham, 2013; Philip, 2007), as well as of perceptions. Thau (2002:221) describes perceptions as pictorial in property and it is based on sensing organs, while beliefs represent only one property of perception.

When it comes to mathematics education, the knowledge and development of mathematics teachers' beliefs is seen as important to improve the quality and effectiveness of the teaching and learning of mathematics (Adnan, Zakaria, & Maati, 2012; Philip, 2007). On the other hand, the beliefs teachers hold about mathematics will determine the type of approach (whether learner-centred or teacher-centred) teachers are going to use when they teach mathematics in the classroom.

Teachers with positive beliefs will tend to use more constructivism approaches when they teach mathematics (Adnan et al., 2012). If during their training they are oriented towards activities that instigate teachers to reflect and create a cognitive conflict, they can afterwards move from traditional to progressive approaches in the mathematics' classroom (Weldeana & Abraham, 2013). Their attitudes, in relation to teaching and learning mathematics, also can positively be influenced by courses that are oriented to mathematics reform (Jong & Hodges, 2013).

To understand and discuss mathematics teachers' beliefs, it is important to look at how this system of beliefs is organised in general. Researchers in mathematics education divide beliefs in to three categories, namely: (1) beliefs about the nature of mathematics or conceptual knowledge; (2) beliefs about mathematics teaching, and (3) beliefs about learning (Mosvold & Fauskanger, 2013; Weldeana & Abraham, 2013, and Zerpa, Kajander, & Barneveld, 2009).

These categories of beliefs may be focused on three approaches: the instrumentalist, Platonist and problem solving. Teachers who hold instrumental beliefs consider mathematics teaching content oriented, performance focused, and view mathematics as a discipline that implies memorisation of formulas and rules. Platonist view considers teaching of mathematics as oriented to develop students' understanding of mathematical content, and learning is an active construction of knowledge. As for problem-solving, teaching of mathematics is oriented towards learners and learning is aimed at exploring students' interests. The approaches above constitute a deep argument of the importance of beliefs in the teaching of mathematics.

Shifting from one approach to another requires training teachers, as well as human resources. In most countries in Africa, especially in Southern Africa, if not in the whole continent, the constructivism approach to education is relatively new. Most in-service teachers in the classroom were trained in environments in which teaching and learning emphasised traditional approaches. Hence, their perceptions or beliefs about new approaches to teaching and learning are built under influence of teacher-centred approaches.

Our study is based on the assumption that beliefs about learner-centred or teacher-centred approaches may be related to teachers' background training and their teaching experience, that is, knowledge of pedagogical content as well as of how long they have been teaching mathematics in basic education.

3.3 STUDIES ON THE EXTENT TO WHICH TEACHERS' BACKGROUND TRAINING CONTRIBUTES TO TEACHERS' PERCEPTION (BELIEFS) OF LEARNER-CENTRED APPROACH IN THE TEACHING OF MATHEMATICS

Although in Mozambique, studies concerning relationship between teachers' background training and perceptions or beliefs about learner-centred teaching in mathematics are rare, several qualitative and quantitative studies encircling this issue were conducted elsewhere. While quantitative studies focused on the use of questionnaires to ascertain teachers' beliefs or perceptions about teaching and learning of mathematics, qualitative studies used observations, self report and reflective journals to measure teachers' beliefs. In general, findings from these studies acknowledge the importance of mathematics teachers' preparation in terms of knowledge of mathematics and pedagogical content knowledge (PCK) as very important aspects for building teachers' beliefs about teaching and learning of mathematics.

Adnan, Zakaria and Maati (2012:1715-1719) conducted a study in which they sought to find out whether there were relationship between mathematics beliefs, conceptual knowledge and mathematical experience among pre-service teachers. To measure mathematics beliefs, they used a twenty two items mathematical beliefs' questionnaire (MBQ). The questionnaire was

constituted of fifteen items that measured constructivism beliefs and seven items that measured traditional beliefs. Based on Confirmatory Factor Analysis, the instrument was subjected to verification of the fitness of the model and afterwards the items of the questionnaire were reduced to twelve, being eight for constructivism beliefs and four for traditional beliefs.

To measure conceptual knowledge, the researchers used a twenty four items test. To measure mathematical experience, they used a mathematical experience questionnaire with sixteen items. seven items measured respondents' experience with contents of mathematics, five measured respondents' perception of their teachers' pedagogical experience and four measured respondents' experience as students of mathematics. These instruments were also subjected to verification of the fitness of the model through Confirmatory Factor Analysis. The participants in the study were three hundred seventeen pre-service teachers randomly drawn from public universities in Malaysia.

Adnan et al., (2012:1715-1719) found a significant relationship between mathematical beliefs and mathematical experience ($\beta=0.38$, $p<0.05$), and between mathematical beliefs and conceptual knowledge ($\beta=0.11$, $p < 0.05$). Significant relationships were also found between conceptual knowledge and mathematical experience ($\beta=0.13$, $p < 0.05$). However, relationships between mathematical beliefs and mathematical experience ($\beta=0.38$), between conceptual knowledge and mathematical beliefs ($\beta=0.11$), and between conceptual knowledge and mathematical experience ($\beta=0.13$) were found to be weak.

The study concluded that mathematical beliefs of pre-service teachers were positive and teachers were inclined to constructivism beliefs. These results suggest that teachers may be keen to use constructivism approaches rather than traditional ones when they teach mathematics. The study emphasised that, through training, teachers beliefs (perception) about teaching practices can be enhanced.

Another study conducted by Adnan and Zakaria (2010:153-154) sought to find out the beliefs held by 83 Malayan, Chinese, Indian pre-service teachers towards mathematics as nature,

mathematics as learning and mathematics as teaching. The sample was withdrawn from a higher education institution. To ascertain pre-service teachers' beliefs, a 42 items Mathematics Beliefs Questionnaire was used. The instrument was divided into three categories of beliefs: (1) beliefs of mathematics as nature with 10 items; (2) beliefs about learning mathematics with 13 items and; (3) beliefs about teaching mathematics with 19 items.

These researchers found that, concerning the beliefs about mathematics as nature, pre-service teachers showed a higher percentage of agreement (55.4%) on the statement that "Mathematic is essentially an abstract subject", and on the statement that consider "Mathematical reasoning involve in solving problems" with 69.9%. The statement that "Mathematics can be used in everyday life" was rated highly in the scale of "Strongly Agree" (77.1%). These results show a strong belief that mathematics isn't abstract at all but it can be used in everyday life and this finding also shows that teachers after training can move from traditional approaches to learner-centred approaches.

Concerning the beliefs about learning mathematics that are held by pre-service teachers, the study found that 60.2% agree with the statement that "In mathematics, students need to understand all the concepts, principles and strategies of solving in mathematics." About 61.4% agree with the statement that "In mathematics, students should be trained in the procedures before the calculation is given in the form of mathematical problem solving". The results also show that 78.3% of pre-service teachers agree with the statement that "In learning mathematics, students should be able to give reasons to support mathematical problems." About 57.8% of pre-service teachers strongly agree with the statement that "In mathematics students need frequent practice." Once again, the results of the study confirm that pre-service teachers may move towards the understandings that in mathematical learning learners have to justify the reason of any mathematical problem solved. The findings of this study suggest that with knowledge of mathematics pedagogy content teachers would organise a teaching in the classroom in such a way that can benefit learners.

As for the beliefs about teaching of mathematics held by pre-service teachers, the study found that 59% of teachers agree on the fact that “Teaching mathematics should involve the investigation and findings by the students themselves.” The belief that “Mathematics should be taught as a set of concepts, skills, and the calculations” is held by 66.3% of pre-service teachers on the scale of agree, while the belief that “In the teaching of mathematics, students should be encouraged to explain their mathematical ideas”, 69.9% have also rated on the scale of agree. Only 50.6% of teachers strongly agree with the statement that says "Teachers should guide students who have difficulties in solving mathematical word problems."

The results in this study show progressive beliefs about teaching and learning of mathematics. Adnan and Zakaria's (2010) study can give an important clues to this study since we also seek to understand how teacher trained teachers perceive their knowledge of mathematics methods and how they use this in the classroom.

Waldeana and Abraham (2013) used a history-based intervention programme that involved problem-solving and writing activities that prompt cognitive conflict to evaluate perspective and prospective teachers' beliefs in learning mathematics. Cognitive conflict refers to a situation in which a given student is confronted with material that contradicts with the previous learning he or she had. In the study, they used pre-test and post-test scores of a 12 theme questionnaire, with 40 items to measure prospective teachers' beliefs about mathematics learning and also used written reflections of prospective teachers. The items of the questionnaire were set into Likert scale in three levels: 1= Agree, 2= Undecided, and 3= Disagree. The items of the questionnaires described favourable beliefs (progressive beliefs), and unfavourable beliefs (traditional beliefs).

Validity and reliability was determined using Cronbach' alpha ranged from 0.76 to 0.83. The researchers also used reflective writing with a set of nine problem-solving activities from the history of mathematics and affective activities. Participants solved mathematical problems, wrote and presented their reflection to a class once a week. The participants were sixty three middle-grade (5-8) prospective and perspective teachers from teacher Education College in Northern

Ethiopia. The study aimed at responding to the following research questions: (a) How would the “history-based intervention program” affect prospective teachers’ beliefs related to the nature of teaching, and learning of mathematics? (b) What lessons would be learned from the “history-based intervention programme” in challenging traditional beliefs and boosting the development of progressive ones among the participants? and (c) What would be the impact of cognitive conflict in challenging traditional beliefs in transforming them to progressive ones?

The pre-test and post-test results have shown that teachers strongly moved from traditional beliefs to progressive ones, that is, from teacher-centred to learner-centred approach. Teachers show strong shifts on themes such as time (time spent to solve a problem, versus its nature) and theme, both with $p < 0.001$ showing that prospective teachers highly disagree with the favourable statement, and highly agree with the unfavourable ones whether in pre-test or in post-test. Significant shifts also were verified in the other themes. This results in evidence that exposing teachers in problem solving and reflective writing, that prompt cognitive conflict, is more likely to change their mathematics teaching from traditional methods (teacher-centred teaching) to progressive methods (learner-centred teaching). The study also concluded that although related to knowing mathematics in the beginning of the programme, teachers seemed to be inclined to traditional beliefs but at the end of the programme, there was a significant shift in the direction to progressive beliefs.

Wilkins and Brand (2004:227) sought to find out whether pre-service teachers beliefs and attitudes could change after participating in a mathematics course. In their research questions, they sought to find out whether: (1) pre-service teachers’ beliefs about mathematics teaching and learning were aligned with reformed curricula in mathematics education after they participated in mathematics course; (2) pre-service teachers’ perceived change in their teaching efficacy after taking the planned mathematics methods’ course, and (3) pre-service beliefs are constant after taking mathematics courses. To carry out the study, they selected 89 pre-service teachers who were being prepared to teach at elementary school. To access teachers’ beliefs, a Mathematical Beliefs Instruments was used. This instrument comprises Part A with sixteen

items, Part B with 12 items (both measuring consistency of person's beliefs about learning and teaching of mathematics) and Part C with two items that measure teachers' perceptions of their effectiveness as mathematics teachers. The answers to the questionnaire were coded into four levels Likert scale (4= strongly agree; 3= agree; 2= disagree, and 1=strongly disagree). The items were internally consistent.

Results from descriptive statistics for Part A ($M=2.89$; $SD=0.27$) and Part B ($M=3.17$; $SD=0.37$) show that pre-service teachers beliefs tended to be in line with mathematics reforms. The direction of agreement with reforms was of 68% for Part A and 73% for Part B. The researchers also found that after pre-service teachers finished their course, there was a positive change in the consistency of beliefs towards the mathematics curriculum reform in Part A ($M=3.24$; $SD=0.29$), Part B ($M=3.50$; $SD=0.59$) and sense of self-efficacy was also higher ($M=3.05$; $SD=0.60$). However, neither Part A $F(4,84)=0.37$, $p=0.83$, nor Part B $F(4,84)=1.97$, $p = 0.11$, of the questionnaire show significant interaction between Time and Class. Similar results were found in Part C of the questionnaire. According to the researchers, these lacks of significance denoted that the rhythm of change was similar in all classes. The effect of TIME in Part A and Part B was statistically significant reinforcing the fact that pre-service teachers' beliefs are in line with mathematical curricula standards.

This study concludes that teachers' beliefs could be changed, where pre-service teachers are engaged in particular mathematical courses and also changes their self efficacy. This is to say that there are relationships between taking a mathematical course and change of beliefs in teaching and learning. These results are similar to those of other researchers who reported that after taking a mathematical course, teachers moved from traditional approaches to progressive ones.

Haciomeroglu (2013:3) used a thirty four items Mathematical Beliefs Instrument to compare three hundred, third and fourth year pre-service beliefs. The instruments comprised four dimensions of beliefs namely: (1) beliefs about students' construct mathematical knowledge; (2)

beliefs about teaching mathematical concepts; (3) beliefs about organisation of teaching, and (4) beliefs about students' development of mathematical knowledge. Haciomeroglu (2013:4-7) found that in responses obtained from the Mathematical Beliefs' Instrument, teachers of both third and fourth year show strong beliefs in relation to how students construct their mathematical knowledge ($M=3.88$; $SD=.43$), about teaching mathematical concepts ($M=4.15$; $SD=.51$), and students' development of mathematical knowledge ($M=3.80$; $SD=.50$).

These results show that pre-service teachers show, in general, greater confidence in their skills to teach mathematics successfully. The results also evidenced that pre-service teachers beliefs to organise teaching was low ($M=3.05$; $SD=.63$), demonstrating a lack of confidence in this matter. The study did not find significant differences between third and fourth year students concerning the belief about how students construct their knowledge ($t=.71$, $p>.05$) and about the belief of how students develop mathematical knowledge ($t=-1.35$, $p>.05$). The study did find significant differences between third year and fourth year pre-service teachers in relation to beliefs about teaching mathematical concepts ($t=2.31$, $p<.05$) and in relation to beliefs about organisation of teaching ($t=-2.32$, $p<.05$). However, fourth year, pre-service teachers show stronger mathematical beliefs when compared with their counterparts from third year. These results suggest that third year, pre-service teachers have lack of confidence in terms of their skills to teach mathematics, and that skills can be improved over time.

Other research about mathematics teachers' perceptions was conducted by West and Rosas (2011). This research sought to find out pre-service teachers' perceptions in respect to their inclination to teach mathematics concepts and how well they were prepared to include mathematical topics in teaching. A total of 5306 students from public (2747) and private (2559) universities took part in the study. Data were collected using a pre-service survey constituted of 167 questions or statements in relation to teachers perceptions of their preparation programmes, professional knowledge and skills, teacher efficacy and concerns about teaching. The responses were set into 5 point Likert scale. The results show that when teachers were requested to indicate ten statements (from Likert type scale *1- not at all*; *2- poorly*; *3- adequately*; *4- well*, to *5- very*

well) about how well their programme prepared them to teach mathematics both pre-service teachers from private ($M=3.31$, $S.D. = 0.15$) and public ($M=3.29$, $S.D. = 0.14$) universities considered the programme adequate. Using a t-Test at $p<0.05$, the results show that differences between pre-service teachers from private and public universities regarding their ratings were not statistically significant. As for the statement which aimed at measuring teachers' beliefs on the integration of mathematical topics in the instruction, both private and public universities neither agreed or disagreed with the statement, showing indifferences ($M=3.40$; $S.D. = 0.3078$).

According to the results of the study, the statement "In my mathematics lessons, I aim for in-depth study of selected topics, even if it means sacrificing comprehensive coverage" was rated lower by both public and private university pre-service teachers. The statement that was rated highest by both teachers from the two types of universities was "My job as a teacher is to encourage students to think and question mathematically", with $M=3.86$; $S.D. = 1.14$ for public and private with $M= 3.85$; $S.D. = 1.16$. Using a t-test was found that in regarding to beliefs on the integration of mathematics topics, the difference between the two groups was not significant.

Results from the study indicated that pre-service teachers from public and private institutions have the same perceptions about if the programme course they have taken is adequate for them to be prepared as teachers, considering this programme simply adequate. That means that the programme may not have produced enough effect for teachers.

Evans (2008) examined and evaluated alternative certification novice teachers' perceptions of their self-efficacy in regard to mathematics development instruction, mathematics teaching, and classroom management and mathematics innovative teaching skills. The study aimed at ascertaining whether significant differences between teachers' perceptions and their self-efficacy mathematics development instruction skills, mathematics teaching skills, classroom management skills, and mathematics innovative teaching skills. The sample was constituted by novice teachers certified through community colleges, 4 year colleges and universities, and government affiliated programmes.

The findings show that perceptions of self-efficacy in the area of mathematics development instruction and mathematics teaching skills among programmes were significant. There were no significant differences between perceptions of self-efficacy and classroom management skills or classroom innovative skills. According to Evans findings, novice teachers from private schools showed that perceptions of their mathematics teaching skills were significantly higher than those from government affiliated programmes. She also found that teachers' perceptions of their teaching skills, using innovative mathematics teaching practices were higher than classroom management skills, but lower than mathematics development and mathematics teaching skills. Novice teachers showed higher perceptions in the effective use of innovative teaching skills in mathematics thematic and other subjects than those trained in universities, four year college and government programmes.

Alongside quantitative researches carried out around the world, related to the effect of teachers' background training in teaching methods and their perceptions, or beliefs about constructivist approach, qualitative researches were also developed to understand these relationships. Zalska (2012:58) argues that using qualitative research to study beliefs, a researcher can be able to discover how these beliefs can be deduced from actions and opinions and how can it be related to practices. Following this perspective, Evans, Leonard, Krier and Ryan (2013:81-82) used a qualitative case study to investigate how reform-based mathematics methods influence pre-service teachers' beliefs. Reform-based mathematics teaching is a curriculum where teachers and students have the opportunity to interact among themselves and reflect about what they are learning, taking in account the link between learning mathematics and daily experience.

The research was qualitative and used video recording to improve teachers' content knowledge and pedagogy, microteaching to give teachers the opportunity to demonstrate their practical experience that consisted of teaching content within 15 to 20 minutes, and reflective journals where teachers wrote about their teaching experience. These reflective journals were then examined by researchers. The sample study was constituted of 25 pre-service participants enrolled in a science methods' course and a mathematic/science practicum in a college in the United States of America.

Evans et al., (2013:83-89) found that the analysis of reflective journals produced 11 factors related to educational beliefs namely: beliefs (i.e., judgment/evaluation), values, educational history, affective states, verbal persuasion, vicarious experiences, mastery experiences, content knowledge, new knowledge, personal teaching efficacy (i.e., self-efficacy), and teacher efficacy (i.e., outcome expectancy). These results were compared and contrasted with educational beliefs at the beginning and end of the course. The main findings on teachers' beliefs on mathematics were that, whereas some teachers during teaching may focus on drill and practice in the mathematics classroom, others may focus more on inquiry. In respect to teachers' mastery, the results show that using videos to tell mathematics history and mastery experience, some teachers were able to change their beliefs about best practices for mathematics, however, a constant reinforcement of beliefs to turn these practices into sustainable ones is very important. At the end of the course, teachers were more confident to teach mathematics.

Qualitative research was also used by Nilas (2003:99-101) to find out the process pre-service teachers use to determine their conceptual and procedural understanding of division of fractions. 10 pre-service teachers were selected to take part in the study. To assess teachers' conceptual and procedural understanding of division of fractions, they were asked to answer 5 problem-solving questions. A written work produced by teachers was then analysed by the researchers. Four of ten teachers selected for the study were interviewed to probe how they understood the division of fractions (Nilas, 2003:101-111). The results from this study reveal that teachers use different strategies to solve problems that involve division of fractions, however, they don't have the ability to solve problems. Nilas (2003) argues that this situation could not guarantee that they have a conceptual understanding of the problems they solve, therefore, it can affect their confidence to teach fractions.

Another qualitative study also was conducted by Mosvold and Fauskenjer (2013) to determine the specific knowledge of mathematics tasks that are required for teachers to teach definitions and what sort of beliefs teachers hold. To reach the intent, Mosvold and Fauskenjer (2013:49) selected fifteen Norwegian teachers who participated in seven semi-structured focus-group

interviews. Before teachers went for interviews, they were given a 30 items stems and 61 items which contained three sets of mathematical knowledge for teaching namely: a) numbers, concepts and operations with 27 items; b) Geometry with 19 items, and c) patterns functions and algebra with 15 items. This form was adapted from the US mathematical knowledge for teaching form to Norwegian context. After teachers had taken this form, they were then subdivided into small groups of three for the interview. The teachers were then asked to give their comments on the basis of following structure: a) teachers' background, b) general considerations of the MKT measures, c) particular considerations in relation to the MC format, d) comments on the mathematical topic, structure and difficulty item by item, and e) comments and reflections that supplement the other issues discussed in the interviews.

The results, found by Mosvold and Fauskenjer (2013:51-56), were that, in relation to definitions, interviewed teachers show a belief that knowing definitions is an important aspect of teachers' knowledge, which shows that teachers' beliefs are that prior to anything, teachers must know concepts. In terms of remembering definitions, teachers showed their disagreement that remembering actual definitions, as well as knowing the formula, is not important for teachers' knowledge of mathematics. The results showed also that teachers' seem to agree that knowledge of definitions is only important in higher grades and that the youngsters did not have to know correct definitions because that would confuse them. Mosvold and Fauskenjer (2013:53) argue that the discussion of knowing definitions might be brought into the cultural difference domain since teachers emphasise learning definitions by heart.

Sandt and Nieuwoudt (2003:200) studied South African seven grades and prospective teachers in their knowledge of geometry. They used an ex post facto research design to determine the level of knowledge of teachers and prospective teachers to teach grade seven geometry. A fifty six items geometry questionnaire, constituted with a variety of concepts, was applied to both in-service and prospective teachers. Twenty three mathematics prospective teachers took part in the study. Findings from Sandt and Nieuwoudt (2003:201-204) indicate that neither group have reached the complete level of geometry taught. Grade 7 teachers reached a higher level and the

prospective teachers the intermediate level. Teachers' level of knowledge is an important step to build confidence and beliefs about teaching. In the case of this study, results indicate that teachers have difficulties in mastering mathematics content. This situation could harm their confidence to teach mathematics since they have a lack of knowledge of mathematics content.

Similarly, Avcu and Avcu (2010:1284) assessed how pre-service elementary mathematics teachers used their strategy to solve mathematics problems. The aim of the research was to find out what sort of strategies teachers use to reach a solution for a specified problem. A ten, open ended items, problem solving test was administrated to 93 Turkish, pre-service, mathematics teachers enrolled at university. In the study, only five items were analysed. The research concentrated on such strategies as: (a) whether a general problem can be solved using different strategies, (b) determining a students' use of finding a pattern strategy, and (c) making a drawing problem. The results from the study of Avcu and Avcu (2010: 1285-1286) showed that pre-service, mathematics teachers are able to use strategies to solve mathematics problems. However, their ability to use different strategies to solve mathematics problems is somewhat narrow. The data from the responses showed that they could use seven different ways of solving mathematics problems such as making a drawing, accounting for all possibilities, adapting a different point of view, finding a pattern, organising data, logical reasoning and working backwards. Notwithstanding, most of them could not solve the problems correctly and their low achievement could act as a barrier for pre-service, mathematics teachers to use different strategies to solve mathematic problems.

Although most results have shown that beliefs about teaching can be change over time, results from Andrew (2006) showed the opposite. He conducted a qualitative study in order to find out the expectations and reactions, in relation to constructivist pedagogy, of a group of pre-service teachers who were taking a final content, mathematical course. Sixty one pre-service teachers enrolled at university level in the USA took part in the study. In the middle of the semester, these participants were asked to rate their interest and enthusiasm for the course, then about their

interest in teaching mathematics, and then about their mathematical ability in geometry. These measures were in on scale of 1 to ten, being low for 1 and high for 10.

The researcher administered the second survey at the end of semester with five questions, the last being two open-ended questions. The results show that among pre-service teachers the expectation was that the content mathematics course supposed to be methods class. Participants considered that learning mathematics was a waste of time and effort and that wouldn't help them to be good teachers. Some of participants considered that doing lesson plan assignments or creating activities and projects would prepare them well to teach mathematics in the classrooms.

A great part of students preferred teacher-centred teaching than learner-centred, and they felt constructivist approach helpless. They also considered that the teacher in their class as passive and lacking in authority. Andrew (2006) argues that changing teachers' conceptions about reform-based philosophy of learning mathematics must be done in small steps to permit that teachers understand the use of new approaches in the learning and teaching of mathematics.

Kalchman (2001) conducted a study in which he sought to find out the effect of specific constructivist learning on pre-service teachers' beliefs, and attitudes about the value of conceptual-based instructional methods. Participants were twenty-two American, undergraduate, elementary education students. To search for teachers' perceptions attitudes and beliefs, the researcher used ethnographic methods and used three sources of data collection, namely whole class discussion, review of pre-service written work, and Math in Everyday Life (MIEL) assignment. In this assignment, students were prompted to do mathematics that values the premises of constructivism. Kachman (2011:86-94) concluded that in the first structured discussion, 61% of the pre-service teachers did not believe that constructivism was an appropriate approach to teach urban elementary mathematics students, 26% were undecided, while 13% agreed to use constructivism approach. The reasons students gave for not believing in the constructivism approach was that urban students were not keen to learn using that approach or they don't have background knowledge. The undecided teachers argued that they did not understand the scope and application of constructivism. Those teachers who believed that constructivism could be used in the classroom argued that they are using this approach in their

daily teaching activities. After the second discussion, that took place after ten weeks, there were no students with the idea of constructivism as the approach for teaching. 30% were undecided and 70% agreed with constructivism. In the end 74% changed their views towards constructivism.

The results, of the studies described above, acknowledge that when teachers are well prepared in terms of mathematics contents, as well as teaching methods, they are likely to change their views in respect to a teaching approach that that can help learners understand mathematics. Although such studies in Mozambique are rare, the results from several researches can give insights to research since it also seeks to understand how trained teachers perceive learner-centred teaching applied to mathematics.

3.4 STUDIES ON THE EXTENT TO WHICH TEACHERS' TEACHING EXPERIENCE CONTRIBUTES TO PERCEPTION OF LEARNER CENTRED APPROACH IN THE TEACHING OF MATHEMATICS

Most studies conducted are related to pre-service teachers' knowledge of mathematics contents, mathematics teaching and learning, and teachers' beliefs in using learner centred approaches. There are few researches concerning the influence of teachers' teaching experience on building their beliefs about the learner centred approach. Aslan (2013:226) investigated pre-service and in-service teachers by using a 14 items Math Anxiety Scale that measures teachers' mathematics anxiety and a 40 items Beliefs' Survey that measures teachers' beliefs about teaching mathematics. The responses in each scale were set into Likert scale. Participants selected for the study were 50 pre-service, first grade university teachers and 50 of last grade. Fifty in-service, mathematics teachers also took part in the study.

As for teachers beliefs, Aslan (2013:227-228) found a statistically significant difference among the pre-and in-service teachers' scores in the Beliefs Survey ($F(2,147) = 113.189, p = .001$). The

results from the Tukey Post Hoc analysis also showed statistically significant differences among in-service teachers, and first and last grade pre-service teachers favouring in-service teachers.

Also, there was a statistically significant difference between first grade, pre-service teachers and last grade, pre-service teachers, favouring last grade pre-service teachers. In-service teachers had higher scores ($M=208.74$, $SD=14.9$) than first and last grades, pre-service teachers. Last grade, pre-service teachers had higher scores ($M=182.62$, $SD=18.25$) than first grade, pre-service teachers ($M=146.52$, $SD=27.16$) in the Beliefs' Survey. It was found that beliefs' scores of in-service teachers were higher than those of pre-service teachers.

On the other hand, it was also found that pre-service teachers, who had mathematics education in early years, had higher beliefs' scores than first grade, pre-service teachers who did not have, who participated in the course. Aslan (2013) argues that the high scores differences that favour in-service mathematics teachers may due to experiences in teaching and in education. He then concluded that differences in education and experience may also cause differences in terms of beliefs about teaching mathematics.

Zerpa, Kajander and Berneveld (2009:63-66) used one-group pre-test and post-test to investigate how pre-service teachers' evolve in terms of conceptual mathematical knowledge after taking a mathematics methods' course. They determined the relationship between changes in conceptual mathematical knowledge and factors such as pre-service teachers' academic background, initial levels of conceptual and procedural mathematical knowledge and values, and the number of mathematics courses taken in high school and university. A Perceptions of Mathematics Survey was administrated to 111 pre-service teachers in the beginning of mathematics course and at the end of the course.

Using a repeated measures t-test, Zerpa et al., (2009:66-74) found a significant improvement in pre-service teachers' conceptual knowledge from the pre-test to the post-test, $t(110) = -15.04$,

$p < 0.025$, $d = 1.43$ (large effect). Through a regression analysis model, they found that the change in conceptual knowledge was affected by pre-service teachers' high school mathematics level ($\beta = 0.26$, $p < 0.05$), procedural knowledge ($\beta = 0.32$, $p < 0.05$) and conceptual knowledge ($\beta = -0.50$, $p < 0.05$) pre-test data. According to the authors, the number of courses that a pre-service mathematics teacher takes at the university did not seem to produce changes on teachers' conceptual knowledge. Instead, it is the experience teachers brought from high school, as well as the level of conceptual and procedural knowledge that they got in the beginning of the course, that appear to account for growth in their conceptual knowledge. Thus, the mathematics content they have attained at high school, and levels of procedural and conceptual knowledge at the pre-test, are the best predictors of conceptual change.

Sapkova (2011:4-7) studied a profile of traditional/constructivist beliefs of Latvian, in-service teachers. Participants were 390 in-service teachers selected from different schools and regions of Latvia. The study sought to find out what was the main approach used to teach mathematics among Latvian teachers and if significant difference would be found among teachers of various sociographic groups in terms of their beliefs towards traditional/constructivist approaches. To conduct the study, a 16 items questionnaire was used. The answers of the questionnaire were set to five point Likert scale, from fully agree to fully disagree. Four items reflected traditional approach while the rest reflected constructivist approach. Data were validated through Principal Components Analysis and were found to be consistent.

