

**UNIVERSITY OF ZAMBIA AND ZIMBABWE OPEN UNIVERSITY
POSTGRADUATE PROGRAMMES**

**PERCEPTION OF HEADS OF DEPARTMENT AND MATHEMATICS TEACHERS
TOWARDS TEACHING AND LEARNING OF MATHEMATICS USING PROBLEM
SOLVING METHOD IN A LESSON STUDY CYCLE**

BY

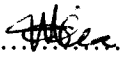
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The Research Dissertation Submitted to The University of Zambia in Collaboration with Zimbabwe Open University for the Partial Fulfillment of the Requirements for the Award of the Degree of Master of Education in Educational Management.

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DECLARATION

This dissertation is the original work of Mr. Michelo Kaliba. It has been prepared in accordance with the guidelines for Masters in Masters of Educational Management dissertation of the University of Zambia in collaboration with Zimbabwe Open University. I hereby declare that this dissertation has never been submitted for a degree in this or any other university.

Signature..........

Date24/02/2017.....


DEDICATION

This work is dedicated to Mildred, my wife, for her unwavering support and constructive criticism. I would like to thank my children for their understanding, patience and support; Malilwe, Nachuuma, Nchimunya, Danny and Namweemba.

APPROVAL

This Dissertation by Michelo Kaliba is approved as fulfillment part of the requirement for the award of the Degree of Masters of Education in Educational Management by The University of Zambia in collaboration with Zimbabwe Open University.

Examiner's Signatures

Signed.......... Date.....03/03/2012.....

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ABSTRACT

Mathematics teachers in Zambia are involved in the teaching and learning of mathematics using the problem solving method. The purpose of the study was to find out the perceptions of Heads of Department and Mathematics teachers towards the teaching and learning of Mathematics using Problem Solving Method in a Lesson Study cycle.

The objectives of the study were to; find out to what extent and how teachers are using Problem Solving method in the teaching and learning of mathematics, determine the Heads of Department and mathematics teachers' understanding of Problem Solving Method in a mathematics lesson and assess the extent to which the Problem Solving Method is monitored by the Heads of Department. The study was guided by Vygotsky's Zone of Proximal Development theory.

Qualitative research design was used in the study following the case study approach in which lesson observations and semi-structured interviews were used to collect data. Two Heads of Department and two mathematics teachers from two secondary schools participated in the study in Siavonga district; one from each school. Teachers were observed teaching lessons and were later interviewed while the Heads of Department were only interviewed.

Thematic approach was used to analyze the data and the findings brought out key issues in the implementation, understanding and monitoring of the problem solving method in terms of; arousal for attention, key question, synthesizing, sharing lesson objectives, pupil self-regulation, lesson evaluation, group work, teaching learning materials, importance of learners' thinking activities, heart of mathematics, engage deeper understanding of mathematical ideas, teacher competence, critical thinking, Continuing Professional Development, feedback, effective communication and effective monitoring.

The findings showed that teachers and Heads of Department are familiar with the problem solving method. However, the findings showed that there were no opportunities given to the pupils to share their different or similar ideas even in group work.

The study recommended that Continuing Professional Development requires to be further re-enforced as a policy for the teachers and the main features of the learner-centred methodologies to be taught at colleges of education and universities in the area of mathematics as a policy. The Heads of Department need to take a leading role in the guidance on the use of the problem solving method and teachers need to engage more on Continuing Professional Development meetings concentrating on the vital stages of the problem solving method through peer lesson observation Further research is required for the teachers to understand the role of questions and key questions in the use of the problem solving method.

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CHAPTER ONE

1.0 INTRODUCTION

This chapter highlights the background, continuing professional development, lesson study, problem solving method, statement of the problem and the purpose of the study, study objectives which were composed of general objectives and specific objectives, significance of the study, scope of the study, delimitation and limitations of the study, operational definitions, ethical considerations and outline of the dissertation.

The research is a study on the perceptions of the Heads of Department and Mathematics teachers towards the teaching and learning of Mathematics using problem solving method in a Lesson Study cycle. In Zambia, Lesson Study, which is part of the Continuing Professional Development for teachers, started as a pilot project in Central Province. It was discovered that most lessons were teacher-centred and problem solving method was introduced as a learner-centred method to be used in the teaching and learning process.

Many writers have attempted to clarify what is meant by problem-solving method to teaching mathematics. Problem solving is considered to be part of the process in mathematics that has often been overlooked in favour of skills in the past. A problem is a situation which is experienced by an agent as different from the situation which an agent ideally would like to be in. A problem is solved by a sequence of actions that reduce the difference between the initial situation and the goal (Heylighen, 1998). Therefore, problem solving method is key in the teaching and learning of mathematics. It is one which not only involves the development of skills, but enhances the role of supporting learning in other areas. Students develop understanding when they figure out how each new idea is related to other things they already know (Hiebert and Carpenter 1992).

Baroody (1998) alludes to the factor that an information and technology based society requires individuals who are able to think critically about complex issues, analyze and think logically about the new situations. Such society has people who are able to devise unspecified solution procedures and communicate their solution clearly and convincingly to others. It is therefore

important to recognize that to prepare pupils to function in such a society; teachers have the responsibility to promote the experience of the problem solving processes in their classrooms. The understanding of concepts grows as pupils' own personal web of connections become more complex. In addition to this, there is need for acquisition of problem solving strategies as well as fostering into the pupils' positive dispositions. Baroody (1998) further posits that becoming a better problem solver is a gradual building process that requires taking on challenging and sometimes frustrating problems.

It is no longer enough for pupils to be able to read, count or multiply as the world is ever changing. Computers are now doing many mundane repetitive tasks for us. Many jobs in today's world require analytical skills and the ability to solve unexpected problems. This is in relation to teaching mathematics and highlighting on teaching mathematical topics through problem-solving devices. It also involves relating with the real day life activities characterized by the teacher. This is done in order to help students construct a deeper understanding of mathematical concepts and procedures. Students are involved in doing mathematics: creating, conjecturing, exploring, testing and verifying (Lester et al., 1994).

Branca (1980:3) quoted Lester (1977) that "problem solving has been said to be at the heart of all mathematics" to illustrate the importance of problem solving. Hiebert, Carpenter, Fennema, et al., (1996) explain that a student learns mathematics by grappling with difficult and absorbing problems rather than by simply memorizing and practicing predetermined procedures. He/she is free to "wonder why things are, to inquire, to search for solutions and to resolve incongruities." This approach yields deeper understandings of the kinds that we value.

Yee (2012) defines problem solving as a process. However, in the field of school mathematics, the primary goal of teaching mathematics is to develop the ability to solve a variety of mathematical problems. Problem solving has an important place in the world of mathematics. A curriculum in various subject areas often calls for pupils to confront problem situations. This is by understanding information that is given in a situation, then identifying critical features and any relationships in a situation. Thereafter, there is the constructing or applying of one or more external representations, resolving ensuing questions. Finally there is the evaluation; justification

and communicating of results as a means to further understand the situation. This is because problem solving is widely seen as providing an essential basis for future learning. It is also for effective participation in society and for conducting personal activities.

Problem solving plays a significantly important role. The role has an influence in mathematics teaching and learning. Through problem solving, pupils can enhance their thinking skills. They can also apply procedures and deepen their conceptual understanding. Problem solving is like a vehicle by which pupils start thinking critically. During problem solving activities, pupils are involved with given information, formula, computations, figures, graphs as well as with synthesizing ideas, for which pupils must be involved with the entire learning system.

The focus is on teaching mathematical topics through problem-solving contexts and enquiry-oriented environments which are characterized by the teacher “helping students construct a deep understanding of mathematical ideas and processes by engaging them in doing mathematics: creating, conjecturing, exploring, testing and verifying” (Lester et al., 1994:154). Creativity is also required in real world situations. However, it has often been claimed that traditional classrooms and their teaching approaches do not focus on developing the creative faculty of students. Advocates of problem solving, by contrast, claim that problem solving develops the students’ creative capacities (Frederiksen, 1984; Slavin, 1997).

According to Resnick (1987), a problem-solving approach contributes to the practical use of mathematics by helping people to develop the facility to be adaptable when, for instance, technology breaks down. It can therefore also help people to transfer into new work environments at this time when most are likely to be faced with several career changes during a working lifetime (NCTM, 1989). Resnick expressed the belief that school should focus its efforts on preparing people to be good adaptive learners, so that they can perform effectively when situations are unpredictable and task demands change. Mathematicians and Mathematics education researchers have long claimed that problem solving is the essence of Mathematics. Wilson, Fernandez and Hadaway (1993:66) expressed a belief when they said, “The art of problem solving is the heart of mathematics.” Cockcroft (1982:73) also advocated problem solving as a means of developing mathematical thinking as a tool for daily living, saying that

problem-solving ability lies 'at the heart of mathematics' because it is the means by which mathematics can be applied to a variety of unfamiliar situations.

Problem solving is an important aspect of the elementary mathematics instruction in which choosing problems wisely and using and adapting problems from instructional materials, is a difficult part of teaching mathematics (NCTM, 2000). It is further observed by Jones (2004) that the call for reform in mathematics classrooms has expected teachers among other things to create conducive mathematical tasks to manage students' (pupils) mathematical discourse and to promote sense making. Pupils can become even more involved in problem solving. This is by formulating and solving their own problems or by rewriting problems in their own words in order to facilitate understanding. It is of particular importance to note that they are encouraged to discuss the processes which they are undertaking, in order to improve understanding, gain new insights into the problem and communicate their ideas (Thompson, 1985, Stacey and Groves, 1985). Monaghan et al (2009:21) quoting Lester (1994:661) states that "most mathematics educators agree that the development of students' problem-solving abilities is a primary objective of instruction." In essence, the development of the pupils' problem solving abilities further strengthens the pupils' skills to solve more complex problems.

1.1 BACKGROUND

Policy on continuing professional development in schools, lesson study practices for teachers, and problem solving as a teaching method formed the background for this study.

1.1.1 Continuing Professional Development

The Ministry of General Education in Zambia has a policy, on the Continuing Professional Development (CPD) of serving teachers at primary and secondary schools. Friedman and Phillips (2004) define CPD as the systematic maintenance, improvement and broadening of knowledge and skills and the development of personal qualities necessary for execution of professional and technical duties throughout the individual's working life. This definition suggests a planned approach to CPD in areas related to work. Friedman and Phillips (2001) also suggest that "CPD might be better characterised as a support for professional practice."

The aim of CPD is to improve the quality of teaching and learning in the classroom. CPD is the means by which professionals maintain and enhance their knowledge and skills and is essential in supporting an individual's current role as well as career progression. CPD is all about upgrading knowledge, skills and capabilities to remain effective and compliant in ones profession. "Hence, the term Continuing Professional Development (CPD) implies, all the activities in which teachers engage in during the course of their career which are designed to enhance their work." (Day and Sachs, 2004:3). The education policy, *Educating our Future*, recommends the implementation of demand-based, continuing small-sized teacher training (Ministry of Education, 1996). Teaching is a learned and a learning profession and every teacher should also be a learner (Ministry of Education, 2007). It had been realized that teachers needed to continuously improve their teaching methodologies as well as content delivery to the pupils.

