IMPROVING TEACHERS' PEDAGOGICAL PRACTICES THROUGH LESSON STUDY IN SECONDARY SCHOOLS IN MASERU LESOTHO

BY

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RESEARCH

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DEDICATION

I wish to dedicate this work in memory of my late parents Makalo Azael Mohlakore and ‘Mamoliehi Eusebia Mohlakore who fostered the value and love for learning in me. I know they would be proud of me for my achievement. I have no doubt when they look down upon me, their hearts are filled with joy. I wish to thank them for making me see the value of education. I also wish to dedicate this piece of work to my late in-laws Noha Albinius Makara and Malineo Mathilda Makara. I know my father-in-law would be smiling with joy over my achievement.

ABSTRACT

In Lesotho, there is a general concern about the performance of learners in mathematics. There are many factors which can contribute to this. One of the factors can be the quality of teachers themselves. This study was set to improve teachers' pedagogical practices through Lesson Study in Secondary Schools in Maseru Lesotho. Firstly, the study established teachers' understanding and their pedagogical practices before and after an intervention could be given. The study also sought to explore if there were any changes in teachers' classroom practices and also if there was any impact on learners' understanding of mathematics after teachers had undergone Lesson Study training. The challenges that teachers experienced in implementing Lesson Study were also looked at.

The study adopted a mixed method approach which employed a questionnaire, observations and interviews. The first phase of the study consisted of 200 secondary mathematics teachers in Maseru to whom questionnaire was administered. The second phase of the study was made up of 18 teachers from three secondary schools based in Maseru. These teachers received a one day intensive training on Lesson Study which was followed up by another one day school-based intensive training. In this phase data was collected using classroom observations and interviews.

The findings from the study indicated that Lesson Study had positive impact on both teachers and learners. As a result of participating in Lesson Study, teachers were now able to reflect on their practices, and this had improved their pedagogical practices, and content knowledge. There had also been an improved teacher collaboration. All these attributes led to improved teacher-confidence in the teaching of mathematics.

The results also revealed learners whose teachers participated in LS were motivated, participated more in classroom discussions and showed more understanding of mathematical concepts. However, the findings had revealed that time was a major of challenge encountered during implementation of Lesson Study in Lesotho. Teachers did not have a common time for meetings due to their packed timetables. A model of Lesson Study which emerged from the findings of this study showed that unlike in other LS models where one teacher presents the research lesson and others observe and take notes on learners' learning, the Lesotho model showed that teachers used team-teaching.

KEYWORDS

Lesson Study

Professional Development

Research Lesson

Collaboration

Pedagogical Practices

Secondary Teachers

Professional Learning Communities

Mathematics teaching

Learners' Learning

Content Knowledge

Pedagogical Knowledge

Pedagogical content Knowledge

DECLARATION WITH REGARD TO

INDEPENDENT WORK

I ‘Mamocheta Makara hereby declares that this research project submitted at the Central University of Technology, Welkom campus for the degree of Philosophiae Doctor Educationis titled: *Improving Teachers’ Pedagogical Practices through Lesson Study in Secondary Schools in Maseru Lesotho*, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and that this has not been submitted before to any institution by myself or any other person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification

_____ _____

DATE

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ACRONYMS AND ABBREVIATIONS

CIE : Cambridge International Examinations

COSC : Cambridge Overseas School Certificate

ECoL : Examinations Council of Lesotho

INSET : In-service Training

JC : Junior Certificate

LGCSE : Lesotho General Certificate in Secondary Education

LPP : Legitimate Peripheral Participation

LS : Lesson Study

MoET : Ministry of Education and Training

NCTM : National Council of Teachers of Mathematics

PCK : Pedagogical Content Knowledge

PLC : Professional Learning Communities

PSLE : Primary School Leaving Examination

RSA : Republic of South Africa

SACMEQ : Southern and Eastern Africa Consortium for Monitoring Educational Quality

SPSS : Statistical Package for the Social Sciences

OECD : Organisation for Economic Cooperation and Development

CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND TO RESEARCH

Lesotho is a small country surrounded by the Republic of South Africa (RSA) and has the population estimated at 1.8 million. Lesotho gained its independence in 1966 and since then Lesotho has been working towards improving its education system from primary level, secondary level and tertiary level by using different systems. Formal education in Lesotho follows a 7–3–2– 4 structure with 7 years of primary, 3 years of junior secondary, 2 years of senior secondary, and 4 years of tertiary education (Human Development Sector Africa Region: 2005). Completing primary education is marked by passage of the Primary School Leaving Examination (PSLE), which measures students' basic knowledge of science, social studies, English, mathematics and Sesotho, at the end of the seven-year primary cycle. However, mathematics, English and Sesotho are regarded as core subject at PSLE and are considered as passing/failing subjects.

The secondary level covers three years after PSLE in which learners are awarded a Junior Certificate (JC). At JC level there are various subjects which learners have to do. Mathematics at this level forms part of core subjects which is awarded more hours than any other subjects. The three years of secondary schooling is followed by two years of senior secondary education. At the end of this senior level, learners used to sit for Cambridge Overseas School Certificate (COSC) which was administered in the United Kingdom (UK), but now COSC has been replaced by Lesotho General Certificate in Secondary Education (LGCSE) which is administered by the Examinations Council of Lesotho (ECoL) in collaboration with Cambridge International Examinations (CIE). After completing LGCSE, learners are now ready for tertiary education.

Even though mathematics has been awarded more hours than any other subjects at all levels, the performance has not been satisfactory at all levels. The study conducted by Nenty (2010) also indicates that there has been a continuing decline in the quality of education at all levels in Lesotho, especially at the secondary level where the rate of pass in Cambridge Overseas School Certificate (COSC) examination declined from 61% in 1970 to 21% in 1981. He further showed that the status quo has resulted in a critical shortage of post-secondary students for scientific and technical training which poses a lot more serious problems when it comes to performance in mathematics, which is required as a core subject for such training.

Learners' performance in mathematics, nationally and internationally, leaves a lot to be desired regarding the state of our mathematics education in Lesotho and the quality of mathematics teachers we have in the country. However, it should be noted that there are many factors that can contribute to low learners' performance in mathematics. Some of these factors could be high teacher-pupil ratio which may not allow teachers to effectively assist learners during teaching-learning process, lack of resources which may constrain the teacher to impart knowledge. According to the SACMEQ data, the performance of Lesotho students falls well below the average, with scores of 447 on mathematics while the average score was 500 (Human Development Sector Africa Region, 2005). Reports by ECoL also show serious deficiencies in the mathematics achievement at both primary and secondary levels as shown in the Tables 1.1 and 1.2.

Table 1.1: Performance of Mathematics at Primary School Leaving Examination from 2007 – 2012

Year	Number of candidates	Symbol 1	Symbol 2	Symbol 3	Failed
2012	39,631	9,404 (23.73%)	9,293 (23.45%)	10,486 (26.46%)	10,447 (26.36%)
2011	40,755	9,537 (23.4%)	11,839 (29.05%)	9,492 (23.29%)	9,887 (24.26%)
2010	41,936	9,138 (21.79%)	10,291 (24.54%)	12,291 (29.31%)	9,796 (23.36%)
2009	41,388	9,788 (23.65%)	10,496 (25.36%)	11,125 (26.88%)	9,979 (24.11%)
2008	41,716	10,250 (24.57%)	10,045 (24.08%)	10,296 (24.68%)	11,126 (26.67%)
2007	42,089	8,906 (21.16%)	10,833 (25.74%)	8,624 (20.49%)	13,752 (32.61%)

Table 1.2: Performance of Mathematics at Junior Certificate level from 2007 - 2012				
Year	**Number of candidates**	**Obtained credit (Symbol A-C)**	**Obtained pass (Symbol D-E)**	**Failed (Symbol F-G)**
2012	24,147	2,796 (11.58%)	9,678 (40.08%)	11,673 (48.34%)
2011	24,582	2,531 (10.3%)	10,275 (41.8%)	11,776 (47.9%)
2010	24,559	2,284 (9.3%)	10,855 (44.2%)	11,420 (46.5%)
2009	22,883	2,082 (9.1%)	9,428 (41.2%)	11,373 (49.7%)
2008	19,823	1,863 (9.4%)	7,632 (38.5%)	10,328 (52.1%)
2007	19,168	1,363 (7.11%)	7,397 (38.59%)	10,408 (54.3%)

(Source: Examinations Council of Lesotho, 2013)

The status quo needs immediate attention with regard to the support provided to the teachers to address this situation. In the past, the Ministry of Education and Training (MoET) embarked on numerous initiatives in an endeavor to improve the performance of mathematics in Lesotho. One of the initiatives involved collaboration between British Overseas Development Agency and MoET. The Secondary School Project was the initiative which was meant to improve the teaching of English, Mathematics and Science through providing resources, advice and guidance on how to teach these core subjects (MoET, 2002).

This project started in 1986 with expatriate experts from Britain assisting teachers in three regions in Lesotho which were central, southern and northern regions. These expatriate experts established resource centres in the regions where they were based. In their regions these experts would meet with teachers every week to deliberate on issues pertaining to the teaching of the three core subjects. In these workshops teachers used to deliberate on how to teach problematic topics in mathematics, relevant teaching materials and provision of exemplars of activities in different subjects that could be used in the classrooms with learners. During school visits, subject specialists would sometimes teach the lesson to show teachers how a certain topic could be taught while the teacher observes and vice versa. The teaching would be followed by discussion between the subject specialist and the teacher.

The project took seven years from 1986 to 1993 during which locals were trained in UK so that they could take over from the British experts. In 1993 when the experts left Lesotho the project was handed over to the MoET which renamed the project as Secondary Education Support Project and was run by locals. The local subject specialists continued with the work left by the British experts, however, the frequency of workshop and schools visits by the subject specialists decreased.

Initially, subject's specialists held weekly workshops, which reduced to monthly workshops, which further reduced to twice a year. The role of the locals' subject specialist changed from those of the British experts in that the local subject specialists were no longer visiting teachers in their schools nor teach certain topics in order to show them how those topics could be taught, and provide teaching materials that would assist teachers and exemplars of activities but rather they spent most of their time in the offices doing clerical work. In the interview with teachers who participated in the project, teachers indicated that they would like to see an increase in the frequency and duration of visits to their schools by the advisors (MoET, 2002). As time passed on, the resource centres just stopped functioning. This means teachers were denied the opportunity to collaborate and assist one another on how to teach Mathematics effectively which they used to do when resource centres were functioning.

Unlike before where teachers were visited and supported in their schools by experts in their mathematics teaching, currently there are no support structures available which address teachers' classroom problems in their schools or even at the resource centers. The only support structure that is now available to teachers is school inspections by inspectors. However, this attempt has had some short-comings in that it does not guide teachers on how to teach mathematics better. During inspection, inspectors observe teachers teaching and write reports on their observation. The Ministry of Education also raised a concern that the subject inspection is limited in scope, for example, in the six years from 1996 to 2001, there were only seven full-scale inspections and with serious delays in submitting a report (MoET, 2005). Hence MoET is concerned that school improvement is unlikely to occur if there is still insufficient inspection coverage coupled with poor quality of reporting especially on information that helps teachers to improve their teaching (*ibid*). Therefore, these

inspections provided by MoET seemed not to assist teachers with challenges they are faced with in their day-to-day teaching. The inspection of schools has been in place for a long time but there has never been any improvement in the performance of Mathematics in schools.

The failure rate of mathematics at all levels of education could be attributed to many factors as has been indicated before. Mogari, Kriek, Stols and Iheanachor (2009) indicate that prominent variables which influence learners' achievement include teachers' knowledge of content and pedagogy, professional development and teaching practices. Mosha (1995) in Komba and Nkumbi (2008) also assert that the effectiveness of the teacher depends on his/her competence, that is, academically and pedagogically. Mogari *et al.* (2009) indicate that for the failure rate to be improved the focus has to be on teachers as they are the ones who daily interact with learners in the class. They further argue that teachers are the ones who prepare and plan lessons to be taught, arrange and organize the subject matter, knowledge, prepare and organize the necessary teaching-learning resources, select and identify appropriate teaching strategies for their lessons. Qhobela and Moru (2014) further indicate that most secondary level teachers in Lesotho tend to use chalk-and talk teaching strategies with minimal opportunities for students to talk amongst themselves about what they are learning or sharing of ideas.

In the classroom, the teacher plays a vital role because he/she is the agent of change. Ways and means by which a teacher conducts himself/herself in the classroom determines to a large extent the behaviour, attitudes and performance of learners. Thus, teachers are faced with a great job of nurturing learners by equipping them with the knowledge and skills that will make them a responsible generation. Thus, during teaching and learning process teachers have to be 'confident in their ability and skills to guide and facilitate meaningful learning' (Mogari *et al*. 2009). On the other hand MoET (2005) is of a view that without sufficient, qualified and well-motivated teachers, quality education would be difficult to achieve. Therefore, if genuine change is desired in the way learners view and perform in mathematics, more emphasis and focus should be on improvement of teachers' teaching practices.

Teaching and learning process is not an easy task especially where teachers are not confident enough with their content and pedagogical knowledge. Hargreaves and Bascia (2000) show that all teaching requires an intellectual grasp of subject matter and reflective relationship to practice. They indicate that teaching is a complex work requiring sophisticated professional judgment that draws on deep intellectual resources of knowledge, expertise, reflection, research and continuous learning. Thus for teachers to work effectively and efficiently, they must be guided by certain behaviors which make teaching a success.

Mogari *et al*. (2009) argue that education and training provided to teachers should not only focus on familiarizing them with various instructional models but it should also put emphasis on deepening their understanding of the mathematical content, their interpretations of the mathematical content in the context of facilitating meaningful learning, their knowledge of learners' conceptions and learning difficulties. Hargreaves and Bascia (2000) indicate that for teachers to overcome the challenges of teaching they must have the following attributes:

- Master new content knowledge and meet increasingly demanding content standard.
- Learn to plan their teaching differently around what students must know, not what teachers prefer to teach. These new forms of planning are highly complex such that even best teachers need considerable time and support to be expert in them.
- They must commit to continuous professional learning of formal and informal kinds as they respond to rapidly changing worlds of their learners and the demands of the policy for ever improving standards.
- Know how to learn from and collaborate effectively with others around them. Teachers need to draw on every source of learning and assistance available so that they do not become overwhelmed by facing the increasing demands of their job alone (p.7)

What is evident from the above discussions is that practicing teachers have to be provided with INSET programmes that allow for collaboration, be committed to

continuous professional development that will allow them to plan lessons which focus on learners' thinking. Since INSET programmes that teachers were provided with failed to bring the desired outcomes, it is important to consider an INSET programmes that are school-based which will allow teachers to collaborate and support each other in the environment where they are. Research has shown that the most effective school-based professional development programmme is lesson study which originated in Japan (Sanders, 2009; Chassels & Melville, 2009). Lesson study is described as a school-based, collaborative, professional development process by which teachers seek to improve the teaching and learning that occur in their classrooms (Stigler & Hiebert, 1999).