Sapkova (2011:7-15) found that in terms of teachers' beliefs towards teaching approach, they were significant differences between teachers living in the countryside, and teachers from urban areas. Teachers teaching in countryside schools tended to favour the constructivist approach more than those in urban areas. The researcher also found significant differences in respect to teachers' academic degree. Teachers holding a Bachelor degree tended to constructivist approach more than their Masters' counterparts. About 90% of teachers consider that the teachers' role is to encourage pupils to learn in independent way rather than prescribing formulas.

Yimer (2009:103) conducted a qualitative analysis that sought to find out whether in-service teachers who participated in the problem based professional development have changed their

beliefs towards knowledge and teaching of mathematics. Fourth two in-service teachers from school districts in USA, teaching mathematics to grade 5-10, were selected to be part of the study. Prior to study, participants indicated that fractions, measurement, and geometry were a major priority for them. The training focused on problem solving. Then, during four months, teachers participated in a 15 days mathematics course which focused on pedagogical contents. Participants came from diverse mathematical teaching experience. Five teachers were B.A.'s majoring in mathematics, seven were B.A. mathematics' minors, and twenty-two were B.A.'s majoring in Elementary Education.

The results from Yimer's (2009) study indicate that in-service teachers were actively participating in mathematical problem solving using different strategies such as drawing a picture, sharing thoughts and attempts about the problem in public, whether those solutions were wrong or right. They also show reflective actions about the way is suitable to understand the content material, and about how this material would be delivered to the students. These findings showed that in-service teachers have changed their beliefs about learning and teaching of mathematics, and developed confidence that teaching is about discussing, justifying findings and solutions, and sharing thoughts.

Jong and Hodges (2013:102-103) investigated how teachers' perceptions of past schooling experiences, and their experience in a mathematics methods course, influence their attitudes about mathematics' teaching and learning. To reach their objective, they administrated pre- and post-survey with 31 items to 75 pre-service teachers enrolled at university in the US, in order to understand whether entering attitudes about mathematics where changed after taking a mathematic course. The pre-survey included such dimensions as: (a) attitudes and practicum experiences, (b) teaching and learning, (3) methods courses expectations, and (4) diverse learners. The post-survey included (a) attitudes and practicum experiences, (b) teaching and learning, (c) diverse learners, and (d) future teaching. The survey items were set to four points Likert scale (Strongly Agree, Agree, Disagree, and Strongly Disagree).

Jong and Hodges (2013:104-114) found that past schooling played an important role in teachers' mathematics perceptions. They examined the relationship between past schooling and pre-service teachers' attitudes and found significant correlations at the 0.01 alpha levels, which indicated that linear relationships between attitudes towards mathematics, experiences in mathematics, and confidence in their ability to teach mathematics were very strong. However, relationships between factors such as teachers having more positive attitudes towards mathematics, and learning a variety of strategies in the mathematics methods courses ($r = .273$, $p < .05$) were moderate. Moderate relationship were also found variables such as teaching mathematics in a conceptual manner ($r = .326$, $p < .01$), planned to require their students to memorise facts ($r = .274$, $p < .05$), and agreed that the mathematics methods course would have a major impact on their future teaching ($r = .268$, $p < .05$). Participants affirmed that they had learned a variety of strategies in the methods' course and they had augmented their desire to teach mathematics ($r = .371$, $p < .01$), their confidence ($r = .277$, $p < .05$), and their belief that what they had learned would have an impact on their future teaching practices ($r = .440$, $p < .01$).

The impact of mathematics on future teaching was significantly related to the teacher's expectation to teach mathematics ($r = .360$, $p < .01$) and to their confidence ($r = .291$, $p < .05$). Confidence was also related to whether pre-service teachers would support students to use multiple strategies ($r = .279$, $p < .05$). The use of multiple strategies to solve mathematics problems is a characteristic that is conceptual focus strategy. The results showed also that the positive relationship was stronger for those who planned to use procedural methods to teach mathematics and also for those who planned to oblige their students to memorise mathematics facts ($r = .601$, $p < .01$).

Jong and Hodges (2013:107) argue that the results of their study show that pre-service teachers were familiar with characteristics that are associated with both approaches (teacher and learner centred). These researchers also found that 100% of pre-service teachers agreed or strongly agree that they would teach mathematics using conceptual way, while 78% agreed or strongly agreed that they would teach using a procedural way. Other findings were that 80% of pre-service

teachers agreed that during their learning of mathematics, teachers always used a traditional approach to teach and that they wouldn't use the same approach when they teaching.

The study of Ampadu (2012) describes the perceptions of students towards pedagogical approaches teachers use in the classroom when they teach mathematics and how those teaching practices impact on their learning experiences. The study was conducted in Ghana and included 358 students randomly selected from junior schools. To collect data, he used a questionnaire that included, among other questions, 10 questions that measured how students perceive their teachers' teaching practices, and 10 questions that measured their perceptions about how they learn mathematics in the classroom. The responses to questionnaire items were set into four points Likert scale that ranged from *strongly agree* to *strongly disagree*. Five questions were related to the learner centred approach, and the other five to teacher centred approach. The results demonstrated that generally students consider that their teachers use both learner and teacher centred strategies. However, there is more consensus that teachers use more teacher centred teaching than student centred teaching.

3.5 STUDIES IN THE EXTENT TO WHICH TEACHERS' BACKGROUND TRAINING CONTRIBUTE TO LEARNER CENTRED PRACTICES IN THE TEACHING OF MATHEMATICS

Flores, Patterson, Shippen, Hinton and Franklin (2010:3-4) sought to find out general and special education knowledge and perceived teaching competences in mathematics. Two hundred and six current and future teachers, enrolled in public universities in the US, participated in the study. The instrument used by the researchers to collect data was the Math Operational test. This was used to survey teachers' computational knowledge. Math Concepts and Applications Test were also used to survey teachers' problem-solving skills. This instrument was used to measure mathematical reasoning such as number concepts, numeration, applied computation, geometry, measurements, charts and graphs, and word problems. The grade levels which represented elementary and middle certification, representing special and general education, and competence

in teaching mathematics skills, were all set as independent variables, while dependent variable were the percentage of correct scores in the computational and problem solving test.

Flores et al., (2010:5-7) found that the MANOVA test indicated a significant main effect for (Wilks' lambda $\lambda = .96$ $F(3, 191) = 2.68$, $p < .05$) and very high significant main effects for perceived competence in teaching mathematics skills (Wilks' lambda $\lambda = .88$, $F(3, 191) = 9.05$, $p < .01$). The study found that there were no significant differences in all variables between general teachers and special education teachers which shows that they have the same mathematical skills. The study also found that teachers have high competence to teach mathematics, despite their difficulties in solving some mathematics problems.

Wilburne and Long (2010:4-5) also conducted a study in which they sought to verify teachers' content knowledge, vocabulary knowledge, and their perceived competence in teaching the content. 70 pre-service teachers enrolled in two universities of the US took part in the study. The study intended to analyse the extent to which pre-service teachers were able to solve mathematical content, to define mathematics vocabulary, and the extent to which pre-service teachers are confident about teaching mathematics. The content assessment instrument used to assess teachers mathematics knowledge, vocabulary knowledge, and perceived confidence in teaching had 55 multiple-choice questions. The main questions asked of the teachers were related with algebra, operations, geometry and measurement, and probability.

The findings from Wilburne and Long (2010:5-11) indicate that the number of correct answers in such items as strands of numbers and operations, geometry and measurement, and data analyses and probability was decreased. Results also showed that teachers had difficulties in pre-calculus. The study found also that there was a strong relationship between teachers who answered the questions correctly and those who defined mathematics vocabulary correctly. Also, it was found that teachers with strong mathematics content would also be more comfortable in teaching mathematics.

Turmuklu and Yesildere (2007:4-6) sought to find out teachers' knowledge of mathematics and mathematics teaching. To reach their intent, they selected 45 pre-service teacher candidates, who were enrolled at university level in Turkey, to participate in the study. The instrument used to collect data was mathematical, in-class problems that included fractions, decimal numbers and integers. Problems were also aimed to assess teachers approach to teaching mathematics. Turmuklu and Yesildere (2007:7-12) found that pre-service teachers were not able to determine students' misconceptions related to fractions and decimal fractions and they lacked assessment knowledge and they had difficulties with forming criteria assessment. When teachers were asked which solutions they could use to remove students' difficulties, they tended to explain procedures or rules and did not instigate pupils to try discovering mathematics contents by themselves. Sometimes they would use questioning. The researchers in this study concluded that teachers tried to create solutions for a problem without looking for reasons why pupils did not understand such content. They also did not try to understand how pupils think for a given mathematical problem.

Burton, Daane, & Giesen (2008:2-7) examined differences in content knowledge for teaching mathematics between pre-service teachers when using traditional versus experimental mathematics methods' course. They selected 44 pre-service teachers from two sections of the mathematics methods' course. They used an experimental approach and assigned 20 teachers for the experimental group and 24 for the control group. A Content Knowledge for Teaching Mathematics Measure (CKTMM) was used in pre-test (version A) and post-test (version B) to assess teachers' content knowledge. The 44 teachers completed version A of the instrument at the beginning of the course which was 16 weeks long. At the end of semester, they took then version B. The experimental group took extra lessons of 20 minutes long and the contents of the lessons were taken from textbooks from fifth and sixth grade mathematics. The CKTMM instrument was administrated twice in alternate forms.

Burton et al., (2008:8-10) found that where the control group had slightly higher scores in the pre-test, and slightly lower in the post-test than the experimental group, the differences were not

statistically significant $F(1, 41) = 1.22, p = .28, \eta^2 = .03$). That means scores did not vary between the control and experimental groups. However, what was found was that the effect between Time x Group was statistically significant, $F(1, 42) = 9.42, p < .01, \eta^2 = .18$), showing that the mean score can change according to the group in which the participants are assigned. The study also found that the experimental group had statistically significant increased in relation to their mathematical content knowledge for teaching from pre-test to post-test. According to the authors, this increment is due to an intervention programme applied to experimental group. Scores from the control group did not show statistical significant differences between the pre-test and post-test.

Gencturk (2012) investigated the relationships among teachers' mathematical knowledge, teachers' teaching practices and students achievement. The researcher sought to know how teachers' mathematical knowledge for teaching affects their instruction and what factors, such as beliefs and the curriculum, mediate the expression of mathematical knowledge for teaching in instruction. Another aim of the study was to find out the extent changes in teachers' mathematical knowledge for teaching, instructional practices, or both related to students' gains in achievement. To respond to these questions, Gencturk (2012:35) used qualitative and quantitative methods. The quantitative data was used to verify whether changes in teachers' mathematical knowledge were related to changes in their teaching practices and students' achievement gains. The qualitative approach was used to find out how the relationships occurred among teachers knowledge, instructional practices and students' learning. The participants were twenty one, K-8, in-service teachers enrolled at masters level. From this sample, eight were assigned to classroom observations and interviews. These teachers were employed at public elementary and middle schools in the US, and their teaching years of experience varied from one to twelve years of experience. Apart from teachers, a sample of eight hundred seventy three students took part in the study. To collect data, Gencturk (2012:41) used a variety of instrument such as paper-and-pencil tests to measure teachers' mathematical knowledge for teaching, a survey of teachers' beliefs about teaching and learning mathematics, and a classroom observation protocol to quantify the quality and frequency of teachers' practices, classroom observations and interviews with the teachers who participated in the study.

To measure teachers' mathematical knowledge for teaching, a two parallel "Learning Mathematic for Teaching" instrument form was used. Form A and form B were both designed to measure mathematical knowledge for teaching. Form A had sixty two items while form B had sixty six. This instrument is designed to measures teachers' mathematical knowledge of three content areas: a) numbers and operations; b) patterns functions and algebra, and c) geometry and both forms had respectively sixty two and sixty six items. Qualitative information was gathered using classroom observations' protocols developed by the researcher. These protocols evaluated such aspects as grade, subject, the purpose of the lesson, how the class time was spent which includes the number of minutes spent in classroom activities, percentage of instructional time spent as a whole class, in pairs or working in small groups, and working individually. The protocols also focused on observation of lessons in the four component areas: lesson design and its implementation; mathematics discourse and sense making; task implementation and classroom culture. As for teachers' beliefs, Gencturk (2012:47) used a twenty six items beliefs' questionnaire whose responses were set into five points Liekert scale that varied from *Strongly disagree* to *Strongly Agree*. This instrument was aimed at measuring teachers' traditional view, or standards-based views, of mathematics. Students in the research were submitted to Illinois Standard Achievement test to measure students' knowledge on: a) number sense; b) measurement; c) algebra; d) geometry, and e) data analysis, statistics, and probability.

With regard to the relationship between teachers Mathematical Knowledge for Teaching and their instructional practices, Gencturk (2012:86-88) found that after taking the course, teachers' mathematical knowledge changed significantly ($F(3, 55) = 33.55, p < .0001$), as well as several aspects of their instructional practices. The researcher also found significant changes in teachers' inquiry-based teaching ($F(3,33) = 3.22, p = .035$), teachers' mathematical-sense making agenda ($F(3, 33) = 3.42, p = .028$), the use of worthwhile mathematical tasks ($F(3,33) = 4.70, p = .008$), and classroom climate ($F(3,33) = 4.72, p = .008$). However, there were no changes in teachers' scores on the student engagement scale ($F(3,33) = .80, p = .50$). When teachers were assessed to find out whether their views of mathematics were aligned with problem-solving views in contrast to traditional views, Gencturk (2012:87-88) also found that in the second year of the programme, teachers' beliefs indicated that, in average, teachers held standard based view of mathematics to

a moderate extent, which show that teachers' mathematical knowledge and instructional practices changed during the course.

With regard to the relationship among teachers' inquiry-oriented lessons, mathematical knowledge for teaching, and beliefs using regression model, Gencturk (2012:89) found that that teachers' scores in the mathematical knowledge for teaching test predicted significantly their scores on the inquiry-oriented lesson design. However, grade level and being experienced in teaching were not found as significant predictors of inquiry-oriented lesson design. It was also found that as teachers' beliefs scores increases, so do the teachers' scores on inquiry-oriented lesson design, which shows that variation of scores on inquiry-oriented lessons was explained by teachers' beliefs score.

As for the relationship among teachers' students engagement, mathematical knowledge for teaching, and beliefs, the results of the study did not found any significant difference. 68.3% of the total variation in student engagement was attributable to differences between teachers, while 31.2% of the total variation was attributable to differences in individual teachers. According to the author, the results suggested that, on average, there was important variation in student engagement across teachers.

The study sought to find out the relationship among teachers' worthwhile tasks choice, and mathematical knowledge for teaching. It found that teachers' mathematical knowledge for teaching score, year, grade level, and dummy coded variable of being a novice or experienced teacher were not significant predictors of teachers' task choice (Gencturk, 2012:95). Neither the relationship between teachers' beliefs scores, and their and their Classroom Climate score ($p = .124$), indicated significant differences.

The results of the observation were that Gencturk (2012:179) found that in terms of changes in teachers' inquiry lessons, all teachers reported some changes towards more inquiry-based teaching as they gained more mathematical knowledge for teaching.

3.6 STUDIES ON THE EXTENT TO WHICH TEACHERS' PROFESSIONAL EXPERIENCE CONTRIBUTES TO PRACTICES OF LEARNER CENTRED APPROACH IN THE TEACHING OF MATHEMATICS

Iheanachor (2007), in his research, sought to demonstrate whether teachers' background, professional development and teaching practices would influence students' achievement. The aims of the study were: (1) to verify what mathematics teachers try to accomplish in their mathematics instruction and what were the activities they used to reach the objectives, and (2) to verify the level of preparation of teachers in relation to mathematics content and pedagogy. He used a sample of 40 Form C (grade 10) mathematics teachers from the city of Maseru. To collect data from participants, he used a Mathematical Teaching Optional. In terms of teaching experience, most (65%) participants have been teaching for more than 10 years and 80% have got at least the first degree. 52% of these teachers have training in mathematics, or mathematics education, while the remaining 48% did not received enough training in mathematics (Iheanachor (2007:52). As for the type of professional development teachers took, the results from this study show that teachers mostly used to meet regularly with each other to discuss mathematics teaching content, or they would attend workshops that focused on mathematics teaching. The results show also significant positive correlation between students' achievement and teachers' background variables such as qualification, subject major and teaching experience. The study also found significant differences in mathematics' achievement among students whose teachers had more than five years of experience, while among students whose teachers had more than ten years of teaching experience, there were no significant differences in mathematics achievement. According to Iheanachor (2007:51), teaching experience above ten years does not affect students' achievement in mathematics.

Supovitz and Turner (2000) investigated the relationship between professional development and the reformers' vision of teaching practice. The study sought to find out: (1) whether high quality professional development, that utilises standard based curriculum, is supported by systematic context statistically related to inquiry-oriented teaching; (2) which level of professional development is associated with the greater use of inquiry-based teaching practices, and (3) how

teachers' background characteristics mediate the relationship between professional development practices. To reach their intent, they used a Self-Reported Teacher Survey to collect data from teachers and principals of 24 communities across the US. 3 464 and 666 principals completed the teacher survey. The questions in the survey were about teachers' attitudes about teaching, their classroom practices, and their experience on professional development. Teachers were also asked to report how frequently they used reform-based teaching practices, such as to engage in hands-on activities; design or implement their own investigation; write reflections in a notebook or journal; and work on extended science investigations or projects.

The results found by Supovitz and Turner (2000:972-979) show that on average, teachers without professional development employed less inquiry-based practices than those taking professional development. However, the level of practices of those who take professional development varied. Teachers who took only 40 hours of professional development tended to more traditional practices, while those with between 40 to 79 hours of professional development had about average teaching practices. Those with 80 hours or above of professional development used inquiry-based teaching practices significantly. These results show that teachers with less hours of professional have less investigative classroom culture than those who have more hours of professional development. The study also found that individual characteristics, such as gender, have an influence on the use of inquiry-based teaching. Male teachers tended to use more traditional methods in the classroom than their female counterpart. The results also indicated that teachers with positive attitudes towards reforms were keen to use inquiry-based practices.

Hill, Rowan and Ball (2005) sought to know how teachers' mathematical knowledge for teaching contributes to gains in student achievement. They collected data from 334 first-grade and 365 third grade teachers and from 1 190 first graders and 1 773 third graders students. Data from students were collected from students' assessments and parents' interviews. As for teachers, an annual questionnaire and a log, that was completed 60 times during one academic year, were administrated to collect data. The results show moderate positive correlations of years of teaching experience with certification and with methods and content courses. Hill et al.,

(2005:392) found also that teachers' mathematical content knowledge for teaching was not significantly correlated with teacher preparation or experience at grade 1, and correlation were also small with teacher certification at Grade 3. According to the authors, neither certification, nor increasing subject-matter or methods' coursework, can guarantee that teachers have strong content knowledge for teaching mathematics.

3.7 STUDIES ON THE EXTENT TO WHICH TEACHERS USE LEARNER CENTRED APPROACH IN CLASSROOM MATHEMATICS

Stols, Kriek and Ogbonnaya (2008:7) conducted an investigation in which they related teachers' practices and students' achievement. The research aimed at verifying whether relationships exist between students' achievement in mathematics, and different ways of teachers' practices (formal presentation, guided discussion, group work and use of homework). A Mathematics Teaching Optional Scale was used on 40, Form C (grade 10) mathematics teachers from the city of Maseru about their teaching practices. The students' achievement in mathematics was obtained from Examination Council of Lesotho (ECOL) 2006 Junior Certificate (JC) examination list.

Stols et al.'s (2008:8-14) results of their study show that at least once a week, 95% of teachers assigned mathematics homework, 70% used formal presentation to introduce mathematics content, 60% used teacher-guided discussion, and 62.5% engaged students in group work. The results of this study showed that among those teachers who assigned homework (95%), the majority of them (62,5%) do this in all or almost all of their mathematics' lessons. The time allocated for homework was also different. In 62% classes, students could spent of about one hour of homework every week, while in 18% of classes, students could spend three hours doing their homework every week. The study also found a weak relationship between students' achievement and formal presentation (teacher-centred teaching). A fairly solid relationship between student's achievement and some forms of learner-centred teaching (whole class teacher guided discussion and group work) was found. A weak but positive relationship was also found between students' achievement and use of homework. These results show that correlations

between students' achievement and teachers teaching practices were not significant. Stols et al. (2008) speculate that the use of teacher-centred teaching, to the detriment of learner-centred teaching, may have caused the fact that learner-centred as coming constantly under criticism.

Frid (2000) was concerned about the lack of impact, particularly in relation to: (a) a gap between teacher education, especially constructivism and school classroom practices, (b) a potential conflict between teacher educators' views and pre-service teachers' own views of their learning, and (c) a neglect to examine the discourses within which educational practices are constituted. She conducted research in which she used a 45 items questionnaire, with responses set to a 5 points Likert scale, that ranged from strongly disagree to strongly agree. 14 volunteers participated also in interviews. The interviews were aimed at ascertaining teachers' ideas on how children learn mathematics best, how they see the role of the teacher and how they see the unity as influencing them as developing teachers. Before she conducted her research, pre-service teachers were submitted to a constructivism lesson in which they learned how to organise mathematics lessons using the constructivism approach (Frid, 2000:19-20). The results from the questionnaire show that pre-service teachers did not hold the belief that mathematics is a discipline with procedures, rules, and with one way to think, that is the traditional view. At the end of the semester, their beliefs were even less stereotyped. As for the beliefs about mathematics teaching, students were oriented to constructivism and some to more traditional beliefs. However, it was found that at the end of semester, there was a slight move towards constructivist views. These findings were similar to those related to beliefs about mathematics learning. Results from interviews also showed students developed constructivist-oriented views about teaching and learning of mathematics. However, during practicum observation, it seemed that pre-service teachers used more traditional approaches for planning, assessment and teaching. Their lesson planning and teaching were derived more from textbooks and worksheets, with more emphasis on performance.

3.8 SUMMARY

In the present chapter, studies related to teachers' background training and teaching experience and their perception of teacher-centred teaching were reviewed. We analysed how teachers' knowledge of teaching mathematics is related to their beliefs of applying learner centred teaching in the classroom. Teachers' background training and their teaching experiences were also analysed in regard to classroom practices, that is whether learner centred teaching would be influenced by teaching experiences or background training. In this chapter, we have analysed whether teachers do practice learner-centred teaching in the mathematics classroom. Table 3.1 summarises researches on which the discussion of research questions was based.

Although the findings indicated that teachers' beliefs may change as result of training, others indicated no changes were verified whatsoever. It has been argued that changes are more difficult to affect in prospective teachers beliefs, than in service teachers (Richardson, 2003). Teachers, who are taking their teaching course for the first time, may experience conflict amid what they bring as believe and the understanding of the content. The beliefs that students bring into the classroom may sometimes constitute a barrier for constructing new beliefs and, to a large extent, the change of beliefs depends on significance of the work to be done and how the involvement is structured in the classroom (Richrdson, 2003). On the other hand, self-efficacy beliefs are due to influence changes in one's beliefs. Self-efficacy is related to capability of persons to mobilise one's resources, and on the other hand to perform a task and accomplish a goal (Maddox & Gosselin, 2012).

Teachers with strong self-efficacy beliefs about their competences, together with challenges associated to new innovations, are able to change their beliefs more than those with weak self-efficacy beliefs. (Kadir &Ellett, 2014). Along with the findings mentioned in the literature review, it is also clear that the effect of experience held by teachers in teaching may in same instances influence their beliefs in teaching, but on the other hand, it is shown that those teaching experiences, in some instances, do not have an effect on teachers' beliefs. Is acknowledgeable

that beliefs about teaching can also be stabilised or some teachers can be resistant to change (Gob & Chen, 2014). From this point of view, it can be argued that beliefs are an intricate process and it depends on multiple factors.

Table 3.1 List of research studies for literature control in the review of previous work done in this field

AIM	AUTHOR AND YEAR	TITLE OF ARTICLE	PARTICIPANTS	SOURCE	RELEVANCE
To determine the extent to which teachers background training contributes perception of learner-centred approach in the teaching of mathematic	Adnan, M., Zakaria, E., & Maati, S. M. (2012)	Relationship between mathematics beliefs, conceptual knowledge and mathematical experience among pre-service teachers	317 Pre-service teachers from public higher education	Procedia – Social and Behavioural Sciences 46(2012)1714-1719	Provides understanding about beliefs and conceptual knowledge
	Adnan, M., & Zakaria, E. (2010)	Exploring Beliefs of Pre-Service Mathematics Teachers: A Malaysian Perspective	83 pre-service teachers from a public high education	Asian Social Science, Volume 6, No 10 October 2010	Explore pre-service teachers beliefs about mathematics as a nature, about learning mathematics, and about mathematics

					teaching
	Weldeana, H. N., & Abraham, S. T. (2013)	The effect of an historical perspective on prospective teachers' beliefs on learning mathematics.	63 middle-grade teacher education college.	Journal of Mathematics Teachers Education	Analyses prospective teachers beliefs about the nature of mathematics and the way is learned, taught and practiced.
	Wilkins, J. L.M., & Brand, B. R. (2004)	Change in pre-service teachers' beliefs; An Evaluation of a Mathematics Methods Course	89 pre-service teachers in US	Journal of School Science and Mathematics. Volume 104(5) May	Examine Pre-service teachers beliefs and attitudes towards teaching of mathematics
	Haciomeroglu, Guney. (2013)	Mathematics Anxiety and Mathematical Beliefs: What Is the Relationship in Elementary Pre-Service Teachers?	301 pre-service teachers enrolled in elementary pre-service teacher education programme	IUMPST: The Journal volume 5	Compare third and fourth year pre-service teachers in relation to their mathematical anxiety and mathematical beliefs

	Rosas, C., & West, W. (2011)	Pre-Service Teachers' Perception and Beliefs of Readiness to Teach Mathematics.	Pre-service teachers	<i>Current Issues in Education</i> , 14(1). Arizona State University	Investigate teacher perceptions on their readiness to teach mathematics.
	Evans, M. A., (2008)	A Study of Mathematics Novice Teacher Perceptions of their Self Efficacy by the Type of Alternative Certification Program.	Pre-service teachers	Texas Southern University	Examines the relationship between background training and learner-centred practices.
	Evans, B. R., Leonardo, J., Krier, K., & Ryan, S. (2013)	The Influence of a Reform-Based Methods Course on Pre-service Teachers Beliefs	25 college pre-service students	Journal of Educational Research and Practice. 2013, Volume 3, Issue 1, Pages 79-92	Examines pre-service teachers beliefs about teaching mathematics
	Nilas, L. (2003)	Division of Fractions: Pre-Service Teachers Understanding	10 Elementary Pre-Service Teachers (USA)	The Mathematics Educator 2003, Volume 7, No. 2, 96-113	Analyses teachers abilities to use procedural and conceptual

		and Use of Problem Solving			knowledge in solving mathematics problems
	Mosvold, R., & Fauskanger, J. (2013)	Teachers Beliefs about Mathematical Knowledge for Teaching Definitions	17 Norwegian high school teachers	International Electronic Journal for Mathematics Education. Volume 8, 2-3 May – September	Examine high school teachers mathematics definitions and how does it affect teaching practices
	Sandt, S. v. d., & Nleuwoudt, H. D. (2003)	Grade 7 Teachers ‘ and Prospective teachers’ Content Knowledge of Geometry	123 teachers and prospective mathematics teachers	South African Journal of Education, Volume 23(3) 199-205	Compare mathematics knowledge of in-service and prospective teachers
	Avcu, S. & Avcu, R. 2010.	Pre-service elementary mathematics teachers’ use of Strategies in mathematical problem solving	93 Pre-service elementary mathematics teachers	Procedia Social and Behavioural Sciences	Enhancement of problem solving strategies
	Andrew, L. (2006)	Pre-service Teachers’ Reaction to	61 Pre-service Teachers	IUMPST: The Journal, Vol 2 (Pedagogy), July	Examine pre-service teachers’

		their final Constructivist Mathematics Class: A Case Study.		2006. [www.k- 12prep.math.ttu.edu]	interest in teaching mathematics using constructivist pedagogy
	Kalchman, M. (2011)	Pre-service Teachers' Changing Conceptions About Teaching Mathematics in Urban Elementary Classrooms	23 pre-service teachers	Journal of Urban Mathematics Education July 2011, Vol. 4, No. 1, pp. 75–97	Examine teachers perceptions and attitudes towards constructivist pedagogy
	Aslan, D. (2013)	A Comparison of Pre- and In- Service Preschool Teachers' Mathematical Anxiety and Beliefs About Mathematics for Young Children	150 Pre-and In- Service Teachers (Turkey)	Social Sciences and Humanities. Volume 4, No. 2 , March 2013	Analyses in service and pre-service mathematics anxiety and beliefs
	Zerpa, C., Kajander, A. & Barneveld, C. V. (2009)	Factors that Impact Pre- service Teachers' Growth in Conceptual	111 grades four to ten pre-service teachers	International Electronic Journal of Mathematics Education. Volume 4, Nr 2, July 2009	Examine pre- service teachers' change in conceptual mathematical

		Mathematical Knowledge During a Mathematics Methods Course			knowledge after taking a reform based mathematics methods course as part a teacher certification programme.
	Sapkova, A. (2011)	Latvian Mathematics Beliefs on Effective Teaching	390 Latvian mathematics teachers	International Journal for Mathematics and Learning (357)	Explore teachers beliefs on constructivism in teaching and learning mathematics
	Asmamaw, Y. (200)	Engaging In-Service Teachers in Mathematical Problem-Solving Activities during Professional Development Programs	42 In-Service mathematics teachers (USA)	Journal of Mathematics Education. June 2009, Volume 2, No. 1, pp.99-114	Analyses in-service teachers' beliefs and confidence on teaching and learning mathematics
	Jong, C., & Hodges, T. E.(2013)	The Influence of Elementary Pre-service Teachers'	75 under graduate and from US university pre-	International Electronic Journal for Mathematics Education. Volume	Examine the connections among pre-service

		Mathematical Experience on their Attitudes towards Teaching and Learning Mathematics	service teachers	8, 2-3 May-September	teachers' attitudes towards mathematics and the factors that influence positive changes along with a growth pre-service teachers' confidence to teach mathematics.
	Ampadu, E. (2012)	Students' Perceptions of Their Teachers' Teaching of Mathematics: The Case of Ghana	358 juniors mathematics students	International Online Journal of Educational Sciences (2012), 4(2), 351-358	Explores students conceptions of their teachers in using learner and teacher-centred teaching when they teach mathematics in the classroom.
To determine the extent to which teachers background training	Flores, M. M., Patterson, D., Shippen, Margaret E., Hinton, V., & Franklin, T.	Especial Education and General Education Teachers' knowledge and	206 General and special education (USA)	The Journal, Volume 1 August 2010	Examines teachers knowledge and how do they perceive teaching in

contributes learner-centred practices in the teaching of mathematics.	M. (2010)	Perceived Teaching Competence in Mathematics			mathematics.
	Wilbourne, J. M., & Long M. (2010)	Secondary Pre-service Teachers' Knowledge for State Assessment. Implications for Mathematics Education Programmes	70 pre-service secondary Mathematics teachers (USA)	The Journal, Volume 1, January 2010	Examines teachers' content knowledge and perceived confidence in teaching mathematics.
	Turmuklu, E. B., & Yesildere, S. (2007)	The Pedagogical Content Knowledge in Mathematics: Pre-Service Primary mathematics Teachers' Perspectives in Turkey	45 Primary Mathematics Teachers candidates	The Journal. Volume 1, October 2007	Examines pre-service primary teachers' competency of pedagogical content knowledge in mathematics.
	Burton, M., Daane, C.J., & Giesen, J. (2008)	Infusing Mathematics Contents into a Method Course: Impacting Content	44 pre-service teachers (USA)	The Journal. Volume 1, May 2008	Examines pre-service content knowledge for teaching.