The Ministry of Education, since the year 2005, has been conducting the School-based Continuing Professional Development (SBCPD) programme through Lesson Study in the teaching of Mathematics and Science. This programme has enabled all the teachers in the primary and secondary schools in Zambia to have the opportunity to continuously learn from one another at school level. In SBCPD, the institutionalized framework is called School Programme of the In-service for the Term (SPRINT). The SPRINT programme involves Teacher Group Meetings (TGMs) in an attempt to institutionalize teacher collaboration. It provides a platform for teachers to continuously have meetings and trainings at both school and zone level which are called Continuing Professional Development (CPD) meetings. It is from CPD meetings that the teachers share experiences on the teaching and learning of mathematics using the problem solving method. With the same goal of improving teacher quality, Lesson Study strengthens SPRINT by focusing specifically on providing school-based CPD in mathematics and science education. It increases school management's stakes in the programme by involving them as advocates of Lesson Study and observers during demo lessons.

Educating Our Future, the education policy of 1996 advocated for the learner-centred lessons as a key element for improving education. UNESCO (1990) suggested that the learner-centred curriculum and teaching and learning materials were effective for education. Traditionally

education had been viewed as a pedagogical relationship between the teacher and the pupil in which the teacher was always the one to decide what the pupil should know and how the knowledge and skills should be taught. Pupils can learn and be self-directed. Emery (1993:79) states that , ‘in learning to learn we are learning to learn from our own perceptions; learning to accept our own perceptions as a direct form of knowledge and learning to suspect forms of knowledge that advance themselves by systematically discounting direct knowledge that people have in their life-sized range of things, event and processes. Children are the centre of the entire education process and education exists for the sake of the learners (Ministry of Education, 1996). Curriculum Development Centre (2003), recommended learner-centred approach for lessons in the mathematics syllabus.

1.1.2 Lesson Study

The government introduced Lesson Study practice for teachers, which was a structured approach to studying, developing and improving lessons in Central province in 2005 with technical cooperation from Japan International Cooperation Agency (JICA). Emerging in the United States in the late 1990s, Lesson Study was modeled on the Japanese practice of *jugyo kenkyu* and is now conducted by teachers in many countries, worldwide. *Jugyo kenkyu* is the Japanese term for Lesson Study. Lesson Study is classroom-based research on how pupils think and learn and is conducted by small teams of teachers who share common goals. Each team’s intensive study of content, teaching methods and student learning within one research lesson is a contribution to a larger, ongoing process of professional knowledge building, both within and across schools. Educators have credited Lesson Study with bringing about Japan’s evolution of effective Mathematics and Science lessons (Lewis, 2002a, 2002b; Lewis and Tsuchida, 1997, 1998; National Research Council, 2002, Takahashi, 2000, Yoshida, 1999a, 1999b).

In 2007, this practice was extended to the Copperbelt and North-Western provinces. In 2013, it was introduced in all the provinces in the country. The government was trying to support teachers through the Teacher Education Department under the Ministry of General Education to facilitate more learner-centred lessons in Mathematics. Lesson study is a cycle of inquiry about pupil learning, conducted for the purposes of teacher learning and instructional improvement. It

sometimes takes place among teachers themselves at a school and sometimes in clusters or workshops.

Gorman et al (2010) observed that Lesson Study provides educators the opportunity to talk in depth about how pupils learn Mathematics, using live classroom lessons as the basis for discussion and learning. Teachers learn techniques to improve learner-centred teaching methods and develop problem solving and critical thinking skills. According to Hiebert and Wearne (2003:6), a problem should be difficult, but not too difficult: “Allowing mathematics to be problematic does not mean making mathematics unnecessarily difficult, but it does mean allowing students to wrestle with what is mathematically challenging.” In Zambia, the 2015 impact assessment also consistently found that higher levels of Lesson Study practices in schools correlated with higher student achievement on national exams (MESVTEE and JICA 2015).

1.1.3 Problem Solving Method

Ministry of Education (2014) presented Problem Solving Method as one of the teaching methods to help achieve a learner-centred lesson. It is the means by which an individual uses previously acquired knowledge, skills and understanding to satisfy the demands of an unfamiliar situation. The process begins with the initial confrontation and concludes when an answer has been obtained and considered with regard to the initial conditions. The student must synthesize what he or she has learned and apply to the new and different situations. Williams (2003) posits that problem solving is a scientific process that a person passes through from understanding the problem to deciding on the information needed for a solution to solving the problem and evaluating the appropriateness of the solution. In the problem solving process, a learner must be able to combine the appropriate operations and apply them to the solution (Bernardo, 1999).

According to Resnick (1987) a problem-solving approach contributes to the practical use of mathematics by helping people to develop the facility to be adaptable when, for instance, technology breaks down. It can therefore also help people to transfer into new work environments at this time when most are likely to be faced with several career changes during a

working lifetime (NCTM, 1989). This entails that problem solving is fundamental to education. It helps to improve pupils' ability to solve problems.

Problem Solving in Mathematics Lessons is recommended because it motivates pupils to think critically and develop new ideas from discussions with other pupils in the classroom. The emphasis on pupils' learning in the problem solving process reminds teachers on how important it is for them to understand pupils' ideas and help bring the visions of reform into the classroom (Hart et al., 2011). Teachers play a very critical role in assisting the pupils to develop their problem solving abilities. Problem solving is central to mathematics. Problem solving should be the site on which all of the strands of mathematics proficiency converge. It should provide opportunities for student to weave together the strands of proficiency and for teachers to assess students' performance on all of the strands (Kilpatrick et al., 2001:421). Takahashi (2010) further contributes that teaching through problem solving has been a major focus in mathematics education because it helps students develop concepts in the context that they can see connections. Problem solving in the mathematics context requires the students to go beyond computing, operations, to interpret and analyze the problem to arrive at a solution (Carpenter et al., 1993, Cawley and Miller, 1986).

According to Ministry of Education (2009), Problem Solving Method involves the pupils having some responsibility, which usually is on the development of the activity. There is purposeful interaction with ideas as well as concepts and phenomenon. In addition there is reflection upon both action and results of an action. The problem solving skills, promotion of development of process skills, autonomous learning, higher order skills, co-operative learning and not competitive learning, confidence in the pupil to question some statement or to seek clarification are encouraged by the Problem Solving Method.

There is consensus among mathematics education researchers that problem solving is fundamental not only to doing mathematics but also to teaching and learning mathematics (Lester and Charles, 2003). In mathematics, the way of success is related with good problem solving, for in teaching and learning of mathematics lessons, problem solving process is important. This is because problem solving is one of the scientific methods as it requires critical

thinking, creative and reflective thinking, and usage of analysis and synthesis abilities. Understanding mathematical knowledge and association of information occurs in problem solving processes (Swings and Peterson, 1988).

In the eyes of mathematicians, mathematics is the single method of thinking that leads us to certain knowledge (Yıldırım, 2004). It is required that the problem be determined for thinking to develop. The individual tries to solve the problem by correlating among the concepts for the solution of problem and at this stage; thinking starts (Ersoy, 2012). Individual's mathematical thinking skill improves in the problem solving stage. National Council of Teachers of Mathematics (2000:182) stated that, "Problem solving is the cornerstone of school mathematics. Without the ability to solve problems, the usefulness and power of mathematical ideas, knowledge and skills are severely limited." One of the aims of teaching through problem solving is to encourage students to refine and build onto their own processes over a period of time as their experiences allow them to discard some ideas and become aware of further possibilities (Carpenter, 1989). Problem solving gives pupils a context. This is in order to help them make sense out of the mathematics they are learning. Problems can be used to introduce new concepts and extend previously learned knowledge for the benefit of the pupils.

NCTM's Agenda for Action and other documents and together, using a process called Lesson Study, began exploring what it would mean to make problem solving "the focus of school mathematics" (NCTM, 1980). In teaching through problem solving method, the goal is for learners to learn precisely that mathematical idea that the curriculum calls for. The lesson would begin with the teacher setting up the context and introducing the problem. Learners then work on the problem for about 10 minutes while the teacher monitors their progress and notes which approach learners are using. Then the teacher begins a whole-class discussion. The idea is that the teacher may call on learners to share their ideas. The teacher will ask learners to think about and compare the different ideas. There is need to identify ideas which are incorrect and why. Similarly, identify which ideas are correct and why. The other aspect is on which ideas are similar to each other as well as which ones are more efficient or more elegant. It is through this discussion that the learners are able to learn new mathematical ideas or procedures.

Cobb et al (1991:187) suggested the purpose for engaging in problem solving is not just to solve specific problems, but to “encourage the interiorization and reorganization of the involved schemes as a result of the activity.” The pupils become active learners in their own right. Not only does this approach develop students' confidence in their own ability to think mathematically (Schifter and Fosnot, 1993), it is a vehicle for students to construct, evaluate and refine their own theories about mathematics and the theories of others (NCTM, 1989). This is because it has become so predominant. Due to this, it is important to consider the processes especially with the focus that the pupil is the centre of the learning activities in a lesson.

Problem solving can be developed as a valuable skill in itself, a way of thinking rather than just as the means to an end of finding the correct answer (NCTM, 1989). Problem solving is more than a vehicle for teaching. It is also considered as reinforcement for mathematical knowledge and helping to meet everyday challenges which the pupils are likely to face. It is also considered a skill which can enhance logical reasoning from any given situation or natural setting in life. Individuals can no longer function optimally in society by just knowing the rules to follow to obtain a correct answer. They also need to be able to decide through a process of logical deduction what algorithm, if any, a situation requires and sometimes need to be able to develop their own rules in a situation where an algorithm cannot be directly applied.

The NCTM (1980, 1989) strongly endorsed the inclusion of problem solving in school mathematics. Problem solving is considered to be a major part of mathematics. It is the sum and substance of our discipline and to reduce the discipline to a set of exercises and skills devoid of problem solving is misrepresenting mathematics as a discipline and shortchanging the pupils. Mathematics has many applications and often those applications represent important problems in mathematics. The subject is used in the work, understanding and communication within other disciplines. There is also an intrinsic motivation embedded in solving mathematics problems. This is because when problem solving in school mathematics is included, it can stimulate the interest and enthusiasm of the pupils. Problem solving can be considered to be fun. It is in this way, that many of the people do mathematics problems for recreation. Problem solving must be in the school mathematics curriculum to allow pupils to develop the art of problem solving. This art is so essential to understanding mathematics and appreciating mathematics that it must even be an instructional goal.

It has been argued (Wilson et al., 1993) that teachers often provide strong rationale for not including problem solving activities in school mathematics instruction. These include arguments that problem solving is too difficult, problem solving takes too much time, the school curriculum is very full and there is no room for problem solving, problem solving will not be measured and tested, mathematics is sequential and students must master facts, procedures and algorithms, appropriate mathematics problems are not available, problem solving is not in the textbooks and basic facts must be mastered through drill and practice before attempting the use of problem solving. For example, Suydam (1987:104) concluded that if problem solving is treated as "apply the procedure," then the students try to follow the rules in subsequent problems. If you teach problem solving as an approach, where one must think and can apply anything that works, then pupils are likely to be less rigid.

The NCTM gives reasons that there should be teaching mathematics through problem solving (NCTM, 2003: 20). Problem solving helps students understand that mathematics develops through a sense-making process. Secondly, it deepens students' understanding of underlying mathematical ideas and methods. It also engages students' interest.