1.2 RESEARCH PROBLEM

For the past decades, the performance of mathematics in the Lesotho secondary schools had not been satisfactory such that some of the topics which were thought to be challenging were removed from the syllabus. This, however, did not bring about any significant change in learners' performance. The Ministry of Education and Training had provided numerous professional development programmes to teachers in an attempt to address this problem. But nothing has changed. The type of professional development programmes provided by MoET were such that only one teacher from each school was invited to such programmes. These programmes were once off as they were normally held during school holidays for a maximum of three days. After these workshops, teachers who had attended were expected to share what they had learnt with their colleagues.

Elmore (2004) points out that the problem with these kinds of professional development programmes offered by the MoET is that they do not offer teachers an opportunity to engage in a continuous and sustained learning about their practices in their own setting, where they can be observed by their colleagues and observe others confronting similar problems. Similarly, HarwelL (2003) illustrates that when teachers take time to interact, study together, discuss teaching, and help one

another put into practice new skills and strategies, they grow and their students' behaviours improve accordingly.

Therefore, Lesotho needs a professional development programme that is school-based, classroom rooted, on-going and collaborative. In order to improve teachers' pedagogical practices, the study sought to establish current teachers' pedagogical practices so that they could be provided with an intervention that is school-based, classroom rooted, on-going and that fosters collaboration amongst teachers.

1.3 THE AIM AND RESEARCH QUESTIONS

In an attempt to establish teachers' pedagogical practices and their understanding of Lesson Study (LS), the study seeks to answer the following research questions:

a) What are teachers' pedagogical practices before lesson study training?
b) How does the lesson study training impact on teachers' pedagogical practice?
c) What are the effects of lesson study on learners' understanding of mathematics?
d) Which challenges do teachers experience in implementing lesson study?

1.4 OBJECTIVES OF THE STUDY

In an attempt to answer the above research questions, the study is intended to address the following objectives:

a) Establish teachers' insights about different teaching strategies;
b) Investigate the changes in the teaching strategies used by teachers ;
c) Determine how the use of lesson study has changed learners' understanding of mathematics;
d) Establish teachers' experiences in using lesson study.

1.5 SIGNIFICANCE OF THE STUDY

Though Lesson study has been widely used in Japan, but it is not popular in many countries including Lesotho. This study is carried out to establish the effects of Lesson Study on teachers' pedagogical practices in secondary schools in Lesotho. Since this study is the first of its kind carried out on Lesson study in Lesotho, it is significant in various ways. The findings of this are going add to the existing body of knowledge on Lesson Study in Lesotho where the conditions might be different from the conditions where lesson study had been practiced.

The study will also inform the key stakeholders – educational leaders, educators, principals and teachers about the impact of lesson study on both teachers and learners who in turn might adopt and use it for other teachers throughout the country. The results of this study may also offer all the stakeholders an understanding regarding challenges that might arise in the implementation of lesson study and how such challenges could be addressed on time. The findings of this study will reveal the type of lesson study model emerged in Lesotho schools. Conceptual framework guides and support the research study that is being carried out by relating it to research work which has been done before. The conceptual framework for which this study was based upon is discussed in the next section.

1.6 CONCEPTUAL FRAMEWORK

Lesson study a form of collaborative practice, is a school based professional development initiative that aims to enhance teaching and learning through the methodology of professional sharing of practice (Burgess, 2009). Lesson study has a long history in Japan as it was first developed as an educational practice in which teachers, in collaboration with lecturers and Japanese Experts, tried out some teaching models where teachers were reflecting and promoting the new paradigm of the secondary mathematics and science education, in which learning activities were not only perceived pragmatically and are short time oriented, but also can be perceived as a long-life time purposes (Marsigit, 2007). In Japan, LS forms an

integral part of pre-service teacher training programme. It is also the core professional development process Japanese teachers use to continually improve the quality of teaching/learning experiences.

Cerbin and Kopp (2006) illustrate that there are seven stages of LS process which are formulating learning goals, designing the research lesson, planning of the research lesson, teaching and observing, reflecting on the research lesson, revising the lesson and documenting the findings**.** According to Burghes and Robinson (2010), LS is based on three underlying principles.

The first principle states that teachers learn best from and improve their practice by seeing others teach. During the planning session, teachers deliberate on the content to be taught and how it should be presented. Through LS, teachers get the opportunity to see teaching and learning as it takes place in the classroom and improve their teaching practices in the process.

The second principle says that teachers who have developed deep understanding of a skill in pedagogy should share their knowledge and experience with colleagues. In LS, teachers are actively involved in the process of instructional change in which the teachers reciprocally learn from one another. Thus, the collaboration through LS minimizes isolation between teachers, builds rapport and develops a common understanding of how to systematically and constantly improve instructions and learning.

The third principle states that teachers should cultivate learners' interest and focus on the quality of learning. By observing other teachers teach, teachers are able to develop a common understanding of what good teaching practice involves, which in turn helps learners understand what they are learning. Hence, LS keeps learners at the heart of the professional development activity.

Research shows that most of what is happening in the classroom is solely left in the hands of an individual teacher and yet, these teachers are expected to perform to the highest quality level. According to Little, Gearhart, Curry, and Kafka (2003), teachers are usually alone when they examine learners' work and think about learners' performance. In an attempt to address this challenge, they described several projects that have enabled teachers to leave the isolation of their own classrooms and think together about learners' work in the broader contexts of school improvement and professional development. The formation of Communities of Practice (CoPs) in the schools or regions has enabled teachers to work together, share their experiences and address their day to day challenges.

Lesson study is a form of professional learning community in which teachers come together to deliberate about their own teaching. Wenger, McDermott and Snyder (2002) illustrate that a community of practice is a group of people who share a common concern, a set of problems, or interest in a topic and who come together to fulfil both individual and group goal. When teachers gain knowledge through participation in professional learning communities, Wenger refers to this as situated learning.

In Lesson Study, teachers get the opportunity to see teaching and learning as it takes place in the classroom. This provides the context for teachers to re-structure beliefs about their own teaching practices. Teachers through LS participation are actively involved in the process of instructional change. Thus, they have an opportunity to integrate the new practices in their teaching.

In participating in LS, teachers may transform their mind-set, beliefs and attitudes as they see their learners' understanding of mathematics improve and as they reflect upon their practices as they see/discuss points of view with each other during LS process. All these attributes are encompassed in transformative learning. Ukpokodu

(2009) defines transformative learning as a process whereby "*we transform our taken-for-granted frames of reference to make them more inclusive … and reflective so that they may generate beliefs and opinion that will prove more justified to guide action".* Learning that induces more far reaching change in the teacher than other kinds of learning, especially learning experiences which shape the teacher and produce a significant impact, or paradigm shift which affects the teacher's subsequent experiences are more desirable. Mezirow (1991) further explains transformative learning as learning that produces change, which upon reflection, has a significant impact on the teacher's experiences. Methodology and research design guides the researcher in their actions when carrying out research. The next section discusses the methodology and the research design that were employed in this study.

1.7 METHODOLOGY AND RESEARCH DESIGN

When carrying out research it is important to show the process that is employed and the designs that are used. The next section presents the research methodology and the design followed when carrying out this research.

1.7.1 Research Methodology

The study was informed by positivism and interpretivism paradigms as it used questionnaire, interviews and participant observation to collect data. According to Kwadwo and Hamza (2015) in positivists' methodology the data collection techniques focus on gathering hard data in the form of numbers to enable evidence to be presented in quantitative form. On the other hand, Kura (2012) illustrates that interpretivist uses research methods such as participant and non-participant observation and interviews to understand details of interaction in their context.

The study utilized the mixed methods design in that both quantitative and qualitative approaches were used in collecting the data. These two approaches complemented each other as they have different strengths and weaknesses. According to Thomas

(2003) quantitative research tends to be based on numerical measurements of specific aspects of phenomena from which general description is abstracted; and seeks measurements and analyses that are easily replicable by other researchers.

On the other hand, Joubish, Khurram, Ahmed, Fatima and Haider (2011) indicate that the aim of qualitative research is to help researchers understand the world in which the participants live and why things are the way they are and that it is also concerned with social aspects of our world and seeks to answer questions about it.

There are two main types of mixed designs which are sequential and concurrent mixed method designs. Under sequential mixed method designs there are three designs namely, exploratory, explanatory and transformative. This research therefore, adopted transformative mixed method design. In this design there are two distinct phases of data collection namely quantitative phase and qualitative. According to Cresswell, Plano-Clark, Gutmann, and Hanson (2003) either method may be used first and the priority may be given to either quantitative or qualitative phase and the results of these two phases are integrated together during the interpretation phase.

1.7.2 Procedure

The data for this study was collected at three stages which are going to be briefly discussed.

Stage 1

The first stage of data collection consisted of administration of questionnaires on two hundred (200) secondary mathematics teachers in Maseru which were randomly sampled. The results from questionnaires were used to establish teachers' understanding of LS and pedagogical practices before training could be provided on how to use LS in the teaching of mathematics.

Stage 2

In the second stage, teachers were trained on LS practices. Four schools were purposively selected from the schools whose teachers filled the questionnaire to participate in the training. Only two teachers from these schools were requested to attend the workshop. After the first LS training, the researcher conducted the second training workshop in the schools where teachers who attended the initial training teach. This was done after two weeks of the training workshop for the two schools and for another school after three weeks. The fourth school withdrew from the study after training of LS was done. After the second training, teams in the schools were given an opportunity to plan research lessons on their own. It was then agreed that the research lesson will be taught the following day after its preparation. The researcher then observed one research lesson from each school.

Stage 3

The third stage involved interviewing one teacher from each of the three teams. The interviews were conducted a week after the research lesson had been observed. When all the data has been gathered, it has to be analysed using different analysis techniques. The next section discusses how the data collected will be analysed.

1.7.3 Data Analysis.

Quantitative data collected through questionnaires was analysed using Statistical Package for the Social Sciences (SPSS). The tool provided the researcher with percentages, means, standard deviation and Chi-square tests results from which the researcher made descriptive and inferential analysis.

On the other, hand qualitative data collected using interviews and observations were coded according to their meanings from which themes were generated. The themes that were generated were: Teacher effectiveness, teacher collaboration, impact of Lesson Study on learners' learning and barriers to Lesson Study implementation.

When carrying out a research there are some challenges experienced which may hinder the researcher to come up with the most perfect research. The next section presents some limitations of this research.

1.8 LIMITATIONS OF THE STUDY

Although some precautions have been taken, the research still had some limitations and shortcomings. These included among others, time, size of the sample and availability of resources. Time factor did not allow the researcher to see teachers implementing LS over an extended period of time which would allow the researcher to see their understanding of LS and also to see the impact of LS on learners' performance. The study could not be prolonged due to timed period of study. The group on which the intervention was provided was small and did not represent the majority of secondary mathematics teachers in Maseru. The findings are therefore not generalised to all teachers in Lesotho, but to the sample on which the data was collected. There was also a challenge with regard to the financial resources as the researcher was self-sponsored and could not afford to buy audio visual equipment and pay for research assistants when collecting data.

1.9 DEFINITIONS OF TERMS

Lesson Study- Lesson Study (LS) is a form of teacher professional development that is continuous, school-based, classroom-rooted, teacher-centred, and is designed to assist teachers to produce quality lesson plans and gain better understanding of student learning (Suhaili & Khalid, 2011).

Research Lesson- A lesson that is collaboratively prepared by a team of teachers in which one teaches the lesson while the rest of the team takes evidence of learners' learning (Lewis, 2002b).

Professional Development- activities that develop an individual's skills, knowledge, expertise and other characteristics of a teacher with the purpose of improving teaching and learning(Villegas-Reimers & Reimers, 2000).

Content knowledge- the amount and organization of knowledge in the mind of the teacher which he/she has to deliver to the learners (Shulman, 1986).

Pedagogical knowledge - broad principles and strategies of classroom management and organization that help the teacher to deliver the content knowledge in an organised manner which will help learners understand better (Shulman, 1987).

Professional learning communities- a group of people who are united by a common purpose, shared vision, collective commitments, working together and helping one another to achieve the set goals (Burnette, 2002).

1.10 OUTLINE OF CHAPTERS

This study has been broken down into different chapters that outline what happens at each stage of the research process. This section presents the outline of these chapters.

Chapter 1: Introduction

This chapter explains the background and the aim of carrying out the study. The research questions and objectives to be achieved are also outlined. The conceptual framework of the study, the research design and methodology that the study followed are also briefly discussed. Finally, the limitations of the study, definitions of the terms are highlighted.

Chapter 2: Literature Review

This chapter reviews the literature, paying more attention to LS as a form of professional development program. The benefits of LS in terms of improving different teacher knowledge and teacher effectiveness, and those of improving learners understanding are outlined. Research evidence on the impact of LS from studies that were carried out is given. The challenges of implementing LS in schools are also presented.

Chapter 3: Theoretical framework

This chapter looks at the theories on which LS is based. Since in this study teachers are expected to change their classroom instructional practices after being introduced to Lesson Study, transformative theory which explains how teachers change is presented. Another theory underpinning this study is situated learning theory. The discussion is made by also reviewing current literature on situated learning more specifically within the professional learning communities for both experienced novice teachers.

Chapter 4: Research Methodology

This chapter discusses the methods used for carrying out this study paying attention to the research paradigms guiding this study. The procedure that was followed, methods of collecting data, the instruments used in each case, and the procedure for analysing the data are also outlined. The approaches that have been used to validate the results, and ethical considerations are also briefly discussed.

Chapter 5: Data Presentation and Analysis

In this chapter both quantitative and qualitative data are presented. Firstly, analysis of descriptive and inferential statistics and their interpretation are presented. Then presentation of the qualitative results, analysis and their interpretation drawn from the themes which were generated from the codes are also presented. Finally, the results from both quantitative and qualitative findings are summarised and merged.

Chapter 6: Summary, Conclusion and Recommendations

The chapter provides a summary of all the chapters in this study, it also presents the conclusions drawn from the findings of both quantitative and qualitative data based on the research questions. The model which emerged from the findings is also presented and finally the recommendations arising from the study are made to the responsible bodies in the education system of Lesotho.