		Knowledge for Teaching			
	Gencturk, Y. C. (2012)	Mathematical Knowledge for Teaching, Instructional Practices, and Students Outcomes	In-service teachers	University of Illinois	Examines in service relationship between teaching experiences, background training and learner centred teaching.
To determine the extent to which teachers' professional experience contributes to practices of learner-centred approach in the teaching of mathematics.	Iheanachor, O. U. (2007)	The influence of Teachers' Background, Professional Development and Teaching Practices on Students Achievement in Mathematics in Lesotho	40 grade 10 mathematics teachers (Maseru)	University of South Africa	Examine teachers background teaching experiences and learner-centred practices
	Supovitz, J. A., & Turner, H. M. (2000)	The Effects of Professional Development on Science Teaching Practices and Classroom	3464 in-service teachers and 666 principals (US)	Journal of Research in Science Teaching Vol. 37, No. 9, PP. 963±980 (2000)	Examine teachers background experience and use of learner-centred teaching.

		Culture			
	Hill, H. C., Rowan, B., & Ball, D. L. (2005)	Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement	334 first-grade and 365 third grade teachers and from 1,190 first graders and 1,773 third graders students (USA)	American Educational Research Journal Summer 2005, Vol. 42, No. 2, pp. 371– 406	Examine the effect of mathematical Knowledge for teaching.
To determine whether teachers use learner- centred approach in classroom mathematics	Stols, G., Kriek, J., & Iheanachor, O. U. (2008)	The Relationship Between Teachers' Practices and Students' Achievement in Lesotho.	40 grade 10 mathematics teachers (Maseru)	African Journal of Research in SMT Education, Volume 12 Special Edition 2008, pp. 107-118	Examine teachers practices on learner-centred teaching.
	Frid, S. (2000)	Constructivism and Reflective Practice in Practice: Challenges and Dilemmas of a Mathematics Teacher Educator	88 pre-service teachers	Mathematics Teacher Education and Development 2000, Vol. 2, 17-33	Examines teachers beliefs on the teaching and learning of mathematics and learner- centred teaching
	Askew, M.,	Effective	Theory	Teacher Training	Beliefs system

	Brown, M., Rhodes, V., William, D., & Johnson, D. (1997).	Teachers of Numeracy : Report of Study Carried Out for The Teacher Training Agency		Agency, Lonon, Kings College, University of London	framework
	Maggioli, G. D. (2004)	Teacher-centred Professional Development	Theory	Association for Supervision and Curriculum Development, USA.	Professional Development
	Nkabinde, Zandile P.(1997)	An Analysis of Educational Challenges in the New South Africa.	Theory	University Press of America, Lanham.	Professional Development
	Wallace, Michael J., Simon, Denis Fred., and Kau, Michael Y. (1991)	Training Foreign Language Teachers: A Reflective Approach.	Theory	Cambridge University Press,	Professional Development
	Zalska, J. (2012)	Mathematics Teachers' Mathematical Beliefs: A Comprehensive	Theory	Scientia in educatione 3(1), 2012 p. 45–65	Examine the origin and development of beliefs in mathematics

		Review of International Research			
	Philip, R. A. (2007)	Mathematics Teachers' Beliefs and Affect	Theory	Second Handbook of Research on Mathematics Teaching and Learning	The effects of beliefs in teaching

CHAPTER FOUR

4.0 RESEARCH DESIGN AND METHODOLOGY

4.1 RESEARCH DESIGN

One of the aims in this research is to determine the extent to which teachers of basic education perceive learner centred teaching approaches in the application and interpretation of Mathematics concepts in the classroom. Following the aim of the research, the study will attempt to describe perceptions in relation to learner-centred teaching approach. Thus, the study will follow a quantitative descriptive approach, with Ex Post Facto design.

Quantitative approach is a technique that is related with collection, analysis and interpretation of numerical information (Teddle & Tashakkori, 2009) and is used more in a situation in which the researcher can control the variables and wish to establish cause-effect relationships between or among them (Grinnell & Unrau, 2011), such as describing teachers' characteristics, perceptions, and beliefs. The quantitative approaches are descriptive.

Descriptive research is concerned with “conditions or relationships that exist; practices that prevail; beliefs, point of views, or attitudes that are held; processes that are going on; effects that are being felt; or trends that are developing” (Cohen, Manion & Morrison, 2007:205). Cohen et al., (2007) assert that the objective of descriptive research is directed towards individuals, groups, methods, materials and it describes them, and compares, classifies, and analyses the events and the elements which constitute a part of various fields of investigation.

Typically, the examination of peoples' perceptions and beliefs, relies on large scale data (Cohen et al., 2000:172), which requires the ability of selecting appropriate descriptive technique. Verma

and Mallick (1999:77) stress that the descriptive research differs from one type of description research to another, depending on the technique used for data collection. Data obtained from testing or from interviews use a different way of description.

Ex Post Facto is a design that contrasts data gathered from preformed groups with the objective of determining the existing relationship between independent and dependent variables. The variables are analysed as they exist in the world, that is, without being subject to experiment on which independent variables are controlled (Krathwohl, 1998). It looks to the effect of independent variable and tries to deduce the causes from these effects (Goddard & Melville, 2007). In fact, Ex Post Facto is a descriptive approach. Descriptive analysis is a research method aimed at describing accurately the characteristics, or the status, of the phenomenon or situation, indicating the relationships that exist among variables (Johnson & Christensen, 2012; Krathwohl, 1998). It is also used to study beliefs, opinions or attitudes of people (Johnson & Christensen, 2012) early experience, home background, father absence, and teacher competence (Ary, Jacobs, Sorensen, & Walker, 2014).

The present study is descriptive since it attempts to describe teachers' beliefs or perceptions about the learner centred approach, and find out the relationship between types of training and teaching experience, on perceptions of learner centred approach in the teaching of mathematics, as well as describing type of training and the learner centred approach teachers use in mathematics classroom.

4.2 RESEARCHER INSTRUMENT

In this particular research, the data were collected through questionnaire and observation techniques. The measure of relationship between background training, teaching experience and teachers' perceptions on learner centred teaching requires collecting a large amount of data from respondents. Using other means, such as observation, would not permit to assess beliefs and

perceptions for large number of teachers, and also would be very costly to collect such kind of information. On the other hand, since this research approach is quantitative, the only instrument that can generate quantitative data is a close-ended questionnaire. Thus, this technique seems to be most appropriate for this research.

The questionnaire method is one of the most used research instrument in education due to its numerous advantages. It can be administrated in the absence of the researcher for a wide sample, and it provides numerical data from which variables can be compared. These aspects deem the questionnaire more attractive to use by the educational researcher, especially when it comes to search on perceptions, beliefs, attitudes, and points of view.

Questionnaires have been used to study teachers and students' beliefs as well as self-concept, self-esteem, self-beliefs. Adnan Zakaria and Maati (2012), and Adnan and Zaria (2010), used a mathematical beliefs' questionnaire to measure teachers' constructivism and traditional beliefs, as well as beliefs about teaching mathematics. Other studies also used questionnaire to measure teachers beliefs about mathematics teaching (Waldeana & Abraham, 2013; Wilks & Brand, 2004; Haciomeroglu, 2013; Aslan, 2013 and Zerpa, Kajander & Berneveld, 2009) and teachers perceptions of self-efficacy (Evans, 2008). All these themes were conducted using a questionnaire to generate data.

Researchers use different types of questionnaires depending on the sample drawn from the population. If the sample is large, the more structured, closed and numerical the questionnaire is (Cohen, Manion, and Morrison 2000:247). Structured questionnaires generate frequencies of responses that can be subjected to statistical analysis. The data can also be compared between groups. For smaller samples, the questionnaire would be less structured and the questions would be word based. That is, respondent would be asked to comment and go deeper into his or her responses. That would be the case of an unstructured questionnaire. The semi-structured questionnaire combines questions that are structured in their response and unstructured. The respondent is asked to answer the questions and then comment on them. It becomes evident that

to search for teachers' perceptions, a large sample was necessary in this research in order to describe the phenomena accurately. Thus, a structured questionnaire was used in this research.

Because some of these aims were to verify the extent to which teachers use learner centred teaching to enhance learning of mathematics concepts in classroom mathematics, an observation technique is seen to be appropriate to reach that aim. Classroom teaching practices implies the collection of qualitative and objective information via structured observation schedule. Since one of the approaches in this research is qualitative, the observation technique is found to be the most appropriate for this purpose. Due to the fact that teachers from Maputo city and Maputo Province have the same characteristics in terms of background training and teaching experience, the observation was conducted in schools located in the urban area of Maputo city, and in schools different to where questionnaires were applied.

The observation, as research technique, permits the researcher to understand and discover what cannot be revealed by other means of research instruments, namely the interview or questionnaire. It permits the researcher to go beyond perceptions gathered by face to face interviews, up to individual personal knowledge (Cohen, Manion, & Morrison, 2000:305). Evans, Leonard, Krier and Ryan (2013) and Yimer (2009) conducted classroom observation to evaluate teachers' teaching practices.

There are different observations techniques a researcher can use for data collection, namely: structured, semi-structured and unstructured. In structured observation, the researcher uses an observational guide to gather numerical data from what he or she observes and the events to be observed are worked in advance. The observer does not interfere with the process but she or he takes notes about the events are being observed. The data generated through observations can be compared, and also frequencies, patterns and trends can be calculated, or noted in an observational schedule.

Cohen, Manion, and Morrison (2004:308-309) point out among others three different ways of noting down the incidence of the factors that are being studied: event sampling, instantaneous sampling, interval recoding.

Event sampling requires a tally mark to be entered against each statement each time it is observed. The researcher would indicate in advance which statements answer the researcher questions. Noting down each event allows the researcher to find out the frequencies of what is being observed so that she or he can make comparisons.

Instantaneous sampling it has to do with chronology of events. In this case, the researcher enters what she or he observes at standard intervals of time. For instance, the events would be entered every twenty seconds or every minute. The researcher will note down in an appropriate category what is happening in that precise time.

Interval sampling methods uses, simultaneously, the event sampling and instantaneous sampling. It charts the chronology of events to some extent and, like instantaneous sampling, requires the data to be entered in the appropriate category at fixed intervals. However, instead of charting what is happening in the instant, it charts what has happened during the preceding interval. For instance, if events were to be note down every one minute, then the researcher would note down in the appropriate category, what had happened during the preceding minute. This method permits frequencies to be calculated and to observe simple patterns, as well as to note the approximate sequence of event.

Another type of observation that might be used for data collection is the *semi-structured observation*. In semi-structured observation, the researcher has an agenda of what is going to be observed, but the issues subjected to observations are less structured, that is, are not put in a systematic manner.

In unstructured observation, the researcher is less clear of for what he or she is looking. The researcher firstly observes what is happening, then decides the relevance of observed events for his research. Both semi-structured and unstructured observations are hypothesis generating rather than hypothesis testing (Cohen, Manion, and Morrison, 2000:305). The use of one of these different observational methods depends upon questions the study is designed to respond to, as well as the hypothesis to be tested. This, of course, will determine the nature of data to be collected and concomitantly, the type of observational methods to be used.

As for the hypothesis stated have stated in the search, the structured observation is found suitable for this study since the data generated frequencies, patterns and trends can be calculated and compared.

In this research, the data were noted in an observational schedule. The scoring process taken was of the event sampling (Cohen, Manion & Morrison, 2000:308), on which each event was entered in an appropriate category using a tally mark with a forward (/) slash. The events were noted in one minute interval time each. Then, the data were mapped for each category. This method enabled to find out the frequencies of observed situations for further comparisons. Teachers' teaching activities in classroom were the unity of analysis. The research included grade 1 to 7.

4.3 SAMPLING DESIGN

Among several sampling strategies (probabilistic and non-probabilistic), this study adopted a purposive sampling, a strategy which consists in selecting a particular group of people with homogenous characteristics that fit to the purposes of the research. According to Krathwohl (1997), purposive sample can be use in both qualitative and quantitative research. He argues that, in quantitative research, purposive sample is used to find a site with particular properties, while for qualitative research, it is used to select individuals, so that it can better produce information about what is being investigated. In the case of this research, the aim was to work with specific

groups of teachers to gather information on them about how they perceive and practice learner centred teaching in the mathematics' classroom in basic education. Thus, purposive sample seem to be appropriate for this proposes. According to Monette, Sullivan and DeJong (1994:142), in purposive or judgment samples, the researcher uses his prior knowledge to choose the people who would best fit to the purpose of the study.

This research is concerned with the views or perceptions of primary schoolteachers, in relation to the use of learner centred teaching approach in classroom mathematics. Based on this aim, a specific group of teachers, who teach all subjects including mathematics, as well as those who teach only mathematics, in the second level of primary school (grade six and seven), were targeted by the research.

The purposive sample has frequently been used in social studies to measure different aspects of human behaviour such as teachers' practices, attitudes, perceptions. Gipps, McCallum, and Hargreaves (2000:168) used a purposive sample to compare effective and less effective teachers by using a range of pedagogic strategies in the classroom.

Although purposive sample may seem a full advantaged technique for researching attitudes, teachers' practices, perceptions or views, on the other hand, it presents disadvantages such as the subjectivity of the researcher's decision making. According to Jupp (2006:245), subjectivity is a source of potential bias and a significant threat to the validity of the conclusions. To reduce such effects, Jupp recommends that the internal consistency between the aim and epistemological basis of the research, and the criteria used for selecting purposive sample be assured.

The sample for the questionnaire was constituted by three hundred seventy two male and female teachers from basic education, drawn from a population of nine thousand seven hundred and nine teachers who work in first and second levels of Primary schools in Maputo City and Maputo province. In Mozambique, primary school is divided into two levels. Level one includes pupils

from first to fifth grade, while level two covers only grade six and seven. Apart from this categorisation, the grades are organised by cycle. Thus, grade one and two stands for the first cycle, grade three to five for the second cycle and grade six to seven for the third cycle.

Table 4.1 Number of teachers by education level and sex.

	Primary Education (1 st Level)			Primary Education (2 nd Level)		
	F	M	Total	F	M	Total
Maputo City	1640	689	2329	555	745	1300
Maputo Province	2477	1757	4234	729	1117	1846
Total	4117	2446	6563	1284	1862	3146

The sample was selected from a total of one hundred ninety four urban and outskirts schools of Maputo city and Maputo province as well as some rural schools from Maputo province. Since the study is quantitative the sample size was selected to meet the requirement of statistical analysis. It was selected in Maputo city and Maputo province because the failure rates in basic education are higher in these provinces when compared with other. On the other hand, Maputo city and Maputo Province have more trained teachers than other provinces.

4.4 PILOT STUDY

The pilot study is described by Tenenbaum and Driscoll (2005:105) as an important tool for research since it allows the researcher to refine and improve procedures, instruments, his or her responsibilities and define which activities are to be carried out.

Although the literature refers the sample for pilot study as being relatively small in this research we had opportunity of collecting information in a larger number of teachers. An initial version o

questionnaire was designed and applied to a sample that included three hundred and nine teachers from rural and urban schools from southern region of Mozambique namely, Maputo province, Gaza province , and Inhambane provicne. This sample was taken in twenty schools. The referred provinces were selected for pilot study because the failure rate in those provinces especially in Gaza province (12.3%) and Maputo province (14.8) and Maputo City (14%) are higher when compared with other provinces.

The responses from this questionnaire allowed checking the clarity of the questionnaire items. From this stage, the questions and the sequence were adjusted. Then, some questions were rewritten, and others were eliminated. This process permitted to refine the final version of the questionnaire.

To ensure validity and reliability of the data obtained from the questionnaire, several measures were taken. The questionnaires were addressed to teachers through the heads of each school that took part in the research. To avoid misunderstanding, the heads were given explanation about how to respond to the questions in the questionnaire. The heads of schools also made a follow-up to request returns.

Validity was also checked through an exploratory factor analysis on which a principal components' analysis was applied. This process allowed checking the internal consistency of the questionnaire items. The items were found to be consistent and the questionnaire appropriate to the study. From these results, a final version of the questionnaire was produced and applied to schoolteachers in Maputo province and Maputo city.

Table 4.2 Distribution of teachers in the Pilot Study ($N=309$)

Nr	School	Province	Respondents
1	EPC Acardos de Lusaka	Maputo City	17
2	EP 7 de Setembro	Maputo City	22
3	EPC Campoane	Maputo Province	5
4	EPC 30 Janeiro	Maputo Province	27
5	EPC T-3	Maputo Province	29
6	EPC Bela Vista	Maputo Province	3
7	EPC Hindane	Inhambane	7
8	EPC Pochane	Inhambane	5
9	EPC Mafuiane	Maputo Province	13
10	EPC Graça Machel	Maputo Province	29
11	EP Filipe S. Magaia	Maputo City	4
12	EPC A Luta Continua	Maputo City	19
13	EPC da Maxixe	Inhambane	31
14	EPC Mapinhane	Inhambane	5
15	EPC Hanhane	Inhambane	17
16	EPC Masslane	Inhambane	11
17	EPC Inhassune	Inhambane	9
18	EPC Macambacuine	Gaza	18

19	EPC 24 de Julho	Gaza	21
20	EPC 16 de Junho	Gaza	17
TOTAL			309

After the questionnaires were scrutinised to verify whether they were filled correctly, twenty eight (8.3%) questionnaires were dropped. The rejection was based on George and Mallery (1999:46) view that “If a particular subject (or case) or a certain variable has more than 15% missing data, it is recommended that you drop that subject or variable from the analysis entirely.” After this procedure, the sample totalled three hundred and nine respondents (92%) included in the pilot study.

4.5 FACTOR ANALYSIS FOR PILOT STUDY

The factor analysis technique is used to verify the structure of a set of interrelated variables (Maroco, 2010:361), and describing the common elements among them (Martinez and Ferreira, 2008:141-142). Through the analysis of interrelationships among the variables, it is possible to reduce the complexity of data (Martinez & Ferreira, 2008:142, George & Mallery, 1999:282). In this study, the relational structure of ten different variables, that aimed at measuring teachers’ perceptions of learner centred teaching were entered and evaluated through Exploratory Factor Analysis (EFA), which was performed over matrix correlations.

To determine the number of principal components to be retained, the level of *eigenvalues* was >1 , with Scree Plot, as well as the percentage of variance retained. KMO (Kaiser-Mayer-Olkin) criteria was also used to evaluate the validity of the Exploratory Factorial Analysis, that is, whether the distribution of values is suitable for Factor Analysis. It is assumed that a KMO

measure >9 is marvellous; >8 is meritorious; >7 is middling; >6 is mediocre; >5 is miserable and; <5 is unacceptable (Maroco, 2010:368; George & Mallery, 1999:292).

A measure of sampling adequacy less than .5 is an indication that a given variable is not suitable to the structure defined, therefore it should be removed from factorial analysis (Maroco, 2010:392). The KMO of .755 in data suggests that all variables can be part of Factor Analysis. Bartlett's Test (335.303, $p < .000$) was significant at the level of $p < .05$, showing that the data produced a correlation matrix that differs significantly from identity and are thus approximately multivariate normal and acceptable for factor analysis.

Furthermore, the factors were extracted using Principal Components Analysis Method (PCAM) followed by varimax rotation, the technique that permits to obtain a factorial structure on which only one original variable is associated to only one factor, and less associated with other factors. PCAM also permits transforming a set of correlated variables into a small number of independent variables, and original variables are linearly combined in order to reduce the complexity of data (Maroco, 2010:329).

Five variables, entered in the analysis, reflected teachers' perception of "Learner-Centred Teaching" (LCT) and another five for "Teacher-Centred Teaching" (TCT), being ten in total. The variables are:

(TCT) Teacher asks general questions;

(TCT) Teacher only explains and solves exercises;

(TCT) Teacher asks specific questions;

(LCT) Teacher takes into account learner's previous knowledge;

(TCT) Teacher asks direct questions;

(LCT) Teacher asks learners to solve exercises on the chalkboard;

(TCT)When teacher explains clearly the content;

(LCT) Teacher asks learner to describe the sequence of maths contents;

(LCT) Teacher allows learners to resolve various maths problems;

(LCT) When teacher asks all type of questions.

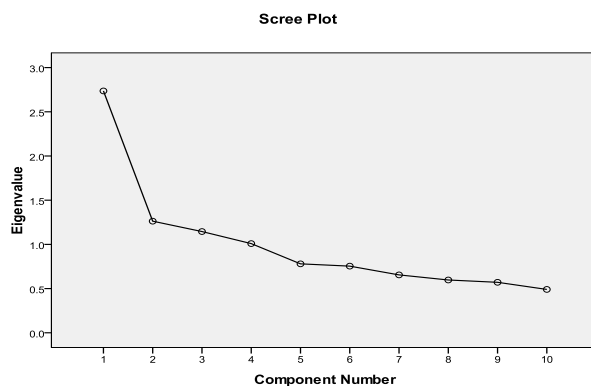
The rotated factor structure is shown in Table 4.3. In this table, communalities, *eigenvalues* and the percentage accounted for are presented.

Table 4.3 Results of Factor Analysis

Item	Component				Eigenvalues	% of variance	Cumulative %	Communalities
	1	2	3	4				
1	.591	-.121	-.418	-.308	2.736	27.358	27.358	.634
2	.487	-.524	.117	-.210	1.262	12.625	39.983	.570
3	.331	.117	.755		1.145	11.453	51.437	.693
4	.140	.776			1.009	10.089	61.526	.629
5	.650	.179	.189		.780	7.798	69.324	.494
6	.646	.419			.754	7.540	76.864	.599
7	.616	-.225	.396		.655	6.548	83.413	.588
8	.212	-.289		.875	.597	5.972	89.385	.897
9	.638		-.272	.269	.571	5.710	95.095	.560
10	.590		-.337	-.134	.491	4.905	100.000	.489

As can be seen in the communalities' column, the percentage of variance explained by extracted common factors exceed 50% for most of variables, except the variable five (teachers ask direct questions), and variable ten (when teachers asks all type of questions) whose percentage of variances are below 50% (49.4% and 48.9% respectively),even though the results show that almost half percentage of variance is explained by the extracted common factors, and another half is explained by factors other than those extracted by KMO method. Although, in some other variables the percentage of variable explained by the extracted factors is relatively higher, there is an amount of variance which is explained by factors other than those extracted by KMO method.

Furthermore, we sought to find out the relationship between each item with the extracted factors. These results are provided through rotated component matrix and are also show in the table 4.3. With *eigenvalues* >1(2.736, 1.262, 1.145, and 1.009) we can see that the items under study are distributed into four factors, which in total account for 61.5% of variance of the scale, while the remaining variance is accounted for by factors with less significant weight. The first factor alone accounts for 27.3% while factors 2, 3, and 4 account for 12.6%, 11.4%, and 10% respectively. These results can also be shown by the Scree Plot graph which shows the influence of only four factors.



Graph 4.1 Scree Plot of the results of Factor Analysis

The results of rotated component matrix are also presented in the table 4.3. The objective of the analysis is to describe how many items are related with extracted four factors. The higher the correlations are between the factors and the items, the purer are the measurement of the factors (Martinez and Ferreira, 2008:157-158). Comrey and Lee (1992), quoted by Martinez and Ferreira (2008:158), assert that commonly a factor $>.71$ is excellent, $>.63$ very good, $>.55$ good, $>.45$ reasonable, and $<.32$ bad.

Looking to the results of the table, it is easy to see that items that best measure the factor 1 are items 5, 6, 9, 7, 1, 10, 2. Factor 2 is best measured by items 4 and 6, while factor 3 is measured by items 3 and 7, and factor 4 is measured by only item 8. It is also possible to note that item 6 is measured by both factor 1 and 2, while items 3 and 7 are highly associated to factors 1 and 3.

The results also show that some items are associated to more than one factor. Such is the case with item 1, which is associated to factors 1 and 3, items 2, and 6 are associated to factors 1 and 2, and item 6 to factors 1 and 2. Items that scored less than .3 were not considered in the analysis.

After the validation process, which took place through the Principal Component Analysis Method that aimed at estimating common and specific factors, a last version of the questionnaire was then administered. The version was constituted by the following sections:

Section A (questions 1 to 9) includes biographic data such as: age, gender, district, teaching experiences, academic qualifications, type of training the teacher received, institution of training, and teaching with and without a certificate. The questions in this section are aligned with the hypothesis that “it would be a relationship between teachers’ background training, and teachers background teaching experience and their approach to teaching mathematics in the classroom.”

Section B (questions 10 to 12) includes teachers' perceptions of learner centred teaching activities in classroom mathematics. The questions in this section are aligned with the second hypothesis which states that: "it would be relationship between teachers perceptions of learner-centred teaching and the type of approach they practice in the classroom mathematics."

In this regard, respondents were asked to manifest their agreement or disagreement with statements related to learner centred activities. The responses were set into five categories following Likert's rating scale. The categories were: 1= strongly agree; 2= agree; 3= neutral; 4= disagree and; 5= strongly disagree.

Section C (question 14) includes the measure of levels of confidence teachers have when applying learner centred or teacher centred approach.

To fill in the questionnaire, respondents were asked to mark an X in the box that correspond with the answer they wished to give. They were also asked to fill in the blank spaces.

4.6 OBSERVATION SCHEDULE

The data were also gathered using an observational guide that contained six events that occur in the classroom (Kapenda, 2007). To ensure reliability of data obtained through observations, a tabular response on which each observed event was consistently and accurately registered in a correspondent category was used. Since structured observation yields a quantitative data, an inter-rate reliability was applied to measure the degree of consistency of the data.

The items for the observational guide were based of Kapenda's observational guide designed to measure the extent to which Namibian teachers apply learner centred teaching in their

classrooms. Kapenda's guide is composed of six themes related to learner-centred teaching. Each theme has its own indicators as shown in the table 4.4.

4.4 Presentation of data according to Kapend's observational guide (Adapted from Kapenda, 2007).

Topic	Theme	Indicators
1	Communication (includes activities carried out by learners)	(verbal/non verbal); written work (class work home work, in exercise books or chalkboard etc.)
2	Questioning	High level cognitive understanding (Why, how, explain)
3	Reference to learner's previous experience	Teachers refer to work done in previous grades or lessons, or refer to what learners already know (background experience)
4	Reference to real-life experience	When teachers use examples that are familiar to learners' background experience.
5	Connections to other subject areas	Refers to subjects such as social studies, natural sciences
6	Connection to prior math knowledge	Basic mathematical knowledge (rules & equations)

From these themes and indicators, an observational guide for the research was build. The objective of observations was to verify how teachers apply learner centred teaching in fifth grade, mathematics' classrooms. The results were then used to check for appropriateness of the categories in the observation guide, as well as to verify whether those categories are in fact operational.

The final version of the observation schedule was constituted by six themes with respective indicators. The themes were stated as follow:

Table 4.5 Final version of observational schedule

Nr	Theme	Indicator
1	Communication	This theme refers to the existence or nonexistence of verbal and non-verbal communication between teacher-learner, learner-teacher, learner-learner that could occur during homework correction in class, work in exercise books, chalkboard work, and other learning activities.
2	Questioning	This theme is related to whether between teacher-learner, learner-teacher, and learner-learner themselves ask questions that encourage learners to explain or describe sequences such as <i>why, how, explain or describe</i> .
3	Previous experience link-	The theme refers to whether teachers link mathematics knowledge to the experiences learners have.
4	Real life experience link	The theme refers to whether teachers, during teaching of a particular content, do link classroom learning activities with everyday life events
5	Other subjects link-	This theme refers to whether teachers connect mathematics knowledge with other subjects learners have learned
6	Previous knowledge link-	The theme refers to whether the teachers explores knowledge brought by learners from their cultural environment

4.7 PROCEDURES FOR EMPIRICAL STUDY AND COMPLIANCE WITH ETHICAL ISSUES

Ethical issues in this research were guided by Strike's principles of educational evaluation (Cohen, Manion, Morrison & Morrison, 2007:70-71), which state eight principles emanated from two broad principles, namely the principle of benefit maximisation and the principle of equal respect. The principle of benefit maximisation states that the best decision is the one that results in the greatest benefit for most people, while the principle of equal respect demands that person's values be respected (Cohen, Manion, Morrison & Morrison, 2007:70-71).

Before carrying on the data collection, we sought to ensure that ethical issues were properly addressed. Questionnaire items were checked by social sciences' experts to guarantee that the word content are properly addressed to the participants, and to avoid expressions that may cause harm to them. Prior to the experiment, permission from departments of education and provincial level was requested. First the researcher made contact via phone calls to set up a meeting with the directors of the Education Department.

After the directors agreed to meet the researcher, a face-to-face interview with each official from those provinces where the data would be gathered, were conducted. During interviews with officials, the researcher explained the objectives of the research and handed over a copy of the questionnaire and interview schedule. Then a junior official was appointed to help the researcher establishing contact with the departments of education at district level, then to contact the school. At this level, face-to-face interviews were also conducted to explain the objectives of the research. At school, the meetings were held with the principals of each school in which the data were to be gathered. Principals were explained the objectives of the research, and the reason the schools were selected to be part of the research.