1.2 STATEMENT OF THE PROBLEM

The performance of pupils in mathematics has been poor despite the strategies that have been put in place by the Ministry of General Education. This has been attributed to the methodology that teachers were using. The ministry with the help of stakeholders like UNESCO suggested for the use of the learner-centred as opposed to teacher-centred methodologies. The problem solving method which is a learner-centred methodology has been encouraged in the Continuing Professional Development and lesson study programmes, to yield the expected results from the pupils. The study therefore focused on the perception of the Heads of Department and mathematics teachers on the use of the Problem Solving Method in Zambia.

1.3 PURPOSE OF THE STUDY

The purpose of the study was to find out the perceptions of Heads of Department and Mathematics teachers towards the teaching and learning of Mathematics using Problem Solving Method in a Lesson Study cycle. The theory which guided the study was Vygotsky's theory of Zone of Proximal Development in which the teacher's role is mediating in the pupil's activities.

1.4 STUDY OBJECTIVES

1.4.1 General Objective

To explore how the heads of department and Mathematics teachers perceive the teaching and learning of mathematics using the Problem Solving Method in a classroom situation.

1.4.2 Specific Objectives

- (i) To find out to what extent and how teachers are using Problem Solving method in the teaching and learning of mathematics.
- (ii) To determine the Heads of Department and mathematics teachers' understanding of Problem Solving Method in a mathematics lessons.
- (iii) To assess the extent to which the Problem Solving Method is monitored by the Heads of Department.

1.5 RESEARCH QUESTIONS

- (i) How are Mathematics teachers implementing the Problem Solving Method in the teaching and learning of mathematics?
- (ii) What is the Heads of Department and Mathematics teachers' understanding of the Problem Solving Method?
- (iii) How are Heads of Department monitoring the extent to which the Problem Solving Method is implemented in the teaching and learning of mathematics?

1.6 SIGNIFICANCE OF THE STUDY

This study intended to show reasons why to some extent some teachers are not using the Problem Solving Method. This study was meant to change the perception of the Problem Solving Method and also help overcome the challenges in the teaching of the Problem Solving Method. This study was also intended to provide useful information to the policy makers, Heads of Department, teachers and stakeholders on the extent to which the Heads of department and teachers perceive and implement the Problem Solving Method. Information from the research would be useful to the researchers who might wish to consider certain areas of this study for their own future studies.

1.7 SCOPE OF THE STUDY

The study took place in Siavonga district.

1.8 DELIMITATION OF THE STUDY

This study was restricted to two schools in Siavonga district. According to Creswell (1994), delimitations are used to address how the study is narrowed in scope. Further, Simon (2011) alludes that delimitations include the population of the study, variables, statistical analysis and focus of the research. He further states that the delimitations are those characteristics that limit the scope and define the boundary of the study.

1.9 LIMITATION OF THE STUDY

The research was localised to Siavonga district and therefore the findings would not be adequately used in making generalizations to cover other regions or the whole country. This means that the findings may not exactly correlate with the rest of the country which may have locally based variations. However, the study provides insights on use of the problem solving method and how it is monitored.

1.10 OPERATIONAL DEFINITIONS

- **Continuing Professional Development** - The process of tracking and documenting the skills, knowledge and experience that one gains both formally and informally as one works, beyond any initial training. It is a record of what one experiences, learns and then applies.
- **Problem Solving Method** – Learner-centred method used in the teaching of Mathematics.
- **Lesson Study** – This is a teaching improvement process that is a widespread in professional development practice.
- **Lesson Study Cycle** – Process in which lesson study is implemented.
- **Learner-Centred Methodology** - Methods of teaching that shift the focus of instruction from the teacher to the learner.
- **Perception** – It is a point of view, an opinion, a perceptive of looking at something.

1.11 ETHICAL CONSIDERATIONS

Ethical considerations in research are critical. Ethics are the norms or standards for conduct that distinguish between right and wrong. Any ethical research should take note of the principle of autonomy and respect for dignity of persons (Blanche, Durkheim and Painter, 2008). All researches involving data collection usually require prior ethical approval to ensure the safety, rights, dignity and well-being of both the participant and the researcher. Ethical standards also require that researchers do not put participants in a situation where they might be at risk of harm as a result of their participation. It is in this vain that the participants were treated with utmost respect. The responses from the participants were treated with utmost confidentiality by ensuring that the names of the respondents were not revealed. Participants were not forced to participate in the research. Clearance was obtained from the University of Zambia Ethics Committee. Permission to conduct the research in Siavonga district was obtained from the Provincial Education Officer. The participants were informed of the nature and purpose of the research as well as the benefits of gathering the data.

1.12 OUTLINE OF THE DISSERTATION

Chapter two focuses on the literature review. It outlines the literature review in terms of the three objectives of the research. Attention is on the implementation of the Problem Solving method in the teaching and learning of mathematics, understanding of the Problem Solving method and the monitoring of the method.

Chapter three focuses on the theoretical and conceptual frameworks. The theoretical frame work is elaborated by Vygotsky’s theory of the Zone of Proximal Development which was used in the study. The conceptual frame work is explained and illustrated to show the matrix of concepts providing the focus for inquiry.

Chapter four focuses on the research methodology. The research methodology is outlined by the research design, study site, study population, study sample, sampling techniques, data collection instruments used to collect data through interviews and lesson observations, data collection procedure, data analysis instruments and procedures, and trustworthiness of the study.

Chapter five focuses on the presentation of the findings through the headings and themes. The headings were on implementation, understanding and monitoring. Themes were arousal for attention, key question, synthesizing, sharing lesson objectives, pupil self-regulation, lesson evaluation, group work, teaching learning materials, importance of learners' thinking activities, heart of mathematics, engage deeper understanding of mathematical ideas, teacher competence, critical thinking, Continuing Professional Development, feedback, effective communication and effective monitoring.

Chapter six focuses on the discussion of findings. These findings were discussed through the headings under implementation, understanding of Problem Solving and monitoring by Heads of Department. The themes under the headings were discussed and related to the literature review as well as the Vygotsky's theory of Zone of Proximal Development.

Chapter seven focuses on the conclusion and recommendations arising from the study. The conclusion arose from the study's findings. The recommendations suggested areas in terms of policy, practice and further research.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter highlights the implementation in which teacher-centred to learner-centred learning, role of the teacher was discussed. The chapter further highlights on the understanding of the problem solving method by both teachers and Heads of Department and monitoring by the Heads of Department.

Literature reviews are a basis for research in nearly every academic field. Literature review helps in exploring and examining a research topic. This is in relation to previous work or studies done and justifying the new study on the basis of knowledge gaps such as what the study intends to contribute. The literature broadly refers to information relevant to your topic of interest. Such works may deal specifically or more generally with the topic of interest. While such information may be obtained from a variety of sources, including books, journal articles, reports, etc., the focus is on scholarly published materials (Andersson and Beveridge, 2007). Combe (2014) points out that the term literature review can be applied to both the process of reviewing the literature, as well as the label given to the output of such a process - the 'literature review' chapter(s) or section(s) in a document such as coursework, project, dissertation, or thesis. A literature review therefore helps us to appreciate something of the sequence and growth of knowledge. The literature review highlights on the implementation, understanding and monitoring of the Problem Solving Method.

2.2 IMPLEMENTATION

Learning mathematics coupled with open-ended and challenging problems accommodates diverse learning styles. The active and varied nature of problem solving helps students with diverse learning styles to develop and demonstrate mathematical understanding (Moyer, Cai and Grampp, 1997). Traditional teaching approaches involving rote learning and teacher-centred instructional strategies. These do not often meet the learning needs of many pupils who may be active learners or require multiple entrances into the curriculum.

2.2.1 Teacher-Centred To Learner-Centred Learning

Teachers, traditionally, occupied a central position while pupils assumed a receptive role in the learning process. The teacher played an active role, pupils were more of listeners. Kim (2005:11) defined traditional teaching approach as “traditional teaching undertakes the following steps: 1) introduction; 2) development; 3) review.” The implication was that the teachers covered a lot of work with less regard to the pupils’ needs. In the way of teaching, there has been a shift from teacher-centred learning to learner-centred learning. Traditionally teachers focused on what they did and not on what the pupils were learning. This emphasis on what teachers did often lead to pupils who were passive learners and who did not take responsibility for their own learning. Pupils are responsible for their own learning. Learner-centred learning techniques get pupils involved in the learning process. Learner-centred learning has student responsibility and activity at its heart, in contrast to the stronger emphasis on teacher-control and the coverage of academic content found in much conventional, didactic teaching (Cannon 2000).

Doyle (2008) posits that one of the reasons students are being asked to take more responsibility for their own learning is because they will be responsible for it the rest of their lives. In general, teachers have a responsibility to develop pupils’ lifelong learning skills. It is also a justification for many of the changes that are there to make in a learner-centred classroom. When the pupils are given different tasks which enable them to think critically, reflect, work with others, accept and give feedback and criticism, then they build self confidence within them, make decisions which enable them to show the greater potential they have to complete more difficult tasks. The lifelong learning skills they acquire enable them to compete in the global economy of an ever flattening world.

Educators commonly use three phrases with this learner-centred approach. Learner-centred teaching places the emphasis on the learner (Weimer, 2002). Learner-centred teaching focuses on the process of learning but with the pupil taking an active role. Both phrases appeal to faculty because these phrases identify their critical role of teaching in the learning process. The phrase learner-centred learning is also used, but some instructors do not like it because it appears to have a consumer focus, seems to encourage pupils to be more empowered and appears to take the teacher out of the critical role (Blumberg, 2004).

Bruce (2002) posits that every effort is made to help feel that they are capable and that each is responsible for the learning of all. Pupils need to have that feeling. Problem solving is a deliberate and serious act, involves the use of some novel method, higher thinking and systematic planned steps for the acquisition of set goals. The basic and foremost aim of this learning model is acquisition of such information which is based on facts (Yuzhi, 2003 and Mangle, 2008). In relation to the study, it is important to find out if the teachers understand the method in order to implement it effectively.

Problem Solving Methods often contrasted with traditional lecturing or teaching methods. Teachers most frequently used the traditional lecturing or teaching methods in the classroom. Traditional teaching is usually judged better developing memorising and in evaluating student's knowledge content (Vernon, 1995). In problem based learning curriculum, teachers change their traditional teaching methods of lectures, discussions and asking students to memorise materials for tests. The instructor acts more as a facilitator in the teaching process and helps in developing learning.

2.2.2 Role of the Teacher

The most important achievement of a teacher is to help his/her pupils along the road to independent learning. In problem based learning, the teacher acts as a facilitator and mediator, rather than a primary source of information or dispenser of knowledge. A mediator is a trusted, neutral person who facilitates a process designed to empower parties to recognize, find their own satisfactory solutions. A facilitator is someone who engages in the activity of facilitation (Bens, 2012). He/she helps a group of people understand their common objectives and assist them to plan how to achieve these objectives. During this process, the facilitator remains "neutral." This means that he/she does not take a particular position in the discussion. Roh (2003) argued that within problem based learning environments, teachers' instructional abilities are more critical than in the traditional teacher-centred classrooms. Beyond presenting mathematical knowledge to the learners, teachers in problem based learning environments must engage learners in marshalling information and using their knowledge in applied and real settings.