1.11 CONCLUSION

The study aimed at establishing the effects of Lesson Study on teachers' pedagogical practices. The study sought to answer the following research questions: What are teachers' pedagogical practices before lesson study training? How does the lesson study training impact on teachers' pedagogical practice? What are the effects of lesson study on learners' understanding of mathematics? Which challenges do teachers experience in implementing lesson study? This chapter provided the background to the study paying more attention to the structure of education in Lesotho, trends in learners' performance in mathematics nationally and internationally and the types of support structures available for teachers. The importance of this study and the research problem also formed the basis for this chapter. The summary of all the chapters in this study was also outlined.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Mathematics is an important element of compulsory education all over the world. For Lesotho, the performance of mathematics in Secondary schools has been declining even though it has been given better status in terms of number of contact hours than other subjects. Current reforms in mathematics teaching have also focused more on learner-centred pedagogy in an effort to improve learners' performance. Furthermore, the Ministry of Education and Training in Lesotho has been providing in-service training programs for mathematics teachers with the purpose of improving their pedagogical practices. Despite all these initiatives taken by the Ministry of Education and Training, learners' performance in mathematics has remained the same. The main reason for the unimproved performance is that "*too little attention has been paid to what actually goes on in the classroom"* (Harwell, 2003:1).

Most of the professional development programs that were provided to teachers did not show the intended results because they did not get to the core of the problem, which was changing teachers' classroom practices. Teachers are introduced to new innovations, yet they are not given an opportunity to practice what they have learnt nor provided with support during implementation of the innovation. Therefore, if teachers continue with old ways of doing things even after undergoing professional development programs; then we cannot expect their learners to change in their performance.

This chapter reviews literature on different types of teacher professional development programs of which the Japanese Lesson Study forms part. The Lesson Study reflects the attributes of effective professional development program. One of the importance of LS is to improve both pedagogical and content knowledge

of teachers; hence this chapter also intends to explore the effects of LS on mathematics teachers' pedagogical practices, the forms of teacher knowledge and how these forms of knowledge impact on teachers' practices. To understand the effectiveness of Lesson Study on improving teachers' practices and learners' performance, evidences from research studies carried out will be presented. In order to improve teachers' classroom practices, effective forms of professional development have to be provided to teachers. The section below presents types of teacher professional development programs and how they differ.

2.2 TEACHER PROFESSIONAL DEVELOPMENT

Teaching is a lifelong career and to become an effective teacher is a journey, not a destination. In professional development, there is no finish line, nor is there a single route to career fulfilment. While most new teachers to the profession go through a standard certification process (see "Professional Development Requirements for Teachers in Louisiana," page 8) and re-certification every five years, the shape a career takes can be significantly different from that of other teachers in a similar grade or subject area. Quality is one of the most important factors as it impacts directly on learners' performance and the quality of learners produced. Therefore, there is a need for teachers to be kept abreast with emerging issues in the teaching and learning of mathematics and for their effectiveness in teaching of mathematics. This could be achieved through provision of teacher professional development programs which address the needs of teachers in their classroom.

According to OECD Report (2010) professional development is defined as "*activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher*" (p.19). Villegas-Reimers and Reimers (2000) also describe teacher professional development as "*a life-long learning process … aimed at consolidating the teachers' professional role … and enabling them to teach effectively at high levels to all children*" (p.19). It is through professional development programmes that teachers acquire knowledge and skills which improve the quality of their teaching and which would ultimately enhance learners' learning. For Schlager and Fusco

(2004) professional development is "*a process of learning how to put knowledge into practice through engagement in practice within a community of practitioners*" (p. 4). Learning within a community of practitioners allows teachers to learn and receive feedback from their peers, and support one another.

2.2.1 Traditional Professional Development

Professional development is a good move towards improving teachers' pedagogical skills and content knowledge for teachers who are already in the teaching fraternity. However, research has shown that the way most teacher professional development programs are structured and introduced to teachers does not bring the intended results. These professional development programs come in the form of workshops, courses and programs which are effected as "top-down" model without considering how effective they might be in developing the teacher professionally.

In introducing teachers to these professional development programs, it is true that they will acquire some new knowledge and skills; however, the question is whether they will be able to translate the new knowledge and skills into effective classroom practices. Designing professional development programs that help teachers change their pedagogical practices poses several challenges. Suurtamm and Vezina (2010) indicate that most teachers have experienced traditional school mathematics programs and in their minds, mathematics largely consists of meaningless memorization of facts, rules, and procedures. Therefore, teachers see their roles as delivering such procedures to learners without necessarily making learners understand what these facts, rules and procedures are and how they came about.

Fullan (1991) posits that nothing has promised so much, yet has been so frustratingly wasteful as the thousands of workshops and conferences that lead to no significant change in practice when the teachers return to their classrooms. Fullan (2007) further elaborates this by saying that, knowledge and skills acquired through workshops, courses and programs "*are not useless, but they can never be powerful enough, specific enough or sustained enough to alter the culture of the classroom*" (p.35). One possible reason for this kind of workshops not to bring about desired

changes in teachers' classroom practices is that they point problems existing in the classrooms but offer little help in changing what happens in the classrooms after the workshops. These programmes also do not provide teachers with opportunities to practice what they learnt. Elmore (2004) reiterates that the problem with teachers development programs is that "*there is almost no opportunity for teachers to engage in continuous and sustained learning about their practice in the settings in which they actually work, observing and being observed by their colleagues in their own classrooms and classrooms of others confronting similar problems"* (p.127).

In summarizing traditional professional development programs, Lieberman and Mace (2008) argue that instead of building a culture of professional learning, teachers are faced with a culture of "compliance", instead of learning from and with their fellow teachers, teachers are being given a script that tightly binds them to a narrow curriculum that may or may not fit the needs of the teachers or of their classrooms. They further say that instead of creating the conditions for teachers to teach each other, support their peers, and deepen their knowledge about their learners, teachers are being given a "one size fits all" set of professional development programs that deny the variability of how teachers teach, and how they and their learners learn. The problem with this type of professional development program is that it assumes teachers have the same problems while in reality they have varied problems depending on their contextual settings as contextual teaching present's information in familiar contexts and in contexts in which the information is useful.

The characteristics of traditional professional development programs discussed above are similar to what mathematics teachers in Lesotho are exposed to. Most of professional development programs offered in Lesotho are run by the Ministry of Education and Training and they normally take place during school holidays where one or two teachers from each school are taken to the centres outside schools and are given a one-shot intensive training on new pedagogies. These professional development programs come in the form of workshops with no follow-ups; it is not surprising that these new innovations are not implemented by teachers in the manner they are meant to be, as teachers do not have enough support within and outside the school during implementation.

2.2.2 Job-embedded Professional Development

For professional development programs to be effective, they should be planned, run and involve the teacher in the context where they work as this will allow them to work within their own frames of reference, thus help them to focus on issues relevant to their situation. To be effective, professional development should include theory, demonstration, practice with feedback, and peer coaching with follow-ups (Joyce and Showers, 2002). According to NCMST (2000) professional development should deepen teachers' knowledge of the subjects being taught, sharpen teaching skills in the classroom; keep up with developments in the individual fields and in education generally; generate and contribute new knowledge to the profession; and increase the ability to monitor learners' work, in order to provide constructive feedback to learners and appropriately redirect teaching. Professional development should always address identified gaps in pedagogical knowledge, content knowledge, pedagogical content knowledge and learner achievement.

On the other hand, Hawley and Valli (1997) in Drago-Severson (2007) indicate that effective professional development for teachers should be job-embedded and be derived from practice. It should also be on-going rather than one-shot experiences; on-site and school based; focus on learner achievement; be centred on teacher collaboration, and be sensitive to teachers' learning needs. Asayesh in CECB (2002) indicates that effective professional development programs are those that have structures set up for consistent follow-up and support. For Hawley and Valli in CECB (2002) support and follow-ups are needed in order to help teachers facing any new issues or problems that may arise from classroom implementation. If teachers are not supported during the implementation of the new practice, they are likely to fall back to their old practices.

Effective professional development should provide teachers with opportunities to practice new skills, strategies and techniques; it should also provide feedback on how teachers are implementing the new practice, and that they should continue to follow-up on teachers but most importantly, professional development should focus on instructional strategies that are proven to impact learners' learning. Hence, the full

potential of professional development may not be reached if teachers do not implement practices learned in their classrooms and supported throughout implementation. Professional development in which participants are given the opportunity to learn new classroom practices in the contexts within which those practices will be used is far more effective than traditional methods of professional development. In other words, contextual teaching is effective in bringing about change in teachers behaviours as well as in improving learner behaviours. Professional development that is designed to take full advantage of the potential of contextual teaching is characterized by the following: it supports interaction among master teachers; it takes place over an extended period of time rather than in one-shot workshops or seminars; it provides opportunities for teachers to try new practices in safe environments and receive feedback from peers about implementation process (Harwell, 2003).

Nowadays, one of the professional development program which has these attributes and is regarded as highly effective is LS. Lesson Study has been traditionally considered one of the professional development processes used to encourage teachers to work together in groups to become more effective (Cheng & Yee, 2011/12). Research evidence shows that LS as a form of professional development can help teachers learn to critically look at learners' work, analyse learners' mathematical thinking and guide learners on the basis of what they have written. Professional development that helps teachers attend to learners' thinking can shift teachers' focus from simply evaluating learners' work as correct or incorrect to analysing the particulars of learners' thinking (NCTM,2010). The above discussion shows that there are different types of professional development programs that teachers can attend. Hence, it is very important to select a professional development program which develops beliefs, skills and knowledge resulting in continued learning. The next section discusses Lesson Study as a form of professional development program.

2.3 LESSON STUDY

Lesson Study (LS) is a form of teacher professional development that originated in Japan and has been cited as a key factor in the improvement of their mathematics and science education (Stigler & Hiebert, 1999). Teachers in Japan work together, to improve their teaching in the context of a classroom through use of LS. Perry and Lewis (2009) describe the LS process as follows:

> *Lesson study is a cycle of instruction improvement in which teachers work together to: formulate goals for learners' learning and long-term development; collaboratively plan a "research lesson" designed to bring to life these goals; conduct the lesson in a classroom, with one team member teaching and others gathering evidence on learners' learning and development; reflect on and discuss the evidence gathered during the lesson, using it to improve the lesson, the unit, and instruction more generally,* (Perry & Lewis, 2009:366).

According to White and Southwell in Suhaili and Khalid (2011), LS is a model of professional development designed to assist teachers to produce quality lesson plans and gain better understanding of learners' learning. It is also perceived as a process in which teachers progressively strive to improve their teaching methods by working with other teachers and critique one another's teaching techniques (*ibid*). Some of the benefits of Lesson Study is that it provides teachers the opportunity to build professional learning communities, deepen their understanding of content and pedagogy, and develop habits of critical observation, analysis, and feedback.

Lesson study is one form of professional development which is on-going, teacher-led, school-based and classroom rooted. Smith (2013) indicates that LS is effective because it occurs within authentic contexts over an extended duration, fosters communication among participants, involves active learning where participants challenge their existing ideas about teaching and learning, and develops new knowledge and skills among teachers informed by data collected through presentation of the lesson. Similarly, Lewis and Hurd (2011) support by saying LS exemplifies qualities of effective professional development as it occurs in a real,

motivating context – the classroom and it focuses on a problem of great interest to teachers which is their shared goal for learners learning and development. In addition, they indicate that teachers draw on expertise from within and outside the school through planning of research lessons.

Lesson Study builds collaboration amongst teachers as they progressively improve lessons that are “our” lessons not “my” lessons (Stigler & Hiebert, 1999). Through collaboration teachers share the problems of discovering connections between research learning and pupils’ outcomes which lead to possible changes in teachers’ practices. Fundamentally, LS is seen as a problem-solving process where improvements to teaching occur over a long period of time through teacher collaboration with the purpose of building their professional and content knowledge, resulting in improved learner achievement. Lesson Study is built on the premise of promoting collaboration among teachers. Each stage of Lesson Study process contains collaborative factors that are enabled during planning of research lesson, reflection of the taught lesson and discussion on the learners’ learning. Ball (1994) illustrates that lack of collaboration result in teachers working in isolation. He demonstrates that:

> *…individualism not only makes it difficult to develop any sense of common standards, it also makes it difficult to disagree. Masking disagreements hides the individual struggles to practice wisely, and so removes an opportunity for learning. Politely refraining from critique and challenge, teachers have no forum for debating and improving their understandings. This lack of collaborative opportunities impedes the capacity to grow.* (p. 16)

In LS, allowing teachers to work together within an established professional community, gives teachers a chance to gain an understanding of learners’ learning and their own pedagogical approaches. Lesson Study therefore, provides a path for teacher advancement within the profession that happens in their environment particularly in the classroom. In LS, classrooms become laboratories where teachers experiment and try-out new ways of teaching without leaving their classrooms. This addresses the problem where teachers used to attend workshops and were later

expected to practice what they have learned in their classrooms and not taking into consideration the differences in their context.

According to Hollingsworth and Oliver (2005) lesson study has the following characteristics:

- Lesson study is characterized by giving teachers an opportunity to see teaching and learning as it takes place in the classroom. It provides the context for teachers to focus their discussions on planning, implementation, observation and reflection on classroom practices. Looking at classroom practice, teachers are able to develop a common understanding of what good teaching practice entails, which in turn helps learners understand what they are learning.
- Lesson study is also characterized by keeping learners at the heart of professional development activity. It provides teachers with an opportunity to carefully observe learners during the learning process and discuss actual classroom practice which in a normal classroom practice does not take place.

Another equally important characteristic of LS is that it is a teacher-led professional development. Through LS teachers are actively involved in the process of instructional change and curriculum development. Teachers participating in LS learn from one another's experiences. In the study carried out by Murata, Bofferding, Pothen, and Taylor (2012) the findings were that through use of lesson study teachers developed in their understanding of learners' learning through conversations around planning a research lesson. This collaboration amongst teachers through LS helps reduce teacher isolation and develops common understanding of how to systematically and consistently improve teaching and learning in the school.

Furthermore engagement in lesson study enhances teacher reflection. Lesson Study is a systematic inquiry into teaching and learning where teachers collaboratively plan, examine, conduct, observe, and reflect on research lessons. After observing the research lesson taught, teachers come together as a group to

reflect on what they saw during the lesson. Ono, Chikamori and Rogan (2013) elaborate that:

> *Reflection, following the observation of a lesson, is an intellectual activity undertaken in a group setting by means of discussion among participants and observers to explore ways of improving the quality of future learners' learning, with particular reference to the design of the lesson, the materials used, and the mode of delivery (p.55*).