As for the questionnaires, the procedures on how to fill them were first given to the principals, then to teachers themselves. Initial instructions were written on the front page, however, additional oral instructions were given to reinforce the meaning of the written ones. Participants were allowed to complete the questionnaire at home, and bring them to school on the following day. The principals of the schools were responsible for collecting the questionnaires from all teachers in the school.

The researcher also explained how the context on which the results obtained from the questionnaire and observations would benefit the participants. Thus, the respondents were explained that their participation in the research would be acknowledged in the research report, and the results would be used to improve the quality of learning and teaching process.

In the process, it was also clarified that each individual was free to willingly join the research or to withdraw during the data collection process. Participants were also explained to that the obtained data would not be publicised without their consent, or be used for illegal purposes that could harm or denigrate a participants' image. To protect the participants' privacy, names, addresses or coding system were not identified in the questionnaire and observations' schedule. Instead, participants were only asked to mark in the empty spaces by an X, or to write a number in the blank space. Observations were carried out strictly under teachers' consent. During observation, the researcher avoided interference and he arrived in the lessons on time.

CHAPTER FIVE

5.0 PRESENTATION AND ANALYSIS OF DATA

5.1 INTRODUCTION

The previous chapter is concerned with the description of the process that led to the construction of research instruments, including the procedures that culminate in piloting and final study. In the present chapter, the collected data are subject to analysis and interpretation using different statistical techniques and procedures aligned with hypothesis stated in the research.

5.2 DISTRIBUTION AND RETURNS OF QUESTIONNAIRE

The questionnaires for final study were distributed to fourteen primary schools located in Maputo province and Maputo city as shown in the table 5.1 and totalled four hundred eight six questionnaires. Three hundred seventy three questionnaires were returned, a number that represents 77% of returns. This figure seems to be in line with recommendations that a sample greater than hundred would be satisfactory to conduct a statistical analysis. Nkosi-Kandaba (2004) conducted a study on which he used a sample of two hundred twenty six respondents.

Table 5.1 Percentage of returned questionnaires by school.

Nr	School	Province	District	Delivered	Returned	%
1	EPC Machava-Sede	Maputo Province	Matola	76	46	60.5
2	EPC Bagamoyo	Maputo Province	Matola	37	20	54.1
3	EPC Machava 15	Maputo Province	Matola	82	63	76.8
4	EPC Tunduru	Maputo Province	Matola	31	30	96.8
5	EPC Machava Bedene	Maputo Province	Matola	52	35	67.3
6	EPC Ngungunyana	Maputo Province	Matola	37	30	81.1
Sub-total				315	224	71.1
7	EPC 25 de Setembro	Maputo City	KaMpfumo	23	21	91.3
8	EPC COOP	Maputo City	KaMpfumo	27	24	88.9
9	EPC Alto Maé	Maputo City	KaMpfumo	25	11	44.0
10	EP B-A-BA	Maputo City	KaMpfumo	18	7	38.9
11	EPC 24 de Julho	Maputo City	KaMpfumo	23	17	73.9
12	EPC Unidade 18	Maputo City	KaLhamankulo	38	33	86.8
13	EPC Casa de Educação da Munhuana	Maputo City	KaMpfumo	30	24	80.0
14	EPC Unidade 10	Maputo City	KaLhamankulo	14	12	85.7
Sub-total				171	149	87.1
TOTAL				486	373	76.7

Owing to the fact that some questionnaires were not properly filled, allowing missing cases to appear, a data cleaning process before the analysis was conducted. This process is of capital importance in research because missing values can contaminate the whole data and create difficulties for the researcher to conduct any kind of analysis (George & Mallery (1999:46). Two different procedures can be followed for data cleaning process: the listwise and pairwise deletion. The listwise deletion allows removal of all data for a given participant if one or more missing values exist for that particular subject, while pairwise deletion consists of excluding missing values during the analysis.

Before conducting the analysis, a researcher must decide which step or procedures should he or she takes to deal with missing values. The researcher can choose whether to replace the missing values or simply delete from the analysis.

Missing values replacement can be conducted in different ways depending on the type of data the researcher has gathered. For categorical data, missing values can be replaced by creating additional levels for the referred variable, while for continuous data, the replacement is applied using the mean score of subject in the variable. However, this procedure can only be used when the questionnaire has up to 15% of missing data (George & Mallery, 1999:46). Above this percentage, the researcher may consider dropping the variables or the subject.

In this research, first of all, we sought to find out which variable or questionnaire did not meet the requirements. Those variables and questionnaire that exceeded 15% of missing cases were dropped.

Thus, the variable (confidence in teacher-centred approach) in the data set, whose code was named “cttap”, was removed from the analysis because more than 15% of respondent did not answer the question. For the same reasons, 43 questionnaires from 378 returned were removed from the analysis.

5.3 PLANNING FOR DATA ANALYSIS

The data obtained through the questionnaire were analysed through different statistical procedures. The analyses were performed using SPSS version 17 (v. 14 SPSS Inc. Chicago, IL). The research aimed at: a) determining the extent to which teachers' background training contributed to learner centred approach to teaching of mathematics; b) to determine the relationship between teachers' perceptions of the learner centred approach and the way they practise it in mathematics classroom, and c) to conduct classroom observations of the use of the learner centred approach.

To determine the relationship between teachers' background training, and their perception of learner centred teaching, log-linear models, especially the ordinal categorical analysis, were used. This type of analysis is suitable for data gathered using the Likert scale. Although the Likert scale is designed to measure attitudes, the same scale may also be used to measure perceptions of the individuals. The respondent marks his or her agreement, or disagreement, towards certain statements using five ranked points, one being the lowest and five the highest.

This study sought to answer the following hypothesis:

- (a) There will be a relationship between teachers' background training and their perception of the approach to teaching mathematics.
- (b) There will be a relationship between teachers' professional experience and their perception of an approach to teaching mathematics.
- (c) There will be a relationship between teachers' professional experience and their approach to teaching mathematics.
- (d) There will be a relationship between teachers' background training and their approach to teaching mathematics.

- (e) There will be a relationship between teachers' teaching practices in the classroom with learner centred teaching.

5.4 BIOGRAPHIC DATA

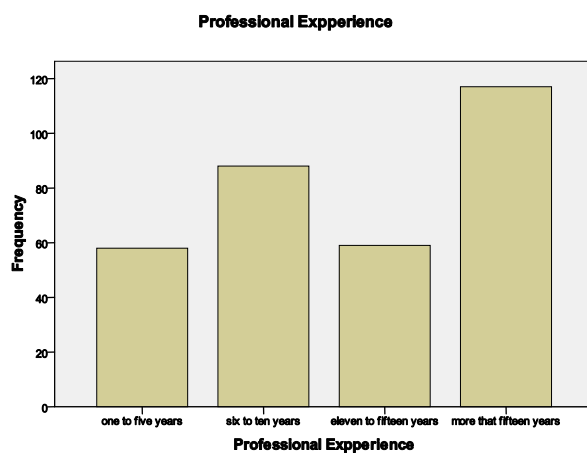
To elucidate the tendencies in each variable of biographic data frequencies, means and graphs were performed. The data of biographic variables were interval and nominal and the variables entered for analysis were the subjects' sex, age, province, professional experience, academic qualifications, training and type of training. Nominal variables were cross-tabulated to verify the following tendencies among them, while for interval data the analysis were centred on frequencies, means and graphs.

More of respondents are from Maputo Province (63%) than Maputo City (37%). As for variable sex, the results show the predominance of female teachers (67%) over male teachers (33%), in all schools where the data were gathered. This suggests that, in basic education, male teachers are underrepresented.

Looking at results of teaching experience is noted that in average male and female have fifteen years of teaching experience in basic education. Among males, there are more teachers who have been teaching for more than six to ten years (32%), and above sixteen years (32%), than in other categories. Nevertheless, a quite significant number of beginners (one to five years = 19%), and those who have been working for eleven to fifteen years (17%), can be observed.

Among female teachers, those with more than sixteen years of teaching experience represent more than 38.5% of all categories. However, it seems that those with six to ten years of teaching experience (25%) appear in a quite significant number, while other categories (one to five years = 17.8% and eleven to fifteen years = 18.8%) are less represented.

From the results, it can also be concluded that between female and male teachers there are some differences in terms of who gains more experience in teaching. In all categories, females appear to be overrepresented in terms of teaching experience (one to five years=66%; six to ten years=61%; eleven to fifteen=70%; more than sixteen=71%) than male teachers (one to five years=34%; six to ten years=39%; eleven to fifteen=30%; more than sixteen=29%). Although the results show a predominance of females over males, in terms of teaching experiences, the data must be interpreted with caution since the sample between the two groups is different. It is worthy to mention that most teachers have more than sixteen years of experience.



Graph 5.1 Teachers' professional experience

The results from the variable age show an average of 37 years among male and female teachers. Among males, the results show that there are more teachers (41%) with ages above 35 years followed by those situated between twenty six to thirty years old (27%). Those with age below twenty five years represent only 11% of the total.

Among female teachers, the situation looks similar to that of males, except that in the age between twenty six to thirty years, the percentage is comparatively (18%) low. Nevertheless, the results suggest that more than half (52%) of female teachers are above 35 years old.

The predominance of female teachers in all categories (eighteen to twenty five=59%; twenty six to thirty=57%; thirty one to thirty five=68%; above thirty five=71%) over male (eighteen to twenty five=41%; twenty six to thirty=43%; thirty one to thirty five=32%; above thirty five=29%) suggests, somehow, that the greater the age, the lesser the number of male teachers, while among females it appears to be the opposite.

Concerning the type of training, the results show that most of teachers (60%) have spent two years of training in middle level, while those who spent less than two years of training (basic level) represent only 12% of the total. It is also possible to note that there are more female (66%) than male teachers (35%) with university degrees in teaching methods. These results show also that most teacher (40%) have got standard ten in their academic qualification, while those with university degrees represent 28% of the total.

The study, we also sought to find out whether teachers had ever learned about learner- centred teaching. The results show that almost all teachers (94%) declared to have learned about learner-centred teaching, whether during training (66%), or in workshops (21%), even in conversations with friends and colleagues (7%), or during individual readings (6%). These results show that most teachers have learned about learner-centred teaching during training and workshops.

5.6 HYPOTHESES TESTING

The instrument used to collect data about teachers' perceptions was a self constructed questionnaire which included two types of questions: a) five questions that aimed at measuring teachers' responses towards learner centred teaching, and b) five questions that aimed at measuring perceptions about teacher-centred teaching.

The questions were set into Likert scale and produced an ordinal responses that ranged from one to five (1= Strongly agree - SA; 2= Agree - A; 3= Neutral - N; 4= Disagree - D and; 5= Strongly Disagree-SD). Agresti (2002), and Maroco (2010) emphasise that in studies where the dependent variable is qualitative and the categories are ordinal, the statistic analysis to be conducted is therefore the categorical regression analysis, with logit models for ordinal responses. The use of this procedure depends on whether the required parameters for ordinal analysis are met. If not, other statistical procedure such as multinomial categorical regression should be considered.

This type of analysis allows calculating the probability of occurrence of a given category in the scale, which implies the definition of a model that best fits the data. As for ordinal data, the probability that a certain category (strongly agree for instance) would be more frequent in the scale is given by cumulative probabilities. The mathematical procedures related to cumulative probabilities are beyond the scope of this study. The evaluation of the model that best fits the data can be conducted using different tests such as qui-squared or the test of deviance or test of maximum likelihood. Qui-square test can be affected by an excessive number of empty cells.

In the analysis, we sought to test the hypotheses that: a) there will be a relationship between teachers' background training and their perceptions of the approach to teaching mathematics, and b) there will be a relationship between teachers' professional experience and their perceptions of approach to teaching mathematics.

To evaluate whether the two independent variables (type of training and teaching experience) have significant effect on the probability of teachers to answer to the dependent variable (learner-centred teaching in mathematics), an analysis based on ordinal regression was performed. The analysis included two ordinal regression functions: the *link log-log* negative and *link logit* function as recommended by Maroco (2010:763;786).

This procedure allowed to compare the two functions and to determine the model that would best fit the data. The Logit function is used when categories of dependent variables are evenly distributed, while the Negative Log-Log is used when categories of lower order are more frequent than those of higher order. Different other functions can be used in ordinal categorical regression, such as Complementary Log-Log, Cauchit, and Probit.

According to Moroco (2010), the logit model assumes that for all categories of dependent variables, the effect of independent variables is identical and a given response can slightly overlap to the right or left of a category. It is important to note that the description mentioned above refers to cumulative probability model. This model assumes that a variable with ordinal characteristics (such is the case of the dependent variable in study) can be analysed in terms of other continuous variables that are not directly measured. In this study, the results are described, comparing the two models - the logit and log-log negative.

To test the hypothesis that in the relationship between teachers' background training and their perceptions of the approach to teaching of mathematics, we first sought to verify the parsimonious model that can best fit the data. To achieve this intent two dependent variables were selected and entered one by one to verify how the data would look like. The dependent variables highlighted two main approaches: the learner-centred approach and teacher-centred approach as shown in tables 5.2 and 5.3.

Table 5.2 Questions that highlight the learner-centred approach

1	Teacher takes into account learners' previous knowledge
2	A teacher asks learners to solve exercises on the board
3	A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena
4	A teacher asks learners to solve various mathematical exercises
5	A teacher asks learners different type of questions

Table 5.3 Questions that highlight the teacher-centred approach

1	A teacher asks general questions during lessons
2	A teacher explains mathematic contents during lesson and solves mathematical exercises
3	A teacher always asks specific questions of his or her students
4	A teacher asks direct questions
5	A teacher explains mathematical content

These dependent variables were then crossed with the following independent variables: 1) type of training teachers have received, and 2) professional experience (number of years in teaching). As for the independent variable (type of training), the levels were: 1- basic; 2- middle, and 3- university degree. The variable professional experience is used as covariate.

Covariates are variables that correlate substantially with the dependent variable and can be included in a study to adjust the results if among subjects some differences prior to any experiment (George & Malallery, 1999:151) occur. As for the analysis, it is assumed that teachers who have gained more teaching experience would tend to perceive better the difference between learner and teacher-centred approaches. Also it is assumed that teachers from different training backgrounds would differ in their perception to learner and teacher-centred teaching in basic education.

5.7 THE ANALYSIS

The respondent was asked the following questions set at Likert Scale (1-Totally agree, 2-Agree, 3-Neutral, 4-Disagree, 5-Totally disagree): “To what extent the following activities related to learner-centred teaching”:

- a) A teacher asks general questions during lessons
- b) A teacher explains mathematic contents during lesson and solves mathematical exercises
- c) A teacher always asks specific questions to his or her students
- d) A teacher takes into account learners’ previous knowledge
- e) A teacher asks direct questions
- f) A teacher asks learners to solve exercises on the board
- g) A teacher explains the content
- h) A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena
- i) A teacher asks learners to solve various mathematical exercises
- j) A teacher asks learners different type of questions

5.7.1 QUESTION ONE (A teacher asks general questions during lessons)

To test whether type of training and teaching experience have a significant effect on the probability of teachers to answer the dependent variable (whether asking general questions is relate learner-centred teaching), an ordinal regression with logit and negative *log-log* link function were used.

The results show that the number of empty cells is about 229, corresponding 55.9 % of the total cells. Excessive empty cells can obstruct the use of Chi-Square of the Model Fitting.

Table 5.4 Percentage of cells of crossed independent variables for question one.

Case Processing Summary

		N	Marginal Percentage
A teacher asks general questions during lessons I strongly agree		72	22.9%
	I agree	116	36.8%
	Neutral	16	5.1%
	I disagree	76	24.1%
	I strongly disagree	35	11.1%
Type of Training	Basic	40	12.7%
	Middle	185	58.7%
	University degree	90	28.6%
Valid		315	100.0%
Missing		27	
Total		342	

As long as the likelihood ratio (-2Log Likelihood), and its proximity to Chi-Squared, is not affected, empty cells wouldn't cause major problems in the analysis (Maroco, 2010:776). In the case of the present data, the number of empty cells did not affect the Chi-squared of the model.

Thus, the data show that the adjusted model (Final) is significantly better than the intercept only model($G^2(3) = 16.356$; $p=0.001$). These results suggest that one of the independent variables

may affect significantly the probability of occurrence of the five categories of dependent variables (totally agree, agree, neutral, disagree, and totally disagree).

Table 5.5 Model fitting information for question one.

Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	528.773			
Final	512.417	16.356	3	.001

Link function: Logit.

For the data to fit into the model it is necessary not to reject the null hypothesis (H_0). If the H_0 is rejected, we are forced to conclude that the model does not fit the data. However, the results from the Goodness-of-fit test show that either for Person($X^2P(321) = 341.509$); $p=0.206$) or Deviance ($(X^2D(321) = 328.239$; $p=0.378$) tests are not significant, suggesting that the null hypothesis that the model fits the current data is not rejected. This is shown by the level of *p-value* which is greater than the required level of significance ($p<.05$), thus we retain the null hypothesis and conclude that the model fits to the current data.

Table 5.6 Test of Goodness-of-Fit for question one.

	Chi-Square	df	Sig.
Pearson	341.509	321	.206
Deviance	328.239	321	.378

Link function: Logit.

The results of Pseudo R-squared are shown in table 5.6 and indicate that the results from all tests appear to be lower ($R^2_{MF}=0.018$; $R^2_N=0.054$; $R^2_{CS}=0.051$).

Table 5.7 Pseudo R-Square test for question one.

Cox and Snell	.051
Nagelkerke	.054
McFadden	.018

Link function: Logit.

The test of parallel lines under H_0 assumes that the lines from *Link* function should be parallel, while General model H_1 assumes that there is at least one slope different from others. This can be evaluated through Chi-square statistics. A *p-value* $> \alpha$ indicates that the H_0 is not rejected ($X^2(9) = 4.807; p=0.851$), suggesting that the slop coefficients are the same across response categories.

Table 5.8 Test of parallel lines for question one.

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	512.417			
General	507.609	4.807	9	.851

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

Furthermore, the results of logit function and log-log negative function were compared to find out which model would best fit the data. This analysis was performed comparing the -2LL (-2 Log Likelihood) of the two link function (the logit and negative log-log), the significance of the coefficients, and the slope coefficients (Maroco, 2010:786) as shown in table 5.9.

Table 5.9 Model fitting information for Logit and Negative Log-Log link functions for question one.

Link Function	Model	-2 Log likelihood	Chi-Square	Df	Significance
Logit	Intercept Only	528.773			
	Final	512.417	16.356	3	.001
Negative Log-Log	Intercept Only	528.773			
	Final	517.539	11.234	3	.011

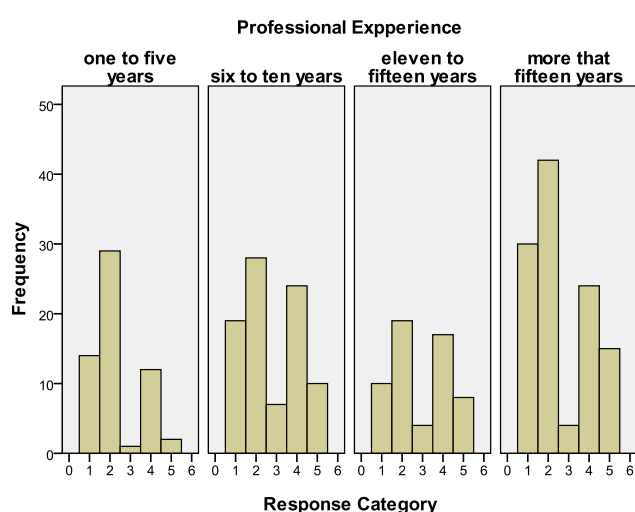
Table 5.9 shows that the -2LL of the Final Model in Logit function (512.417) is lower than those of Negative Log-Log function (517.539). Maroco (2010) stresses that the lower the -2LL, the best the model. The model Final seems to be better in both Logit ($G^2(3) = 16.356; p=0.001$), or Negative Log-Log model ($G^2(3) = 11.234; p=0.11$), showing that at least one of independent variable may affect the category of dependent variables. In light of these results, we can conclude that the Logit function is the one that best fits the model.

Additionally, it is possible to note that the *p-value* in the test of parallel lines in logit function is bigger ($p=0.851$), almost twice than in Negative Log-Log function ($p=0.383$), suggesting that the logit model is more appropriate in terms of how observed frequencies would be distributed along the five categories of dependent variable (strongly agree, agree, neutral, disagree, strongly agree). However, in both cases, the *H₀* is not rejected since the *p-value* is not significant at $p>.05$. If null hypothesis was rejected, we would be forced to assume that the slope coefficients are different across the response categories and the frequencies would be differently distributed. These findings reinforce the conviction that these data can be best interpreted using the logit rather than negative log-log model.

Table 5.10 Test of Parallel Lines for Logit and Negative Log-Log link functions for question one.

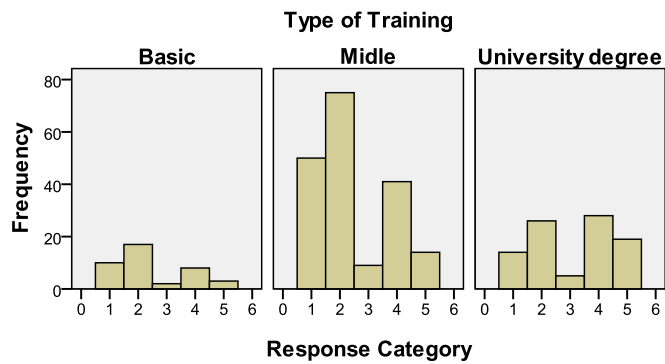
Link Function	Model	-2 Log likelihood	Chi-Square	Df	Significance
Logit	Null Hypothesis	512.417			
	General	507.609	4.807	9	.851
Negative Log-Log	Null Hypothesis	517.539			
	General	507.927	9.612	9	.383

The graph 5.2 shows the most frequent categories in the four levels of teaching experience. There are more teachers with one to five years of teaching experience, with the responses falling into the category two (I agree), followed by category one (I strongly agree). Those who have six to ten years of experience, their responses seems to fall into category one (I strongly agree) and are then followed by category four (disagree). These results are similar to those who have been teaching for eleven to fifteen years. The responses of teachers with teaching experience above fifteen years tend to fall into category two (I agree), category one (I strongly agree), and category four (I disagree).



Graph 5.2 Frequencies of responses in terms of teaching experience and dependent variable for question one

As for type of training, the results show that the responses of teachers from basic training fall mostly into category two (I agree) and category one (I strongly agree). For those whose training in teaching methods is middle level, the responses fall mostly into category two (I agree), category one (I strongly agree), and then category four (I disagree). For those with university degrees, the responses fall mostly into category four (I disagree), then category two (I agree), then to category five (I strongly disagree) and lastly to category one (I strongly agree).



Graph 5.3 Frequencies of responses in terms of type of training and dependent variable for question one

The estimates of thresholds, standard error, Wald statistics, the regression coefficient, the *p-value*, and interval confidence for logit model are show in the table 5.11. As for variable professional experience (Profexp), the results show that with the increase of number of years in teaching experiences, the probability of observing a high level category response (disagreement), relative to low level category (agreement), only increases -0.005.

Table 5.11 Results of parameter estimates for variables professional experience, type of training and dependent variable for question one.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold (Question levels)	[gquet = 1]	-2.003	.263	58.011	1	.000	-2.518	-1.488
	[gquet = 2]	-.340	.238	2.039	1	.153	-.806	.127
	[gquet = 3]	-.114	.237	.230	1	.631	-.579	.351
	[gquet = 4]	1.412	.262	29.072	1	.000	.899	1.926
Location (Type of Training)	Professional experience	-.005	.010	.271	1	.603	-.025	.014
	[ttrainin2=1]	-.906	.351	6.653	1	.010	-1.594	-.217
	[ttrainin2=2]	-.917	.237	14.970	1	.000	-1.382	-.452
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.

Link function: Logit.

We would say that with increase of teaching experiences, teachers would tend to agree with the fact that answering general questions in classroom mathematics is part of exercising learner-centred teaching. However, this increment in responses is not significant as shown by table 5.11 ($b = -0.005$; $X^2(Wald)(1) = 0.271$; $p = 0.603$). These results show that the number of years of teaching experience in mathematics does not affect a teachers' perceptions in terms of whether asking general questions is part or not of learner-centred teaching.

Furthermore, we sought to verify whether type of training (basic, middle, high) would affect the probability of teacher perceiving whether asking general questions in mathematics classroom is or is not part of learner-centred teaching. The results show that the probability of observing a low level category (agreement) is significantly higher in basic ($b = -0.906; X^2(Wald)(1) = 6.653; p = 0.010$) and middle ($b = -0.917; X^2(Wald)(1) = 14.970; p = 0.000$). These results show that the responses of those who have basic and middle training would tend to fall into low level categories (agreement) than those with high level of training. This suggests that teachers with basic and middle training tend to agree with the fact that asking a general question in classroom mathematics is part of learner-centred teaching.

5.7.2 QUESTION TWO (A teacher asks specific questions of his or her learners)

In the second analysis, we sought to verify the influence of the independent variables type of training (ttrainin2=1-basic; 2-middle; 3-high) on the dependent variable (specqut = response to specific questions to his or her learners). The variable professional experience (Profexp) was included as covariate. The data were analysed using the logit and negative log-log models to verify which one would best fit the data.

Table 5.12 Model fitting information for Logit and Negative Log-Log link functions for question two

Link Function	Model	-2 Log likelihood	Chi-Square	Df	Significance
Logit	Intercept Only	467.377			
	Final	461.370	6.007	3	.111
Negative Log-Log	Intercept Only	467.377			
	Final	465.103	2.274	3	.518

The results shown on table 5.12 suggest that the -2LL of Final Model in Logit function(461.370) is lower than in those of Negative Log-Log function(465.103). Final model either in Logit ($G^2(3) = 6.007; p=0.111$) or in Negative Log-Log ($G^2(3) = 2.274; p=0.111$) did not show to be better than Intercept Only model suggesting that none of independent variables (professional experience and type of training) could affect the dependent variable.

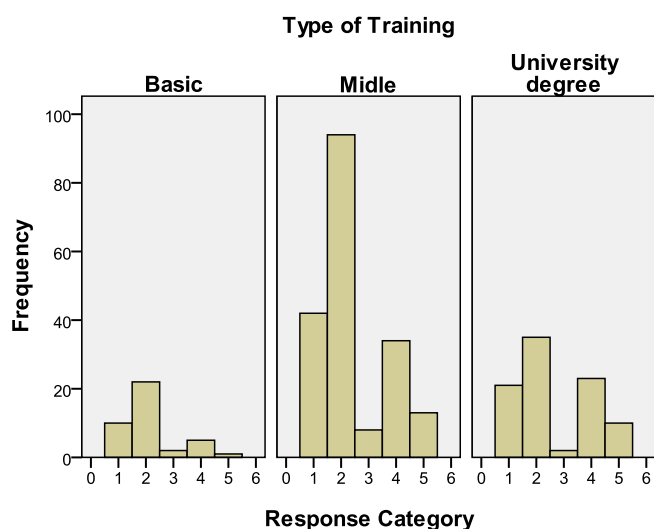
The Goodness of fit test show that either for Person($X^2P(321) = 317.514$); $p=0.544$) or Deviance ($(X^2D(321) = 287.349$; $p=0.912$) tests are not significant, suggesting that the null hypothesis that the model fits the current data is not rejected. The results of Pseudo R-squared suggests a lower effect of the model ($R^2MF=0.007$; $R^2N=0.020$; $R^2CS=0.019$).

The *p-value* in the test of parallel lines in logit function, shown in table 5.13, is slightly bigger ($p=0.302$) than in Negative Log-Log function ($p=0.110$). Under null hypothesis, the results show that the slope's coefficients in either logit ($(X^2(9) = 10.627$; $p= 0.302$) or negative log-log ($(X^2(9) = 10.627$; $p=0.110$) are the same along responses' categories, therefore the null hypothesis is not rejected.

Table 5.13 Test of Parallel Lines for Logit and Negative Log-Log link functions for question two

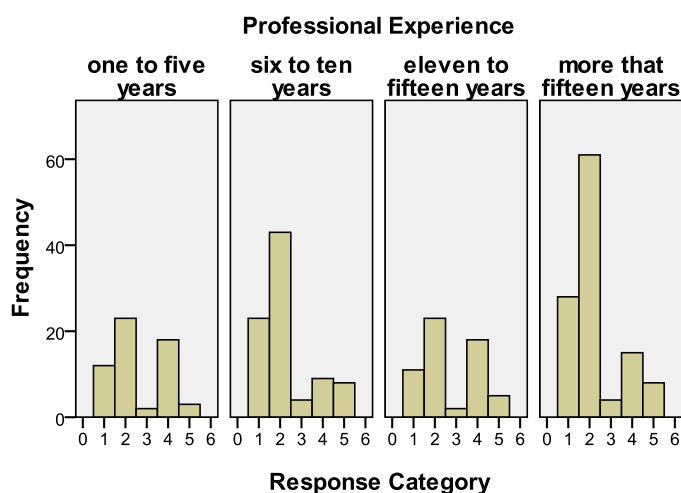
Link Function	Model	-2 Log likelihood	Chi-Square	Df	Significance
Logit	Null Hypothesis	461.370			
	General	450.743	10.627	9	.302
Negative Log-Log	Null Hypothesis	465.103			
	General	450.755	14.348	9	.110

The graph 5.4 shows the frequencies of responses for the variables type of training (basic, middle, and university). As it can be seen in the results, the responses of teachers with basic training fall into category two (I agree) and one (I strongly agree). As for those who have middle training, the responses fall mostly into category two (I agree), category one (I strongly agree). For those trained at university level, their responses tend also to fall mostly into categories two and one, for agree and strongly agree respectively. However, the data show that there are more teachers who are in middle and university levels whose response fall into categories 4 and 5, that stands for disagree and strongly disagree respectively.



Graph 5.4 Frequencies of responses in terms type of training and dependent variable for question two.

The variable professional experience (one to five years, six to ten years, eleven to fifteen years, and more than fifteen years) on graph 5.5 shows that in almost all categories, the responses tend to fall into categories two (agree), category one (I strongly agree). However, category four (I disagree) is more frequent, mainly on those with one to five, eleven to fifteen years, and more than fifteen years of teaching experience.