Yager (2000) states that we live in a dynamic society in which social, political and technological conditions are changing continuously, so educators should analyze and evaluate the trends in order to decide an appropriate curricula and method of instruction which will make students ready for real life situation. It is a recognized factor that every person must be empowered to suggest possible explanations, to propose ways to test personal or class, to collect and interpret data obtained, to communicate the process and results to others. It is believed that merely telling is not teaching and simply listening is not learning. Some learning process revolves around the teacher, where the pupils are only passive information receivers.

In learner-centred learning process, the teacher is merely a mediator or guide, which is the focal point of modern systems of education. In all active learning process, the learners learn according to their own needs and pace (Orhan and Ruhan, 2006). They are given the opportunities to make decisions regarding various dimensions of the learning process and to perform self regulation. In case of active learning process, learning is not a standard process but a personalized process. Human beings face a multiple dimensional problem in their lives and they try to solve these problems in a particular way in the light of their previously gained knowledge and experiences. In this regard it is essential for the pupils to be prepared for future or near future challenges by facing real life, or real like problems in their learning environment and finding appropriate solution of these problems. Each society expects from its education system that it enables the individuals to become an effective problem solver in their real life (Walker and Lofton, 2003; Chin and Chia, 2004). It is important to find out how the pupils are given the opportunity to find the solutions on their own.

Bostic (2011) carried out a study on the effects of teaching mathematics through problem solving contexts on sixth grade learners' problem solving performance and representative use. This study aimed to investigate the effects of an instructional intervention. This was by teaching Mathematics through problem-solving contexts on adolescents' problem-solving performance and representation use when solving word problems. The purpose of this study was to investigate the effects of student-centred, discourse-rich mathematics instruction (i.e., instructional intervention) on students' problem-solving performance as well as their representation use when solving word problems. Sixth-grade learners' performance on a test of word problems as well as

their use of different representations was examined and compared to peers experiencing their everyday instruction from their classroom teacher. Instruction in the intervention classroom emphasized student-to-student discourse and participants examined problems on a daily basis. The intervention's intent was to enhance mathematics learning by examining, solving and reflecting on word problems. The gap in the research was on the performance of the learners.

Donaldson (2011) carried out a study to investigate the teaching practices used by those who teach mathematics through problem solving. The study involved high school mathematics teachers. The study concluded that the teachers were able to engage the pupils into problem solving. The four teachers implemented teaching practices in addition to assigning good problems. For each teacher, problem solving played a central role in his or her teaching. The practices were consistent with the advice given by the mathematics education experts. The research questions were referred to a select group of high school mathematics teachers who have a strong reputation for effective teaching and have been identified as those who teach through problem solving. The gap was that the information on the performance of the pupils was not shown.

2.3 UNDERSTANDING OF THE PROBLEM SOLVING METHOD

A teacher's understanding of the problem solving method is key to a successful mathematical lesson. NCTM (2000) stated that a significant part of a teacher's responsibility consists of planning problems that will give students the opportunity to learn important content through their explorations of the problems and to learn and practice a wide range of heuristic strategies. NCTM (2000) further identifies the process standards of problem solving, reasoning and proof, representation, communication and connections as ways to think about how children should engage in learning the content as they develop both procedural fluency and conceptual understanding. Pupils engaged in the process of problem solving build mathematical knowledge and understanding by grappling with and solving genuine problems, as opposed to completing routine exercises. Teachers need to support the pupils to develop the skills they need to tackle problems by the classroom culture which teachers create. It needs to be one where questioning

and deep thinking are valued. The mistakes are seen as useful. Apart from that, all pupils contribute and their suggestions are valued.

Perveen (2010) studied on effect of the problem-solving approach on academic achievement of students in mathematics at the secondary level. The results indicated that the problem-solving method need not be more time consuming than the expository method of instruction at this age level. When given an equal amount of time to work on learning tasks, pupils using the problem-solving method tended to be superior to pupils taught by the expository method. Expository teaching strategy is basically direct instruction. A teacher is in the front of the room lecturing and students are taking notes. Students are being told (expository learning), what they need to know. There is some evidence that problem-solving experiences had become “normal” to students in mathematics classrooms (Gay, 1999). The results of this study strongly suggested that the presentation of mathematical concepts to secondary level pupils through the problem-solving sequence causes the learner to integrate the content conceptually in such a manner that the student can retain it more readily than if the concepts were presented to him in an expository sequence. It is also concluded that both methods of instruction were fairly presented and that no factors operated would tend to give either method a significant advantage.

Ward (2012) undertook a study on problem solving toward mathematical understanding: instructional design for students and learning disabilities. Problem Solving Toward Mathematical Understanding (PSTMU) was designed to teach Learning (LD) children multiple ways to represent and solve problems, improve reasoning skills and persevere. Through the use of higher-order questioning, students develop meta-cognitive awareness helping them monitor the effectiveness of a strategy and to consider different options. PSTMU was designed to develop a deeper understanding of mathematics concepts through scaffold instruction, peer-talk and group discussions. The result of the research indicated that all students increased their abilities in two or more areas evaluated.

Pinter (2012) carried out a research on teaching mathematical problem solving and problem posing. The research focused on the investigation of the development of problem solving skills of elementary education factors. The results were that student’s problem solving skills improved

and were able to solve more difficult problems. They also showed considerable improvement in posing problems. They were also able to create a problem for a given situation and a continuation in a given problem.

Matheson (2012) carried out a research on teaching through problem solving: bridging the gap between vision and practice. The study examined a mathematics classroom where students were taught mathematics through problem solving. Information was collected through weekly observations as well as interviews in order to collect information from students with a broad range of ability levels and diverse attitudes about mathematics. The research viewed whether it was possible to create a dynamic, problem solving environment consistently within the classroom. It also tried to view how teaching through problem solving affect low-achieving students. The findings were that it was possible to create a conducive environment for problem solving. The knowledge gap was that the research did not show the link between the understanding of the problem solving method the teachers had and how this affected the performance of the learners.

2.4 MONITORING OF THE PROBLEM SOLVING METHOD

The most important achievement of a teacher is to help his/her students along the road to independent learning. In problem based learning, teacher acts just as facilitator, rather than a primary source of information or dispenser of knowledge. Roh (2003) argued that within problem based learning environments, teachers' instructional abilities are more critical than in the traditional teacher-centred classrooms. Beyond presenting mathematical knowledge to these students, teachers in problem based learning environments must engage students in marshalling information and using their knowledge in applied and real settings. The most important achievement of a teacher is to help his/her students along the road to independent learning. In problem based learning, teacher acts just as facilitator, rather than a primary source of information or dispenser of knowledge.

The teacher has an important achievement role to play of helping his/her pupils along the teaching learning process. In the problem solving method, the teacher acts as a mediator, facilitator. This is rather than being a primary source of information or dispenser of knowledge. We include problem solving in mathematics because it can stimulate the interest of the students (Wilson, 1993).

"Problem solving is natural to young children because the world is new to them and they exhibit curiosity, intelligence and flexibility as they face new situations. The challenge at this level is to build on children's innate problem-solving inclinations and to preserve and encourage a disposition that values problem solving. Teachers should encourage students to use the new mathematics they are learning to develop a broad range of problem-solving strategies, to pose (formulate) challenging problems and to learn to monitor and reflect on their own ideas in solving problems" (NCTM: 116). Pupils are curious. Therefore in order to build on their innate curiosity, problem-solving experiences should be integrated. They need to be integrated into many aspects of their school day. Mathematical ideas can be developed around problems posed by teachers and pupils. Teachers need to value the thinking and efforts of the pupils as they develop a wide variety of strategies for tackling problems.

Mathematics Heads of Department play a significant role. They provide leadership as mathematics specialists in assisting teachers in the teaching and learning of the subject within the department. For a teacher to succeed, they provide both guidance and support in order for the teacher to perform well consistently. The National Council of Supervisors of Mathematics (NCSM, 2008) advocated for the leaders in Mathematics education at all levels of the school or education institution, which would include Heads of Department, of high quality school programmes. This would include the problem solving method. In addition, NCTM (2000) acknowledges and supports the idea that teacher leaders (HoDs) can have a significant influence in assisting teachers in building their mathematical and pedagogical knowledge.

Pennant (2013) laid down the aspects to view in a mathematics lesson involving the problem solving method. She has considered aspects such as who does most of the talking in the classroom and the questions which need to be asked. For example, solving an advanced

mathematics problem independently by the pupils require the coordination of a number of complex skills. The pupil in this case must have the capacity to reliably implement the specific steps of a particular problem-solving process, or cognitive strategy. It also requires the pupils to also possess the necessary meta cognitive skills to analyze the problem. Thereafter select an appropriate strategy to solve that problem from an array of possible alternatives. Later, monitor the problem-solving process to ensure that it is carried out correctly. It is incumbent for those monitoring the use of the problem solving method in the teaching of mathematics to be conversant.

Ali (2010) carried out a study to investigate the effects of using problem solving method on student's achievement in mathematics. The result showed that there was significant difference between the effectiveness of traditional teaching method and problem solving method in teaching mathematics at elementary level.

Zang (2010) carried out a study on the inference on students' problem solving performance through three case studies. The study investigated the problem solving behaviours as each solved four common non-routine problems. The major goals of the researcher were to determine whether the individual's performances were consistent across different subject areas and problem types that could be solved using different heuristics and to identify possible factors that influenced children's choices and strategy use in different contexts. The results showed that self-monitoring was positively correlated with success in performance on certain mathematical activities.

Brown (2016) carried out a study on the use of the problem solving method in a middle school mathematics response to intervention programme. He carried out a study in order to gain insight on how middle school mathematics teachers use the problem solving process to design interventions for struggling students and to understand the strategies they used to implement the plan. The result was that the social change could be achieved through the response to interventions mathematics study by providing teachers with instructional strategies that cultivate the growth of academic confidence and achievement of all students in the general education classroom.

Yuan (2016) carried out a study on the teacher's role in problem solving, a study of elementary mathematics programmes from teacher's perspectives. The purpose of this study was to investigate the possible discrepancies between theoretical understandings of problem-solving and the implementation of problem-solving in classroom settings. Despite the fact that a lot of research has been conducted on how students engage in problem-solving, it is still unclear how teachers implement and assess the development of problem-solving competences of their students. This study examined the ways in which elementary school teachers incorporated problem-solving in their math programs to provide insights on how to improve current problem-solving instruction. The findings indicated that teachers' actions before, during and after a problem-solving task greatly influenced the quality of the task. In addition, teachers addressed the importance of creating a classroom environment that encourages students to engage in problem-solving. These findings provide practical ideas that teachers can implement to improve their own problem-solving instruction.

CHAPTER THREE

3.0 THEORETICAL AND CONCEPTUAL FRAMEWORKS

3.1 INTRODUCTION

This chapter highlights the theoretical and conceptual frameworks.

3.2 THEORETICAL FRAME WORK

The theoretical frame work plays an important role in guiding the entire process of the research. Eisenhart (1991:205) defined a theoretical framework as “a structure that guides research by relying on a formal theory...constructed by using an established, coherent explanation of certain phenomena and relationships.” A theoretical frame work is a group of related ideas. These related ideas provide guidance to a research project. The theoretical frame work is also considered to be a structure for supporting ideas. The theoretical framework is the structure that can hold or support a theory of a research study. Theoretical frameworks provide a particular perspective, or lens, through which to examine a topic.