Lesson study is also a form of action research which allows teachers to take a central role as investigators of their own classroom practices in an attempt to improve these practices and learners' understanding. Lieberman and Miller in Widjaja (2013) indicate that *"teachers are problem posers and problem-solvers; they are researchers, and they are intellectuals engaged in unravelling the process both for themselves and for their learners*" (p. 725). Similarly, Takahashi and Yoshida (2004) posit that LS allows teachers to investigate their own classroom practices and engages them as researchers of teaching and learning in the classroom. Thus, during the teaching of a research lesson, teachers act as researchers by collecting evidence of learners' learning (which includes misconceptions and difficulties), observe, and document critical behaviours in teaching and learning process.

2.3.1 Lesson Study Process

Lesson study process follows six cyclic steps which are; collaboratively planning the study lesson, observing the researcher lesson in action, evaluating and reflecting on the research lesson, revising the research lesson, teaching and observing the revised lesson, and sharing the new version of the research lesson (Fernandez & Yoshida, 2004). Rock and Wilson (2005) claimed that completing these steps "*requires a group of teachers to collaborate and share their ideas, opinions, and conclusions regarding the research lesson. This process requires substantial time and commitment*" (p. 79). They also asserted that the LS process serves as a

catalyst to encourage teachers to become more reflective practitioners and to use what they learned to collegially revise and implement future lessons.

2.3.1.1 Collaboratively planning the study lesson

Collaboration is a cornerstone of Lesson Study that many teachers embrace as it alleviates the isolation of teaching and allows practitioners to share their experiences and knowledge (Itzel, 2002). The research lesson is developed jointly by all team members. This process starts with the team planning collectively by formulating a learning goal which is of interest to them. Once this has been set, teachers then begin to work on the research lesson which serve as a roadmap that might lead to the achievement of the set goal. Teachers collaboratively discuss the mathematical concept to be taught, how the concept is linked to other mathematical concepts, anticipate learners' misconceptions and questions on the concept and identify key factors leading to learners' misconceptions or learning difficulties. Once this has been done, teachers plan a lesson by drawing on their past experiences, observations of their current learners, their teacher's guide, their textbooks, and other resource books.

The product of this first step is a lesson plan that describes in detail the design which the group has settled for. In essence, Ferreira and Ono (2010) summarize this phase by pointing out that mapping out lesson plans requires teachers to have a good understanding of their learners' needs, pre-knowledge and misconceptions and are also encouraged to anticipate the challenges learners may encounter in the lesson and to be prepared with appropriate strategies to assist them. Similarly, Richardson (2004) points out that at the beginning of the planning phase, teachers share and discuss their existing lessons related to the concept to be taught, explaining what they believe has been successful and where they believe the lessons could be improved. The group also identifies what learners will say and do which will signal that they have learned what the teacher intends to have them learn. The development of the lesson by the group of teachers signals that the lesson is not owned by an individual but by the team.

Research has shown that teachers who have participated in LS found this phase to be important and beneficial. One teacher who participated in Lesson study carried out by Ni Shuilleabhain (2015) said

> "*I am not going to say I like planning but it is useful…it's been a very positive experience for me. I've enjoyed it and I have got a lot out of it so it's been good. It really shows me that planning is not only important but that it's productive as well and it's a very useful thing to do…It's just working in teams, working with the people that you are with, there's just so many potential benefits in it* (p. 19).

The collaboration that takes place during planning has been found to have many benefits to teachers as it provides them with opportunities to deliberate on concepts to be taught. In the process teacher share their experience, and through this, teachers gain a lot of knowledge and skills about the concept under discussion.

2.3.1.2 Observing the study lesson in action

Once a team of teachers has a planned research lesson, the next step is to implement it. One member of the group teaches the research lesson while the rest of the members observe the lesson as it unfolds and gathers evidence related to the learning goal. Specifically, the team does not observe how the teacher teaches, rather focuses on how learners respond to the lesson, that is, learners' comments, the questions they ask, their thinking, and the work that they produced during the lesson. According to Naresh (2013) during lesson planning and instruction the teachers' goal is to understand learners' mathematical thinking and to use it as a lens to further explore mathematical ideas, and inform and enhance their teaching. He further indicates for teachers to use learners' mathematical thinking in their teaching, they must first know what listening entails, in particular, they must know how to question learners, what to listen for, and how to identify learners' understanding based on their verbal and written responses. A teacher who participated in a study carried out by Lewis, Perry, Friedkin and Roth (2012) said:

> *I was surprised at how many learners in each class, including my own, did not successfully complete the objective of the lesson. This made me think not only about math, but about how often learners do not understand what is being taught in other subject areas as well. Having the opportunity to observe learners in class, examine their work afterwards and discuss it was also valuable because we typically do not operate like that, but the knowledge we gained from that process was critical and worthy of our time* (p.372).

In summary, Ferreira and Ono (2010) indicate that the observers listen attentively to all contributions made by the learners, and make a note of the critical remarks by and/or behaviours of the learners in relation to achieving the lesson outcomes. Lesson Study provides an opportunity for teachers to examine leaners' work to make decisions in relation to learners' learning difficulties and to offer solutions which address these difficulties. The observational notes on a lesson plan serve as evidence for later discussions in a post-lesson conference or forum.

2.3.1.3 Evaluating and reflecting on the taught lesson

After lesson observation, an observing team together with the presenter come together to evaluate and reflect on the lesson now that they have seen it unfold in a real classroom. Here the team shares its observations and examine additional evidence that may reveal important insight into teaching practice and learners' learning. Hurd and Licciardo-Musso (2005) point out that during debriefing phase, the teacher who presented the lesson speaks first, reflects on the lesson, commenting on the strengths of the lesson, changes made to the original lesson plan, surprises, and evidence that the lesson met the instructional goals. Then the other members from the planning team individually report what took place during the lesson. It is at this stage that each teacher shares with the rest of the team the strengths and the weaknesses of the lesson, paying more attention to learners' thinking and understanding of the concept that was presented. It is again at this stage where learners' misconceptions become apparent and are discussed in relation to what can be done to improve the lesson such that it addresses these misconceptions.

Ferreira and Ono (2010) sum up this phase by mentioning that all observers are encouraged to contribute to refining and improving the lesson by asking for clarification, recognizing the strengths or good aspects of the lesson and identifying the challenges. Comments on the challenges are accompanied by suggestions and alternatives.

2.3.1.4 Revising the Research lesson

During revision of the research lesson, information that has been collected during the debriefing is used to modify the research lesson (Lewis, 2002). As the team works on modification of the lesson, it specifically looks for incidences during the lesson when learners did not show behaviours that were anticipated and by so doing, the team is able to make necessary adjustments on the research lesson (*ibid*). This process is carried in an effort to increase learners' participation and learning (Hurd & Licciardo-Musso, 2005).

2.3.1.5 Teaching and observing the revised lesson

Once the research lesson has been revised, another member of the group teaches the new version of the research lesson in his or her classroom, while colleagues again come to observe. One important reason for changing the teacher and the class or learners is to allow the team a broader base of experiences and give as many teachers as possible a chance to teach in the presence of others (Cerbin & Kopp, 2006).

2.3.1.6 Sharing the new version of the study lesson

Once the revised research lesson has been taught, the team comes together again to discuss what transpired when the revised research lesson was taught. The research lesson is then documented so that other teachers can use it at the later stage (Cerbin & Kopp, 2006).

Lesson Study is an on-going professional development activity that is characterised as classroom-rooted, school-based, learner-focused, content and pedagogical improvement- oriented, teacher-owned and done collaboratively. In other words LS allows teachers to work collaboratively as a team in their own setting, sharing ideas, visions, beliefs, attitudes, challenges and goals. In summary, teacher participation in Lesson Study provide them with opportunities to build on their understanding of both teaching and learning approaches, they have a chance to incorporate new practices in their own teaching and they begin to focus more on learners' thinking when planning. There are different types of teacher knowledge which teachers gain as they participate in LS. The next section discusses different types of teachers' knowledge gained as a result of participation in Lesson Study.

2.4 TYPES OF TEACHER KNOWLEDGE

Lesson study is not only about producing a well-planned lesson, but it is also about building capacity of teachers, their expertise and knowledge base. For teachers to teach more efficiently and effectively, they need to understand the content they teach, how to pass it to the learners and how learners acquire that content. This implies that there are different types of knowledge that teachers should have. Shulman (1986) classifies teacher knowledge into three broad categories, namely content knowledge, pedagogical knowledge and pedagogical content knowledge.

2.4.1 CONTENT KNOWLEDGE

According to Shulman (1986) content knowledge refers to *"the amount and organization of knowledge per se in the mind of the teacher"* (p**.** 9**).** He further indicates that content knowledge includes knowledge of concepts, theories, ideas, organizational frameworks, methods of evidence and proof, as well as established practices and approaches toward developing such knowledge in a particular discipline. In short, content knowledge can be seen as "*… the amount and organization of knowledge in the mind of the teacher*" (Shulman, 1998:9). Hence in the teaching of mathematics, mathematics teachers should deeply understand the

mathematical ideas (concepts, procedures, and reasoning skills) that are central to the levels they teach and be in a position to communicate these ideas in a developmentally appropriate manner (Papick, 2011).

They should know how to represent and connect mathematical ideas so that learners may comprehend them and appreciate the power, utility, and diversity of these ideas, and they should be able to understand learners' thinking (questions, solution strategies, misconceptions, etc.) and address such in a manner that supports learners' learning. Cox, Webb, Abbott, Blakeley, Beauchamp and Rhodes (2003) support this by saying that teachers need to possess relevant content knowledge in order to make appropriate decisions when choosing content to be taught.

As Shulman (1986) noted, teachers must not only be capable of defining for learners the accepted truths in a domain, they must also be able to explain why a particular proposition is deemed warranted, why it is worth knowing, and how it relates to other propositions, both within the discipline and without, both in theory and in practice. Adedoyin (2011) indicates that teachers who have strong subject matter knowledge give details in their lesson, link the topic to other topics, ask learners many questions, and stray from the textbook. Thus, in the teaching of mathematics teachers not only need to know the mathematics they teach but they need to know the mathematics in ways that are useful for teaching and also be able to understand why a particular content is taught and how the content is developed (Ball, Lubienski, & Mewborn, 2001). Research indicates that there is a relationship between teachers' mathematical content knowledge and their ability to teach well in the classroom (Ball, *et al.,* 2005).

Shulman (1986) also points out that the teacher needs not only understand that something is so; the teacher must further understand why it is so, on what grounds its warrant can be asserted, and under what circumstances. He further indicates that teachers are expected to understand why a given topic is particularly central to a discipline whereas, another may be somewhat peripheral. This highlights that it is important for teachers to know their content knowledge well. Knowing the content knowledge involves being knowledgeable about ideas in the discipline and how they are connected.

In most cases, it is taken for granted that almost all teachers who teach mathematics have enough content knowledge and when things go wrong in teaching, the focus is normally placed on other forms of teacher knowledge (Rollinick, Bennett, Rhemtula, Dharsey, & Ndlovu, 2008). Smith (2004) in Rohaan, Taconis, and Jochems, (2010) points out that content knowledge is important for effective teaching as strong and useful pedagogical content knowledge (PCK) cannot be built on shaky content foundation. Thus, forms of teacher knowledge have been found to depend on one another as a teacher who possesses one form of knowledge cannot function well without other forms of knowledge.

In the absence of sufficient content knowledge, learners can receive incorrect information from their teachers and may develop misconceptions about the content area. In the same way, without adequate mathematical content knowledge, teachers will not be in a position to deal with day to day, recurrent tasks of mathematics teaching, and as such, will not cater for the learning needs of diverse learners (Ball & Bass, 2000). Doerr and English (2006) point out that a lack of mathematical content knowledge can impede teachers' abilities to notice and analyse learners' mathematical thinking, design actions that respond to learners' understanding, or engage in productive professional conversations. Likewise, Mishra and Koehler (2006) show that "*teacher must know and understand the mathematics that they teach, including knowledge of central facts, concepts, theories and procedures within a given topic; knowledge of explanatory frameworks that organize and connect ideas; and knowledge of the rules of evidence and proof*" (p.1026). Hence content knowledge is central to the teacher especially if the teacher `is to teach that content effectively.

2.4.2. Pedagogical Knowledge

Shulman (1987) defines pedagogical knowledge as the broad principles and strategies of classroom management and organization that appear to go beyond subject knowledge. Mishra and Koehler (2008) also describe pedagogical knowledge as a *"deep knowledge about the processes and practices of teaching and learning, encompassing educational purposes, goals, values, strategies, and more"* (p.397).

They further point out that pedagogical knowledge is a generic form of knowledge that applies to learners' learning, classroom management, instructional planning and implementation, and learner assessment. The implication is that pedagogical knowledge requires teachers to have deep knowledge about cognitive, social and developmental theories of learning and how these affect learners learning, thus, how learners construct their own knowledge and acquire skills.

Richards and Farrell (2005) point out that *"pedagogical knowledge empowers prospective teachers with self-awareness of the educational system as a whole together with an understanding of learners supported by studies in psychology and pedagogy*" (p. 9/10). Thus, pedagogical knowledge is vital to teachers as they need to understand how learners come to acquire knowledge. Lesson study offers valuable means of generating teacher knowledge base. It produces knowledge that is immediate and useful to all participating in it. It allows teachers to generate knowledge within the context that responds to everyday demands of the classroom. The lesson study process that is used to produce this knowledge include planning, teaching, gathering data on leaners' learning and evaluating the effectiveness of the teaching. All these attributes corresponds to what teachers do on daily basis and therefore generates a knowledge base that is grounded in the activities of their daily work.

2.4.3 Pedagogical Content Knowledge

Teacher's content knowledge and pedagogical knowledge are complementary and interdependent. These two knowledge categories are synthesized to what Shulman (1986) calls pedagogical content knowledge. Shulman (1987) sees pedagogical content knowledge as "*the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction"* (p.8). He further illustrates that pedagogical content knowledge is knowledge of *"the most useful forms of representation of those (mathematical) ideas, the most powerful analogies, illustrations, examples, explanations and*

demonstrations" (p 9). In other words, pedagogical content knowledge expresses how best a teacher can represent the mathematics content to make it more understandable to the learners.

Also included in this category was knowledge of how learners perceive the topic: what makes the topic difficult or easy for them, misconceptions they might have and strategies for reshaping learners' misunderstandings of these mathematical topics. Gess-Newsome and Lederman (2001) indicate that pedagogical knowledge is a synthesis of all knowledge needed in order to be an effective teacher as it transforms subject matter, pedagogical and contextual knowledge into a unique form –the only form of knowledge that impacts teaching practice.