Graph 5.5 Frequencies of responses in terms of teaching experience and dependent variable for question two.

As for variable professional experience (Profexp) on table 5.14 of the parameter estimates, the results show that when the number of years increase in teaching, the probability of observing a high level category response (disagreement), relative to low level category (agreement), increases by -0.018. However, the increment is marginally significant ($b = -0.018$; $X^2(Wald)(1) = 2.210$; $p = 0.088$) showing teaching experience may have some influence on the perception that asking specific questions to students is somehow a way of practicing learner-centred approach in classroom mathematics.

Table 5.14 Results of parameter estimates for variables professional experience, type of training and dependent variable for question two

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold (Question levels)	[specqut = 1]	-1.729	.264	42.979	1	.000	-2.246	-1.212
	[specqut = 2]	.365	.243	2.258	1	.133	-.111	.840
	[specqut = 3]	.557	.244	5.199	1	.023	.078	1.036
	[specqut = 4]	2.091	.296	49.774	1	.000	1.510	2.672
Location (Type of training)	Professional experience	-.018	.010	2.910	1	.088	-.038	.003
	[ttrainin2=1]	-.499	.359	1.933	1	.164	-1.203	.204
	[ttrainin2=2]	-.257	.239	1.159	1	.282	-.725	.211
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

The results from variable type of training show that the probability of observing a low level category (agreement) related to high level (disagreement) in either basic training $b = -0.499; X^2(Wald)(1) = 1.933; p = 0.164$ or for middle $b = -0.257; X^2(Wald)(1) = 1.159; p = 0.282$ is not significant. These results suggest being trained in basic, middle or university level does not affect teachers' perceptions that asking specific questions to learners is related or not to learner-centred teaching.

5.7.3 QUESTION THREE (A Teacher explains mathematics' content during lessons and solves exercises)

This analysis was concerned with testing the effect of the independent variables type of training (ttrainin2=1-basic; 2-middle; 3-high) on dependent variable (texpsex = teacher explains mathematics' contents during lessons and solves exercises). The variable professional experience (Profexp) was kept as covariate. The model function link logit and negative log-log were performed to verify the suitability of the data between the two models.

Table 5.15 Model fitting information for Logit and Negative Log-Log link functions for question three

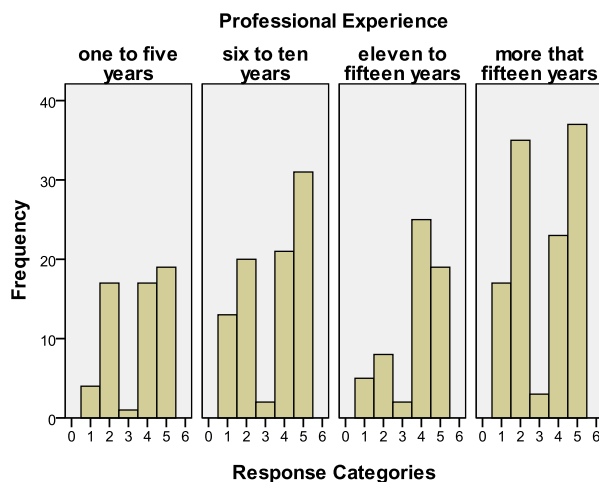
Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Intercept Only	491.773			
	Final	475.107	16.666	3	.001
Negative Log-Log	Intercept Only	491.773			
	Final	479.782	11.992	3	.007

It is possible to see in the table 5.15 that the -2LL in the two link function (logit=475; 107) Negative Log-Log=479.782) are different, suggesting that the Logit function is better than the Negative Log-Log function. The model Final in both Logit ($G^2(3) = 16.666; p=0.001$) and Negative Log-Log ($G^2(3) = 11.992; p=0.007$) functions seems to be better than the model Intercept Only showing that one of the independent variables may affect the category of dependent variables.

Goodness of fit test did not seem to be significant in Logit (Person, $X^2P(321) = 296.197; p=0.836$; Deviance, $X^2D(321) = 388.996; p=0.836$) nor in Negative Log-Log (Person; $X^2P(321) = 306.541; p=0.710$; Deviance, $X^2D(321) = 293.667; p=0.861$) functions. Thus, the null hypothesis that the model fits the current data is not rejected.

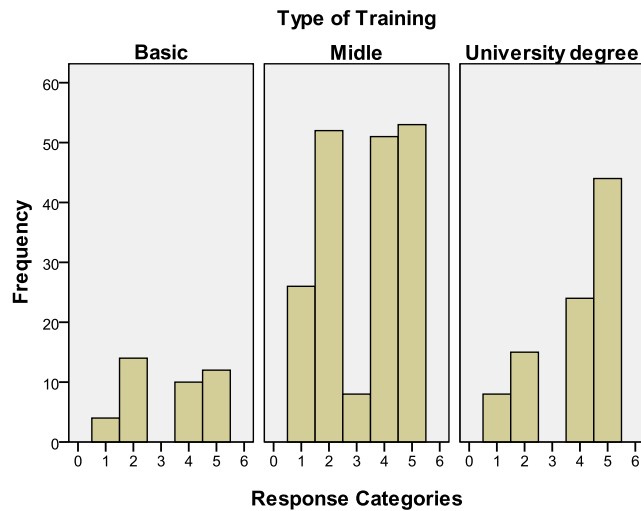
The Pseudo R-squared in Logit ($R^2MF = 0.019$; $R^2N = 0.055$; $R^2CS = 0.052$) and Negative Log-Log ($R^2MF = 0.013$; $R^2N = 0.040$; $R^2CS = 0.037$) functions are lower. The Chi-squared for test of parallel lines in logit function ($X^2(9) = 35.929; p = 0.000$) show that the coefficients slopes are the same across response categories.

As it can be noted in graph 5.6, concerning teaching experience among teachers with one to five years of experience, the responses fall mostly into category five (I completely disagree) followed by categories four (I disagree) and two (I agree). For those who have six to ten years of teaching experiences, the responses fall also in to category five (I completely disagree), followed by categories four (I disagree) and two (I agree). For those with eleven years of experience in teaching, the responses fall mostly in category four and five. The responses of those teachers with more than fifteen years of experience in teaching are more frequent in categories five and category two, than followed by category four.



Graph 5.6 Frequencies of responses in terms of teaching experience and dependent variable for question three.

Concerning type of training, the results show that the responses of those who have basic training fall mostly in category two (I agree) and five (I completely disagree), while for those trained in middle level, the responses fall into category five (I completely disagree), category two (I agree) and four (I disagree). For those trained at university level, the responses fall into category four (I disagree) and five (I completely disagree).



Graph 5.7 Frequencies of responses in terms of type of training and dependent variable for question three.

Results from parameter estimates on table 5.16 show that as for the variable years of teaching, the probability to observe a high level category response (disagreement), relative to low level category (agreement), increases by -0.023, and this increment seems to be significant ($b = -0.023$; $X^2(Wald)(1) = 5.091$; $p = 0.024$). Concerning the variable type of training, the results show that as teachers become more trained, the probability of observing high level category is significantly marginal for basic level ($b = -0.0646$; $X^2(Wald)(1) = 3.394$; $p = 0.065$), while middle level increases significantly $b = -0.781$; $X^2(Wald)(1) = 10.645$; $p = 0.001$).

Table 5.16 Results of parameter estimates for variables professional experience, type of training and dependent variable for question three

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold (Question levels)	[texpsex = 1]	-2.939	.296	98.808	1	.000	-3.519	-2.360
	[texpsex = 2]	-1.432	.254	31.835	1	.000	-1.930	-.935
	[texpsex = 3]	-1.319	.252	27.415	1	.000	-1.813	-.826
	[texpsex = 4]	-.155	.240	.415	1	.519	-.626	.316
Location (Type of training)	Professional experience	-.023	.010	5.091	1	.024	-.042	-.003
	[ttrainin2=1]	-.646	.350	3.394	1	.065	-1.333	.041
	[ttrainin2=2]	-.781	.239	10.645	1	.001	-1.250	-.312
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

These results suggest that as the number of years of teaching increases, teachers would tend to disagree with the statement that when a teacher explain mathematics content and solve exercises,

he or she is practicing learner-centred teaching. As for training, it also seems that the more trained teacher would be the more likely to disagree with the statement.

5.7.4 QUESTION FOUR (Teacher takes into account learners' previous knowledge)

Furthermore, the effect of independent variables type of training (ttrainin2=1-basic; 2-middle; 3-high) on dependent variable (teacher takes into account learners previous knowledge) was tested. The variable professional experience (Profexp) was set as covariate. The model function link logit and negative log-log were performed to verify the suitability of the data between the two models.

Table 5.17 Model fitting information for Logit and Negative Log-Log link functions for question four

Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Intercept Only	368.212			
	Final	362.552	5.660	3	.129
Negative Log-Log	Intercept Only	368.212			
	Final	361.759	6.453	3	.092

As it is reported in table 5.17, we would assume that the Negative Log-Log function is better than the logit, since the -2LL of Final model in Negative Log-Log (361.759) is less than the Final Model of Logit (362.552), therefore, this data could be best explained using Negative Log-Log function. However, we should note that the Final Model is not significant at $p \leq 0.05$ ($G^2(3) = 6.453$; $p=0.092$). These results suggest that none of the independent variable (teachers' professional experience and type of training) of the model influence significantly the

occurrence of categories (I completely agree, I agree, neutral, I disagree, I completely disagree) of the dependent variable (teachers take into account learner-centred model).

The test of Goodness-of-fit shows that the *p-value* for Person test is significant ($X^2(1) = 390.525; p = 0.005$), while for Deviance test ($X^2(321) = 222.658; p = 1.00$) it is not significant. These results suggest that since the *Ho(Null hypothesis)* is not rejected at least for Person's test, we may assume that the model does not fit to the data. However, for Deviance test the *Null hypothesis* is rejected. These results may have been influenced by the number of empty cells that reached 258(62.9%). The Pseudo R-squared show moderate and low values for all statistics especially for Mcfadden pseudo- R^2 ($R^2_{MF} = 0.009$; $R^2_N = 0.023$; $R^2_{CS} = 0.020$)

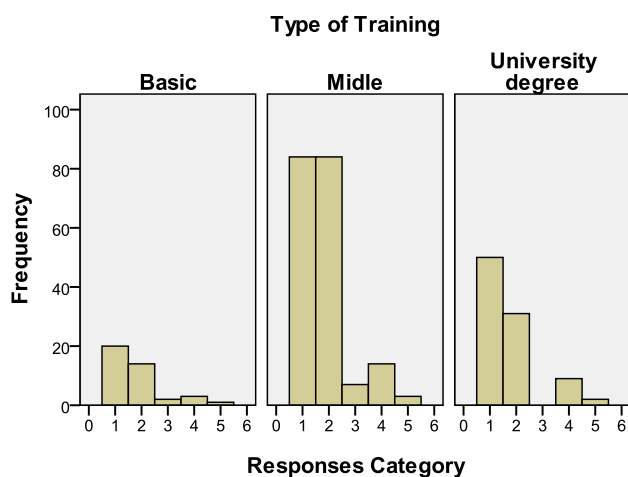
Table 5.18 Test of Parallel Lines for Logit and Negative Log-Log link functions for question four

Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Null Hypothesis	362.552			
	General	357.354 ^a	5.198 ^b	9	.817
Negative Log-Log	Null Hypothesis	361.759			
	General	354.461 ^a	7.298 ^b	9	.606

The slope coefficients were also compared in the two link function (Logit and Negative Log-Log) and show that the Negative Log-Log function presents lower -2LL (354.461) than de Logit (357.354), showing that Negative Log-Log function is better than Logit. Indeed, in the Model General of Negative Log-Log, the *Ho(Null hypothesis)* that the slope coefficients are the same across all categories of dependent variable, is not rejected ($X^2(9) = 7.298; p = 0.606$). Therefore, we keep the *Null hypothesis* and reject the *H1* that would be at least one slope that could be different from the others.

Amid the results, there is a warning that if *maximum step-halving* of 5 was not able to achieve enough algorithm steps the validity of the test may be questioned. Then was performed another analysis adjusting the *maximum step-halving* up to 50 as recommended by Maroco (2010:779), even though no improvement was achieved.

Teachers' responses on statement whether when "*teacher takes into account learners' previous knowledge*", would mean practicing learner or teacher-centred, the graph 5.8 shows that the responses of those with basic training fall mostly into category one (I strongly agree) and category two (I agree). For those with middle training, the frequencies are also falling into category one and two. Similar results can be observed in those teachers with university degrees. The results in this level show that there are more teachers with the responses falling mostly in category one (I strongly agree) then followed by category two (I agree).

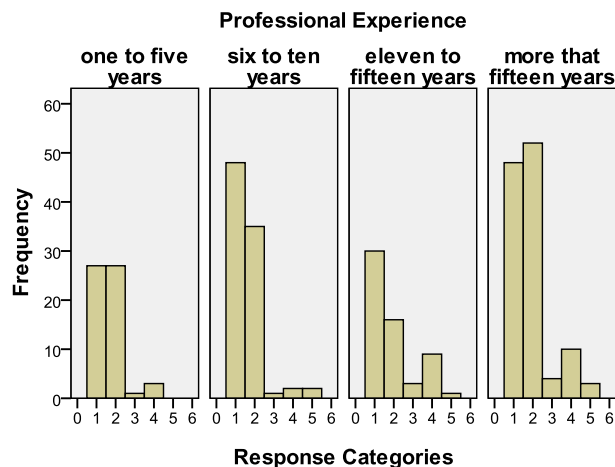


Graph 5.8 Frequencies of responses in terms of type of training and dependent variable for question four

As for teaching experience, it is possible to note that in all level of teaching experience the responses fall mostly into category one and two, showing that mostly teachers consider that taking in account learners' previous experience while teaching mathematics is part of learner-

centred teaching approach. However, the frequencies vary depending of the level of teaching experience. While in those with teaching experiences that vary from one to five years the responses fall mainly on both categories one and two (I strongly agree and I Agree), those whose experience in teaching is between six to ten years, the frequencies fall primarily into category one (strongly agree) then to category two (I agree).

For eleven to fifteen years, the mostly observed frequencies are in the category one then followed by category two. The results show that at this level of teaching experience, some frequency responses are at category four (I disagree). The responses of those with more than fifteen years of teaching experience fall primarily on category two (I agree), and then followed by category one (I completely agree). It is possible to note in this level of teaching experience that there are also responses that fall into category four (I disagree), showing that among teachers there is an expressive number of teachers who do not agree with the fact that taking in account learners' previous experience is part of learner-centred teaching.



Graph 5.9 Frequencies of responses in terms of teaching experience and dependent variable for question four.

Results from parameter estimates on table 5.19 show that as the number of years in teaching increases, the probability to observe high level category responses (disagreement), relative to low level category (agreement), increases only 0.014 and the increment seem to be significant at $p \leq 0.05$ ($b_{profexp} = 0.014$; $X^2(Wald)(1) = 3.581$; $p = 0.058$). As for variable type of training, the results show that there are more probability of observing categories of lower order (I strongly agree and agree), on those with middle ($b_M = 0.285$; $X^2(Wald)(1) = 2.340$; $p = 0.126$) training than those of basic and university degree. However, we noted that in all type of training the category one is the one that occurs more frequently, and then followed by category two.

Table 5.19 Results of parameter estimates for variables professional experience, type of training and dependent variable for question four.

Parameter Estimates								
		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold (Question levels)	[lpknld = 1]	.678	.188	13.016	1	.000	.310	1.047
	[lpknld = 2]	2.440	.238	105.206	1	.000	1.974	2.907
	[lpknld = 3]	2.719	.254	114.808	1	.000	2.222	3.216
	[lpknld = 4]	4.368	.445	96.404	1	.000	3.496	5.241
Location (Type of training)	Professional experience	.014	.007	3.581	1	.058	.000	.029
	[ttrainin2=1]	.066	.278	.057	1	.811	-.478	.611
	[ttrainin2=2]	.285	.186	2.340	1	.126	-.080	.650
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.

Link function: Negative Log-log.

a. This parameter is set to zero because it is redundant.

5.7.5 QUESTION FIVE (Teacher asks learners to solve exercises on the board)

The effect of independent variables type of training on dependent variable (teacher ask learners to solve exercises on the board) was tested. The variable professional experience (Profexp) was kept as covariate. The model function link logit and negative log-log were performed to verify the suitability of the data between the two models. Due to the fact that the previous defined (5) *maximum step-halving* was not achieved in any of these two functions, the procedures were performed again, this time with an increase the *Maximum step-halving* up to 50 as recommended by Maroco (2010:779). The results showed that although the log-likelihood (-2LL) of the Negative Log-Log is lower compared to that of Logit function, the Chi-squared statistics remained uncertain, while in Logit function seems to have improved. Therefore, the results that were kept for analysis are those produced in Logit function because they seemed to fit well to current data.

Table 5.20 Model fitting information for Logit and Negative Log-Log link functions for question five

Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Intercept Only	415.300			
	Final	412.082	3.217	3	.359
Negative Log-Log	Intercept Only	415.300			
	Final	410.714	4.586	3	.205

As can be seen in the Table 5.20, the Final Model in both Logit ($G^2(3) = 3.217; p=0.359$) and Negative Log-Log ($G^2(3) = 4.586; p=0.205$) functions does not seem significant at $p \leq 0.05$, suggesting that none of the independent variable (teachers' professional experience and type of training) of the model influence significantly the occurrence of categories (I completely agree, I agree, neutral, I disagree, I completely disagree) of the dependent variable (teacher asks learner to solve exercises on the board).

The test of Goodness-of-fit test show that $p\text{-value } p \leq 0.05$ Person ($X^2(321) = 340.071; p = 0.222$) and Deviance ($X^2(321) = 249.324; p = 0.999$) tests were not significant. The Pseudo R-squared show moderate and low values for all statistics especially for Mcfadden pseudo- R^2 ($R^2_{MF} = 0.004$; $R^2_N = 0.011$; $R^2_{CS} = 0.010$).

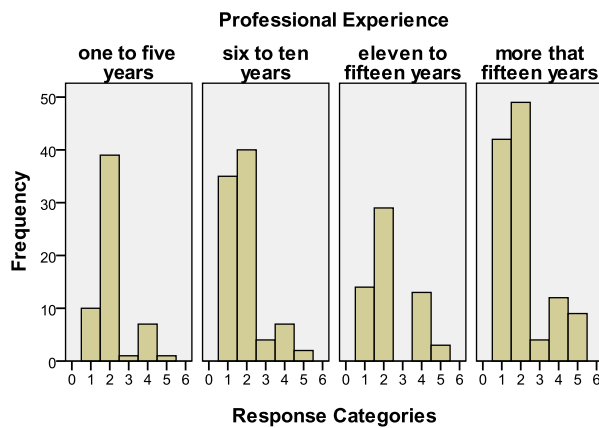
From the results of test of parallel lines shown in Table 5.21, it is possible to note that for Model General in Logit function, the H_0 (Null hypothesis that the slope coefficients are the same across all categories of dependent variable) is rejected ($X^2(9) = 217.684; p = 0.000$). Therefore, it can be conclude that at least there is one slope that is different from the others.

Table 5.21 Test of Parallel Lines for Logit and Negative Log-Log link functions for question five

Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Null Hypothesis	412.082			
	General	194.399	217.684	9	.000
Negative Log-Log	Null Hypothesis	410.714			
	General	22.170 ^a	388.544 ^b	9	.000

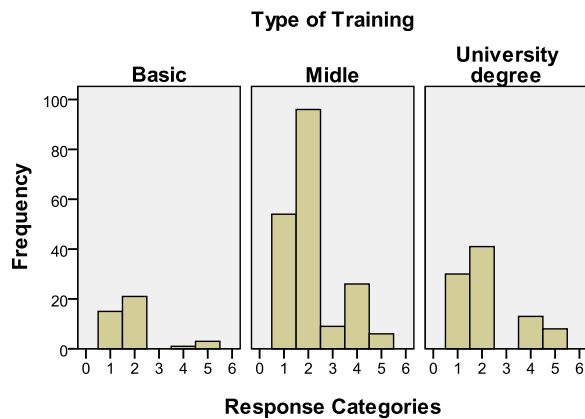
According to the results shown in the Graph 5.10, the responses of those teachers between one to ten years fall into category two (I agree), while for those whose teaching experiences is between

six to ten years fall mostly into category two (I agree), and category one (I completely agree). For those with eleven to fifteen years of teaching experience, the responses fall into category two (I agree), while for those with more than fifteen years of teaching experience, the responses fall into categories one and two.



Graph 5.10 Frequencies of responses in terms of teaching experience and dependent variable for question five.

As for variable type of training shown on Graph 5.11, the results show that for those with basic level of training the responses fall into category two (I agree) and those with basic training fall into category two and one. Those with university degree their responses fall mostly into categories two and one (I agree, I strongly agree).



Graph 5.11 Frequencies of responses in terms of type of training and dependent variable for question five.

The results from parameter estimates shown in the Table 5.22 indicate that the probability to observe a high level category of responses (disagreement), relative to low level (agreement), increases only -0.011, and that this increment is not sufficiently enough to become significant at $p \leq 0.05$ ($b_{profexp} = -0.011$; $X^2(Wald)(1) = 1.191$; $p = 0.275$). Similarly, concerning variable type of training, the results show that there are more probability of observing categories of lower order (agreement), whether in basic ($b_B = -0.342$; $X^2(Wald)(1) = 0.886$; $p = 0.346$) or middle ($b_M = 0.066$; $X^2(Wald)(1) = 0.075$; $p = 0.784$). None of the results have show significance on the effect of independent variable over dependent variable. This means that teachers agree with the fact that asking learners to go to the board and solve mathematics problems is a part of learner-centred teaching.

Table 5.22 Results of parameter estimates for variables professional experience, type of training and dependent variable for question five

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[cbexrc = 1]	-.981	.251	15.288	1	.000	-1.473	-.489
Question levels)	[cbexrc = 2]	1.239	.256	23.467	1	.000	.738	1.740
	[cbexrc = 3]	1.429	.260	30.105	1	.000	.919	1.940
	[cbexrc = 4]	2.849	.340	70.413	1	.000	2.184	3.515
	[cbexrc = 5]	2.849	.340	70.413	1	.000	2.184	3.515
Location	Professional experience	-.011	.010	1.191	1	.275	-.032	.009
(Type of training)	[ttrainin2=1]	-.342	.364	.886	1	.346	-1.055	.370
	[ttrainin2=2]	.066	.242	.075	1	.784	-.408	.541
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.
	[ttrainin2=4]	0 ^a	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

5.7.6 QUESTION SIX (teacher explain mathematical content)

As for this analysis, we sought to find out whether the probability of occurrence of any of the categories of the dependent variable (teacher explain mathematical content) was affected by the independent variable type of training and teachers' background experience in teaching. The dependent variable was coded as exmtvw2 and the independent variables were coded as ttrain2 and Profexp respectively for type of training and teachers' professional experience.

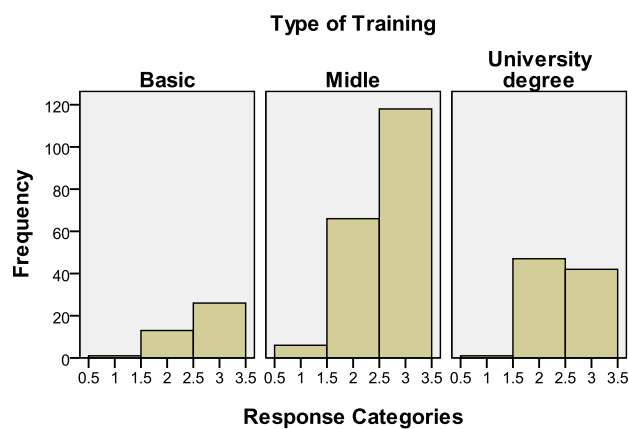
To accomplish this intent, a multinomial regression model was used to estimate the probability of each of the categories of dependent variable (teacher explain mathematical content, 1-Neutral; 2- I disagree; 3- I Agree) over professional experience and type of training (1-basic; 2- middle; 3- university degree).

The results show that the Final model is more statistically significant ($G^2(6) = 11.576$; $p=0.072$) than the *intercept only* model. Since the null hypothesis (H_0) that the model is not significant is rejected, we can conclude that the model is adjusted to the current data, suggesting on the other side that at least there is one independent variable that affects the dependent variable. As for Goodness-of-fit test, we found that the Person's test $X^2(156) = 268.217$; $p = 0.000$ is statistically significant at $p \leq 0.05$ and non significant for Deviance test $D(156) = 143.233$; $p = 0.760$. This suggests that interpretation of the results from these two tests might be done cautiously. The Pseudo-R test shows a low statistic in almost all tests ($R^2_{MF} = 0.004$; $R^2_N = 0.011$; $R^2_{CS} = 0.010$) specially the McFadden.

The effect of independent variables on dependent variables was also tested through Likelihood tests. The results suggest that the variable professional experience ($G^2(2) = 2.265$; $p=0.322$) did not significantly affect the *Logit* of probability of occurrence of the categories of dependent variables (neutral, disagree, agree). The *Null Hypothesis* (H_0) that the independent variable type of training would not affect the *Logit* of probability of occurrence of any of the categories of

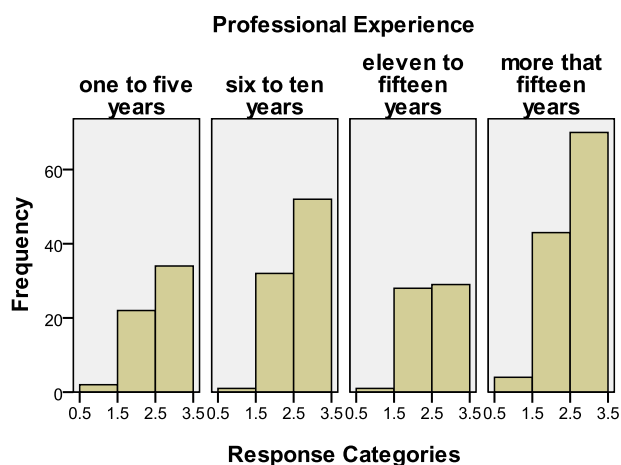
dependent variable is rejected ($G^2(4) = 8.423$; $p=0.072$) since the p -value is marginally significant at $p \leq 0.05$. In the sight of these results, we can conclude that the probability of respondent to agree, disagree or be neutral, depends on his or her level of training in teaching methods.

Graph 5.12 shows the frequency of responses, by type of training and professional experience, compared with dependent variable (teacher explain mathematical content). As can be seen concerning type of training, we note that for basic and middle level the frequency of responses are mostly concentrated in category three (I agree), and then category two (I disagree). As for university degree, the results show that category two (I disagree) is more frequent, and then followed by category three (I agree).



Graph 5.12 Frequencies of responses in terms of type of training and dependent variable for question six.

In the variable professional experience the results show that categories three (I agree) is more frequent then followed by category two (I disagree). In those teachers whose teaching experience is from eleven to fifteen years the frequencies seem to be similar for category three and two showing that most of the responses are in these two categories.



Graph 5.13 Frequencies of responses in terms of teaching experience and dependent variable for question six.

The estimates for parameters are shown on the Table 5.23. As can be seen in the results, it is possible to note that the shift from reference category one (neutral) to category two (disagree) and category three (agree) is not affected by number of years teachers have in education ($b_{profexp}=-0.043$; $OR=0.958$; $p=0.199$ and $b_{profexp}=-0.030$; $OR=0.970$; $p=0.357$).

The ratio of chance of shifting from category one (neutral) to category 3 (disagree) is of 0.970, that is the chances that one year of teaching experience grow would lead teacher to disagree with the statement that learner-centred teaching consist simply of explaining mathematical content during lessons decreases by 3% ($100 \times (0.970 - 1) = -3$, while the ratio of chance to shift from category one (neutral) to category two (agree= 0.958) decreases by 4.8% ($100 \times 0.958 - 1 = -4.2$). That means that a one year grow in teaching experience does not constitute a warranty that teachers' views would change.

Concerning the independent variable type of training, we found that either basic ($b_{ttrainin2=1} = -1.016$; $OR=0.372$; $p=0.489$) or middle level ($b_{ttrainin2=2} = -1.369$; $OR=0.254$; $p=0.214$) did not show a significant effect on the occurrence of categories of dependent variable (neutral, agree, disagree).

The ratio of chance shifting from category one (neutral) to category two (I agree) is of 0.362 ($100 \times 0.362 - 1 = -63.8$) for basic level and 0.254 ($100 \times 0.254 - 1 = -74.6$) for middle. That means, that per year of experience, the probability to shift from category one (neutral) to category two (I agree) would decrease by 63.8% and 74.6% respectively for basic and middle level.

Similarly, the ratio of chances of shifting from category one (neutral) to category three (disagree) is of 0.763 ($100 \times 0.763 - 1 = -76.3$) for basic level, and 0.508 ($100 \times 0.508 - 1 = -50.8$) for middle, which means that per year of growth those chances would decreased by 76.2% and 50.8% respectively for basic and middle levels respectively.

In light of these results, we can conclude that neither teaching experience, nor type of training, have an effect on teachers' views over whether learner-centred teaching consist simply of explaining mathematical content during lessons.

Table 5.23 Results of parameter estimates for variables professional experience, type of training and dependent variable for question six

Parameter Estimates

A teacher explains mathematical content		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
I disagree (Type of training)	Intercept	4.440	1.140	15.156	1	.000			
	Professional experience	-.043	.033	1.646	1	.199	.958	.898	1.023
	[ttrainin2=1]	1.016	1.469	.479	1	.489	.362	.020	6.438
	[ttrainin2=2]	1.369	1.103	1.542	1	.214	.254	.029	2.209
	[ttrainin2=3]	0 ^b	.	.	0	.	.	.	.
I agree (Type of training)	Intercept	4.157	1.138	13.355	1	.000			
	Professional experience	-.030	.033	.850	1	.357	.970	.910	1.034
	[ttrainin2=1]	-.270	1.455	.034	1	.853	.763	.044	13.224
	[ttrainin2=2]	-.678	1.101	.379	1	.538	.508	.059	4.390
	[ttrainin2=3]	0 ^b	.	.	0	.	.	.	.

a. The reference category is: Neutral.

b. This parameter is set to zero because it is redundant.