This research was guided by Vygotsky’s Zone of Proximal Development theory. It has been argued that the application of Vygotsky’s theory of the Zone of Proximal Development (ZPD) could improve mathematical achievement (Roosevelt, 2008). “Zone of proximal development’ is a term which is most widely and well known. This term has been associated with Vygotsky’s scientific production. The term now appears in most developmental and educational psychology textbooks, as well as some general psychology textbooks. The zone of proximal development (ZPD) has been defined as, “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers” (Vygotsky, 1978:86).

The issue of the perception of the Heads of department and Mathematics teachers towards the teaching and learning of Mathematics using problem solving method is critical in the teaching and learning process for the pupils. Within educational research, the concept of zone of proximal development is now used widely in studies about teaching and learning in many subject-matter

areas such as mathematics. It has been argued that the theoretical significance of the ZPD is that it enables penetration into the causal-dynamic and genetic connections determining the process of mental development (Chaiklin 2003; Obukhova and Korepanova, 2009). Therefore, the zone of proximal development is the distance between what a person can do with and without help. The term proximal, which means nearby, indicates that the assistance provided goes just slightly beyond the pupils' current competence complementing and building on their existing abilities (Cole and Cole, 2001).

According to Vygotsky, for the curriculum to be developmentally appropriate, the teacher must plan activities that encompass not only what children are capable of doing on their own but what they can learn with the help of others (Karpov and Haywood, 1998). The pupils gain knowledge from previous lessons, share experiences with the other pupils in the classroom. Vygotsky's theory does not mean that anything can be taught to any child. In essence, only instruction and activities that fall within the zone promote development. Practice of previously known skills and introduction of concepts that are too difficult and complex have little positive impact. Teachers can therefore use information about both levels of Vygotsky's zone of proximal development. This is in relation to organizing classroom activities. This can be done through the instruction. It can be planned to provide practice in the zone of proximal development for individual children or for groups of pupils. This means that the pupils in a new learning situation can practice what they previously learnt in terms of information or pre-requisite knowledge. Cooperative learning activities can be planned with groups of children at different levels who can help each other learn. The ZPD is believed to point out the difference between the child's capacity to solve problems on his own and his capacity to solve them along with receiving assistance (Schultz, 2004).

Scaffolding (Wood, Bruner and Ross, 1976) is a tactic for helping the child in his or her zone of proximal development in which the adult provides hints and prompts at different levels. In scaffolding, the adult does not simplify the task, but the role of the learner is simplified "through the graduated intervention of the teacher" (Greenfield, 1984:119). In this case the teacher plays a critical role of the mediator. The concept of ZPD involves connecting unlearned material to what is familiar. The teachers play a pivotal role in the application of ZPD in the classroom. They

provide appropriate scaffolding strategic social interactions, learning experiences and instruction based on a student's past performance, intuition and current thinking that guide effective learning and development.

Scaffolding facilitates a pupil's ability to make sense of new situations. This is built on prior knowledge as well as transfer learning. Scaffolding improves learning and there are many ways to do this. Scaffolds may include manipulatives, games, models, cues, prompts and hints, partial solutions, think-aloud modeling, or using contextual problems based on a student's interests. Scaffolds should engage learners in sense-making and critical thinking and this is in line with the use of the problem solving method in the teaching and learning of mathematics. Vygotsky's (1978) theory addresses how to increase a student's cognitive development. His term, zone of proximal development (ZPD), addresses the manner in which a teacher can increase cognitive growth. According to Vygotsky, a student should be presented with problems to solve that are challenging. The student should be capable of solving the problem with guidance from the teacher whose role should be more like a facilitator (Vygotsky, 1978).

A teacher who teaches one or two subjects would have more time to adequately plan the learning experiences suggested by Vygotsky (1978). If a teacher teaches in his or her area of specialty, he or she will be equipped with the content knowledge to provide skill appropriate opportunities for learning. The teacher in a departmentalized setting would have time to create experiences in which the teacher has a role that is more facilitative in nature. The depth of knowledge the teacher has in the subject would allow the teacher time to assess an accurate skill level of a student in order to provide a prescribed problem that falls in the students' ZPD (Vygotsky, 1978). Some supporters of the traditional classroom share the belief that a pupil's psychological needs are met.

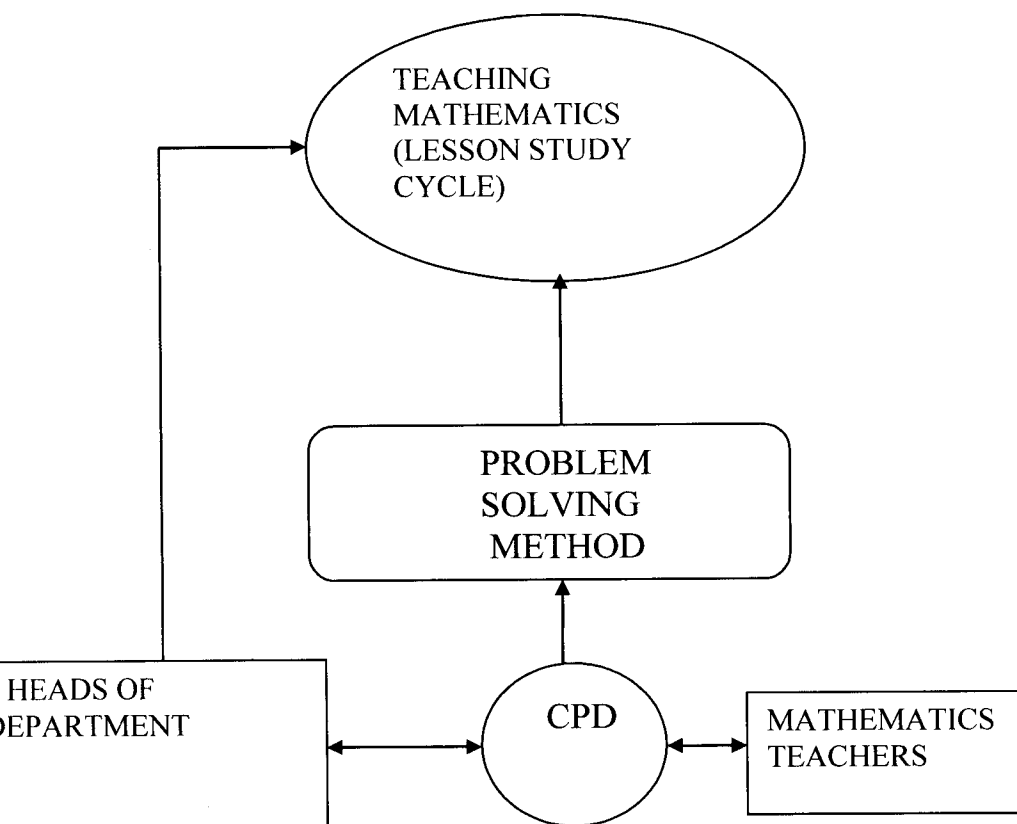
Examining Maslow's hierarchy of needs reveals that following physical needs, one of the most basic needs for people is safety. The diagram supports that elementary students in a traditional setting feel safe; therefore, their needs are met and they are in a better place to learn. In Maslow's opinion, it is more important that the student be in a classroom with a nurturing teacher rather than a knowledgeable teacher. Following the quote by Roosevelt, the security of

the classroom is more beneficial to learning than the knowledge possessed by the teacher (Maslow, 1970).

3.3 CONCEPTUAL FRAMEWORK

Miles and Huberman (1994) defined a conceptual framework as a visual or written product, one that explains, either graphically or in narrative form, the main things to be studied - the key factors, concepts, or variables and the presumed relationships among them. A conceptual framework is considered an analytical tool with several variations and contexts. It is used to make conceptual distinctions and organize ideas. Strong conceptual frameworks capture something real and do this in a way that is easy to remember and apply (Kaplan, 1964). A conceptual framework is also considered as an organization or matrix of concepts that provides a focus for inquiry. There are a group of concepts that are broadly defined and systematically organized. This is in order to provide a focus, a rationale and a tool for the integration and interpretation of information. The conceptual framework is usually expressed abstractly through word models. The framework is the conceptual basis for many theories, such as communication theory and general systems theory. Conceptual frameworks also provide a foundation and organization for planning.

Figure 1: Conceptual Framework



CHAPTER FOUR

4.0 RESEARCH METHODOLOGY

4.1 INTRODUCTION

Chapter four highlights the research design, study site, study sample, sampling techniques, data collection instruments, data analysis instrument and procedures and trustworthiness of the study.

According to Polit and Hungler (2004:233), methodology refers to ways of obtaining, organizing and analyzing data. Methodology decisions depend on the nature of the research question. Methodology in research can be considered to be the theory of correct scientific decisions (Karfman as cited in Mouton and Marais 1996:16).

Buckley and Chiang (1976) define research methodology as “a strategy or architectural design by which the researcher maps out an approach to problem-finding or problem-solving.” Noor (2008) further alludes to that the choice of research methodology is based upon the type and features of the research problem. The research methodology covered the research design, study site, study population, study sample, sampling techniques, data collection instruments and data collection procedure and timeline.

4.2 RESEARCH DESIGN

The research was qualitative in nature. Parahoo (1997:59) states that a ‘qualitative research focuses on the experiences of people as well as stressing uniqueness of the individual.’ Qualitative research refers to inductive, holistic, emic, subjective and process- oriented methods used to understand, interpret, describe and develop a theory on a phenomena or setting. It is a systematic, subjective approach used to describe life experiences and give them meaning (Burns and Grove 2003:356; Morse and Field 1996:1999). Qualitative research is mostly associated with words, language and experiences rather than measurements, statistics and numerical figures. The qualitative approach in a way allows a systematic subjective way to describe life experiences and situation. It gives meanings to this. In qualitative research, the process of interpretation produced data. The data which was collected suited the qualitative research due to the natural settings such as the classroom observations backed by interviews.

Survey design method was deployed. Scheuren (2004) posits that the word "survey" is used most often to describe a method of gathering information from a sample of individuals. This "sample" is usually just a fraction of the population being studied. Survey research or design is a method of sociological investigation that uses question based or statistical surveys to collect information about how people think and act.

Survey research is often used to assess thoughts, opinions and feelings (Shaughnessy, Zechmeister and Jeanne, 2011). The survey design was chosen because the study involved asking the respondents, for information using interviews. Survey design is defined as a research technique in which information is gathered from a sample of people by use of data collection technique based on communication with a representative sample of individuals (Zikumund, 2000).

4.3 STUDY SITE

The study was carried out in 2 secondary schools in Siavonga district, A and B,

4.4 STUDY POPULATION

The intended respondents were the Heads of Department and Mathematics teachers.

4.5 STUDY SAMPLE

The sample included 2 Mathematics Heads of Department and 2 Mathematics teachers.

4.6 SAMPLING TECHNIQUES

Sampling is the procedure a researcher uses to gather people, places or things to study. It is considered to be a process of selecting a number of individuals or objects from a population. That population is such that the selected the selected group contains elements representative of the characteristics found in the entire group (Orodho and Kombo, 2002). The sampling technique which was used was purposive. Two secondary schools were purposely selected within Siavonga district.

Purposive sampling, also known as judgmental, selective or subjective sampling, is a type of non-probability sampling technique. Non-probability sampling focuses on sampling techniques

where the units that are investigated are based on the judgment of the researcher. The main goal of purposive sampling was to focus on particular characteristics of a population that are of interest, which enabled you to answer the research questions. Purposive sampling was used to select the Heads of Department. Simple random sampling was used to select the Mathematics teachers.