Adedoyin (2011) demonstrated that in PCK, teachers are always expected to exhibit a basic set of pedagogical knowledge and skills in the classroom, which involves a good knowledge of their teaching subjects, teaching methods, skills and knowledge of child development. He further indicated that in the teaching and learning of mathematics for proper understanding, in-depth pedagogical content knowledge of the mathematics teachers should include, knowing what topics are typically difficult for learners and why, knowing different representations that are useful for teaching a specific idea, and knowing ways to develop learners' understanding of mathematics. This means that a teacher should be able to realize where learners are having challenges in learning the mathematics and hence be able to represent mathematical concepts in a way that their learners can understand without difficulties. For teachers to be able to assist their learners with mathematics content they should have acquired mathematical content knowledge.

2.4.4 Mathematical Content Knowledge as a Form of PCK

Research shows that subject area knowledge is an essential aspect of teacher knowledge and that teachers who possess good mathematical content knowledge have the ability to improve learners' performance in mathematics. Ma (1999) in Livy and Vale (2011) described teachers' mathematical content knowledge as thorough understanding of mathematics which has breadth, depth, connectedness and

thoroughness, referring to this as Profound Understanding of Fundamental Mathematics.

Franke in Eylul and Yesildere (2007) argue that if a teacher has a conceptual understanding of mathematics, this influences classroom instruction in a positive way; therefore, it is important to have mathematics knowledge for teachers. Knowing mathematical content enables the teacher to select the most appropriate teaching methods that can be used to teach a particular topic, explain difficult concepts and guide learners on how to come up with the correct solutions. In support of this Ball, Thames and Phelps (2008) indicated that knowledge for teaching mathematics is essential to learning how to teach subject matter in order for learners to understand, but most importantly it is the subject matter as a teacher cannot teach what he/she does not know. They further point out that an academically rich environment begins with teachers who are knowledgeable in mathematics, learners, and instructional strategies. Knowledge of subject matter with an understanding of instruction, results in a highly effective teacher.

According to Eylul and Yesildere (2007) teachers' interrelated knowledge, procedural rules as well as the mathematical representations are very important because mathematics is seen as a composition of a large set of highly related abstractions. Fennema and Franke (1992) in Eylul & Yesildere (2007) state that 'if teachers do not know how to translate those abstractions into a form that enables learners to relate the mathematics to what they already know, they will not learn with understanding'.

Papick (2011) also indicated that mathematics teachers should deeply understand the mathematical ideas (concepts, procedures, and reasoning skills) that are central to the grade levels they will be teaching and be able to communicate these ideas in a developmentally appropriate manner. He further asserts that teachers should know how to represent and connect mathematical ideas so that learners may comprehend them and appreciate the power, utility, and diversity of these ideas, and they should

be able to understand learners' thinking (questions, solution strategies, misconceptions, *etc*.) and address it in a manner that supports learners' learning.

Similarly, Schoenfeld and Kilpatrick (2008) also indicated that knowing school mathematics in depth and breadth is an important dimension that proficient mathematics teachers require. They described proficient teachers of mathematics as having broad as well as a deep knowledge of mathematics, knowing multiple methods of teaching mathematics, the curriculum and how the ideas develop from conceptual understanding. Likewise, NCTM (2010) show that teachers must be able to choose appropriate mathematical tasks, judge the advantages of particular representations of a mathematical concept, help learners make connections among mathematical ideas, and grasp and respond to learners' mathematical arguments and solutions. They further indicate that a lack of mathematical content knowledge can impede teachers' abilities to notice and analyse learners' mathematical thinking, design actions that respond to learners' understanding or engage in productive professionalism.

Ball (2003) points out that:

> "…*the mathematical knowledge needed for teaching must be usable for those mathematical problems. Mathematical knowledge for teaching must be serviceable for the mathematical work that teaching entails, from offering clear explanations, to posing good problems to learners, to mapping across alternative models, to examining instructional materials with a keen and critical mathematical eye, to modifying or correcting inaccurate or incorrect expositions. The mathematical knowledge needed for teaching, even at the elementary level, is not a watered-down version of "real" mathematics. Teaching mathematics is a serious and demanding arena of mathematical work*." (p. 7).

It is important that teachers possess adequate mathematical content for teaching so that they can be able to help their learners.

According to NCTM (2010) teachers' mathematical knowledge matters and significantly predicts gains in learners' achievement and that to promote instruction which supports learners' learning, teachers need mathematical knowledge that extends beyond an understanding of mathematical procedures and concepts. Ball and Bass (2003) in Burgess (2009) argue strongly that without adequate mathematical knowledge, teachers will not be in a position to deal with the day-to-day, recurrent tasks of mathematics teaching, and as such, will not cater for the learning needs of diverse learners.

Mathematical content knowledge of the teacher determines to a significant extent which questions from learners should or should not be followed up, and also this enables the teacher to interpret and appraise learners' ideas (Burgess, 2009). According to Ball, Hill, and Bass (2005), the quality of mathematics teaching depends on teachers' mathematical content knowledge. If teachers have deficiencies of mathematical content knowledge their abilities to select appropriate mathematical tasks, notice and analyse learners' mathematical thinking will be deterred. In the light of the discussion above, Lesson study provides ongoing opportunities for peer critique of the knowledge that emerges through the process during planning and debriefing.

As teachers collaboratively design and evaluate the research lesson, they engage in rigorous discussion concerning the problematic topic they have to teach, deliberate on the teaching strategies, and materials to be used in the lesson. Once the lesson has been taught during debriefing stage, teachers reflect and deliberate about the effectiveness of the lesson. A teacher with appropriate content knowledge, pedagogical knowledge, pedagogical content knowledge and mathematical content knowledge is effective. The attributes that lead to teacher effectiveness are discussed in the next section.

2.5 TEACHER EFFECTIVENESS

The term "effective" can be used in various ways depending on the discipline one is coming from. In education, teacher effectiveness means the degree to which a teacher achieves desired effects upon learners (Stanford, 2001, in Ismaila, Shahrillb

& Mundiab, 2015). For Moreno Rubio (2009) effective teachers are known by their dedication to the learners and their job of teaching, feel responsible for the achievement and success of their learners and own professional development. He further illustrates that effective teachers really believe that all learners can learn though differently. Hence, it is the responsibility of the effective teacher to motivate their learners, engage all their learners in learning and attend to learners' learning needs. `

In the teaching of mathematics an effective teacher can therefore be the one who uses teaching strategies that generate the desired results and promote learners' understanding (*ibid*). In other words, effective mathematics teacher should have deep knowledge of the subject matter, understanding of what optimizes students' learning, and have best instructional classroom practice. There are different factors that determine teacher effectiveness. These factors are categorized into two, namely professional skills and personal teacher characteristics. The professional factors which this research is more interested in are content knowledge, pedagogical knowledge, good planning, confidence and self-reflective. These factors are elaborately discussed below.

2.5.1 Content Knowledge

The most effective teachers have deep knowledge of the subject they teacher. Once this knowledge falls below a certain level it becomes impediment to learners' learning (Coe, Aloisi, Higgins & Major, 2014). Effective teachers should be competent with the mathematics they teach because lack of subject matter will confine them to the use of learners' textbook. Smith (2004) in Prendergast and O'Donoghue (2014) illustrates that when teachers' knowledge of the subject he/she teaches is restricted to what is in the textbook, the teacher will frequently be at a loss when learners come up with a question, an answer or method different to the one provided.

Stronge (2007) points out that teachers with firm subject matter knowledge are better able to go beyond textbook content. For Reynolds and Muijs (1999) in Moreno Rubio (2009), an effective teacher who has good content knowledge is able to respond spontaneously to demanding learners' questions. In addition, Smith (2004) indicates that a teacher with firm subject knowledge is able to make connections between different elements of mathematics and other subject areas. Making connections between different elements of mathematics and with other subjects is important as it shows the relevance of mathematics to everyday life situations.

2.5.2 Pedagogical Knowledge

Though deep knowledge of subject matter has been found to be very important in promoting teacher effectiveness, but that knowledge on its own is not adequate. Pedagogical knowledge is another important factor that shapes an effective teacher. According to Walker (2013) effective teachers employ a variety of teaching strategies and techniques that engage and keep learners on task as they understand that learners have different learning styles and should adjust their teaching accordingly. He illustrated that for teachers to effectively engage and keep learners on task, they should map out strategies on how well they will teach the content such that it will be beneficial to their learners. McKenzie (2003) illustrates that pedagogy refers to the teaching skills teachers use to impart specialized mathematical content knowledge. He further demonstrates that effective teachers display a wide range of skills and abilities that lead to creating an environment where all learners feel comfortable and are sure that they can succeed both academically and personally.

2.5.3 Good Planning

Having good content and good pedagogical knowledge is not sufficient without a well-planned lesson. A good lesson plan clearly outlines the content and the best ways of delivering the content that will involve learners and keep them interested in the lesson. Effective teachers are therefore considered to be good at planning as

they set clear and achievable learning targets for each lesson and they do this in a very systematic manner. For Santrock (2010) effective teachers set high goals for their teaching and develop organized plans for reaching those goals. These teachers also spent considerable time in instructional planning, organizing their lessons to maximize learners' learning by ensuring that lessons provide learners with opportunities to discuss amongst themselves, also by allowing the learners to give the teacher their feedback in order to improve own knowledge, methodology and learning environment if needed (Moreno Rubio, 2009). Santrock (2010) indicates that as they plan, effective teachers reflect and think about how they can make learning both challenging and interesting. As part of effective planning teachers should give meaning to the subject by facilitating relevant material to the learners wherever possible, and by finding means to stimulate interest on it.

2.5.4 Confidence

A teacher with deep content knowledge and who has a knowledge of appropriate methodologies to deliver that content and who also has good lesson planning skills is highly effective. According to Moreno Rubio (2009) effective teachers believe in themselves, they achieve a lot in the classroom, and the teacher knows what material to cover, and how to teach it. An effective teacher is confident in that he/she knows his/her content, is able to select the best teaching strategies that allows learners to actively participate in the learning, is able to select appropriate teaching and learning materials, he/she can handle any question asked by learners and can open door to other teachers to observe his/her teaching.

2.5.5 Self-reflection

An effective teacher is the one who constantly keeps on reflecting, evaluating and critiquing his/her teaching practices to see if they promote learners' learning. In the process of reflecting, evaluating and critiquing, effective teachers search for better ways of teaching, new tools, materials and methodologies especially for learners

who are not performing well. Moreno Rubio (2009) illustrates that effective teachers promote their own learning by inviting observation and suggestions from colleagues, and by reflecting upon own practices. He further indicates that effective teachers also work collaboratively with other members, are willing to share their ideas, and assist other teachers with difficulties and volunteer to lead work teams and to be mentors to new teachers.

Moral and Dallat (1995) in Cimer, Cimer and Vekli (2013) show that the quality of the learning environment in which teachers are empowered to reflect on their practice is a vital determinant for reflective practice. They however illustrate that when teachers reflect by themselves, their interpretation of action might be more intuitive than interpretive because people bring with them the beliefs and assumptions that define their educational values. Generally, when a person reflects, it is difficult to leave out personal prejudices. Hence, Cimer *et al*. (2013) suggest that teachers need to be supported by colleagues who can assist with teachers' analytic reflection and can reflect, analyse and dialogue about their own practice. They further indicate that reflection is mostly likely to be demonstrated when critical colleagues or collaborative discussions in a supportive and trusting environment are adopted. Hence, if schools are to foster reflective practice in the classroom they must create an environment that values communication, participation, and collaboration where teachers can openly discuss their challenges without fear of being embarrassed. There are different ways in which teacher effectiveness for productive and meaningful teaching can be enhanced. The next section discusses how Lesson Study can be used to improve teacher effectiveness.

2.6 LESSON STUDY AS A MODEL OF IMPROVING TEACHER EFFECTIVENESS

To become an effective teacher one has to keep on improving his/her professional skills to meet the ever-changing needs of the learners. Initial teacher training programmes alone cannot give teacher-to-be enough training that will sustain them throughout their career, especially in the face of the changing needs of today's

learners. It is therefore important that teachers once they are engaged in a teaching profession, they should be supported and be exposed to on-going professional development that will keep their content and pedagogical knowledge alive. Langer in Rock (2003) indicates that teachers who are effective at increasing learners learning are not alone in their efforts, they are connected with people with similar goals with whom they can plan and problem-solve**.** She further indicates:

> *Teachers in the effective programs have at least one colleague at school, or someone who taught elsewhere, or an interested significant other with whom to share joys, agonies, and ideas that affect instructional plans, decisions, and actions. They have contact with individuals who influence the way they view their subject, their learners, and themselves as professionals. Through these interactions, they confront philosophical and superficial differences, learn from and challenge each other, and develop their own voices* (p.36)

Lesson Study involves teachers working in teams or within communities that support development of knowledge and connections among different types of knowledge. It is the process that incorporates solving and discussing mathematics problems, studying learners' mathematical thinking, collaborating with other teachers in planning and discussing instructions, analysing instances of classroom practice, and provision of meaningful feedback during reflection and debriefing stages (Lewis, Perry, & Hurd, 2009). It is during this process that teachers delve deeply into subject matter and increase their content knowledge (Stepanek, Appel, Leong, Mangan, & Mitchell, 2007).

Teachers also identify gaps in their own understanding and develop new insights about content and how to explore it with learners with the help of the knowledgeable others, who are fellow teachers or subject specialists (Stepanek, Appel, Leong, Mangan, & Mitchell, 2007). Thus, the combination of collaboration and focused observation in Lesson Study possesses great potential as a powerful tool for facilitating teacher growth in content knowledge, understanding of pedagogy and ability to observe and understand learners' learning (Myers, 2012).

For Garet, Porter, Desimore, Birman and Yoon (2001) LS is a form of professional development which attends to dimensions of teachers' mathematical knowledge which is more effective than professional development that focuses only on pedagogy or generic teaching skills. On the other hand, LS as a form of practitioners' research provides teachers with an opportunity to investigate issues of teaching and learning in their own classrooms. It can be a method for generating not only practitioner's knowledge but also professional knowledge if it becomes a way to carry out scholarship of teaching and learning (Cerbin & Kopp, 2006).

Lesson Study has been found to impact on all types of teacher knowledge. Fernandez (2005) demonstrates that LS provides teachers with opportunities to develop new pedagogical content knowledge, to learn how to reason mathematically, and give the incentive to learn more mathematics. Meyer and Wilkerson (2011) point out that LS allows teachers to view teaching and learning as they occur in the classroom which with time may result in instructional improvement and increase in teachers' knowledge with focus on the learner and the content.