5.7.7 QUESTION SEVEN (A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena)

In this analysis, we sought to test if the probability of occurrence of any of the categories of the dependent variable (a teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena coded as dcrsft2) was affected by the independent variable type training and professional experience in teaching. A multinomial regression model was used to estimate the probability of each of the categories of dependent variable (a teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena; 1-Neutral; 2-disagree; 3-Agree) over professional experience and type of training (1-basic; 2-middle; 3- university degree).

In the results shown in the Table 5.16, was found that the Final model was not statistically significant ($G^2(6) = 4.471; p=0.613$). Thus, we reject the *Null Hypothesis* (H_0) that the model is not significant is assumed, suggesting that none of independent variables affect the dependent variable.

Looking at Goodness-of-fit test (see table 5.24), we found that either Person's $X^2(156) = 174.106; p = 0.153$ and Deviance's tests $D(156) = 155.371; p = 0.499$ are statistically not significant at $p \leq 0.05$, therefore we can reject the H_1 and retain the H_0 and conclude that the model thus fit to the current data. The Pseudo-R test show a low statistic in almost all tests ($R^2_{MF} = 0.010$; $R^2_N = 0.018$; $R^2_{CS} = 0.014$) specially the McFadden.

Table 5.24 Results of Goodness-of-fit test for question seven

Goodness-of-Fit			
	Chi-Square	Df	Sign
Person	174.106	156	.153
Deviance	155.571	156	.499

The Likelihood tests (see table 5.25) suggest that the variable professional experience ($G^2(2) = 1.595$; $p=0.459$) and type of training ($G^2(4) = 3.083$; $p=0.544$) did not significantly affect the *Logit* of probability of occurrence of the categories of dependent variables (neutral, disagree, agree). Since $p>0.05$, we retain the *Null Hypothesis (Ho)* that the independent variable type of training would not affect the *Logit* of probability of occurrence of any of the categories of dependent variable. In the light of these results, we can conclude that the probability of occurrence of categories neutral, agree and disagree is not affected by teachers' professional experience, nor by their level of training.

Table 5.25 Results of Likelihood Ratio Test from question seven.

Likelihood Ratio Tests

Effect	Model Fitting Criteria			Likelihood Ratio Tests		
	AIC of Reduced Model	BIC of Reduced Model	-2 Log Likelihood of Reduced Model	Chi-Square	Df	Sig.
Intercept	257.596	287.642	2.416E2	.000	0	.
Profexp	255.191	277.726	243.191	1.595	2	.450
tttrainin2	252.679	267.702	244.679	3.083	4	.544

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Along with the tests described above, estimates for parameters were also calculated as shown on Table 5.26. The results shown in the table suggest that the shift from reference category one (neutral) to category two (disagree) and category three (agree) is not affected by teachers' professional experience ($b_{profexp} = 0.017$; $OR=1.018$; $p=0.540$ and $b_{profexp} = 0.028$; $OR=1.028$; $p=0.298$ respectively).

The results of estimates for parameters also show that the ratio of chance shifting from category one (neutral) to category two (I agree) is of 1.018, and from neutral to category three (disagree) is of 1.28. The chances are that a one year growing of teaching experience leads to an increase of 1.8% ($100 \times 1.018 - 1 = 1.8$) from category neutral to agree and increase of 28% ($100 \times 1.28 - 1 = 28$) from category one (neutral), to category three (disagree).

As for type of training, it is possible to note that either basic ($b_{ttrainin2=1} = -0.969$; $OR = 0.379$; $p = 0.347$) or middle level ($b_{ttrainin2=2} = -1.174$; $OR = 0.309$; $p = 0.132$) did not show a significant effect on the occurrence of categories of dependent variables (neutral, agree, disagree). The ratio of chance of shifting from category one (neutral) to category two (I agree) for basic level is of 0.417, while for middle level it is 0.376. These values correspond to a decrease of 58.3% ($100 \times 0.417 - 1 = -58.3$) and 62.4% ($100 \times 0.376 - 1 = -62.4$) respectively for basic and middle levels. Similarly, the ratio of chance of shifting from category one (neutral) to category three (disagree) for basic and middle levels are respectively 0.379 and 0.309. That means that for the basic level there is a decrease of 62% and 69% respectively.

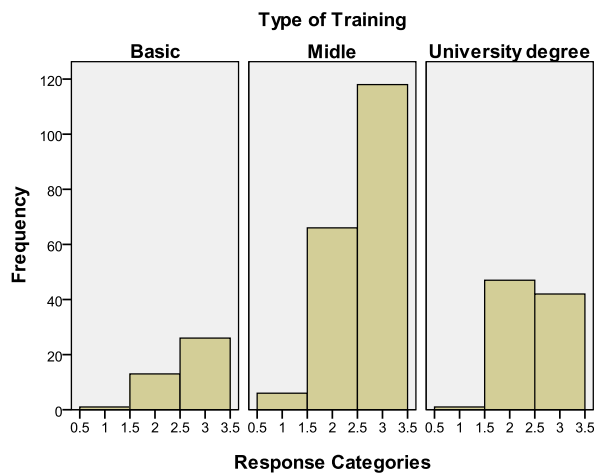
Table 5.26 Results of parameter estimates for variables professional experience, type of training and dependent variable for question seven

Parameter Estimates

A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Disagree (Type of training)	Intercept	2.089	.816	6.557	1	.010			
	Professional experience	.017	.028	.376	1	.540	1.018	.962	1.076
	[ttrainin2=1]	-.875	1.084	.652	1	.420	.417	.050	3.490
	[ttrainin2=2]	-.977	.810	1.456	1	.228	.376	.077	1.841
	[ttrainin2=3]	0 ^b	.	.	0	.	.	.	.
Agree (Type of training)	Intercept	3.161	.785	16.208	1	.000			
	Professional experience	.028	.027	1.084	1	.298	1.028	.976	1.084
	[ttrainin2=1]	-.969	1.031	.884	1	.347	.379	.050	2.863
	[ttrainin2=2]	-1.174	.779	2.268	1	.132	.309	.067	1.424
	[ttrainin2=3]	0 ^b	.	.	0	.	.	.	.

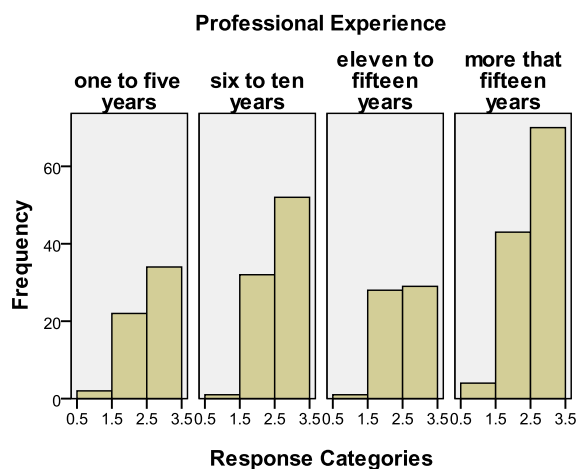
- a. The reference category is: Neutral.
- b. This parameter is set to zero because it is redundant.

Graph 5.14 illustrates the frequencies of responses for variable types of training and professional experience. As can be seen in graph, the frequencies of responses on type of training concentrate more on those with a middle level of training. In this category, we can note that there are more responses for category 3 (I agree) than other categories. The responses of those teachers who were trained in universities, as well as those with basic level, fall mainly into category three (I agree).



Graph 5.14 Frequencies of responses in terms of type of training and dependent variable for question seven

A similar event occurs in relation to variable professional experience (see Graph 5.15). As shown on the graph, there are more frequencies falling in the category three (I agree) in almost all levels (one to five years, six to ten years, eleven to fifteen years, and more than fifteen years of teaching), however, in those with more than fifteen years of experience, the responses are more frequent than those of other levels.



Graph 5.15 Frequencies of responses in terms of teaching experience and dependent variable for question seven.

5.7.8 QUESTION EIGHT (teacher asks learners different types of questions)

The effect of independent variables type of training on dependent variable (teacher asks learners different type of questions) was subject to analysis. The variable professional experience (Profexp) was selected as covariate, while type of training was kept as factor. To perform the analysis, a link logit and Negative Log-Log functions were performed and the results showed that logit function did not adjust to the results. In this case, a Negative Log-Log function was found perfect to the results.

In the Table 5.27, we can note that the -2LL in the Negative Log-Log (503.433) are lesser than in Logit (503.986) function, showing that the Negative Log-Log function fits best to the data. As can be shown in the table, the Final model in Negative Log-Log ($G^2(3) = 0.972$; $p=0.808$) function did not seem significant at $p \leq 0.05$ suggesting that none of the independent variable (teachers' professional experience and type of training) of the model influence significantly the occurrence of categories (I completely agree, I agree, neutral, I disagree, I completely disagree) of the dependent variable (teacher asks learners different type of questions).

Table 5.27 Model fitting information for Logit and Negative Log-Log link functions for question eight

Link Function	Model	-2 Log likelihood	Chi-Square	Df	Significance
Logit	Intercept Only	504.405			
	Final	503.986	.419	3	.936
Negative Log-Log	Intercept Only	504.405			
	Final	503.433	.972	3	.808

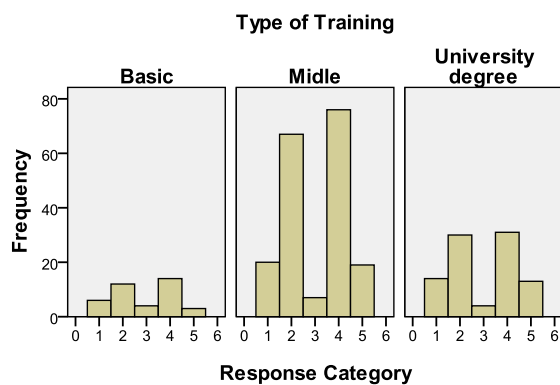
The Goodness-of-fit test show that the Person test ($X^2(321) = 371.705; p = 0.027$) is significant at $p \leq 0.05$, and the Deviance test ($D(321) = 334.886; p = 0.286$) was not significant. These results suggest that the *Null Hypothesis* (H_0), that the model fits to the data, is rejected only by Person's test, while with the Deviance test, the *Null Hypothesis* is kept. With these results, the data must be cautiously interpreted. The Pseudo R-squared shows moderate and low values for all statistics, especially for Mcfadden pseudo- R^2 ($R^2_{MF} = 0.001$; $R^2_N = 0.003$; $R^2_{CS} = 0.003$).

With the test of parallel lines, the -2LL of Negative Log-Log function (495.179) seems to be lower than that of Logit function (495.598). Aside that, after maximum number of step-halving in the Logit function, the -2LL was not increased whatsoever. Thus, the Negative Log-Log function seems to fit best to the results. In the sight of these results, we can conclude that with the results of Model General in Negative Log-Log function ($X^2(9) = 8.254; p = 0.509$) we cannot reject the *Ho* (*Null hypothesis*) that the slope coefficients are the same across all categories of dependent variable.

Table 5.28 Test of Parallel Lines for Logit and Negative Log-Log link functions for question eight

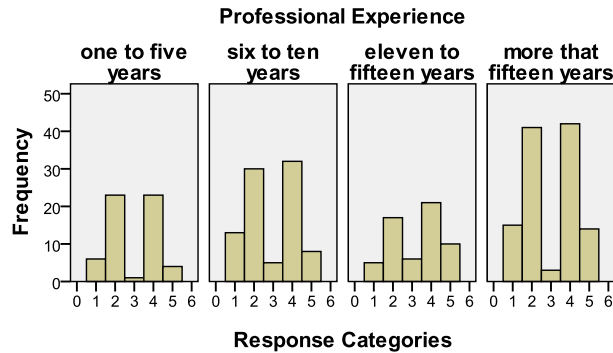
Link Function	Model	-2 Log likelihood	Chi-Square	Df	Significance
Logit	Null Hypothesis	503.986			
	General	495.528 ^a	8.458 ^b	9	.489
Negative Log-Log	Null Hypothesis	503.433			
	General	495.179	8.254	9	.509

The frequencies of responses for variable type of training and professional experience are shown in the Graph 5.16. In this graph, we can see that the frequencies of responses for those who were trained in middle level are much higher than the basic and the university degree. In the middle level it is possible to note that the frequencies of responses are more concentrated in categories four (I disagree) and two (I agree), and then followed by categories five (I Strongly disagree) and one (I strongly agree). In other levels, although the frequency of responses are lower compared with basic level, the results also show that the frequencies of responses are in the categories four (I disagree) and two (I agree) for both university and basic levels.



Graph 5.16 Frequencies of responses in terms of teaching experience, type of training and dependent variable for question eight

For variable professional experience, the results show that the responses are more frequent in those with more than fifteen years of experience in teaching, and then followed by those with six to ten years of teaching experience. However, in all categories it seems that the frequencies of responses fall into categories four (I disagree) and one (I strongly agree).



Graph 5.17 Frequencies of responses in terms of teaching experience, type of training and dependent variable for question eight

As for the parameter estimates tests, the results shown in Table 5.22 suggests that as the teaching experience increases, the probability of observing a high level categories also increases by -0.002, and the increment is not significant at $p \leq 0.05$ ($b_{profexp} = -0.002$; $X^2(Wald)(1) = 0.098$; $p = 0.754$).

The results show also that, in relation to type of training, the more the teacher is educated, the more they tend to disagree with the statement that “asking learners different type of questions” is related to learner-centred teaching ($b_{ttrain2=2} = 0.101$; $X^2(Wald)(1) = 0.504$; $p = 0.478$).

Table 5.29 Results of parameter estimates for variables professional experience, type of training and dependent variable for question eight

Parameter Estimates

		Estimate	Std. Error	Wald	Df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold (Question levels)	[alltyqut = 1]	-.725	.146	24.470	1	.000	-1.012	-.437
	[alltyqut = 2]	.299	.151	3.951	1	.047	.004	.595
	[alltyqut = 3]	.436	.152	8.178	1	.004	.137	.735
	[alltyqut = 4]	2.168	.212	104.113	1	.000	1.751	2.584
Location	Professional experience	-.002	.006	.098	1	.754	-.014	.010
(Type of training)	[ttrainin2=1]	-.036	.216	.028	1	.866	-.460	.387
	[ttrainin2=2]	.101	.142	.504	1	.478	-.178	.380
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.

Link function: Negative Log-log.

a. This parameter is set to zero because it is redundant.

5.7.9 QUESTION NINE (teacher asks direct questions)

In this analysis, we sought to find out whether the probability of occurrence of any of the categories of the dependent variable (teacher asks direct questions) is affected by the independent variables type of training and professional experience. A multinomial regression model was used to estimate the probability of each of the categories of dependent variable (1-

Neutral; 2-disagree; 3-Agree) over professional experience and type of training (1-basic; 2-middle; 3- university degree).

The results in the Table 5.23 show that the Final model was not statistically significant at $p \leq 0.05$ $G^2(6) = 6.500$; $p = 0.370$, thus we retain the *Null Hypothesis* (Ho), and conclude that none of the independent variables (type of training and professional experience) has an effect on the dependent variable.

Table 5.30 Results of model fitting for independent and dependent variables for question nine

Model Fitting Information

Model	Model Fitting Criteria			Likelihood Ratio Tests		
	AIC	BIC	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	274.048	281.547	270.048			
Final	279.548	309.543	263.548	6.500	6	.370

Results of the test of Goodness-of-fit show that Person's $\chi^2(156) = 2020.513$; $p = 0.007$ is significant, while the Deviance test $D(156) = 164.588$; $p = 0.303$ did not show statistical significance at $p \leq 0.05$. The Pseudo-R test shows a low statistics in almost all tests ($R^2_{MF} = 0.013$; $R^2_N = 0.025$; $R^2_{CS} = 0.020$), specially the McFadden.

Table 5.31 Results of Goodness-of-Fit for independent and dependent variables for question nine

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	202.513	156	.007
Deviance	164.588	156	.303

The Likelihood tests suggest that the variable professional experience ($G^2(2) = 0.445; p=0.800$) and type of training ($G^2(4) = 6.121; p=0.190$) did not significantly affect the *Logit* of probability of occurrence of categories of dependent variables (neutral, disagree, agree). Since $p>0.05$, we retain the *Null Hypothesis* (H_0) that the independent variable type of training would not affect the *Logit* of probability of occurrence of any of the categories of the dependent variable. In the light of these results, we can conclude that the probability of occurrence of categories neutral, and agree and disagree is not affected by teachers' professional experience, nor by their level of training.

Table 5.32 Results of Likelihood Ratio Tests for question nine.

Likelihood Ratio Tests

Effect	Model Fitting Criteria			Likelihood Ratio Tests		
	AIC of Reduced Model	BIC of Reduced Model	-2 Log Likelihood of Reduced Model	Chi-Square	Df	Sig.
Intercept	279.548	309.543	2.635E2	.000	0	.
Profexp	275.994	298.490	263.994	.445	2	.800
ttrainin2	277.669	292.667	269.669	6.121	4	.190

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Along with the tests described above, estimates for parameters were also calculated as shown on the Table 5.21. The results suggest that the shift from reference category one (neutral), to category two (agree) and category three (disagree) is not affected by teachers professional experience ($b_{profexp}=0.017$; $OR=1.017$; $p=0.550$ and $b_{profexp}=0.019$; $OR=1.019$; $p=0.513$ respectively).

The results of estimates for parameters described on the Table 5.26 also show that the ratio of chance of shifting from category one (neutral) to category two (I disagree) is of 1.017, and from

neutral to category three (I agree) is of 1.019. The chances are that a one year growing of teaching experience leads to an increase of 1.7% ($100 \times 1.017 - 1 = 1.7$) from category neutral to agree and increase of 1.9% ($100 \times 1.019 - 1 = 1.9$) from category one (neutral)s to category three (I agree)

As for type of training, it is possible to note that for basic level there is no significant effect of the independent variable on the occurrence of category agree ($b_{ttrainin2=1} = -0.717$; $OR = 0.488$; $p = 0.619$) and disagree ($b_{ttrainin2=1} = -1.192$; $OR = 0.304$; $p = 0.413$), while for middle training, the effect is not significant on the occurrence of category agree ($b_{ttrainin2=2} = -1.638$; $OR = 0.194$; $p = 0.122$) but it shows marginal significant differences on the occurrence of category disagree ($b_{ttrainin2=2} = -1.881$; $OR = 0.152$; $p = 0.077$), suggesting that those trained at middle level have a greater probability of disagreeing with the statement that “asking direct questions” is related to learner-centred teaching.

The ratio of chance of shifting from category one (neutral) to category two (I agree) for basic level is of 0.448, while for the middle level it is 0.194. These values correspond to a decrease of 55.2% ($100 \times (0.448 - 1) = -55.2$) and 80.6% ($100 \times (0.194 - 1) = -80.6$) respectively for basic and middle level of probability of occurrence of the referred categories of dependent variables.

The ratio of chance of shifting from category one (neutral), to category three (agree) for basic and middle levels is respectively 0.304 and 0.152. That means that for basic level there is a decrease of 69.6% ($100 \times (0.304 - 1) = -69.6$) and 84.8% ($100 \times (0.152 - 1) = -84.8$).

Table 5.33 Results of parameter estimates for variables professional experience, type of training and dependent variable for question nine.

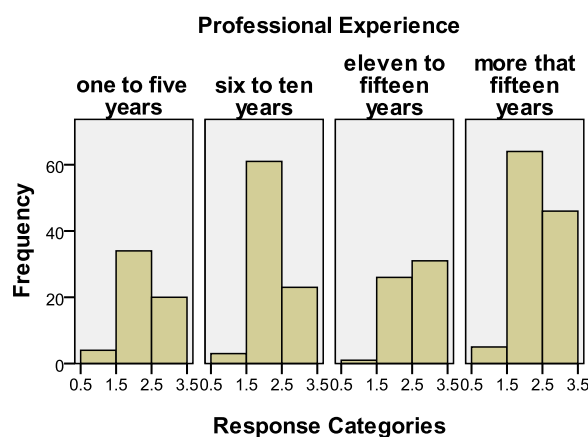
Parameter Estimates

A teacher asks direct questions ^a		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Agree	Intercept	3.673	1.070	11.782	1	.001			
	Professional experience	.017	.029	.357	1	.550	1.017	.961	1.077
	[ttrainin2=1]	-.717	1.441	.247	1	.619	.488	.029	8.224
	(Type of [ttrainin2=2] training)	-1.638	1.059	2.391	1	.122	.194	.024	1.550
	[ttrainin2=3]	0 ^b	.	.	0	.	.	.	.
Disagree	Intercept	3.419	1.075	10.111	1	.001			
	Professional experience	.019	.029	.427	1	.513	1.019	.962	1.080
	(Type of [ttrainin2=1] training)	-1.192	1.456	.670	1	.413	.304	.017	5.270
	[ttrainin2=2]	-1.881	1.064	3.124	1	.077	.152	.019	1.227
	[ttrainin2=3]	0 ^b	.	.	0	.	.	.	.

a. The reference category is: Neutral.

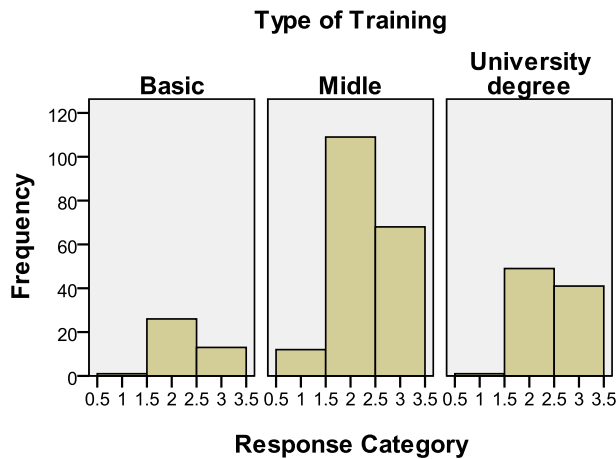
b. This parameter is set to zero because it is redundant.

Looking at the results of variable teaching experience on graph 5.18, we can conclude that those with more than fifteen years of experience, their responses fall also in to category two (I disagree), then followed by category three (I agree). Those with teaching experience ranging from six to ten years, their responses also fall into category one and three. These results are similar to those with one to five years of teaching experience. However, those with experience that ranges from eleven to fifteen years, their responses tend to fall into category three, and then category one.



Graph 5.18: Frequencies of responses in terms of teaching experience, dependent variable for question nine

The results of Graph 5.19 show that for those with basic training, there are more frequencies on category two (I disagree), and then followed by category three (I agree), while for those with university degrees, the responses fall also into category two and three. For basic level, the responses fall mostly into category two (I disagree).



Graph 5.19 Frequencies of responses in terms of type of training and dependent variable for question nine.

5.7.10 QUESTION TEN (teacher ask learners to solve various mathematical exercises)

The effect of independent variable type of training on dependent variable (teacher ask learners to solve various mathematical exercises) was subject to analysis. The variable professional experience (Profexp) was selected as covariate, while type of training was kept as factor. The analysis was performed using a link logit and Negative Log-Log functions.

As shown in the Table 5.34 the Final model in Logit function ($G^2(3) = 3.054$; $p=0.383$) seems to be better than the Negative Log-Log ($G^2(3) = 2.482$; $p=0.479$) function, and both are not significant at $p \leq 0.05$. This suggests that none of the independent variables (teachers' professional experience and type of training) of the model influence significantly the occurrence of categories (I completely agree, I agree, neutral, I disagree, I completely disagree) of the dependent variable.

Table 5.34 Model fitting information for Logit and Negative Log-Log link functions for question ten

Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Intercept Only	385.450			
	Final	382.396	3.054	3	.383
Negative Log-Log	Intercept Only	385.450			
	Final	382.968	2.482	3	.479

The Goodness-of-fit test show that the Person's ($\chi^2(321) = 289.393; p = 0.897$) and Deviance tests ($D(321) = 227.585; p = 1.000$) are not significant at $p \leq 0.05$. These results suggests that the *Null Hypothesis* (H_0) is not rejected, and therefore conclude that the model fits to current data. The Pseudo R-squared show moderate and low values for all statistics, especially for Mcfadden pseudo- R^2 ($R^2_{MF} = 0.004$; $R^2_N = 0.011$; $R^2_{CS} = 0.010$).

With the results of the test of parallel lines (see table 5.28) for the Logit function ($\chi^2(9) = 2.550; p = 0.980$), we found that the *Ho(Null hypothesis)* is not rejected, and therefore conclude that the slope coefficients are the same across all categories of dependent variable. However, we have to stress that this results must be interpreted with caution since the validity of the test is not guaranteed.

Table 5.35 Test of Parallel Lines for Logit and Negative Log-Log link functions for question ten

Link Function	Model	-2 Log likelihood	Chi-Square	df	Significance
Logit	Null Hypothesis	382.396			
	General	379.846 ^a	2.550 ^b	9	.980
Negative Log-Log	Null Hypothesis	382.968			
	General	379.685 ^a	3.283 ^b	9	.952

The results from parameter estimates shown in the table indicate that the probability to observe a high level category of responses (disagreement), relative to low level (agreement), increases by only -0.014, and that this increment is not sufficiently enough to become significant at $p \leq 0.05$ ($b_{profexp} = -0.014$; $X^2(Wald)(1) = 1.766$; $p = 0.184$). Concerning the variable type of training, the results show that there is probability of observing categories of higher order (disagreement), whether in basic ($b_B = .376$; $X^2(Wald)(1) = 1.043$; $p = 0.307$) or middle ($b_M = .282$; $X^2(Wald)(1) = 1.336$; $p = 0.248$), showing that as the training increases, teachers would tend to disagree with the statement that when teachers ask learner to solve various mathematics problems it is related to learner-centred teaching. None of the results have show significance on the effect of independent variable over dependent variable.

Table 5.36 Results of parameter estimates for variables professional experience, type of training and dependent variable for question ten

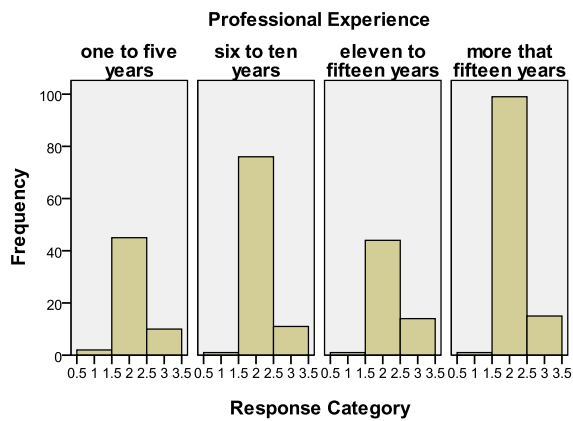
Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold (Question levels)	[vriosemt = 1]	-.668	.249	7.198	1	.007	-1.156	-.180
	[vriosemt = 2]	1.594	.265	36.141	1	.000	1.074	2.113
	[vriosemt = 3]	1.711	.269	40.596	1	.000	1.185	2.237
	[vriosemt = 4]	3.343	.377	78.443	1	.000	2.603	4.083
Location (Type of training)	Professional experience	-.014	.011	1.766	1	.184	-.035	.007
	[ttrainin2=1]	.376	.368	1.043	1	.307	-.345	1.097
	[ttrainin2=2]	.282	.244	1.336	1	.248	-.196	.761
	[ttrainin2=3]	0 ^a	.	.	0	.	.	.

Link function: Logit.

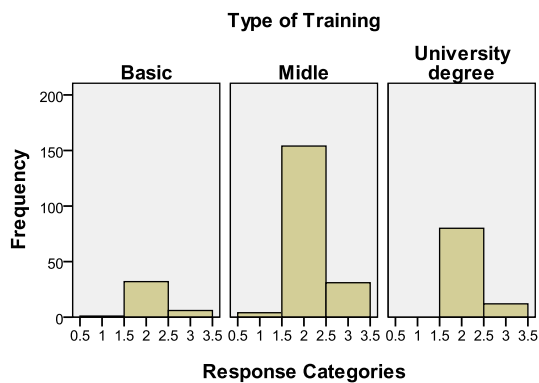
a. This parameter is set to zero because it is redundant.

The results on Graph 5.20 show that in terms of teaching experience, the frequencies of responses fall mostly into category two (I disagree) for those with more than fifteen years of teaching experience. We can also note that there are more frequencies falling into category two (I disagree) for sixteen to ten years, as well as for one to five, and six to ten years of experience.



Graph 5.20 Frequencies of responses in terms of teaching experience and dependent variable for question ten.

In terms of type of training, it is possible to note that there are more frequencies falling into category two (I disagree) for those with basic and middle training, and then followed for those with university degrees.



Graph 5.21 Frequencies of responses in terms of teaching experience and dependent variable for question ten.

5.7.11 QUESTION ELEVEN (which type of approach do you apply more)

As for question eleven, the following hypotheses were stated:

- There will be a relationship between teachers' professional experience and their approach to teaching mathematics.
- There will be a relationship between teachers' background training and their approach to teaching mathematics

The dependent variable was initially set into four categories (1-learner-centred approach; 2-teacher-centred approach; 3-both (learner and teacher-centred), and 4-none). Due to the fact that the categories two and four produced low observed frequencies, they were recoded. Thus, the dependent variable have in the last two categories (1-Learner-centred approach; 2-Both teacher and learner-centred).

With this analysis, we sought to test whether the independent variable type of training, as well as professional experience, are independent of the approach teachers use in classroom mathematics. Firstly, we sought to verify whether the type of training (basic, Middle and University degree) and the type of approach teachers practice in classroom mathematics (learner-centred, learner and teacher-centred) were independent to each other. A Chi-square (χ^2) test of independence was used to test whether the observed values (count) differ significantly from expected values at $p \leq 0.05$.

As can be seen in the Table 5.37, the observed and expected values are quite similar. The highest discrepancy is for basic (learner-centred 20 actual count, and 18.5 expected count) and middle (learner-centred 46 actual count, 44.2 expected count; teacher and learner-centred 99 actual count, 95.7 expected count). Looking at observed and expected count, we can conclude that the type of training teachers have received, and the approach they practiced in classroom

mathematics, are independent of each other. This is confirmed by the low Chi-squared value ($\chi^2(2) = 0.634, p = 0.728$).