4.7 DATA COLLECTION INSTRUMENTS

Data for this study was gathered through, interviews and observations through the lessons.

4.7.1 Interviews

Fraenkel and Wallen (2009) define interviews as the careful asking of relevant questions. In-depth semi-structured interviews were used to collect data because feelings, thoughts and intentions cannot be observed. The type of interviewing used was the semi-structured interviewing. Semi-structured interviewing, according to Bernard (1988), is best used when you won't get more than one chance to interview someone and when you will be sending several interviewers out into the field to collect data. The semi-structured interview guide provides a clear set of instructions for interviewers and can provide reliable, comparable qualitative data.

Semi-structured interviews are often preceded by observation, informal and unstructured interviewing in order to allow the researchers to develop a keen understanding of the topic of interest necessary for developing relevant and meaningful semi-structured questions.

The inclusion of open-ended questions and training of interviewers to follow relevant topics that may stray from the interview guide does, however, still provided the opportunity for identifying new ways of seeing and understanding the topic at hand.

Typically, the interviewer has a paper-based interview guide that he or she follows. Since semi-structured interviews often contain open-ended questions and discussions may diverge from the interview guide, it is generally best to audio-record interviews and later transcript this information for analysis. Semi-structure interviews can provide reliable, comparable qualitative data. This is in reference to Appendices A and B. HoD (Head of Department) 1 and Teacher 1 from school A and HoD 2 and Teacher 2 from school B were interviewed. Data was collected through in - depth interviews from the Heads of Department and teachers. Lesson observation

was done with the teachers. Appendix A was used to interview the Heads of Department whilst Appendix B was used for the teachers. Appendix A and Appendix B were slightly different. Appendix A was focusing on the aspect of administration and management on the problem solving method by the Heads of Department. Appendix B dwelt mostly on the aspect of the teaching and learning of the problem solving method by the teacher.

4.7.2 Lesson observations

Marshall and Rossman (1989) define observation as, “the systematic description of events, behaviours and artifacts in the social setting chosen for the study.” Observation is therefore the active acquisition of information from a primary source. Qualitative research uses observation as one of the data collecting methods. Fraenkel and Wallen (2009) contend that for researchers, observation entails that the researchers observe subjects as they go about their daily activities and record what they do. Similarly, in this study, the researcher observed the instructional delivery by the selected teachers and recorded the observed data using a classroom observation checklist. Observations consist of detailed rotation of behavior, events and interactions and the contexts surrounding these (Best and Kah, 2006; Cohen et al 201; Miles and Huberman, 1986). Each teacher was observed twice. The tenets of the progressivism learning theory was employed, the researcher observed how teachers ensured learners’ participation in learning in their implementation of classroom practices, how they organized and implemented classroom practices that stimulate learners’ interest and aroused their curiosity to learn and how they involved learners in critical thinking and problem solving in the learning process.

Appendix C was used as the observation schedule. Two lessons were observed for each teacher. Each lesson was video recorded while the researcher was using the observation schedule to take note of the proceedings of the lesson so that the flow of the lesson could be closely followed.

4.8 DATA COLLECTION PROCEDURE

The schools were purposively selected because the population sample was well defined. The purpose of the research was explained to the respondents. There were lesson observations, followed by interviews, using the semi-structured interview with the teachers who taught the mathematics lessons. The Heads of Department were later interviewed.

4.9 DATA ANALYSIS INSTRUMENTS AND PROCEDURES

Hatch (2002: 148) states that “Data analysis is a systematic search for meaning. It is a way to process qualitative data so that what has been learned can be communicated to others. Analysis means organizing and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations, make interpretations, mount critiques, or generate theories.” Kombo and Tromp (2006) stated that data analysis is the examining of what has been collected in a survey or experiment and making deductions and inferences. Analysis of data is a process of inspecting, cleaning, transforming and modeling data with the goal of discovering useful information, suggesting conclusions and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, in different business, science and social science domains.

Data collected was analyzed qualitatively. Qualitative research is a form of social inquiry which is important to understand as it is not a single type of social inquiry. This type of research emerges from a number of different research traditions or disciplines. As a result, there is great variation in approaches for doing qualitative research as a result of this and these approaches are often in conflict. Denzin and Lincoln (2004:2) posit that "Qualitative research is multimethod in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of a variety of empirical materials – case study, personal experience, introspective, life story, interview, observational, historical, interactional and visual texts – that describe routine and problematic moments and meanings in individuals' lives. Dawson (2002:14) posits that “Qualitative research explores attitudes, behaviour and experiences through such methods as interviews or focus groups. It attempts to get an in-depth opinion from participants. As it is attitudes, behaviour and experiences which are important, fewer people take part in the research, but the contact with these people tends to last a lot longer.”

The analysis of qualitative research was involved, aimed to uncover, as well as understand data. Thematic analysis was done in the qualitative research. Thematic analysis is used in qualitative research and focuses on examining themes within data. Thematic analysis is one of the most

common forms of analysis in qualitative research (Guest, 2012). It emphasizes pinpointing, examining and recording patterns within data. Themes are patterns across data sets that are important to the description of a phenomenon and are associated to a specific research question.

The information gathered from the interview schedules from both the heads of department as well as teachers were laid down, compared and contrasted. Information gathered from the four lessons observed was also laid down. The information was then place into themes. Sub-themes were further generated from the main themes.

4.10 TRUSTWORTHINESS OF THE STUDY

Streubert, Speziale and Carpenter (2003: 364) describe trustworthiness as “establishing the validity and reliability of qualitative research”. Qualitative research is trustworthy when it accurately represents the experiences of the study participants. Trustworthiness establishes the validity and reliability of qualitative research (Talbot 1995:428). The research demonstrates trustworthiness when the experiences of the participants were accurately represented (Streubert, Speziale and Carpenter 2003:38). Trustworthiness of data in method triangulation is demonstrated through the researcher’s attention to and confirmation of information discovery. This is referred to as rigour. The goal of rigour in qualitative research is to accurately represent the study participants’ experiences (Streubert, Speziale and Carpenter 2003:39). To ensure trustworthiness of the study, information from the research was gathered through lesson observation and interviews for teachers and Heads of Department which were later triangulated, since they were used as strategies for the qualitative research. Moreover, excerpts in participants own words were presented to evidence the themes generated. These were subjected to expert review to check whether the themes were recognizable to others or better themes needed to be generated.

CHAPTER FIVE

5.0 PRESENTATION OF FINDINGS

5.1 INTRODUCTION

The chapter highlights the findings. The findings are presented under headings and themes.

The approach which was used to present the data was the thematic approach. Thematic analysis is a method for identifying, analysing and reporting patterns or themes within data. It minimally organises and describes your data set in detail. However, it also often goes further than this and interprets various aspects of the research topic (Boyatzis, 1998). The themes were in line with the three research questions. The following were the research questions:

- (i) How are Mathematics teachers implementing the Problem Solving Method in the teaching and learning of mathematics?
- (ii) What is the Heads of Department and Mathematics teachers' understanding of the Problem Solving Method?
- (iii) How are Heads of Department monitoring the extent to which the Problem Solving Method is implemented in the teaching and learning of mathematics?

Therefore, the main focus of this chapter was to present and analyze data on the the perception of the Heads of Department and Mathematics teachers towards the teaching and learning of Mathematics using problem solving method in a Lesson Study cycle under the following themes.

5.2 The first research question was how are Mathematics teachers implementing the Problem Solving Method in the teaching and learning of mathematics?

The video and audio recordings targeted two schools, two classes and two teachers of mathematics. Both teachers were asked how they used problem solving method. The following themes emerged through the responses.

5.2.1 Arousal for attention

The teachers started lessons with the introduction which had a brief review of the previous lesson. This aroused the attention of the pupils for the new lesson.

Teacher 1: *What did we learn in the previous lesson?*

Pupil 1: *Algebraic expressions in addition and subtraction.*

Teacher 1: *Who can give an example of an algebraic expression?*

Pupil 2: $4y + 2y$

Teacher 1: *Which other way can you show the algebraic expressions?*

Pupil 3: *Apart from addition and subtraction, you may also multiply and divide.*

5.2.2 Key Question

The respondents showed that the key question initiates the Problem Solving Method at the beginning of a problem. One of the teachers responded in this way:

Teacher 1: *Problem solving method process begins with the initial confrontation. It is concluded when an answer has been obtained and considered with regard to the initial conditions.*

5.2.3 Synthesizing

Both teachers responded that they used problem solving activities during their teaching of mathematics. This is what the Teacher 1 had to say:

During my teaching of mathematics, Problem solving method is one of my best methods of teaching mathematics. As I teach using this method, pupils must synthesize what they learnt and apply to the new and different situations.

Teacher 2 had this to say:

I use problem solving method by beginning with the initial confrontation and conclude when an answer has been obtained and considered with regard to the initial conditions. This helps my learners to make connections between theories involved in mathematics and use them in real life situation to deal with different new situations.

5.2.4 Sharing Lesson Objectives

Both teachers were observed teaching Grade 9 classes respectively. In one out of the four lessons observed, Teacher 1 shared the lesson objectives with pupils. Teacher 1 had the following to say:

I introduce to my pupils the objectives of the lesson because I want to assist them to plan how to achieve these objectives.

5.2.5 Pupil Self-regulation

In one out of the four lessons observed, Teacher 2 in one lesson delivered had an indication that the pupils found core contents or concept by themselves and they had the time for evaluating or confirming what they had learnt. Pupils were discussing on the faces, edges and vertex of the three dimensional shapes as they had been placed into groups.

On the cone;

Teacher 2: *How many edges are on the cone?*

Pupil 1: 2. *(Comes in front of the board and counts) There are two faces.*

Teacher 2: *Is it true? (Asks the class).*

Pupils were in agreement

Teacher 2: *How many edges are on the cone?*

Pupil 2: *(Comes in front of the board and counts) There are three edges.*

Teacher 2: *Is it true?*

Pupils murmur

Teacher 2: *I want to hear from you.*

Pupil 3: *(Comes in front of the board) One, two.*

Pupil 4: *One, two, three.*

(Pupils 3 and 4 were hesitant in explaining how they arrived to the answers)

Another pupil volunteered.

Pupil 5: *(demonstrates and holds the actual solid cone showing the edge) A cone has one edge.*

5.2.6 Lesson Evaluation

From the findings from lesson observations by the two teachers, the core contents or concept were explained by the teachers and there was time for evaluating or confirming what the pupils had learnt. Both teacher 1 and Teacher 2 used question and answer method and class exercises to evaluate their lessons and attainment.

Teacher 1 and 2 brought out the following responses:

The lessons objectives were attained. The indications were that the lessons had the key question which motivates learners to solve the problem and drive them to find the core concept (Teacher 2).

My lesson was successful in that I asked the pupils to hypothesize a solution before instructing them to have an activity or experiment. I gave pupils time to solve individually according to the task (Teacher 1).

5.2.7 Group work

From the lessons observed, teacher 1 and 2 introduced group work to solve the problem. The conclusion by both the teacher and the learners was done in the four lessons.

In school A, the teacher wrote some examples of solving algebraic expressions. The teacher asked the individual pupils from the groups to show the working on the board.