There are numerous studies on LS which established that during LS process teachers gain different kinds of knowledge at different stage of LS process. In practice, Lesson Study has been found to improve teacher knowledge through group discussion, observation and reflection. In the study conducted by Lim, Allan and Chiew (2005) teachers who participated in the project indicated that through group discussion and observing other teachers teach, they gained and enhanced their mathematical content knowledge as well as pedagogical knowledge.

Similarly, Zanaton, Siti, Siti, and Effandi (2014) saw the element of reflection in teaching as a good approach because teachers have the opportunity to reflect on what is good or bad in their teaching, or rather the extent to which it complied with what was planned and what was delivered in a teaching session. In addition, Lim *et al.* (2005) showed that upon reflection and advice from other teachers who observed the teaching, teachers were able to rectify their own teaching errors. Lim *et al*. (2014) indicated that novice teachers had the opportunity to improve themselves by observing and learning from their experienced colleagues, the skills and techniques in teaching various mathematical concepts and in the same way, the experienced

teachers, can also gain a lot of new and innovative ideas by sharing with the juniors through discussing mathematical concepts, which can enhance their content knowledge and pedagogical content knowledge. During the study, Lim *et al* (2005) observed that participants have regarded the LS sessions as the venue to solve their teaching problems, and to develop their professional knowledge of mathematics teaching and learning.

Lesson Study can enhance teachers' learning experience which includes their content knowledge of the lesson and pedagogical knowledge as well as improving their teaching through observation and reflection activities of teaching practices. In another study conducted by Chiew and Lim (2003) with learner teachers in Malaysia, it was revealed that LS helped in improving the pre-service mathematics teachers' content knowledge, enhancing their confidence to teach the lesson as well and gaining much more diverse teaching ideas, which in turn, helped them improve their pedagogical content knowledge.

In another study carried out in one elementary school by Rock and Wilson (2005) teachers indicated that information learned through the LS process had prompted them to strengthen their instructional vocabulary. For example, one teacher commented during her interview that:

> *I think my vocabulary has improved a great deal. Ann said it really takes a conscious effort to use that vocabulary. When I was doing the lessons I actually had to have an index card with the list of words we said we wanted to use. Having that in front of me made me more conscious about saying "make" instead of saying "build" or "create"* (p. 88).

An academically rich environment begins with teachers who are knowledgeable in mathematics, knowledgeable of learners, and knowledgeable of instructional strategies, (Meyer & Wilkerson, 2011). Thus, LS provides this kind of an environment by supporting the development and transformation of teacher's content knowledge, pedagogical knowledge, and pedagogical content knowledge (Pothen & Murata, 2007). Lesson Study has many benefits for both the teacher and the learner who

practice it especially in the teaching of mathematics and these are outlined in the next section.

2.7 RESEARCH-BASED EVIDENCE OF BENEFITS OF LESSON STUDY

Research evidence has shown that Lesson Study has numerous benefits for both teachers and learners. These benefits include reduction of teacher isolation and stress, enhanced teacher collaboration, building teacher confidence, improving teacher observation and critiquing skills, improvement of learners' achievement and improvement of teacher professionalism.

2.7.1 Benefits to Teachers

Teachers who implemented LS indicated that it had impacted positively in their classroom practices. They illustrated that in engaging in LS process, they have changed the way they plan as they now have to consider learners' learning; the way they teach, as they have improved on pedagogical knowledge gained from fellow teachers; and has promoted their reflection skills. The research-based evidence which shows how LS impacted on teachers is discussed in the next section.

2.7.1.1 Improved Teacher Practice and content Knowledge

Lesson Study provides teachers with opportunities to improve their teaching and learning abilities. It also helps teachers to better understand and analyse learners' learning through reflective process. Lesson Study offers teachers a platform to collaborate among themselves on issues related to mathematics content and the best ways to deliver it to learners. During this process teachers gain more insight into the subject itself and how best it can be delivered to the learners. Research evidence shows that teachers have benefited a lot from participating in LS. In a study carried out by Gardner, Galanouli, Devlin, Magee, McSweeney, McHenry, McVeigh, and Mitchell (2012) one teacher said:

> *I have been inspired by certain strategies that my colleagues employ in their classrooms, so this has allowed me the opportunity to learn from fellow professionals and continue to develop and grow. In addition, and perhaps most importantly, it has highlighted the thoughts and opinions that my pupils have regarding my teaching methods. Through focusing on the pupil voice it has ensured that my evaluation of my teaching is much more worthwhile. … lesson observation is allowing us to focus more meaningfully on the engagement and learning of our pupils. It continually highlights the utmost importance of differentiation and the necessity of implementing a range of teaching activities within our lessons* (p.9).

The above quotation illustrates that LS provides teachers with an opportunity to learn from each other and in the process they improve their own classroom practices and grow professionally. This importance of LS in improving teachers' instructional practices has also been evidenced by another teacher participating in the same study who alluded that:

> *As a result of this project I have gained an invaluable insight into my colleagues' teaching methods and ideas and I have been able to implement these in my own teaching. I have been inspired by certain strategies that my colleagues employ in their classrooms so this has allowed me the opportunity to learn from fellow professionals and continue to develop and grow. In addition, and perhaps most importantly it has highlighted the thoughts and opinions that my pupils have regarding my teaching methods. Through focusing on the pupil voice it has ensured that my evaluation of my teaching is much more worthwhile* (p.8).

A similar observation about the importance of LS towards improving teachers' instructional practices has also been made by a teacher who took part in LS project carried out by Fernandez (2002). This teacher indicated that:

> *In my experience LS is the most important thing for me to improve my teaching method or teaching techniques. Many teachers have observed me*

> *during my lessons and I have asked them to give me comments and to criticize my lessons. . . . Through these experiences, I believe that my teaching method has improved, I believe so* (p.395).

Lesson Study has also been found to reduce teacher isolation by engaging in lesson study process which gives them an opportunity to collaborate with other professionals. The importance of collaboration has been elaborately discussed in the next section.

2.7.1.2 Enhanced Teacher Collaboration

Collaboration among teachers has not been historically the norm, as it is neither taught nor modelled in teacher training courses nor do practicing teachers receive substantial support from colleagues or administrators (Goddard, Goddard & Tschannen-Moran, 2007). Collaboration, which is often absent among teachers, is one of the pillars in Lesson Study. According to Hiebert, Gallimore and Stigler (2002), Collaboration is:

> *"….a process considered central to successful professional development programs—ensures that what is discovered will be communicable because it is discovered in the context of group discussion. Collaboration, then, becomes essential for the development of professional knowledge, not because collaborations provide teachers with social support groups but because collaborations force their participants to make their knowledge public and understood by colleagues* (p. 7).

Lesson Study as a form of professional development shows features of this type of collaboration at different stages of its process. During LS process, a group of teachers meet regularly, once a week for several hours, to collaboratively plan, implement, evaluate, and revise lessons. While this process is unfolding, teachers learn from one another and grow in depth of understanding of content, strategies for teaching that particular concept and critiquing a lesson.

The importance of collaboration in LS has been documented by Buckwalter (2002) who pointed out that many teachers find the collaborative element found in LS to be a welcome change from teaching and planning in isolation, as it gives teachers a terrific chance to collaborate, but more than usual, they can be on the same page about not only having developed the lesson together but also having seen the lesson taught. Likewise, Kilpatrick in Buckwalter (2002) also indicates that the collaborative nature of LS allows teachers to bring new techniques into their regular repertoire by handing out discovery questions, posting learners' responses, and providing more hand outs and hands-on activities.

Evidence showed that mathematics teachers who participated in the study carried out by Cheah and Lim (2005) in Malaysia espoused positively that LS has promoted a collaborative culture that enhances their professional collegial bonds with their colleagues, helped them gain and enhance their mathematical and pedagogical content knowledge through group discussion and peer observation and encouraged teachers to prepare better learner-based activities that constitute good practices of mathematics teaching and learning.

For Rock and Wilson (2005) regular collaboration with peers about curriculum objectives during LS planning stage helps teachers learn new approaches to instructing learners. This was evident from one of the teachers who participated in their study who said:

> *Today's meeting was basically a teacher's planning dream. It was wonderful to sit down together and focus on a lesson plan with the purpose of designing it to meet all of our learners' needs. Sadly, teachers never, or rarely, get an opportunity to work and plan together closely* (p. 86).

Similarly in a study carried out by Chassels and Melville (2009) one teacher alluded that:

> *I learned how extremely beneficial it is for teachers to work together, share ideas, and collaborate with one another. Not only does it help you improve*

> *as a teacher, but it also brings the teachers closer together, so there is a sense of community (p.749).*

Collaboration is therefore at the heart of LS as it allows teachers to engage in regular routines where they share classroom experiences in an effort to strengthen their content and pedagogical expertise. Hence, collaboration is one aspect of LS which is important in promoting effective teaching and learning.

The collaborative nature of LS is to cab the problem of teacher isolation that is so widespread in our schools today. In Lesotho, the situation is such that teachers after joining the teaching profession are left to take control of what is happening in their own classrooms. They are not afforded any opportunity to collaborate and discuss the challenges and successes they experience on daily basis. This situation is similar to what has been described by Robinson (2001) who states that:

> *South African schools have traditionally operated very much in isolation from one another and teachers have not always been offered opportunities to discuss issues which they might be facing in their classrooms and their schools. Even within schools, teachers tend to adopt an approach to teaching which is privatized rather than collaborative, thus minimizing the possibilities for sharing understanding and insights ... The culture that has been encouraged and developed in many schools has been one where teachers would rather work on their own behind closed doors than be open about their concerns and difficulties* (p.103).

Once teachers operate in isolation behind closed doors, this becomes a greatest impediment to learning to teach or to improving existing skills because the situation forces them to rely on trial and error and to fall back on their own memories of schooling for models of teaching (Goddard *et al*., 2007). Through collaboration, LS is seen as a tool for addressing teacher isolation by opening the doors for teachers who work within their classroom and never work with other teachers to improve their practices. DuFour and Eaker (1998) indicate that while traditional teachers work in

isolation, teachers who participate in LS share ideas and knowledge about their practice.

Flinders (1988) in Sindberg and Lipscomb (2005) indicates that isolation restricts opportunities for professional growth and represents a potential barrier to the implementation of reform initiatives. He further points out that isolation in the teaching profession presents two paradoxes. The first paradox is that classrooms are full of learners, but teachers have few opportunities to discuss their work with peers. The second paradox is that teachers may view their classrooms as both a barrier to interaction and a means of protection from outside interferences.

According Lewis (2004), a US educational researcher, Richard Elmore, indicates that "*isolation is the enemy of improvement" (*p. 125). This, according to Lewis (2004), has been supported by one Japanese teacher who noted that if a teacher isolates him/herself and does whatever he/she wish to do, he/she can never conduct good lessons even if he/she has a good lesson plan or good textbooks. Stigler and Hiebert (1999) view LS as a process that "*balances the self-critiquing of individual teachers with the idea that improved teaching is a joint process, not the province or responsibility of any individual*" (p. 123).

On the other hand, Elmore (2006), states that the current traditional structure of schools not only allows for isolation, but in many cases fosters this structure. Hence, lesson study which encourages collaboration amongst teachers should be encouraged in Lesotho schools where this traditional structure is still in practice. Apart from enhancing teacher collaboration, LS has also been found to improve teachers' confidence. The next section discusses the importance of lesson study in promoting teachers' confidence.

2.7.1.3 Building Teacher's Confidence

Confidence is one factor which is very important in teaching as it makes teachers to have a strong feeling about their ability to teach effectively and efficiently. Lesson Study is a tool that can be used to improve teacher's mathematical knowledge which

in turn can help them develop the confidence to teach mathematics as a subject. Craig (2007) in Prince, Snowden and Matthews (2010) sees confidence as a multidimensional concept related to self-esteem, self-efficacy and optimism. She indicates that when one has confidence, he/she:

- Tries new things and becomes more open to learning
- relishes challenging tasks
- risks making mistakes
- says they don't understand and they ask for help (p.46)

Lesson Study improves teachers' confidence by providing them with conducive atmosphere where members of a team collaborate openly without fear of being scrutinized. According to Lim *et al*. (2005) LS is a tool that provides teachers with more self-confidence through the supporting environment provided by their peers. In the study that was carried out in Australia with two secondary schools, Pierce and Stacey (2011) reported that initially only two teachers from school 1 had volunteered to teach a lesson in front of their colleagues, but following the discussion after the first presentation of the lesson, all of the four other teachers volunteered to teach the revised research lesson. They further indicated that this change in confidence seemed to stem from two causes which are seeing the lesson taught and also some difficulties regarding the lesson. This pre-empted the feeling that, they were confident that they would not be personally scrutinized during debriefing because discussion would be on the lesson and details of teaching that lesson. Similarly, in a study carried out by Rock and Wilson (2005) one teacher who participated in that study said:

> *I feel more confident. You always hear about differentiation and things like that, but this is my eleventh year, so I have heard it a lot. You do a little bit here and there but it just seems like a complicated process. This experience has allowed me to stop, organize it, experiment with it, reflect on it and revise my ideas with help from others and with the speakers and the research we have explored during the lesson study* (p. 85).

The evidence given above indicates that participating in lesson study, teachers become more confident as they see other teachers teaching the research lesson, and this gives them the confidence that with the assistance of other teachers, they can also teach the research. The fact that they also know that they would be scrutinised as individual also gives them confidence to teach the prepared lesson. This is again evidenced by a teacher who participated in a study carried out by Gardner *et al*. (2012) who said:

> *Initially I was apprehensive about being observed. However, as the LS process developed I felt more secure and confident with this aspect of it. I felt the lesson itself was being observed and the impact of the lesson on the learners. This made being observed just a part of the lesson planning process. I had the opportunity to learn from another teacher's learning strategies, and then employ these in my own teaching. Watching the pupils as an observer was very useful as we got to focus on the learning from another perspective.*

This shows that LS can be used as a means of improving teachers' confidence in Lesotho where there is no form of collaboration among teachers in a school setting. Furthermore, LS has been found to improve teachers' observation and critiquing skills when observing the research lesson taught. The importance of LS in improving teachers' observation and critiquing skills is discussed in the next section.

2.7.1.4 Improving Teacher Observation and Critiquing Skills

Bandura (1977) in Myers (2012) points out that observation as a critical part of developing any ability and any experience that allows teachers to observe teaching should be considered a key component of teacher education and professional development. While observation is important, teachers should be provided with a focus for observation so that they know what to look for since in reality they have few opportunities to observe classroom instruction or to be observed by others. This is evidenced by what a teacher who participated in a study carried out by Gardner *et al*. (2012) said:

> *As the person observing I have both enjoyed the experience and found it very worthwhile. What has been most beneficial to me has been the variety of approaches and strategies used which I believe have enhanced my practice. When observing, we also have been observing the pupils' learning not the actual individual teacher. When discussing the lesson before and afterwards, we discuss the effectiveness of the strategies used and the pupil learning, not the individual teacher* (p.11).