Table 5.37 Count and expected count for variables type of training and type of approach for question eleven

Type of approach	Type of training				
		Basic	Middle	University degree	Total
Learner-Centred	Count	20	87	46	153
	Expected count	18.5	90.3	44.2	153.0
Teacher and learner-centred	Count	18	99	45	162
	Expected count	19.5	95.7	46.8	162.0
Total	Count	38	186	91	315
	Expected count	38.0	186.0	91.0	315.0

The Table 5.38 shows the results of count and expected count from variable professional experience and the type of approach teachers use more. As can be seen, there are many similarities between the observed and expected values. The greatest discrepancy is with teachers with more than eleven to fifteen years of teaching (learner-centred, 59 count, 56.3 expected count), and those with eleven to fifteen years (learner-centred, 23 count, 27.2 expected count, learner and teacher-centred, 33 count, 28.8 expected count). The value of Chi-squared is also low ($\chi^2(3) = 1.648, p = 0.648$), and therefore not significant at $p \leq 0.05$.

Table 5.38 Count and expected count for variables professional experience and type of approach for question eleven

Type of approach	Professional Experience					Total
		one to five	six to ten	eleven to fifteen	more than fifteen	
Learner-Centred	Count	26	44	23	59	152
	Expected count	26.2	42.2	27.2	56.3	152.0
Teacher and learner- centred	Count	28	43	33	57	161
	Expected count	27.8	44.8	28.8	59.7	161.0
Total	Count	54	87	56	116	313
	Expected count	54.0	87.0	56.0	116.0	313.0

These results suggest that teachers' professional experience and the type of approach teachers practice in classroom mathematics are independent of each other. In other words, this shows that teaching experience is not related to the type of approach teachers practice in the classroom teaching mathematics.

Table 5.39 Summary of results of teachers' perceptions of learner-centred approach by type of training

No.	Independent variable	Dependent variable	Accounted Ho	Significance level ($p \leq 0.05$)		
				Basic	Middle	University degree
1	Type of training	Teacher takes into account learners' previous knowledge	H0=Teachers' background training is not related to perceptions of learner centred teaching in classroom mathematics.	0.811	0.126	.
2		A teacher asks learners to solve exercises on the board		0.346	0.784	.
3		A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena		0.347	0.132	.
4		A Teacher asks learners to solve various mathematical exercises		0.307	0.248	.
5		A teacher asks learners different type of questions		0.866	0.478	.

Table 5.40 Summary of results of teachers' perceptions of learner centred approach by professional experience

No.	Independent variable	Dependent variable	Accounted Ho	Significance level ($p \leq 0.05$)
1	Professional Experience	Teacher takes into account learners' previous knowledge	H0= Teachers' professional experience is not related to perceptions of learner-centred teaching.	0.058
2		A teacher asks learners to solve exercises on the board		0.275
3		A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena		0.298
4		A Teacher asks learners to solve various mathematical exercises		0.184
5		A teacher asks learners different types of questions		0.754

Table 5.41 Summary of results of teachers' perceptions of teacher-centred approach by type of training

No.	Independent variable	Dependent variable	Accounted Ho	Significance level ($p \leq 0.05$)		
				Basic	Middle	University degree
1	Type of	A teacher asks general questions during	H0=Teachers' background training is not related to	0.010	0.000	.

	training	lessons	perceptions of learner-centred teaching in classroom mathematics.			
2		A teacher explains mathematic contents during lesson and solves mathematical exercises		0.065	0.001	.
3		A teacher always asks specific questions to his or her students		0.164	0.282	.
4		A teacher asks direct questions		0.413	0.077	.
5		A teacher explains mathematical content		0.853	0.538	.

5.42 Table 5.42 Summary of results of teachers' perceptions of teacher-centred approach by professional experience

No.	Independent variable	Dependent variable	Accounted Ho	Significance level ($p \leq 0.05$)
1	Professional Experience	A teacher asks general questions during lessons	H0= Teachers' professional experience is not related to perceptions of learner-centred teaching.	0.603
2		A teacher explains mathematic contents during lesson and solves mathematical exercises		0.024

3		A teacher always asks specific questions to his or her students		0.088
4		A teacher asks direct questions		0.513
5		A teacher explains mathematical content		0.357

Table 5.43 Summary of results of teachers' teaching approach by type of training and professional experience

Independent variable	Dependent variable	Accounted Ho	Significance ($p \leq 0.05$)
Type of training	Type of approach	H0= Teachers' background training is not related to teachers' teaching approach.	0.728
Professional experience	Type of approach	H0= Teachers' professional experience is not related to teachers' teaching approach	0.648

5.8 HOW TEACHERS USE LEARNER-CENTRED TEACHING IN CLASSROOM MATHEMATICS?

5.8.1 CLASSROOM OBSERVATIONS

At this level, we sought to verify the frequencies of practices of learner-centred events in classroom mathematics by teachers. To achieve that aim, an observation schedule was used to mark the events of observed classroom activities. The schedule was composed of six dimensions that reflected learner-centred activities. The dimensions were: 1) communication, 2) questioning, previous experience link, 4) real life experience link, 5) other subject Areas Link, and 6) Previous Math knowledge link.

5.8.2 Communication

The aim of this dimension was to verify whether communication between teacher and learner is conducted during mathematics lessons, or teachers allow communication among learners themselves (such as group activities and discussion). The communication dimension involved homework correction activities (homework activities that have been assigned in the previous lessons), exercises with learners' book, and exercises on the board (learners solve exercises using chalkboard) or other activities. In all these activities, we verified whether teacher communicate with learners or allow learners to communicate among each other.

5.8.3 Questioning

In this dimension, the observer sought to verify whether during lessons teachers attend to questions that enhance learners' higher order mathematical thinking by asking learners such

questions as “why”, “how” or “explain/describe”, and allowing learners to ask such questions among themselves.

5.8.4 Previous experience link

Here we verified whether, during lessons, teachers seek to link current mathematic content with previous experience.

5.8.5 Real life experience link

At this stage, we sought to verify whether teachers bring into classroom mathematics’ examples depicted from learners’ real life.

5.8.6 Other subject areas link

The aim here was to verify to which extent actual mathematical knowledge connects with knowledge from other disciplines to help clarifying mathematical procedures.

5.8.7 Previous math knowledge link

We sought to verify whether teachers use learners’ mathematical previous knowledge to introduce new content.

The events in each dimension were marked every three (3) minutes using the forward (/) slash, and the length of observation was of forty (40) minutes. Frequencies were then calculated for each event.

The observations took place in five different primary schools of Maputo city, namely 16 de Junho Primary School, 3 de Fevereiro Primary School, 7 de Setembro Primary School, Filipe Samuel Magaia Primary School, and A Luta Continua Primary School. The observation involved thirty seven (37) teachers and ranged from grade one (1) to seven (7). Some classes were in the afternoon, while others were in the morning. The lessons involved the following mathematical content: division, multiplication and decimal numbers, addition and subtraction, numerical expression, geometry, and the calendar,

5.9 THE RESULTS

The results shown in Table 5.30 suggest that during lessons in the mathematics' classroom, teachers mostly communicate with their learners when they assign tasks that have to be solved in their exercise books (Mean=8.43). After every learner finishes his or her assignment, she or he has to show it to the teacher so that she or he can correct the exercise. This teaching strategy frequently overcrowds the teachers' space and it becomes difficult to control other learners activities, who mostly at this time, have practically no activity to occupy them whatsoever when correction of each learner exercise book is taking place.

Table 5.44 Time spent for classroom activities and direction of communication

Classroom activities	Direction of communication	Mean
Communication homework	teacher-learner	2.58
Communication exercise book	teacher-learner	8.43
Communication exercise book learner-teacher	learner-teacher	3.03
Communication exercise book	learner works individually	9.92
Communication on chalkboard	teacher-learner	3.81
Communication on chalkboard	learner-teacher	2.14
Communication on chalkboard	learner works individually	2.76
Communication other	teacher-learner	2.19
Communication other	working individually	1.24
Questioning 'how'	teacher-learner	1.14
Explain/Describe	teacher learner	6.81
Previous mathematic	knowledge link	1.16

We also noted that learners spend more time mostly (Mean=9.92) working individually on assignment with their exercise books. At this time, the teacher could walk around the classroom, only to prevent learners playing during lesson. The results also show that some teachers spend more time (Mean=6,81) asking learners to describe or explain a given problem's content or

procedure. This strategy enhances learners' ability to think and follow mathematics procedures in problem solving and it is a good way of evaluating learners' mathematics abilities.

During the observation, we also noted that the type of communication that usually takes place in classroom mathematics is mostly from teacher to learner. There were very few cases where learners were prompted to ask questions of teachers or among themselves, when for instance the explanation is not so clear for them. When teachers asked questions, the learners would all raise their hands, showing readiness to answer. However, taking into account that questioning such as 'why' and 'how' helps learner to develop their high order thinking. Almost all teacher did not practice this strategy (Mean=1.14).

Sometimes teachers would communicate with students (teacher-learner, Mean=3.81) through chalkboard mathematics exercises, or allow a bit of dialogue between learner and teacher (learner-teacher, Mean=2.14), but most of the times learners would be asked to individually solve problems using the chalkboard, with no dialogue between teacher and learner or among learners. In this case, after each learner finishes solving a given problem, the teacher would ask the whole class if the answer was or not correct. Whether it was correct or not, the learner would be asked to take his or her seat, and replaced by another one to give a correct answer or initiate another exercise.

Apart from communication dimension activities and questioning, others such as "previous mathematics knowledge link (Mean=1.16), "real life link (Mean=.64), other subjects link (Mean=.00), and previous experience knowledge (Mean=.58) suggest that teachers during lessons do not connect mathematics content with other important aspects that help learners acquire mathematics knowledge.

During observations, we note that many learner-centred items such as questioning, communication, previous experience link, real life link, other subjects' areas link, and previous

mathematics knowledge could not be attained during teaching, except that in some instances when teachers could attempt asking questions of students during lessons. In respect to communication, we observed that it was only one sided (teacher-learner) through corrections of exercise books, and that learners were not prompted to initiate communication with the teacher, or among each other through, for example, group work. This situation may have to do with the fact that teachers did not have knowledge about what strategies were to be used in order to encourage learners be interested in learning mathematics' contents.

Although it is known that to develop cognitive and metacognitive process in learners is a complex process, when a learning is carefully planned as to which strategies are to be used and appropriate monitoring of learning process is taken (McGilly, 1998:5), as well as the use of collaborative methods such as group work (Chelmers & Nason, 2005), cognitive and methacognitive processes are enhanced. On the other hand, reinforcing teacher-learner, learner-teacher, and learner-learner communication is also an effective way of developing cognitive and methacognitive processes. When a learner is prompted to talk and exchange views with others asking questions such as "why" "explain" or "describe", he or she is forced to find an answer to those questions, and thereby develop his or her cognitive and metacognitive processes.

The fact that teachers are not willing to embark in teaching approaches, that favour a development of learners cognitive skills in mathematics, may be related to teachers lack of knowledge as to which strategy is appropriate for learners to learn effectively, so they favour a teacher-centred approach. Probably, they are replicating the same way they have learning during training as teachers, and therefore they consider the teacher-centred approach as effective for teaching mathematics. Richardson (2003) argues that the beliefs teachers bring into their education programmes are related with way they have experienced, thus they may think that the role of teachers is to place knowledge into students' heads.

Nonetheless, it should be recognised that shifting from one teaching approach to another is an intricate process since it requires a deeper knowledge and understanding of learner-centered teaching methods, as well as the ability to design contextualised teaching strategies that help

learners to master mathematical content. Blumberg (2009) argues that what make teachers resist applying new teaching approaches is that the curriculum is overloaded with contents, and they have to teach all of them within a time frame. However, in our view it seems that only changing the curriculum may not be sufficient to change teachers' view and practices towards learner-centered teaching. It also implies changing the whole education structure, focusing especially on empowering teachers with methods that focus on learners. In the context where teachers are being prepared in terms of new teaching methods, it seems that the results are encouraging Breen (2005). However, teacher training should also focus on helping teachers to implement new practices, and on the other hand, teachers should feel themselves committed, motivated and dedicated so that new teaching practices can replace old ones.

5.9 SUMMARY

Chapter 5 was concerned with analysis of data obtained from a questionnaire and classroom observations. The following chapter (chapter 6) will discuss the implication of the findings concerning the learner-centred approach to mathematics.

CHAPTER SIX

6.0 DISCUSSION OF THE FINDINGS

6.1 INTRODUCTION

In this chapter, we sought to determine whether objectives of this study have been met. The aims and research questions will also be evaluated against existing theory. The research questions were stated as follow:

- i. Does teachers' background training contribute to the perception of learner – centred approach in the discipline of mathematics?
- ii. Does teachers' professional experience contribute to the perception of learner- centred teaching in the discipline of mathematics?
- iii. Is there any relationship between teachers' training and their teaching approach in mathematics' classroom?
- iv. Is there any relationship between teachers' professional experience and their teaching approach in mathematics
- v. Do teachers use learner-centred approach in the classroom?

6.2 FINDINGS WITH RESPECT TO THE CONTRIBUTION OF BACKGROUND TRAINING TO THE PERCEPTION OF LEARNER-CENTRED APPROACH IN THE DISCIPLINE OF MATHEMATICS

The findings on the relationship between teachers' background training and perception of learner-centred teaching in the discipline of mathematics are divided in to two aspects:

- i. Statements that are related to learner-centred teaching, and
- ii. Statements related to teacher-centred teaching.

The statement related to learner-centred teaching are:

- i. A teacher takes into account learners' previous knowledge;
- ii. A teacher asks learners to solve exercises on the board;
- iii. A teacher asks questions that require learners to explain and describe the sequence of mathematical phenomena;
- iv. A teacher asks learners to solve various mathematical exercises, and
- v. A teacher asks learners different type of questions.

The statements related to teacher-centred teaching are

- i. A teacher asks general questions during lessons;
- ii. A teacher explains mathematic contents during lessons, and solves mathematical exercises;
- iii. A teacher always asks specific questions to his or her students;
- iv. A teacher asks direct questions, and
- v. A teacher explains the content.

6.3 RELATIONSHIP BETWEEN TEACHERS' BACKGROUND TRAINING AND PERCEPTIONS OF LEARNER-CENTRED TEACHING

The influence of type of training over teachers' perceptions of learner-centred teaching seems to vary among all who participated in this research. Although in some statements, teachers' perception is influenced by variables type of training, and teachers' background experience in teaching, many results show that those variables have little influence on the way teachers perceive those statements. We expected that as teachers get more training, the greater would be their difference on the perception of learner and teacher-centred teaching.

For instance, when teachers were asked to respond whether “asking general questions” in the mathematics' classroom the mathematics' teacher would be practicing learner-centred teaching, it was found that in this case teachers' perceptions are significantly influenced by type of training, but not by their teacher background training. The probability of agreeing with this statement is much higher among teachers who have basic and middle training, while those with university degree would tend to disagree or strongly disagree. That means that teachers perceive this statement differently as their level of training in teaching methods gets higher. Although differences are found to be significant, the probability of observing high level category (I strongly disagree), under influence of type of training, is not higher since among teachers with university degree, and there are some who disagree with the statement.

As for other teacher-centred statements, such as “ teacher asks specific questions of his or her students”, “ teacher explains mathematical contents during lessons and solves exercises”, “ teacher explains mathematical content” and “teacher asks direct questions”, the results show basically that teachers' views do not change significantly, due to variable type of training. Teachers with basic and middle training would tend to consider the statements above as reflecting learner-centred teaching, while those who are trained at university level have mixed perceptions. On one hand, some teachers disagree, and others agree with the fact that those

statements reflect learner-centred teaching activities when mathematical teachers use them in the classroom.

The results also shows that teachers' perceptions of those statements related to learner-centred teaching are not affected by variable type of training teachers have received. Mostly teachers to some extent would tend to agree and disagree with some statement.

Although in some statements, the differences of the perceptions, due to type of training, seem to be significant, the probability of teachers shifting from category agreement to disagreement, or vice versa, is hardly anything. The fact that the results show little influence of type of training on teachers' perceptions of learner-centred teaching may cause to think about whether during teachers' preparation emphasis on learner-centred activities is given necessary attention. The findings in this research, seems that in basic education, teachers' perceptions on learner-centred teaching are not accounted for by the training level they posses in teaching methods.

The findings from this present study seem to be consistent with findings from Avcu and Avcu (2010: 1285-1286). Avcu and Avcu (2010: 1285-1286) found that teachers' ability to use different strategies to solve mathematics problems is somewhat narrow, and most of them could not solve the problems correctly, and their low achievement could be acting as a barrier for pre-service mathematics' teachers to use different strategies to solve mathematic problems.

The findings from this present study seems to contradict with quantitative studies conducted by Adnan and Zakaria (2010:154-155), Adnan, Zakaria and Maati (2012: 1715-1719), Waldeana and Abraham (2013), Wilkins and Brand (2004:228-232), and Hacıomeroglu (2013:4-7). These studies have shown that, through training, teachers can change their beliefs or perceptions, moving from teacher-centred teaching to teacher learner-centred. For instance, Adnan et al., (2012:1715-1719) have found a relationship between training and beliefs on learner-centred

teaching. The study concluded that mathematical beliefs of pre-service teachers were positive, and teachers were inclined to constructivism beliefs.

Contradictory findings between this present study and other studies, with respect to relationship between teachers background training and their beliefs towards learner-centred teaching, were also reported in the study of Adnan and Zakaria (2010:154-155). In their study, they reported a higher percentage of agreement with the following statements: “Mathematical reasoning involve in solving problems”, “Mathematics can be used in everyday life”, "In mathematics, students need to understand all the concepts, principles and strategies of solving in mathematics", "In mathematics, students should be trained in the procedures before the calculation is given in the form of mathematical problem solving", "In learning mathematics, students should be able to give reasons to support each solve mathematical problems”, and “In mathematics students need frequent practice.” Waldeana and Abraham (2013) also found that, although related to knowing mathematics, in the beginning of the programme, teachers seemed to be inclined to traditional beliefs, at the end of the programme, there was a significant shift in the direction to progressive beliefs.

Although contradictory findings are reported between the present study, and the others reported above, about the relationship between background training and teachers’ perceptions or beliefs of learner-centred approach, a quantitative study conducted by Haciomeroglu (2013:4-7) has found significant differences between third and fourth year students, concerning the belief about how students construct their knowledge, and about the belief how students develop mathematical knowledge. The study did find significant differences between third year and fourth year pre-service teachers, in relation to beliefs about teaching mathematical concepts, and in relation to beliefs about the organisation of teaching. However, fourth year, pre-service teachers showed stronger mathematical beliefs when compared with their counterparts from third year.

West and Rosas (2011) also found that teachers from private and public universities neither agreed nor disagreed with the statement which aimed at measuring teachers’ beliefs on the

integration of mathematical topics in the instruction. Both private teachers from public and private sectors rated lower to the statement, “In my mathematics lessons, I aim for in-depth study of selected topics, even if it means sacrificing comprehensive coverage.”

Qualitative studies from Evans, Leonard, Krier and Ryan (2013:83-89), and Mosvold and Fauskenjer, (2013:51-56), seems to corroborate with our findings. For instance, Evans et al., (2013:83-89) findings show that in respect to teachers’ mastery using videos to tell mathematics history and mastery experience, some teachers were able to change their beliefs about best practices for mathematics, however a constant reinforcement of beliefs to turn these practices sustainable is very important. Mosvold and Fauskenjer (2013:51-56) report that in relation to definitions, interviewed teachers showed a belief that knowing definitions is an important aspects of teachers’ knowledge which shows that it is teachers’ beliefs that prior to anything teachers must know concepts. In terms of remembering definitions, teachers showed their disagreement that remembering actual definitions, as well as knowing the formula, is not important for teachers’ knowledge of mathematics.

In the light of these results, it is important to note that beliefs on the teacher-centred teaching statements may have different interpretations among teachers. We can assume that the level of training teacher possess is due to change teachers beliefs, but due to other kind of beliefs teachers may possess, they may find those statements not related to learner-centred teaching. That means that, perception of learner-centred teaching may not simply be affected by training. There are some other factors that can interfere with teachers’ perception of learner-centred teaching. Those factors may be related to school background, as well as classroom settings (OECD, 2009:90). On the other hand, we do believe that training can provoke changes in some one’s belief, but is important to note that prior to training, teacher acquired a set of beliefs towards how a certain approach should be applied. This situation may act as a barrier in acquiring new beliefs.

Results from the present research show mostly that teachers' perceptions of teaching approach is almost the same in almost all levels of type of training. This might be a clear warning that programme contents in teacher training institutions at all level may focus on the same content or emphasising teacher-centred teaching. In training teachers, the programme should focus in those aspects that help teachers to understand and organise mathematics classroom activities in such that teachers may apply to foster learning.

6.4 RELATIONSHIP BETWEEN TEACHERS' BACKGROUND TEACHING EXPERIENCE AND PERCEPTIONS OF LEARNER-CENTRED TEACHING

Concerning whether teachers' background experience in teaching would influence perceptions between teacher and learner-centred statement, we found that two statements, one related to teacher-centred teaching ("teacher explain mathematics concepts during lessons and solve exercises") and another to learner-centred teaching ("teacher takes into account learners previous knowledge"), are significantly affected by teachers' teaching experience.

Teachers with teaching experience of up to ten years seem to have mixed perceptions concerning the statement that says that learner-centred teaching is when "teachers explain mathematics concepts during lessons and solve exercises". Some tend to completely disagree and others to agree with this statement. Those with eleven and more years of experience in teaching tend to completely disagree. The perceptions of the statement that learner-centred teaching is when "teachers takes into account learners' previous knowledge" is also affected by teachers' teaching experience. Teachers with teaching experience of above six years would tend to completely agree. Other statements, whether related to learner or teacher-centred teaching, did not seem to be affected by teacher teaching experience.

In general, in this study, we found that teachers' perceptions of learner-centred teaching was not affected by teachers' teaching experience except in statements "teacher takes into account

learners previous experience” and “teacher explain mathematics concepts during lessons and solve exercises.”

Although findings from this present study did not show a relationships between teaching experience and teachers’ perceptions of learner-centred teaching, the findings from Aslan (2013:227-228), Zepa, Kajander and Berneveld (2009:66-74), Sapkova (2011:7-15), Yimer (2009:103-112), and Jong and Hodges (2013:104-114) indicate that beliefs are built under experience. Aslan (2013:227-228) found that in-service teachers had higher scores than first and last grades, pre-service teachers. Last grade, pre-service teachers had higher scores than first grade, pre-service teachers in the Beliefs’ Survey. It was found that beliefs’ scores of in-service teachers were higher than those of pre-service teachers. Aslan (2013) argues that the high scores differences that favour in-service mathematics teachers may be due to experiences in teaching and in education. The influence of past experience on the perceptions of mathematics teaching was reported in the findings of Zepa, Kajander & Berneveld (2009:63-66). Zepa et.al.,(2009:63-66) report that the experience teachers brought from high school, as well as the level of conceptual and procedural knowledge that they got in the beginning of the course, appear to account for growth in their conceptual knowledge.

Beliefs about teaching using constructivism or traditional approaches were found to be related to experience in teaching urban or rural schools. Concerning teachers’ beliefs towards teaching approaches, there were significant differences between teachers from the countryside and teachers from urban areas (Sapkova, 2011:7-15). After actively participating in mathematics activities that involved mathematical problem solving using different strategies, in-service teachers have changed their beliefs about learning and teaching of mathematics and developed confidence that teaching is about discussing, justifying findings and solutions, sharing thoughts Yimer (2009:103-112). There was also a relationship between past schooling and pre-service teachers attitudes which indicated that linear relationships between attitudes towards mathematics, experiences in mathematics, and confidence in their ability to teach mathematics, were very strong Jong and Hodges (2013:104-114). In the case of this study, the results show

that type of training and teachers' teaching experience did not affect their perception of teacher or learner-centred teaching.

6.5 RELATIONSHIP BETWEEN TEACHERS' BACKGROUND TRAINING AND THEIR TEACHING APPROACH IN THE MATHEMATICS' CLASSROOM

Relationship between teachers' background training and the approach teachers use in the classroom was assessed in this study. Using the Chi-squared test of independence, we sought to find out whether teachers differ in terms of type of training and the approach they use in the classroom. This study has found no significant relationship between type of training and the approach teachers' use in the classroom. Most teachers said they use both learner and teacher-centred teaching when they are in the classroom. The failure of teachers to use the learner-centred approach was consistent with the study of Turmuklu & Yesildere (2007:4-6). In their study, they have found that when teachers were asked which solutions they could use to remove students' difficulties, they tended to explain procedures or rules and did not instigate pupils to make a discovery of mathematics' contents by themselves. Sometimes they could use questioning.

These results are contrary to the findings of Flores, Patterson, Shippen, Hinton & Franklin (2010:3-4), Wilburne & Long (2010:4-5), Burton, Daane, & Giesen (2008:2-7), and Gencturk (2012). These studies have indicated that after teachers are submitted to intense to training, they are able to apply learner-centred teaching approaches. Significant and very high significant main effects for perceived mathematics in teaching (Flores, Patterson, Shippen, Hinton & Franklin (2010:3-4), or teachers with strong mathematics content, would also be more comfortable in teaching mathematics (Wilburne & Long 2010:5-11). Adnan, Zakaria and Maati (2012:1715-1719) also found a significant relationship between conceptual knowledge and mathematical experience, mathematical beliefs and mathematical experience. Burton, Daane, & Giesen (2008:2-7) also reported that after an intervention programme, teachers could improve their

teaching practices. Gencturk (2012:179) found that teachers report some changes towards more inquiry-based teaching as they gain more mathematical knowledge for teaching.

The results reported here suggest that teachers' background training does not necessarily guarantee that they would change their practices in the classroom. Teachers may prefer to maintain their older practice since they feel more confident to use them and, in their view, are more susceptible to produce more results in terms of students learning.

6.6 RELATIONSHIP BETWEEN TEACHERS' BACKGROUND PROFESSIONAL EXPERIENCE AND THEIR TEACHING APPROACH IN MATHEMATICS CLASSROOM

Similar to analysis of relationship between teachers' background training, and the approach teacher use in the classroom, the relationship between teachers' teaching experience and the approach they use in the classroom was assessed. With the use of Chi-squared test of independence, the results show no significant relationship between teacher teaching experience and the use of learner-centred approach in the classroom. This suggests that the number of years teachers have in teaching mathematics do not influence their decision to use learner-centred teaching.

These findings are consistent with findings by Hill, Rowan and Ball (2005). Hill et al., moderate found positive correlations between years of teaching experience with certification, methods and content courses. However, teachers' mathematical content knowledge for teaching was not significantly correlated with teacher preparation or experience at grade 1. Correlation was also small with teacher certification at Grade 3. According to the authors, there is no guarantee that teachers who take methods' coursework would be sufficiently strong to teach mathematics in the classroom. Contradicting findings were reported in the study of Obgonnaya (2007), and Supovitz and Turner (2000). Results from Obgonnaya (2007) indicate significant positive correlation between students' achievement and teachers' background variable, such as qualification, subject

major and teaching experience. Significant differences in mathematics achievement among students whose teachers had more than five years of experience were found, while among students whose teachers had more than ten years of teaching experience, no significant differences on mathematics achievement were found. Teaching experience above ten years does not affect students' achievement in mathematics.

Supovitz and Turner (2000) found that on average, teachers without professional development employed less inquiry-based practices than those taking professional development. However, the level of practices of those who have taken professional development varied. Teachers who took only 40 hours of professional development tended to use more traditional practices, while those with between 40 to 79 hours of professional development had about average teaching practices. Those with 80 hours above of professional development used inquiry-based teaching practices significantly. The results of these studies show how teachers can be built through years of teaching. As a teacher gains more experience in teaching, his or her knowledge of mathematics, as well as reform-based curricula confidence of using learner-centred teaching, also increase.

6.7 DO TEACHERS USE LEARNER-CENTRED APPROACH IN THE CLASSROOM?

To assess whether teachers' practices in the classroom were related to learner-centred teaching, teachers were subject to observation during mathematics' lessons. The observation focused mostly in interaction between teacher and learner, that is, whether teachers interacted with learners during mathematics lessons.

This research has found that the dimension subject to observation, namely communication, questioning, explaining/describing, previous experience link, real life experience, other subjects link, and previous mathematics knowledge, were rarely observed in classroom. Teachers spent more time working with learners individually more than talking with them to discuss about mathematics. Some teachers would tend to establish a controlled environment in the classroom,

while in other cases, teachers would let learners doing what they wanted. In any case, learners were stimulated to work together, communicate among themselves, and discuss about mathematics. In our view, this might be due to the fact that teachers have no confidence in how to connect learners to the environment that would prompt learners to develop their mathematics' skills.

This study, for instance, found that when teachers of different type of training and teaching were asked what approach they used more in the classroom when they teach mathematics, more than 98% of teacher responded that they used both teacher and learner-centred approach. Teachers may believe that teaching mathematics is complex, therefore using both approaches may help dealing with poor students in mathematics. On the other hand, it may show that teachers themselves have little confidence to use whether learner or teacher-centred approaches. Despite teachers' answers that they use both approaches, classroom observation found no evidence that teaching practices in classroom mathematics are related to learner-centred approach.

The findings in this research contradict with the findings from Stols, Kriek and Ogbonnaya (2008: 8-14) and Frid (2000). Stols et al., (2008: 8-14) found that most teachers assigned mathematics homework, used formal presentation to introduce mathematics content, used teacher-guided discussion, and engaged students in group work. The majority of teachers assigned homework in all, or almost all, of their mathematics' lessons. Students could spend from about one to three hours of homework every week. Frid (2000) found that pre-service teachers moved slightly from traditional views to more constructivist approach after they were submitted to a constructivism lessons on which they learned how to organise mathematics lessons using constructivism approach. Adnan & Zakaria (2010:154-155) found that teachers agree on the fact that "Teaching mathematics should involve the investigation and findings by the students themselves", "Mathematics should be taught as a set of concepts, skills, and the calculations", "In the teaching of mathematics, students should be encouraged to explain their mathematical ideas", and "Teachers should guide students who have difficulties in solving mathematical word problems".