Teacher 1: *Simplify* $6a + 2b + 4a - 4b$

Pupil 4: *(Writes on the board:* $8a + 4a - 4b$
 $12a - 4b)$

The answer is $12a - 4b$

Teacher 1: Is that the correct answer?

Pupils raised their hands

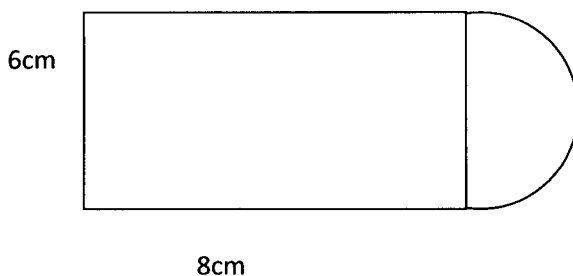
Pupil 5: *(Writes on the board:* $6a + 4a + 2b - 4b$
 $10a - 2b)$

Teacher 1: *Is this answer correct?*

Pupils: *Yes!*

In school B, the teacher wrote on the board the following:

Find the perimeter of this shape below



Teacher 2: *Who can come and show us how to find the answer? Who can come and show us how to find the perimeter of this shape?*

Pupil 6: *(Comes to the board and shows that the perimeter covers the shape of the rectangle board)*

Pupil 7: *(Comes to the board and shows that the perimeter covers one side of the rectangle and the semi-circle)*

Pupil 8: *(Comes to the board and shows that the perimeter covers the distance around the whole shape)*

Pupils agreed with pupil 8.

Teacher 2: *Work in the groups as well as pairs to find the circumference of the shape.*

Group work did not provide the opportunity for the pupils to share their different or similar ideas.

5.2.8 Teaching Learning Materials

All the four lessons had teaching materials used in the lesson such as lids of buckets and containers which were used in School B. One lesson used locally available materials.

In school A, the teacher 1 used a chart showing addition and subtraction of algebraic expressions during the lesson.

Teacher 1: *I would like you to look at the chart showing the algebraic expressions. What is $8b + 3b$?*

Pupil 6: *The answer will be $11b$ (referring to the chart)*

In school B, the teacher used the locally available materials such as lids of containers.

Teacher 2: *In groups, I would like you to discuss and find the circumference of those objects.*

Pupils used these objects to find the circumference by measuring using the strings and rulers.

5.2.9 Importance of Learners’ Thinking Activities

Respondents were not conscious of the importance of learners’ thinking activities which would give them the opportunity to present and discuss their ideas. Both teachers did not allow the learners to justify their wrong answers. In one the lessons, Teacher 2 responded this way:

Teacher 2: *I want someone to count the edges of the pyramid(which has four faces).*

Pupil 9: *One, two, three, four, five.*

Teacher: *Five?.....there are six. You have tried. Who can count properly?*

Pupil 10: *One, two, three, four, five six.*

No follow up was made on why the other pupil found five.

5.3 The second question was what is the Heads of Department and Mathematics teachers' understanding of the problem solving method?

The study had a total number of 2 Heads of Department (HoD) as well a total of 2 teachers. They fully participated during the interviews.

5.3.1 Heart of Mathematics

The respondents' responses showed that Problem Solving Method had the ability to solve a variety of mathematics problems.

HOD 1: *Problem solving is the heart of all mathematics to illustrate the importance of problem solving. In the field of school mathematics, the primary goal of teaching mathematics is to develop the ability to solve a variety of mathematical problems.*

Mathematics as a subject has an important role to play through problem solving. It provides and proves that it has an essential place for future learning. HoD 2 responded as follows:

Problem solving has an important place in the world of mathematics. Evaluation, justification and communicating results are a means to further understand the situation. This is because problem solving is widely seen as providing an essential basis for future learning, for effectively participating in society and for conducting personal activities.

Pupils are able to find their own solutions.

Teacher 1: *Problem solving gives time for pupils to find the solution.*

Teacher 2: *Problem solving enables pupils to be given chance to think on their own, to find their solutions they will never forget*

5.3.2 Enhancing Critical Thinking

Teacher 1 and 2 responded that Problem solving plays a significantly important role as it enhances critical thinking. The teachers further responded that through problem solving pupils can enhance their thinking skills. The following were the responses:

Teacher 1: *Problem solving method is important. Learners are able to think critically.*

Teacher 2: *Problem solving also apply procedures and deepen their conceptual understanding. Problem solving is like a vehicle by which pupils start thinking critically.*

5.3.3 Synthesis of Ideas

The respondents showed that the Problem Solving Method is about synthesis of ideas. Teacher 1 had this to say:

During problem solving activities pupils are involved with given information, formula, computations, figures, graphs etc. with synthesizing ideas, for which pupils must be involved with the entire learning system. Learners' learning is entirely at the centre of the lesson.

5.3.4 Engage Deeper Understanding of Mathematical Ideas

Teacher 2 revealed that problem solving activities is characterized with helping pupils with deeper understanding of mathematical ideas. The following was his narration:

The focus is on teaching mathematical topics through problem-solving contexts and enquiry-oriented environments which are characterized by the teacher helping students construct a deep understanding of mathematical ideas and processes by engaging them in doing mathematics: creating, conjecturing, exploring, testing and verifying.

5.4 The third question was how are Heads of Department monitoring the extent to which the Problem Solving Method is implemented in the teaching and learning of mathematics?

Heads of Department from two schools respectively revealed the extent to which the problem solving method was implemented in teaching and learning mathematics in their schools. The following themes showed the extent of implementation:

5.4.1 Teacher Competence

The study revealed that, the Heads of Department generally monitored the teachers teaching problem solving method. There was consensus that the teachers were trained in the use of the

problem solving methodology in the lesson study cycle. The general concern was that they were few mathematics teachers in the schools. The following were some of the responses:

HOD 1: *Teachers have been trained in the use of the problem solving method.*

HOD 2: *Teachers were trained in problem solving but the number of maths teachers is few.*

5.4.2 Critical Thinking

HOD had similar responses on how they ensure that pupil's work was encompassed with the problem solving method of learning. The work needs to involve critical thinking. This is what they had to say:

HoD 1: *I go round to check the pupils' individual work regularly.*

HoD2 :*I check, I analyze the activities and concepts of capacity building for mathematics knowledge for teaching and instructional leadership*

5.4.3 Continuing Professional Development

HOD 1 and 2 had the following additions:

I also capacity build my members in the Department to improve student achievement in mathematics, I make decisions about programme interventions for student at risk and direct appropriate resources to support student learning of mathematics (HOD 2).

The use of many questions was key in allowing the teachers to mediate and allow the pupils to think critically on their own (HOD1).

This is clearly part of Continuing Professional Development.

5.4.4 Feedback

HOD 2 emphasized the importance of feedback in promoting problem solving method in teaching and learning. He said:

Administrators, such as Mathematics heads of department play a key role in this process for teachers. It is important that administrators develop and refine their mentorship skills in providing informative and reflective feedback to their teachers.

5.4.5 Effective Communication

HOD 2 also pointed on issues of effective communication. The following was the response from him:

“Such informal dialogue promotes a consistent school-wide focus on developing a school culture of inquiry and learning of mathematics for teaching.”

5.4.6 Effective Monitoring

HoD 2 emphasized on the need for monitoring.

HoD 2: Promoting the use of effective mathematics instructional practices, improving student achievement in mathematics, making decisions about programme interventions for students at risk, building capacity for mathematics knowledge for teaching and instructional leadership in mathematics education, directing appropriate resources to support student learning of mathematics.

CHAPTER SIX

6.0 DISCUSSION OF FINDINGS

6.1 INTRODUCTION

The chapter discussed on the findings presented in the previous chapter under the thematic headings and sub headings which were derived from the data. The data collected from the Heads of Department and the teachers gave the insight of how the problem solving method was used in the teaching and learning of Mathematics in a Lesson Study cycle.

6.2 Implementation

The findings show that the teachers try to use Problem Solving method in the teaching and learning of mathematics. There was pupil involvement and the pupils were given chance to think independently. There was arousal for attention when lessons were introduced. The teachers acknowledged that the key question initiates the Problem Solving Method. There was evidence of self regulation. All the lessons involved Teaching Learning materials which were relevant to the lessons. Consideration was not taken on the importance of the learners' thinking activities. There was group work, though it did not provide the opportunity for the pupils to share their different or similar ideas.

In reference to Vogotsky's learning theory of Zone of Proximal Development, The pupils gain knowledge from previous lessons, share experiences with the other pupils in the classroom. According to Vygotsky, a student should be presented with problems to solve that are challenging. Feedback is also important.

The findings are consistent with the prior research by Donaldson (2011) who carried out a study to investigate the teaching practices used by those who teach mathematics through problem solving in terms of the teachers implementing the problem solving method this is in line with the findings on key question and synthesizing. According to the research carried out by Donaldson, teachers taught and mentioned ways of using the problem solving method. In the area of the step of looking back, in the two lessons, the teachers could develop the lesson by showing the

importance of thinking activities for pupils in the reflection part of the Problem Solving Method as was shown on the theme of pupil self regulation. Merely accepting answers, without attempting to critique and synthesize individual contributions does guarantee participation, is less demanding on the teacher, but can constrain the development of mathematical thinking (Mercer 1995). Pupil self regulation was an indication that the pupil was thinking critically.

Vygotsky's concept of the zone of proximal development is based on the idea that development is defined both by what a child can do independently and by what the child can do when assisted by an adult or more competent peer (Daniels, 1995; Wertsch, 1991). Knowing both levels of Vygotsky's zone is useful for teachers, for these levels indicate where the child is at a given moment as well as the pace at which the pupil is performing. The zone of proximal development has several implications for teaching in the classroom.

The findings on sharing of lesson objectives give an indication that the problem solving method is yet to be maximized by the teachers in terms of implementation. In the problem solving method, pupils are required to take more responsibility for their own learning.

6.3 Understanding of Problem Solving Method

With regards to the understanding of the problem solving method by the teachers and the Heads of Department, the study yielded the following findings; Problem solving was considered to be the heart of mathematics. Problem solving has an important place in the world of mathematics and that it was widely seen as providing an essential basis for future learning. Problem solving enhances critical thinking. It is also about the synthesis of ideas with the learner as the centre of the learning system. The findings also showed that problem solving is a catalyst for helping pupils with deeper understanding of mathematics.

The results of the findings on understanding, the theme engage deeper understanding of mathematical ideas, concurred with Perveen (2010) who studied on effect of the problem-solving approach on academic achievement of students in mathematics at the secondary level. The results from the research done by Perveen indicated that the problem-solving method need not

be more time consuming than the expository method of instruction at the age level. When given an equal amount of time to work on learning tasks, pupils using the problem-solving method tended to be superior to pupils taught by the expository method. The theme engage deeper understanding of mathematical ideas on problem solving activities can be connected to the theme on lesson evaluation which was based on the lessons which were taught. It must be borne in mind that Perveen's aim of his study was to compare the effectiveness of the expository and problem solving approach of teaching mathematics at the secondary school level. In contrast, the current study concentrated on the problem solving approach. The variance is that Perveen's study brought out the view that when subjects were taught using the problem solving method, their achievement in Mathematics improved compared to the subjects taught by the expository strategy. The attribute to improvement and achievement of the pupils is the teachers' understanding of the problem solving method. The theme of synthesis of ideas correlated with the theme synthesizing under the heading implementation.