Buckwalter (2002) reveals that offering constructive critiques that help everyone, hurt no one, and get to the heart of learners' learning. Lesson Study is a strategy that allows teachers to observe one another in a live classroom situation. Chassels and Melville (2009) argue that LS relies on the observation of live classroom lessons by a group of teachers who collect data on teaching and learning and collaboratively analyse it. While observing each other, teachers engage in a process of systematically examining their own teaching, with the goal of becoming more effective and efficient (Myers, 2012).

According to Chassels and Melville (2009) the live observations which are followed by discussions on learners' learning and reflecting on the teaching methods and the impact are the central activities of lesson study. Hurd and Licciardo-Musso (2005) emphasize that

> "*Observing the research lesson is always a highlight for teachers. We seldom have an opportunity to examine the thinking and learning of a small group of learners. In our classroom practice, we are often juggling too many things while teaching to allow this type of in-depth observation. Teachers find many unexpected things when given the opportunity to just watch learners closely. With many pairs of trained eyes collecting data in the classroom, we are able to gain greater insights into the particular moments when learners seem to "grasp" a concept, to listen closely to learners discourse for information about learners' thinking and misconceptions"* (p. 393).

Takahashi and Yoshida (2004) suggest that LS is a powerful source of growth for teachers as it allows them to make sense of pedagogical ideas, to change their

perspectives about teaching and learning, to see their practice from the child's perspective, and to enjoy support and collaboration among colleagues. One of the attributes of LS which promote this change is through the promotion of reflective practice that teachers have to engage in. The next section discuss the importance of reflection in promoting teacher effectiveness.

2.7.1.5 Promoting Reflective Practice

Reflection is an important component of teaching and learning process as it helps teachers to review their practices and act accordingly where necessary. Widayati (2008) defines reflection as *"thinking about the strategies to be used to change the situation… and using the results to inform the on -going process*" (p. 201). Likewise, Freese (1999) in Juliasih *et al*. (2014) state that reflection is "*the process of making sense of one's experiences by deliberately and actively examining one's thoughts and actions to arrive at new ways of understanding oneself as a teacher* " (p. 659).

According to Myers (2012), reflection is an essential practice in teaching. He points out that the ability for the teachers to persistently and carefully consider what and how they teach, and to reflect on their actions to determine what works best for their learners, is central to successful teaching. Clarke (1995) in Ahmad, Said, Zeb, Rehman, Ahmad and Khan. (2013:74) also reiterates that "*reflective teachers always engage themselves in a continuous cycle of self-observation and self-evaluation in order to understand their own actions*". Thus, reflection assists teachers to evaluate themselves and help them in realising their own weaknesses as well as strengths and it is through reflection that teachers recognize the complex nature of learners' learning.

Radovic, Archer, Lenski, Morgan, Pope and williams (2014) assert that LS is a tool that calls for teachers to reflect upon multiple aspects of their teaching, such as lesson planning, task development, lesson implementation, and learners' learning.

Similarly, thus, during planning stage, teachers engage in 'anticipatory reflection' by anticipating learners' questions, problems and misconceptions. Anticipatory reflection is defined as "*framing a problem before it occurs"* (Sherwin, 2012: 226).

According to Ono, Chikamori and Rogan (2013) in LS, the reflection is undertaken in a group setting where the potential exists to build on others' concerns, insights, and ideas for future action. For Manen (1991) in Ono *et al*. (2013) reflection is possible in those moments when we are able to think about our experiences, about what we did or should have done, or what we might do next. When defining reflection in the context of LS, Ono *et al*. (2013) said:

> *Reflection, following the observation of a lesson, is an intellectual activity undertaken in a group setting by means of discussion among participants and observers to explore ways of improving the quality of future learners' learning, with particular reference to the design of the lesson, the materials used, and the mode of delivery* (p.55)

The definition provided by Ono *et al*. (2013) illustrate that when reflecting upon the research lesson, teachers pay special attention to whether the design of the lesson has improved the quality of learners' learning and how it can be improved to meet learners' learning needs. Teachers also reflect on the materials that were used as to whether they were suitable or not. Furthermore, they also reflect upon how the lesson was delivered and whether the strategies used promoted learners' understanding of the subject matter. The reflection that teachers engage in after the research lesson has been taught, is referred to by Sherwin (2012) as 'retrospective reflection'.

Teachers who participated in LS have shown the importance of engaging in reflective practice. This is evidenced from a teacher who participated in a study carried out by Gardner (2012) who said:

> *I think this LS project is proving to be an invaluable means of self-evaluation. We are enabled to truly reflect on our teaching strategies and through working*

> *as part of a team, we are able to share good practice in an attempt to ensure that we achieve quality learning and teaching* (p.12).

Another teacher who also took part in the same study was of the same feeling about the importance of reflection. The teacher said:

> *I feel this is a highly effective way to self-reflect about different aspects of my teaching. I feel I have also begun to reflect more deeply about the learning of the pupils, and more specifically how they learn. The process of LRS encourages constant self-reflection, not only when planning lessons but in the production of resources etc* (p.12)

Therefore, teacher reflection is a vital practice as it enables teachers to think, consider, develop and articulate many aspects of their practice in a better way as part of their knowledge base. It also enables teachers to link theory and practice (Suratno & Iskandar, 2010). Thus, LS is seen a tool that serves as "*a catalyst to encourage teachers to become more reflective practitioners and to use what they have learnt to collegially revise and implement future lessons*" (Rock & Wilson (2005) in Suryani, 2014, 7).

2.7.2 Benefits to Learners

According to Naresh (2013), one of the strengths of the LS model is that it places learners' learning at the heart of professional development activity in that during the initial phase of LS process, teachers identify and describe the overall goals of the process in terms of learners' learning. He further maintains that in the subsequent phases which involve research lesson development and enactment, teachers focus on learner's learning by developing lessons that build on learners' prior knowledge, and enacting lessons both to make learner's learning visible and to gain insights about their thinking. For Lewis and Hurd (2011), *"LS focuses on learners' learning and development. It provides a rare and valuable chance for teachers to be in a classroom solely to investigate learners' learning unencumbered by the need to manage learners or provide instruction" (p. 624).*

When teachers participate in LS community, they verbalize their thinking which usually occurs during individual planning. The group interactions also provide multiple ways to envision the lesson. As the teachers negotiate their final plan, they are able to examine a wider range of possibilities for lesson instructions, possible learner responses, and how to evaluate learners' learning. This is quite important for the learners because what is taught is the best. Learners receive quality product lesson that has been prepared by teachers from different backgrounds and with different knowledge base. Exploring strategies or mechanisms of delivering the research lesson and also anticipating learners' responses caters for all learners even those who would have a problem in understanding the concept if it were to be taught by one teacher.

In LS, teachers are able to develop a common understanding of what good teaching practice entails, which in turn helps learners understand what they are learning. Lesson Study also keeps learners at the heart of the professional development activity by providing teachers with an opportunity to carefully observe learners during the learning process and discuss actual classroom practice by unpacking what learners understanding of a particular topic is like (Gorman et al.,2010, and Lenski & Caskey,2009). This process is vital as it allows teachers to make necessary adjustments that will benefit the learners. Thus, LS improves instruction by deepening teachers' knowledge of how learners think about and learn mathematics. Emphasizing the importance of anticipating and planning for learners' responses, a teacher who took part in a study carried out by Buckwalter (2002) emphasises that:

> *Planning for learners' responses not only creates a more engaging lesson, but it also serves all learners better, from those with high needs who may struggle with math, to those who don't need as much attention. I take all possible responses into account* (p. 5).

Burghes and Robinson (2010) also illustrates the importance of LS as enhancing learners' motivation and confidence thereby, increasing their participation and satisfaction with their work. He further demonstrates that learners whose teachers participated in LS showed improvements in their learning, and in performance.

In LS, the emphasis is on learners' interest in the lesson, their participation, and whether they are learning or not (Perry & Lewis, 2008). One teacher who participated in the research carried out by Texas Teachers' Quality Grants Programme also noted that:

> *……the research lesson that I taught gave me insight about my learners. I found out that some learners were not giving me all that they could … I saw [that] each one had a potential that had not been tapped or used very much. This indicated to me as a teacher that I needed to provide more opportunities for learners to explore areas that were unfamiliar to them so that the knowledge base that each one had could be expanded. Researching and teaching this lesson has shown me that I need to step more often out of my comfort zone and try the out of the ordinary from time to time … Teaching this type of lesson has made me want to do more … Time constraints … will be a problem, but I have a goal of doing some type of lesson out of the box at least once a semester* (Yarema, 2010:14-15).

According to Gorman *et al*. (2010), in Lesson Study, teachers work towards improving instruction by deepening their knowledge of how learners think about and learn mathematics by .unpacking what learner understanding of the particular topic looks like, anticipating learner responses, developing a lesson that encourages learners to think, and using data on learners to inform the lesson design.

As teachers engage in LS, they put learners at the heart of the whole process by anticipating their questions and responses; by providing learners with activities that will allow them to be actively involved and by gathering evidence about learners learning which will in turn inform what to do next. Lesson Study could therefore be seen as integrating a number of effective professional development strategies, including development of subject knowledge and pedagogical skills, on-going collaboration, peer observation, self-reflection and awareness of learners' needs and difficulties which can easily be addressed during the planning phase. From the above discussion, LS has many benefits for teachers and learners, however, implementing LS in schools has its own challenges, the section to follow discussed challenges experienced in implementing LS.

2.8 RESEARCH-BASED EVIDENCE ON CHALLENGES OF LESSON STUDY

Though LS has numerous benefits for both teachers and learners, there are major obstacles that impede its implementation in schools. Some of the challenges of implementing LS are lack of time, lack of training for teachers, lack of resources, teachers feeling insecure of being observed and the unusual classroom setting.

2.8.1 Time Constraints

Lesson Study process involves teachers coming together to prepare, teach, analyse and revise the lesson where necessary. This requires a lot of time from all teachers concerned given the tight schedule they already have. For Mesfin and Rustaman (2014) LS requires more time for preparation as teachers spend time in finding most appropriate teaching resources and doing consultation with each other regarding lesson plan preparation as well as discussing the subject matter to be taught. In the same manner, Chew *et al*. (2011) point out that in view of the heavy workload most teachers have, it is always a great challenge to create more time for LS on the limited time they already have. The issue of lack of time has been raised by a teacher who took part in a study conducted by Gardner *et al*. (2012) who said:

> *Time – it has been difficult to meet with our teams outside of our directed meeting time. It has also been difficult meeting with the focus group children soon after the lesson due to timetable constraints* (p.14)

Chew and Yee (2011) suggest that time constraint can be addressed by having administrators' support for planning the weekly time table in such a way that the teachers who are involved in LS can have common free periods so that they can discuss, and observe each other. This idea was supported by a teacher who participated in a study carried out by Cheng and Yee (2011/2012) who illustrated that the issues of re-scheduling time-table to include LS activities has to be looked into when implementing LS. Evidence presented above shows that time poses a serious

concern for teachers implementing LS especially when looking at the LS cycle which requires teachers to meet regularly.

2.8.2 Lack of training

Research shows that some teachers implement LS after having undergone minimal training and not getting sufficient support. Mesfin and Rustaman (2014) demonstrate that teachers participating in LS need to get proper training regarding the LS process, its importance, how to collect evidence during enactment phase, how to give comments during reflection as well as where the focus of the comments should be, before LS implementation.

Teachers must first come to understand LS and do it well, before it can be treated as a testable intervention." Lewis et al. (2006:8) contend that *"it seems reasonable to ask that an innovation be highly developed and transportable before subjecting it to summative trials*." It is through proper training that teachers will get required knowledge and skills that will help them to effectively implement LS and ensure its sustainability.

2.8.3 Feeling of insecurity

There is also some reluctance among teachers to open themselves up to critical peer analysis (Stewart & Brendefur, 2005). The feeling of insecurity for teachers occurs during observation and reflection phases. During observation teachers both experienced and non-experienced may feel insecure as they may be intimidated by the presence of other teachers who are invading their privacy as they are normally not observed while teaching. Mesfin and Rustaman (2014) indicate that during reflection (see phase), the observers directly tend to give negative comments without considering the positive (good) aspects. This is considered as a big problem especially for teachers who implement LS for the first time. Initially, the school teachers considered LS as a means for judging teachers and to compare and create

differences among them, instead of improving teachers' profession and learners learning.

2.9 CONCLUSION

This chapter has discussed kinds of professional development which are traditional and job-embedded and how they benefit teachers. Lesson Study as a form of teacher professional development has been looked into especially explaining the cycle through which the teacher has to go through, which are planning research lesson, teaching/observing the research lesson being taught, debriefing and revising the lesson ready to be taught again.

Lesson Study process makes various types of teacher knowledge more visible, in the light of this, types of teacher knowledge especially content, pedagogical knowledge, pedagogical content knowledge and mathematical content knowledge were briefly discussed. Lesson Study has also been found to impact on various teacher practices like collaboration, confidence and observation skills. The effects of LS on learners' participation, motivation and understanding have also been discussed. The challenges of implementing LS which include among others, time, resources and training have been discussed.

CHAPTER 3

THEORETICAL FRAMEWORK

'The purpose of theories is to help us sort out our world, make sense of it, guide how we behave in it, and predict what might happen next (LeCompte & Preissle, 1993: 120)

3.1 INTRODUCTION

In Lesotho education system, mathematics ranks high in subjects that are considered core in the curriculum at all levels. However, the performance of mathematics at all levels has been very poor for years, such that the Ministry of Education and Training (MoET) has tried different strategies that were meant to bring about change in performance. Strategies that were tried include among others, change of mathematics curriculum which was geared at accommodating learners with different abilities. At senior secondary level, learners sit for different mathematics examinations, where the less able learners take core syllabus and the more able learners sit for extended syllabus.

Numerous interventions were also provided by MoET with the intention to improve teachers' pedagogical practices which would in turn enhance learners' understanding of mathematics. Most of these interventions came in the form of short workshops and seminars with no follow ups. Opfer and Pedder (2010) assert that teachers spend majority of their professional development time in workshops and seminars that do not have many of the forms and features associated with a positive impact. Varella (2000) indicates that teachers' professional development has positive effects on learners' achievement on condition that it happens over a considerable time. However, the interventions provided by MoET seemed not to get to the core of the problem maybe because of the way they had been structured as they did not bring about the desired outcomes.