The findings from the questionnaires in this research indicate that neither the level of training, nor professional experience, did affect teachers' perceptions on learner-centred approach. Teachers from different types of training (basic, middle, university degree) and different teaching experiences (one to five years, six to ten years, eleven to fifteen years, and more than fifteen years) did almost perceive in the same way the statements related to learner and teacher-centred approaches, showing that those variables do not have an effect on teachers' perceptions. While some statements were perceived as learner-centred, in others they had mixed perception. In some they would agree in part that those statements are related to learner-centred, while in others they would disagree. These results suggest that, in some cases, teachers are able to distinguish learner-centred from teacher-centred practices, but in other cases, they have mixed perceptions or simply do not agree.

When teachers were asked about the approach they practice more in classroom mathematics, they said that they use both learner and teacher-centred teaching. Not surprisingly, these results may reflect their mixed perceptions of learner and teacher-centred approaches, as well as a lack of confidence as to what approach they should use to enhance learners' learning in the mathematics' classroom. Teachers seem to hold the beliefs that teacher-centred teaching is more effective in classroom mathematics. This attitude may be impelled by prior beliefs teachers hold about teaching and learning of mathematics. Brain (2002) argues that a combination of guided and discovery learning (teacher and learner-centred teaching), especially with older students, could be beneficial since it permits quick learning and retention to occur. In our view, Brain's argument can only be applicable in the situation where teachers are well prepared in learner-centred methodology and they are aware of the advantages and disadvantages of each approach. As for the teachers in this research, it seems that they apply both approach for any teaching circumstances.

Although teachers seem to be aware of importance of learner-centred teaching in classroom mathematics, they lack appropriate methodology to practice it. The results of observations on the other side seem to corroborate with findings from the questionnaire since it shows that teachers

were not able to organise teaching activities that are related to learner-centred approach, or to combine guided and discovery learning. Indeed, there is a distance between beliefs and practices in the classroom.

What is important is to understand the culture of teaching mathematics, and what are the values emphasised (Sutherland, 2007). That means that it depends on what mathematics in certain culture or environment means, and what a certain curriculum recommends to be done in teaching. In some it might mean memorisation of rules, formula, or procedures, while in others, mathematics could mean challenging activities, sharing thoughts, and promoting confidence in learners. In the first case, teachers would be forced to use the teacher-centred approach to meet the challenge of the curriculum, while in the second case, teachers would use learner-centred approach.

Besides that, a teacher-centred environment allows teachers to control the process and to determine what steps could be taken next, while in learner-centred, teachers follow what learners are able to do. Following this perspective, teachers may focus on certain type of beliefs supported by objectives drawn in the curriculum or by what means mathematics for particular curriculum. In the case where teachers hold strong beliefs about teacher-centred teaching, they may resist moving from one teacher approach to another, unless appropriate measures are taken and such measures include training in teaching methods. Not only professional development of teachers is a key role for successfully learning, indeed there are unnumbered factors that can affect learners learning. Brain (2002) argues that factors related to teachers themselves, such as their teaching style, which can lead them to choose between programming or discovery learning (teacher-centred or student-centred), or different expectations and attitudes towards the student, which also can direct him to stereotyping, are due to influence learning. Other aspects, such as cognitive and metacognitive (McGilly, 1998; Sete, Tachibana, Umano and Ikeda, 2005), motivational and affective (McCombs & Miller, 2009; Mishan, 2005; Sansone & Harackiewicz, 2000; Hativa, 2000), developmental and social (Lacasa, Del Campo and Reina, 2001), and

individual differences (Jonassen & Grabowski, 2011; Berch, 1979; Gholson and Beilin, 1979; Kendler; 1979), are among other factors that influence learner-centred teaching.

6.8 SUMMARY

In this chapter, we compared the findings from this study, and results of various studies concerning the effect of type of training, of teachers' teaching experiences over their perception of learner-centred teaching. We also discussed the findings concerning the relationship between teachers' teaching experiences, as well as type of training and their practice of learner-centred teaching in the mathematics' classroom.

The influence of type of training over teachers' perceptions of learner and teacher-centred teaching seems to vary across the studies. While in some studies, type of training and teacher teaching experience influence teachers' teaching experience of learner-centred teaching, in other studies it seems that those variables have little influence. Although in the present study, in some statement', teachers' perception seem to be related with type of training and teachers' background experience in teaching, the relationship is not strong and could conclude that in general these variables are not related.

The results of the present study seem somehow to contradict with findings from other studies which show the type of training and teacher teaching experience influences the way teachers perceive how mathematics teaching should be conducted in the classroom. To understand deeply this phenomena, more studies over this issue should be addressed to measure the impact of different variables over teachers' perceptions of their own teaching. There is a need of more qualitative and quantitative investigation in Mozambique in order to find out whether teachers' teaching experience, or type of training, has an impact on teachers' beliefs to use different teaching strategies in the classroom to enhance learning.

CHAPTER SEVEN

7.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY

7.1.1 THE PROBLEM

This study was designed to ascertain teachers' perceptions of learner-centred teaching, as well as their practice in classroom mathematics at basic education level. The research questions formulated to achieve this aim were as follow:

- i. Does teachers' background training contribute to their perception of the learner-centred approach in the discipline of mathematics?
- ii. Does teachers' professional experience contribute to their perception of learner-centred teaching in the discipline of mathematics?
- iii. Is there any relationship between teachers' background training and their teaching approach in the mathematics classroom?
- iv. Is there any relationship between teachers' professional experience and their teaching approach in mathematics
- v. Do teachers use the learner-centred approach in the classroom?

7.1.2 THE AIMS OF THE STUDY

The aims that guided this study were:

- a) To determine the extent to which teachers' background training contributes to the perception of the learner-centred approach in the teaching of mathematics.
- b) To determine the extent to which teachers' professional experience contributes to the perception of the learner-centred approach in the teaching of mathematics.
- c) To determine the extent to which teachers' background training contributes to learner-centred practices in the teaching of mathematics.
- d) To determine the extent to which teachers professional experience contributes to practices of learner-centred approach in the teaching of mathematics.
- e) To conduct classrooms observation on the use of learner-centred approach.

7.1.3 THE HYPOTHESES

A. H0=Teachers' background training is not related to perceptions of the learner-centred teaching in classroom mathematics.

H1= There will be a relationship between teachers' background training and their perceptions of the learner-centred approach in the teaching of mathematics.

B. H0= Teachers' professional experience is not related to perceptions of learner-centred teaching.

H1= There will be relationship between teachers' professional experience and their perception of the learner-centred approach in the teaching of mathematics.

C. H0= Teachers' background training is not related to teachers' teaching approach.

H1= There will be a relationship between teachers' background training and their approach to teaching mathematics.

D. H_0 = Teachers' professional experience is not related to teachers' teaching approach.

H_1 = There will be a relationship between teachers' professional experience and their teaching practices.

E. How do teachers use learner-centred teaching in classroom mathematics?

7.1.4 METHODOLOGY

The instrument used to collect data about teachers' perceptions was a self constructed questionnaire which included biographic data and two types of questions: a) five questions that aimed at measuring teachers' responses towards learner-centred teaching, and b) five questions that aimed at measuring perceptions of teacher-centred teaching.

The initial version of the questionnaire was designed for a purpose of validity and applied to a sample of three hundred and nine teachers, depicted from twenty rural and urban schools from southern region of Mozambique namely, the provinces of Maputo, Gaza, and Inhambane. The responses from this questionnaire allowed checking the clarity of the questionnaire items. The validity of the questionnaire was checked through an exploratory factor analysis on which a principal components analysis was applied.

This process allowed checking the internal consistency of the questionnaire items. The items were found to be consistent and the questionnaire appropriate to the study. From these results, a final version of the questionnaire was produced and applied to 373 schoolteachers of basic education in Maputo province and Maputo city.

Since the dependent variable is qualitative, and the categories are ordinal, a categorical regression analysis with logit models for ordinal responses was found to be appropriate to test the hypotheses. This procedure was used where the required parameters for ordinal analysis were met. Otherwise, statistical procedures, such as multinomial categorical regression, were considered.

This type of analysis permitted us to calculate the probability of occurrence of a given category in the scale, which implied the definition of a model that best fits the data. To evaluate the model that best fit the data, tests such as qui-squared, the test of deviance and test of maximum likelihood were performed. In this study, the results are described comparing two models: the *logit* and *log-log negative*.

7.1.5 CONCLUSIONS

- (a) The probability of shifting from one category response (strongly disagree to strongly agree) to another, learner and teacher-centred statements, is not significant. Therefore, the type of training (basic, middle, university degree) teachers have received during their preparation for teaching mathematics in basic education could not account for teachers' perceptions of learner and teacher-centred approach. We conclude that teachers' level of response in almost all statements (learner and teacher-centred statements) do not vary due to the type of training each has received.
- (b) Teachers with teaching experience of up to ten years of teaching seem to have mixed perceptions concerning some statements. In some cases, the probability of shifting from the category strongly disagrees, to strongly agree, regarding statements related to learner and teacher-centred teaching, seems to be affected by teachers' teaching experience, and is therefore significant. These would lead to a conclusion that teachers' perceptions in those statements can be explained by number of years of experience in

teaching mathematics in basic education. However, in general teachers' teaching experiences seem to have no effect on the category responses (strongly disagree to strongly agree) since the majority of them did not show significant effect of teacher teaching experience on their perceptions of learner and teacher-centred teaching.

- (c) The study has concluded that teachers' professional experience, as well as the type of training teachers have received in teaching methods, did not affect the type of approach (learner or learner-centred approaches) teachers use in classroom mathematics. Teachers of basic education prefer to use both approaches when they teach mathematics.
- (d) The research has also concluded that teachers during mathematics lessons communicate less and they spend more time with few learners, while the majority of learners have no activities to do whatsoever during lessons.
- (e) Communication was unilateral, that is, it started always from teacher to students, not the opposite. Learners were not prompted to comment or ask questions neither of the teacher nor of themselves. Learners spent most of their time working on assignments in their exercise books, than working in groups or on the chalkboard. Teachers did not ask questions that required learners to describe and explain a given mathematical problem.

7.2 GENERALISATION

The questions raised in this study, with regard to basic education teachers' perceptions towards learner-centred approach in mathematics, were answered.

The sample used in this study was quite large and taken from two provinces of southern Mozambique. Thus, the results obtained can be generalised with a measure of confidence.

7.3 RECOMMENDATIONS

7.3.1 LEARNER-CENTRED APPROACH IN THE TEACHING OF MATHEMATICS: A CONSIDERATION OF TEACHERS' PERCEPTIONS.

7.3.1.1 This study was aimed at determining the extent to which background training in teaching methods and teachers' teaching experience contribute to perception of learner-centred teaching approach in the teaching of mathematics.

7.3.1.2 The findings obtained from this study lead to the recommendation that the curriculum at teacher training institutions must focus on methodologies that enhance the use of learner-centred teaching so that teachers can understand them and therefore change their perceptions

7.3.1.3 Practices during training should focus on the use of active methods in mathematics so that teachers may understand how to apply the in classroom practices.

7.3.2 LIMITATIONS OF THE STUDY

The limitations of this study are related to administration of research instruments namely questionnaire and observation schedule; the non return of some instruments; and the sampling covered.

- (a) To collect data from observation, we used an observation schedule which was applied by research assistants deployed in some school of Maputo city. Prior to data collection, they received training on how to use the instrument and received a chronometer each for time registration. This aspect required a lot of concentration from the observers so that they did not miss the sequence of data.

- (b) The administration of the questionnaire was planned accordingly and involved principals and vice-principals of schools. Respondents did not have direct contact with researcher. This fact created difficulties for the researcher to have some questionnaires returned. Thus, of 486 questionnaires, only 373 were returned. Direct contact with respondents would have made them more accountable.
- (c) In basic education, a greater majority of teachers are female which affected the characteristics of the sample. Due to the inequality of the sample size between male and female, the results could not be compared.

Although there were the limitations mentioned above, the results of this study can be applied to analyse current education problems in mathematics. The statistical procedures used in the study lead to significant interpretation.

7.3.3 AVENUES FOR FUTURE STUDIES

The future studies are indicated as follows:

- (a) More research should be done regarding teachers' mathematics beliefs to measure how teachers perceive their own knowledge of learner-centred approach and how they practice it.
- (b) The study focused only in schools from two provinces, namely Maputo City and Maputo Province. Future studies should allow comparisons among teachers from different provinces across the country.
- (c) The sample used in this study contained more female than male respondents. Future studies should focus on how male and female teachers perceive learner-centred teaching in mathematics.

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APENDIX A

QUESTIONNAIRE

The instrument used in the pilot study sample

Dear Teacher

The improvement of the quality of teaching depends a great deal on teacher's conscience or awareness to his or her daily work and on the way they assess their students. It also depends on the student's awareness and work.

This questionnaire (**QACN**) is aimed at gathering your opinion in relation to the learning process at large and, in particular, the learning process at your school. We are expected to contribute with results in order to improve the professional development of teachers and, consequently, improve the teaching-learning process.

The questionnaire is composed of 12 items; some of the items are just to be marked with an "X" in the square/box in front of each answer. The others need you to write your opinion, filling in the blank spaces. Answer carefully. Consider your answers before you mark or write your answer. If you make any mistakes in your choice, please just cross over what you marked or wrote and write again the answer you consider most convenient. If you are tired or a little bit confused about the answer to give, make a break in order to better reflect on your answer. What is important is to fill in the gaps according to what you feel and not just fill in for filling in.

YOUR COLLABORATION WILL BE APPRECIATED.

ALL THE BEST.

Please, answer the following questions, marking with an “X” in the box/square in front or below of the answer you consider appropriate. In addition, fill in the blank spaces with the most suitable answers for each question.

SECTION A

BIOGRAPHICAL DATA

1. Your age

2. SEX/GENDER	
1 -Male	2 –Female
<input type="text"/>	<input type="text"/>

3. Name of the district _____

4. How long have you been a teacher? (Indicate the number of years)

5. What are your academic qualifications?

1- Standard 7	2 – Standard 8	3 - Standard 9	4 - Standard 10	5- Standard 11	6- Standard 12	7 – University degree
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

6. Indicate the type of training you have received

1 6+1	2 6+2	3 7+3	4 9+2	5 9+3	6 10+1	7 10+2	8 Bachelor	9 Licentiate	10 Master	11 Other	12 None

7. Indicate the type of institution you were trained

1 Institute for Elementary Education <i>IEE</i>	2 Teacher Training Institute TTI	3 In Service Teacher training Institute ISTTI	4 Teacher training School TTS	5 Pedagogical Teacher training Institute PTTI	6 Pedagogic Influence Zone PIZ	7 People to People Danish Organization PPDO	8 Pedagogical University/ UP/	9 Eduard o Mondlane University UEM	10 Other	11 None

8. Others indicate _____

9. Indicate the number of years you taught

1- Teaching with certificate	2-Teaching without certificate

10. Have you ever learned about *learner-centred teaching* in mathematics?

1 -Yes ☐ 2 -No ☐

11. If yes, indicate where you learnt it

1 During my training	2 In my individual readings	3 In workshops	4 In conversations with colleagues and friends

SECTION B

12- To what extent do the following activities relate to the learner-centred approach?

(Mark with an X only one option)

12.1 A teacher asks general questions during lessons

1-I Strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.2 A teacher explains mathematical content during lessons and solves mathematical exercises

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.3 A teacher always asks specific questions of his or her students

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.4 A teacher takes into account learners' previous knowledge

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.4 A teacher asks direct questions

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.5 A teacher asks learner to solve exercises on the board

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.6 A teacher explains the content

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.7 A teacher asks questions that require learner to explain and describe the sequence of mathematical phenomena

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

12.8 A teacher asks learners to solve various mathematical exercises

1-I strongly Agree	2-I Agree	3-Neutral	4-Disagree	5-I strongly disagree

12.9 A teacher asks learners different type of questions

1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

13. Which of the following approaches (learner-centred approach, teacher-centred approach) do you practise more in your mathematics lessons?

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

3. I practise both

☐

4. I don't practise any of these two types of approaches

☐

14. Do you feel that the knowledge you have acquired during your training allow you to safely apply any of these types of teaching in the classroom?

14.1 I feel secure to apply

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

14.2 I apply the following teaching approaches with security

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

14.3 I still need to practise

1- Learner-centred approach

☐

2- Teacher-centred approach

☐

14.4 I don't have any knowledge to apply

1- Learner-centred approach

☐

2- Teacher-centred approach

☐

THE END

THANK YOU

APENDIX B

QUESTIONNAIRE

The instrument used in final study sample

Dear Teacher

The improvement of the quality of teaching depends a great deal on teacher's conscience or awareness to his or her daily work and on the way they assess their students. It also depends on the student's awareness and work.

This questionnaire (QACN) is aimed at gathering your opinion in relation to the learning process at large and, in particular, the learning process at your school. We are expected to contribute with results in order to improve the professional development of teachers and, consequently, improve the teaching-learning process.

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<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

6. Indicate the type of training you have received

1	2	3	4	5	6	7	8	9	10	11	12
6+1	6+2	7+3	9+2	9+3	10+1	10+2	bachelor	Licentiate	Master	Other	None

7. Indicate the type of institution you were trained

1	2	3	4	5	6	7	8	9	10	11
Institut e for Elemen tary Educati on <i>IEE</i>	Teac her Train ing Instit ute TTI	In Servi ce Teac her traini ng Instit ute ISTT I	Teac her traini ng Scho ol TTS	Pedagog ical Teacher training Institute PTTI	Pedago gic Influen ce Zone PIZ	People to People Danish Organiza tion PPDO	Pedagog ical Universi ty/ UP/	Eduard o Mondl ane Univer sity UEM	Oth er	No ne

8. Other indicate _____

9. Indicate the number of years you taught

1- Teaching with certificate	2-Teaching without certificate

10. Have you ever learned about *learner-centred teaching* in mathematics?

1 -Yes ☐ 2 -No ☐

11. If yes indicate where you learnt it

1 During my training	2 In my individual readings	3 In workshops	4 In conversations with colleagues and friends

SECTION B

12- To what extent do the following activities relate to the learner-centred approach?

(Mark with an X only one option)

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1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

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1-I strongly Agree	2-I Agree	3-Neutral	4-I Disagree	5-I strongly disagree

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13. Which of the following approaches (learner-centred approach, teacher-centred approach) do you practise more in your mathematic lessons?

1. Learner-centred approach

2. Teacher-centred approach

3. I practise both

c) I don't practise any of these two types of approaches

☐

14. Do you feel that the knowledge you have acquired during your training allows you to safely apply any of these types of teaching in the classroom?

14.1 I feel secure to apply

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

14.2 I apply the following teaching approaches with security

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

14.3 I still need to practise

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

14.4 I don't have any knowledge to apply

1. Learner-centred approach

☐

2. Teacher-centred approach

☐

THE END

THANK YOU

APPENDIX C

DISTRIBUTION AND RETURNS OF QUESTIONNAIRES-FINAL STUDY

N r	School	Province	District	Deliver ed	Return ed	%
1	EPC Machava-Sede	Maputo Province	Matola	76	46	60. 5
2	EPC Bagamoyo	Maputo Province	Matola	37	20	54. 1
3	EPC Machava 15	Maputo Province	Matola	82	63	76. 8
4	EPC Tunduru	Maputo Province	Matola	31	30	96. 8
5	EPC Machava Bedene	Maputo Province	Matola	52	35	67. 3
6	EPC Ngungunyana	Maputo Province	Matola	37	30	81. 1
Total				315	224	71. 1
7	EPC 25 de Setembro	Maputo City	KaMpfumo	23	21	91. 3
8	EPC COOP	Maputo City	KaMpfumo	27	24	88.

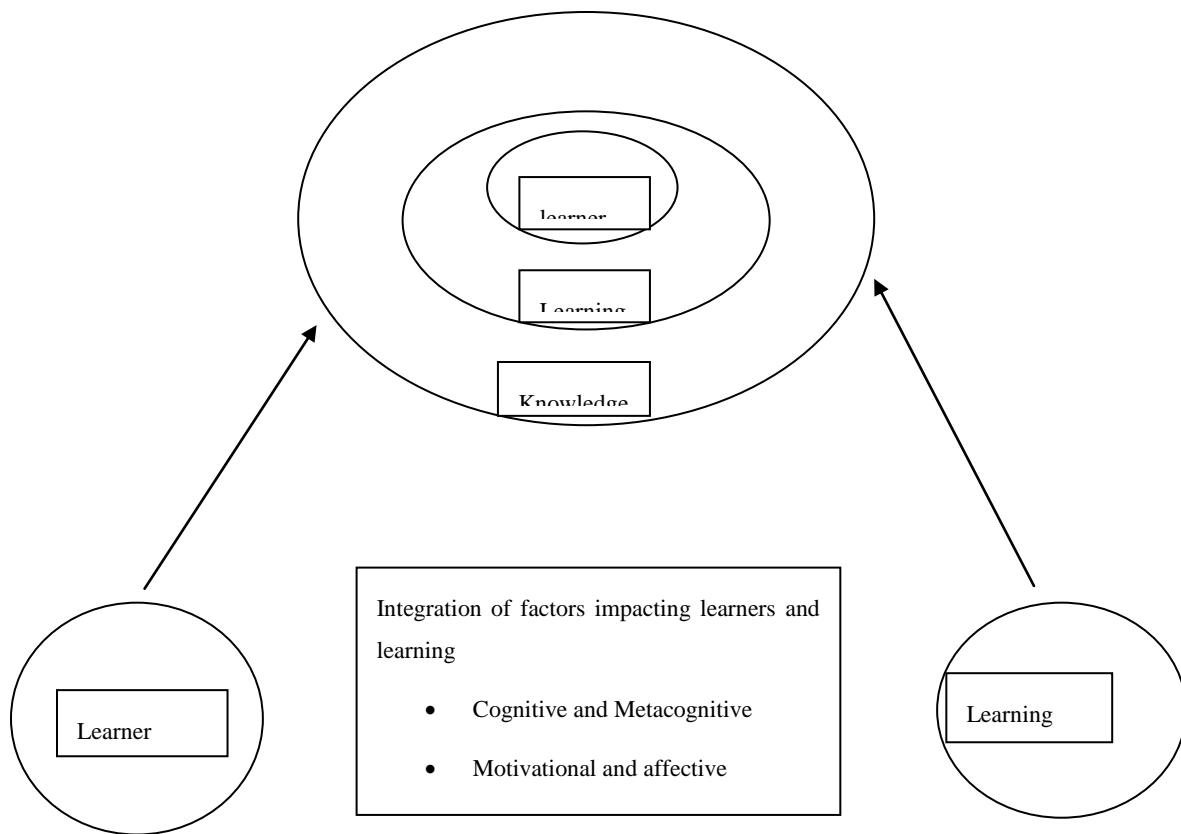
						9
9	EPC Alto Maé	Maputo City	KaMpfumo	25	11	44. 0
1 0	EP B-A-BA	Maputo City	KaMpfumo	18	7	38. 9
1 1	EPC 24 de Julho	Maputo City	KaMpfumo	23	17	73. 9
1 2	EPC Unidade 18	Maputo City	KaLhamank ulo	38	33	86. 8
1 3	EPC Casa de Educação da Munhuana	Maputo City	KaMpfumo	30	24	80. 0
1 4	EPC Unidade 10	Maputo City	KaLhamank ulo	14	12	85. 7
Total				171	149	87. 1
TOTAL				486	373	76. 7

APPENDIX D

OBSERVATION SCHEDULE

FIGURE 2.1

Learner-Centred Model: a holistic perspective (McCombs and Miller, 2009:6)



ANEXURE A

COVERING LETTER: QUESTIONNAIRE

UNIVERSITY OF ZULULAND
FACULTY OF EDUCATION
DEPARTMENT OF MATHEMATICS, SCIENCE
AND TECHNOLOGY EDUCATION
CONSENT FORM FOR RESEARCH PARTICIPANTS.

Introduction

My name is Jaime da Costa Alipio. I am a Doctorate degree student at the University of Zululand in the Department of Mathematics, Science and Technology education. The topic of my research study is: Learner-centred approach in the teaching of Mathematics: a consideration of teachers' perceptions

Aims of the Study:

1. To determine the extent to which teachers background training contributes perception of learner centered approach in the teaching of mathematics
2. To determine the extent to which teachers professional experience contributes to perception of learner centered approach in the teaching of mathematics
3. To determine the extent to which teachers background training contribute learner centered practices in the teaching of mathematics
4. To determine the extent to which teachers professional experience contribute to practices of learner centered approach in the teaching of mathematics
5. To conduct classrooms observation on the use of learner centered approach.

Procedures:

You are required to answer a questionnaire which is aimed at ascertaining the extent teachers' perceive and apply learner centered teaching and practices in mathematics classroom. As part of the project your practice teaching using learner centered teaching will be assessed and scores from the observation will also be analyzed. Please note that your participation in this project is voluntary, you may withdraw at any time if you like to do so.

I have read and accept the conditions of the project:

Name of the participant: Andrie Tarnis Albino

Signature: Signature: Andrie Tarnis Albino

Signature of Researcher: Jaimi da Costa Alipio

Date: 04/04/2022

Name of the Supervisor: Professor DC Sibaya

Contact Details: University of Zululand

Faculty of Education

Mathematics, Science and Technology Education Department

Phone number: 035 9026546

Cell number: 0732711126



FACULTY OF EDUCACION AND PSYCHOLOGY

DEPARTMENT OF PSYCHOLOGY

Av. de Moçambique Km 1, *Campus* de Lhanguene, PO BOX 4040, Tel. 21431309, Maputo-Moçambique

To the Director of Department of Education of Maputo City

CREDENTIAL

This is to confirm that Mr Jaime da Costa Alipio is a lecturer at Department of Psychology and wish to collect data from teachers at primary school level. The data is related to research he is conducting about teachers practices and the objective is to ascertain their perceptions. The topic of his research is: Learner-centred approach in the teaching of Mathematics: a consideration of teachers' perceptions

Maputo, 11 of August 2011

The Dean of the Faculty

(Prof. Dr. Daniel Daniel Nivagara)

*Visto,
Poderá coordenar e/ou
escolas visadas, s/ prejuizo
das actividades lectivas.
Grandelmo
09.09.11*



UNIVERSIDADE PEDAGÓGICA
FACULDADE DE CIÊNCIAS DA EDUCAÇÃO E PSICOLOGIA

DEPARTAMENTO DE PSICOLOGIA EDUCACIONAL



CREDENCIAL

À Direcção de Educação da Cidade de Maputo

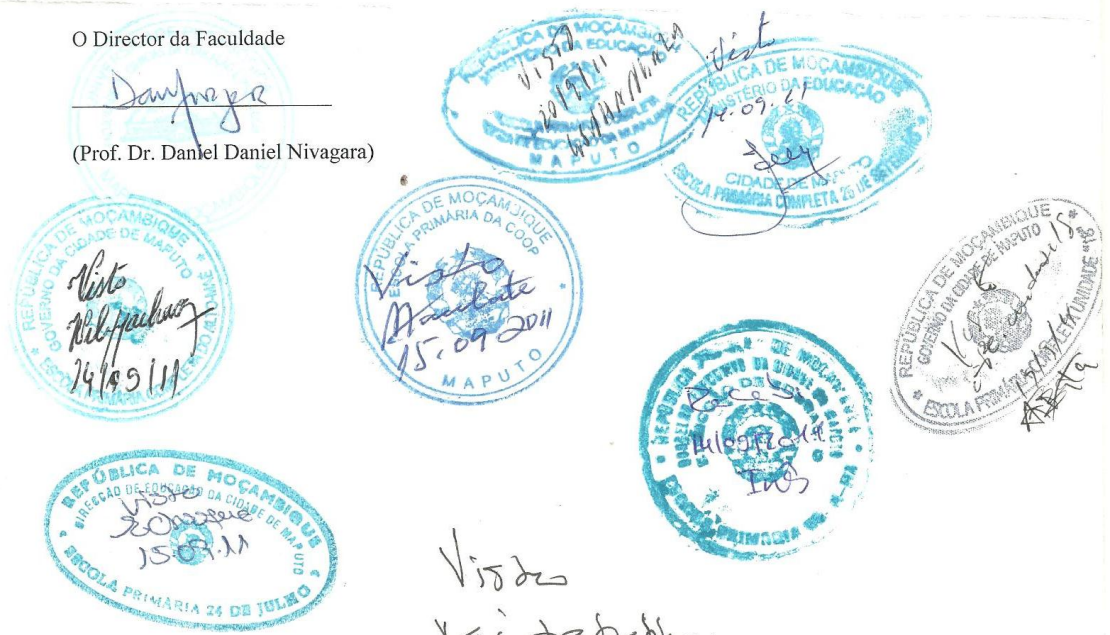
Serve a presente, para credenciar o docente desta Faculdade, o Prof. Dr. Jaime da Costa Alipio afecto no Departamento de Psicologia, que se desloca a Cidade de Maputo com a finalidade de recolher dados nas escolas primárias do primeiro e segundo graus para a sua pesquisa intitulada: "Percepções e Práticas de Uma Avaliação e Ensino Centradas no Aluno. Um Olhar Sobre a Disciplina de Matemática no Ensino Básico".

Maputo, 11 de Agosto de 2011

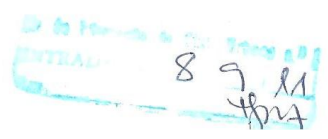
O Director da Faculdade

Daniel Nivagara

(Prof. Dr. Daniel Daniel Nivagara)



*Visto
Vai trabalhar
com o professor da
Escola: (Jaime da Costa Alipio)
RPE de Matutano, 4. B, 10,
Min. de Educação e Ciência*





UNIVERSIDADE PEDAGÓGICA
FACULDADE DE CIÊNCIAS DA EDUCAÇÃO E PSICOLOGIA

DEPARTAMENTO DE PSICOLOGIA EDUCACIONAL

CREDENCIAL

A Direcção Provincial de Educação de Maputo

Serve a presente, para credenciar o docente desta Faculdade, o Prof. Dr. Jaime da Costa Alipio afecto no Departamento de Psicologia, que se desloca a essa Província com a finalidade de recolher dados nas escolas primárias do primeiro e segundo graus para a sua pesquisa intitulada: "Percepções e Práticas de Uma Avaliação e Ensino Centradas no Aluno. Um Olhar Sobre a Disciplina de Matemática no Ensino Básico".

Maputo, 11 de Agosto de 2011

O Director da Faculdade

(Prof. Dr. Daniel Daniel Nivagara)



Apresentar-se
nesta instituição de
ensino



Apresentar-se
nesta instituição de
ensino



apresentar-se
01.09.2011
30.08.2011