According to Vygotsky, for the curriculum to be developmentally appropriate, the teacher must plan activities that encompass not only what children are capable of doing on their own but what they can learn with the help of others (Karpov and Haywood, 1998). Vygotsky coined the term 'Zone of Proximal Development' to refer to the zone where teachers and students work as children move towards independence. The teaching of mathematics using the problem solving method is appropriate for Vygotsky's theory. This is in reference to the findings on the catapult deeper understanding of mathematical ideas on problem solving activities

The emphasis is on finding interesting and engaging tasks or problems that help illuminate a mathematical concept or procedure when problem solving is used as context for mathematics,. By providing this problem-solving context, the teacher's goals are multiple: He/she should be able to create opportunities for students to make discoveries. To be able to solve problems, one must have deep, conceptual understanding of the mathematics involved; otherwise, one will be able to solve only routine problems and not those that are complex. For a pupil to become a good problem solver, he/she must truly understand the inherent concepts. In this case, understanding enhances problem solving.

Pupils' mental webs of ideas grow more complex and more robust when they solve problems that force them to think deeply and to connect, extend and elaborate on their prior knowledge. Pupils should be able to brainstorm, become creative using previously learnt concepts. Pupils demonstrate conceptual understanding by interpreting the mathematical principles in a problem and translating those ideas into a coherent mathematical representation using the important facts of the problem. Students show good conceptual understanding of the mathematics in a problem when they choose appropriate representations, use relevant information, use mathematical terms precisely and select applicable mathematical procedures (NCTM, 1989, 2000).

6.4 Monitoring by the Heads of Department

The findings showed that the Heads of Department were aware of the teacher's competence in the problem solving method. The Heads of Department were aware of the involvement of the pupils' critical thinking exhibited in the work given by the teacher. The Heads of Department were involved in the Continuing Professional Development as exhibited through their response on capacity building. Feedback plays a vital role as well as the effective communication within the department as well as carrying out effective monitoring.

The findings on monitoring were consistent with the research done by Brown (2016) who carried out a study on the use of the problem solving method in a middle school mathematics response to intervention programme. He had carried out a study in order to gain insight on how middle school mathematics teachers use the problem solving process to design interventions for struggling students and to understand the strategies they used to implement the plan. The instructional strategies which are provided to the teacher show that the teachers require Continuing Professional Development as part of capacity building.

Vygotsky's theory of ZPD plays a pivotal role in encouraging the teachers to plan for their work, bearing in mind the prior knowledge of the pupils. Pupils need to be challenged and actively engaged in the learning of mathematics appropriately. Pupils need to develop thinking skills that will help to make sense. Fisher (2000) alludes that thinking skills enable pupils to turn experience into learning.

True problem solving is as demanding on the teacher as it is on the pupils. The art of teaching mathematical problem solving is best mastered over a long period of time (Thompson, 1989). Teachers must perceive the implications of pupils' different approaches, whether they may be fruitful or not. The teacher must also decide when to intervene and what suggestions will help the pupils while leaving the solution essentially in their hands and carry this through for each pupil.

Other researchers have also adopted similar models for structuring classroom activity, in part, perhaps, influenced by the Japanese approaches. These researchers emphasize the importance of: anticipating student responses to cognitively demanding tasks; careful monitoring of student work; discerning the mathematical value of alternative approaches in order to scaffold learning; purposefully selecting solution-methods for whole class discussion; orchestrating this discussion to build on the collective sense-making of students by intentionally ordering the work to be shared; helping students make connections between and among different approaches and looking for generalizations; and recognizing and valuing students' constructed solutions by comparing this with existing valued knowledge, so that they may be transformed into reusable knowledge (Brousseau 1997; Chazan and Ball 1999; Lampert 2001; Stein, et al. 2008).

Pedagogically, teachers must make complex decisions about the level of difficulty of the problems assigned. They need to know when to give help and how to give assistance that supports pupils' success. In the process the teacher needs to ensure that the pupils retain ownership of their solution strategies.

McIntosh and Jarret (2000:10) posit that "Letting go of the "expert" role teachers have traditionally played requires experience, confidence and self-awareness." It has been discussed from the past experiences that teachers were asked to teach mathematics they never encountered in school and in a way that differs from how they were taught.

CHAPTER SEVEN

7.0 CONCLUSION AND RECOMMENDATIONS

The chapter presents the conclusion and recommendations from the dissertation.

7.1 CONCLUSION

The research aimed at analyzing the perception of the heads of department and Mathematics teachers towards the teaching and learning of Mathematics using problem solving method in a Lesson Study cycle. The two mathematics teachers knew the Problem Solving Method and they said that they had used it in their lessons. Through lesson observation, the teachers were conscious in setting objectives in lesson planning and were able to set attainable and measurable lesson objectives. The teachers started lessons with the introduction which had a brief review of the previous lesson and this aroused the attention of the pupils for the new lesson. The teachers prepared and used teaching materials apart from chalkboard and chalk. One teacher did fully understand the importance of key question as this is connected to the lesson objectives comparatively as well as to select appropriately the contents to be dealt in group work. Teachers at times were not conscious of the importance of learners thinking activities which give them the opportunity to present and discuss their ideas. In some of the lessons it was clear that the teachers had difficulties in allowing pupils to find the core contents or concepts of lesson by themselves.

In terms of understanding, it is clear that the Heads of Department know the problem solving method in the teaching and learning of mathematics with the teachers. Today's mathematics teachers are experiencing major changes not only in the mathematics content they teach, but also in the way they teach. Nearly all of these teachers came through school when mathematics consisted of a collection of facts and skills to be memorized or mastered by a relatively homogeneous group of students taught using a lecture approach. Now teachers are called on to teach new, more challenging mathematics to a very diverse audience using active learning approaches designed to develop understanding.

The study has clearly brought concerns in the way the pupils are handled in the classroom. In as much as teachers are using the problem solving method, the pupils lacked more activities and situations which would allow the pupils to continue thinking critically and express themselves in

terms of their opinions in the finding of the solutions. Problem solving method involves pupils who need to be active and are able to share their experiences in the learning environment.

7.2 RECOMMENDATIONS

The following were the recommendations.

7.2.1 Recommendations for policy

Continuing Professional Development requires to be further re-enforced as a policy for the teachers to share the knowledge and skills in the use of the problem solving method in mathematics from those teachers who have gained experience and expertise. Furthermore, problem solving method is required to be one the main features of the learner-centred methodologies to be taught at colleges of education and universities in the area of mathematics as a policy.

7.2.2 Recommendations for practice

Heads of Department need to take a leading role in the guidance on the use of the problem solving method so that there is effective practice in the classroom. Teachers need to engage more on Continuing Professional Development meetings concentrating on the vital stages of the problem solving method through peer lesson observations.

7.2.3 Recommendation for further research

Further research is required for the teachers to understand the role of questions and key questions in the use of the problem solving method.

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APPENDIX A
INTERVIEW GUIDE FOR HEAD OF DEPARTMENT

You have been selected for the interview. Please be assured that there is no right or wrong answer. Your responses shall be accorded the due recognition and confidentiality they so deserve.

SECTION A: GENERAL INFORMATION

1. Gender (a) Male (b) Female
2. Age bracket (a) 22-30 years (b) 31-40 years (c) 41-49 years (d.) 50 years and above
3. Highest education level (a) Doctorate (b) Masters (c) Bachelors (d) Diploma
4. (i) Academic..... (ii) Professional Qualification:
5. Date of a as Appointment as Head of Department.....

SECTION B: OTHER INFORMATION

6. What type and levels of questions do teachers ask their pupils during the teaching and learning of Mathematics?

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7. Do the questions provoke pupils thinking and cause them to come up with their own ideas?

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8. To what extent do the teachers' use the problem solving method to help in improving pupils' achievement in Mathematics in the school?

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9. How does the teachers' use of many questions in a lesson help the pupils understand a concept?

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10. In a short statement explain how questions and exercise help pupils understand the mathematical concepts fully?

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11. How do you monitor activities given to pupils during a lesson?.....

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12. Do the activities given to the pupils promote problem solving? If yes explain briefly how they do so.

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13. What kind of activities and questions do you think can promote thinking in pupils?

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THANK YOU FOR YOUR CO-OPERATION

APPENDIX B

INTERVIEW GUIDE FOR TEACHERS

You have been selected to attend the interview. Please be assured that there is no right or wrong answer. Your responses shall be accorded the due recognition and confidentiality they so deserve.

SECTION A: GENERAL INFORMATION

1. Gender (a) Male (b) Female
2. Age bracket (a) 22-30 years (b) 31-40 years (c) 41-49 years (d.) 50 years and above
3. Highest education level (a) Doctorate (b) Masters (c) Bachelors (d) Diploma
4. (i) Academic..... (ii) Professional Qualification:
5. Date of Appointment as a teacher.

SECTION B: OTHER INFORMATION

6. Do you think your lesson had the problem solving method?
If yes, state how the method was used
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.....
7. Do you think it's important to use the problem solving method in any mathematics lesson and was the objective achieved? If Yes... State the reasons.
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8. Were teaching/learning aids used? If yes mention the aid and explain how they were useful to the pupils.

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9. What kind of group work was used?

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10. What activities were given to pupils to do in groups or pair?

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11. To what extent was group work effective to the pupils?

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12. Did the teacher give enough time to pupils to do the activity? Explain

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13. Were the pupils able to give out their ideas on the activity given to them? Explain

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14. Did the pupils have a part in concluding the lesson? Explain

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15. Do you think it is important to use a problem solving method in a lesson?

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THANK YOU FOR YOUR CO-OPERATION

APPENDIX C

LESSON OBSERVATION GUIDE

A. GENERAL INFORMATION

GRADE	
TOPIC	
SUB TOPIC	
DURATION	
NO. OF PUPILS	

B. OBJECTIVES AND ATTAINMENT

S/N	ITEM	YES	NO	COMMENTS
1.1	Are the lesson objectives clearly stated in the lesson plan?			
1.2	Are the stated objectives attainable in the lesson by the learners?			
1.3	Are the stated objectives measurable?			
1.4	Were the lesson objectives told to the learners during the lesson?			
1.5	In the lesson, did the learners find core contents or concept by themselves?			
1.6	Was there time for evaluating or confirming what the learners had learnt?			
1.7	Were the lesson objectives attained?			

B. LESSON PROGRESSION

S/N	ITEM	YES	NO	COMMENTS
2.1	Was there an introduction in the lesson?			
2.2	Did the teacher present the problem?			
2.3	Was there key question in the lesson?			
2.4	Did the teacher ask the pupils to hypothesize a solution before instructing them to have an activity or experiment?			
2.5	Was there time to solve the task given by individual?			
2.6	Was there presentation by learners after an activity?			
2.7	Was there a discussion among learners to find answers or better solutions to the given tasks?			
2.8	Were both the teacher and the pupils able to conclude what they had learnt in the lesson?			

D.TEACHING MATERIALS

S/N	ITEM	YES	NO	COMMENTS
2.1	Did the teacher use any kind of teaching materials apart from chalkboard and chalk?			
2.2	Did the teacher use improvised or locally available teaching materials in the lesson?			

2.3	Were the pupils were able to use or understand the prepared teaching materials?			
2.4	Did the teaching materials used in a lesson enhance pupils' understanding?			

GENERAL COMMENTS

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