This study therefore, explored the effects of Lesson Study on secondary mathematics teachers' pedagogical practices in Maseru. Since this study was the

first of its kind in Lesotho, teachers who participated in the study had to be trained on issues pertaining to Lesson Study. The reason why teachers had to be trained is that Lesson Study as a form of teacher professional development is different from other forms of professional development which were provided by MoET. If secondary teachers in Maseru are to effectively espoused and enact Lesson Study practices in their classrooms, they have to transform their practices as well as their beliefs and attitudes. Hence, this section looks into theories that provide basis and guidelines on how teachers' practices, beliefs and attitudes can be changed. The theories that have guided this study are: transformative theory, and the situated theory which both underpin Lesson Study practice and locate teacher learning within communities of practice.

3.2 TRANSFORMATIVE THEORY

The theory of transformative learning has been developed by Jack Mezirow in the late 70s and early 80s. Transformative learning theory came out of Mezirow's earlier theory of perspective transformation which was built from the work of Habermas on 'emanicipatory action' and Freire's work on 'critical pedagogy'. Mezirow (1991) defines transformative learning as learning that transforms problematic frames of reference to make them more inclusive, discriminating, open, reflective and emotionally able to change. He defines frames of reference as a set of fixed assumptions and expectations (habits of mind, meaning perspectives, mind sets). Such frames of reference are better than others because they are more likely to generate beliefs and opinions that will prove truer or justified to guide action (*ibid*). Mezirow (2000) indicates that the focus of transformation theory is on:

> *how we learn to negotiate and act on our own purposes, values, feelings, and meanings rather than those we have uncritically assimilated from others – to gain greater control over our lives as socially responsible, clear thinking decision makers* (p.8).

Transformative learning theory is largely based on constructivist assumptions that meaning is seen to exist within one's self and not in external forms (Cranton, 2006). Johnson and Santalucia (2010) assert that in constructivism, learning is contextual

as *"we do not learn isolated facts and theories in an abstract, ethereal land of the mind separate from the rest of our lives, rather we learn in relationship to what else we know, what we believe, our prejudices and our fears"* (p.2).

3.2.1 Transformative Learning

Learning is about transformative, it is about change, and it is about seeing oneself in relation to the world differently. Cranton (2000) defines transformative learning as a process of individuation, a lifelong journey of coming to understand oneself through reflecting on the psychic structures that make up an individual identity. Similarly, O'Sullivan et al. (2002) in Meyer, Land and Baillie (2009) describe transformative learning as a process that involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions. They further see transformative learning as a shift of consciousness that dramatically and irreversibly alters our way of being in the world. On the other hand Mezirow, 2000 defines transformative learning as:

> *the process by which we transform our taken-for-granted frames of reference (meaning perspectives, habits of mind and mind-sets) to make them more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate believes and opinions that will prove more true or justified to guide action. Transformative learning involves participation in constructive discourse to use experience of others to assess reasons justifying these assumptions, and making an action decision based on the resulting process* (p.8).

Both Mezirow (2000) and Cranton (2006) agree that transformative learning is a process by which previously uncritically assimilated assumptions, beliefs, values and perspectives are questioned and thereby become more open, permeable, and better justified. Cranton (2002) further posits that at the centre of transformative learning is a challenge of our beliefs, assumptions, and perspectives that lead us to question ourselves.

However, Sterling (2011), argues that transformative learning is more difficult and often uncomfortable for the learner to achieve because it is challenging and involves reflecting critically on learning and change that takes place at simple learning. Mezirow's study on US women highlighted that the process of personal transformation occurs through ten phases. Mezirow (1975) in Kroth and Cranton (2014) list these ten as:

- Experiencing a disorienting dilemma (Adult learners encounter beliefs that are different from the beliefs they hold).
- Undergoing a self-examination (Adult learners are led to question their own beliefs).
- Feeling a sense of alienation from traditional social expectations (Adult learners feel isolated and alienated).
- Relating their discontent to similar experiences of others (Adult learners recognize that their situation is shared by others).
- Exploring options for new ways of acting (Adult learners contemplate "what now?").
- Building competence and self-confidence in new roles (Adult learners realize that they need to gain new skills and new roles).
- Planning a course of action (building competence and confidence lead to a plan to make changes in their lives).
- Acquiring the knowledge and skills for implementing a new course of action (developing a plan for change often leads to the need for further knowledge and skills).
- Trying out new roles and assessing them (Adult learners try out the new roles and contemplate how well they suite what they want to do).
- Reintegrating into society with the new perspective (Adult learners bring their new learning and their changed perspectives back into their everyday life in society) (p.3).

For Johnson and Santalucia (2010), disorienting dilemma or a triggering event is the one that starts the process of transformative learning by stimulating learners to undergo a process of critical self-reflection and self-examination in which they must closely examine their assumptions, beliefs and underlying habits of mind. Mezirow

(1991) defines disorienting dilemma as *"experiences, often emotionally charged situations, that fail to fit our expectations and consequently lack meaning for us, or we encounter an anomaly that cannot be given coherence either by learning within existing schemes or by learning new schemes*" (p.94). He also indicates that "*a disorienting dilemma that begins the process of transformation can also result from an eye opening discussion, book,…or from efforts to understand a different culture with customs that contradict our previously accepted pre-suppositions*" (*ibid*, p.168).

According to Bruen, and Grammes (2014) transformative learning can be viewed as a form of reaction to a crisis as a critical incident which poses new challenges which cannot be adequately dealt with by existing means. They further indicate that transformation is associated with what is foreign, what is new and unknown, what has not been previously experienced and as such disturbs the "taken-for-granted" perspective and the epistemological framework of everyday knowledge. According to Mezirow (1995) in transformative learning, the most significant learning occurs in the communicative domain which involves "*identifying problematic ideas, beliefs, values and feelings, critically examining the assumptions upon which they are based, testing their justification through rational discourse and making decisions predicated upon the resulting consensus"*. In other words, transformation results from engaging with discomfort and dissonance.

According to Taylor (1998) collaboration is an essential condition for dissonance and conflict as embracing conflict among group member as opposed to avoiding it; being necessary for transformative learning. In the Lesotho situation Lesson Study is new as teachers have never been involved in such a form of teaching technique. The process of Lesson Study can cause teachers to begin questioning and altering their current teaching practices before reintegrating them into completely different ways of seeing the world. In conclusion of these stages, Mezirow postulates that:

> *the process by which we transform our taken for granted frames of reference (meaning perspectives, habits of mind, mind sets) to make them more inclusive, discriminating, open, emotionally capable of change, and reflective*

so that they may generate beliefs and opinions that will prove more true or justified to guide action (Mezirow & Associates, 2000, pp. 8–9)..

Coming to this study, it is envisaged that teachers who engaged in LS training and its processes experienced different worldview to their own and hence, became disoriented about their beliefs, assumptions especially concerning their pedagogical practices and choices. Hence, Lesson Study has characteristics that promotes transformative learning. In Lesson Study teachers have the opportunity to share their experiences with each other in a collaborative and democratic setting where their voices are heard. Lesson Study also provides a platform in which teachers can become consciously active in the exploration and reconstruction of their identities by exploring their own practices. Furthermore, as teachers participate in Lesson Study, they are directly involved in negotiating the goal of the group, and in that way they develop the understanding of how to change individually and collectively.

In Lesson Study, when teachers begin to share and reflect on their practices in a collaborative setting, they often experience clashes among differing perspectives. By embracing these clashes as learning opportunities, teachers are basically engaging in transformative learning. This is the stage which Mezirow refers to as “disorienting dilemma”. Lesson Study provides an opportunity for demonstrating authentic learning situations as it involves the group of teachers observing and participating in the learning which is led by one teacher.

During LS process as teachers observe and participate in the research lesson, they start to reflect on their practices, generating new knowledge based on the reflective action experience. Through the establishment of authentic learning communities which focus on building knowledge and collaborative reflection about learners’ progress, Lesson Study provides persistent and extended learning opportunities for teachers (Perry & Lewis, 2009). The debriefing session in Lesson Study provides teachers with an opportunity to evaluate their practices through critique and evaluation. Through this process teacher begin to construct changes in their everyday practices and beliefs that may impede their effectiveness.

Morris and Faulk (2012) show that the process of self-examination includes reflection, evaluation, recognition of the need to transform, and altering patterns of thinking, knowing, and learning of self. However, this process is seen as painful and emotional as one's values, deeply held beliefs, and attitudes are very difficult to recognise and also difficult to change. It is normal that teachers participating in this study will have a feeling of fear, anger, guilt or shame due to being introduced to Lesson Study as an effective way of teaching mathematics. It is therefore essential to provide support during this phase (Cranton, 2000).

Morris and Faulk (2012), elaborate by indicating that transformation cannot begin unless assumptions are identified and evaluated. During this phase, the person undertakes an assessment of his beliefs, assumptions and actions through critical reflection. Feelings of discontent can be expected when teachers as learners experience diminished success (Morris and Faulk, 2012). It is through the processes of critical assessment of assumptions and self-reflection that teachers recognise areas of discontent. Once they have identified this area, then they are able to achieve another step in the transition to success. It is during this phase that teachers should be able to identify potential or alternate roles for success. This phase can also provide teachers with the opportunities to regain control of the learning process through setting realistic attainable goals (*ibid*).

In the same manner, Cranton (2002) presents seven facets that provide a guide to help in setting up a learning environment that fosters transformative learning process. These facets are parallel to Mezirow's ten phases that were presented above.

- An activating event that typically exposes a discrepancy between what a person has always assumed to be true and what has just been experienced, heard, or read.
- Articulating assumptions, that is, recognizing underlying assumptions that have been uncritically assimilated and are largely unconscious.

- Critical self-reflection that is, questioning and examining assumptions in terms of where they came from, the consequences of holding them, and why they are important.
- Being open to alternative viewpoints.
- Engaging in discourse, where evidence is weighed, arguments assessed, alternative perspectives explored, and knowledge constructed by consensus.
- Revising assumptions and perspectives to make them more open and better justified.
- Acting on revisions, behaving, talking, and thinking in a way that is congruent with transformed assumptions or perspectives. (Cranton, 2002: 66).

The above facets indicate that transformative involves a number of processes of which critical reflection and rational discourse are the key elements in bringing about transformative learning. Critical reflection enables the individuals to examine their long held beliefs and meaning schemes from an internal perspective, whilst rational or critical discourse enables the individual to externalize this process with other teachers in order to validate these long held beliefs through dialogue. Two major elements of transformative learning are critical reflection and critical discourse. Mezirow's transformative theory suggests that teachers' assumptions can be changed only after critical reflection and discourse with those who can shed light on the preconceptions teachers have are incorporated in the transformation process (McComish & Parsons, 2013). These processes are elaborated in the section to follow.

3.2.2 Reflection

Lesson Study is considered as a process for creating deep and grounded reflection about the complex activities of teaching as it used as a powerful tool for facilitating teachers' growth in content knowledge, understanding of pedagogy, and ability to observe and understand learners' learning. Reflection is one of the important qualities that an effective teacher should have. Radovic *et al*. (2015) define reflective

practice as "*teachers' capacity to think about what happened during a classroom lesson, why it happened, and what could be done next time to make it happen more successfully"* (p. 272). Dewey (1933), who is considered the originator of reflection, defines it as an "*active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and further conclusions to which it tends [that] constitutes reflective thought*"(p. 16). From Dewey's point of view, teaching from traditional way in which teachers act impulsively without thinking is worrying. In his view, teachers should engage in reflective thinking about problems in their own teaching. He reiterates that:

> *Reflection emancipates us from merely impulsive and merely routine activity, it enables us to direct our activities with foresight and to plan according to ends-in-view or purposes of which we are aware, to act in deliberate and intentional fashion, to know what we are about when we act*. (p. 17)

In essence, Dewey (1933) considers reflection as an influential factor that helps in improving the quality of teaching. He characterized reflection as a state of doubt and an act of searching. Van Manen (1991) in Tsui (2011) points out that reflection can take place only if teachers in general have the time to think about their teaching in terms of what was done, what could have been done and what the next step should be. Lesson Study is one such tool that can assist teachers to reflect upon their practices by firstly anticipating learners' questions, how to address those questions during teaching and also how the lesson can be improved for future use.

Dewey (1933) indicates that in order to engage in reflective practice teachers should have three important qualities, namely, open-mindedness - an active desire to listen to more than one; responsibility – careful consideration of consequences of a particular action and wholeheartedness – individual teachers willingly take a risk of putting their ideals into practice. On the other hand Cruickshank, Bainer and Metcalf (1999) in Tsui (2011) demonstrate that reflective practitioners purposefully deliberate or reflect on teaching; they are open-minded, freely questioning their own views and reactions to their teaching practices; they consider and accept responsibility for the

consequences of the decisions; and they are enthusiastic and eagerly focus on the ways to improve their teaching.

Schon (1983) has expanded what Dewey proposed about reflection. He indicates that in order to improve some aspect of practice (what he calls tacit knowledge or knowing-in-action), reflection is needed. He indicates that there are two components of reflective practice, namely, reflecting-on-practice which involves looking back after an event has happened, that is, it involves teachers reviewing, analysing and evaluating their actions in order to enhance their professional growth; and reflecting-in-practice which involves modifying of immediate actions, thus, teachers become aware of their actions and decisions as they are teaching and take necessary steps to modify their actions. However, Schon later proposed a third type which he referred to as reflection for action, which is the anticipated outcome of reflection in and on action (Naresh, 2013). Ono *et al*. (2013) distinguish between reflection and critical reflection, they indicate that critical reflection is high-order reflection while the other one is low-order. According to Mezirow (1998), critical reflection involves an examination of the assumptions or presuppositions on which judgments are being made or actions designed, while reflection does not necessarily challenge any basic assumptions.

Critical reflection which is an important aspect of transformation is the process whereby teachers intentionally construe new meanings through critically examining their beliefs (Mezirow, 2000). Thus, critical reflection involves questioning ones actions in which the questions propel the individual to identify new methods of thinking and knowing. Critical reflection often occurs in response to an awareness of conflicting thoughts, feelings, and actions and at times can lead to a perspective transformation (Mezirow, 1991). "*Reflection is the appreciative process by which we change our minds, literally and figuratively, it is the process of turning our attention to the justification for what we know, feel, believe and act upon*" (Mezirow, 1995:46).

According to Fook (2006) critical reflection

> "…. *enables an understanding of the way (socially dominant) assumptions may be socially restrictive, and thus enables new, more empowering ideas and practices. Critical reflection thus enables social change beginning at individual levels. Once individuals become aware of the hidden power of ideas they have absorbed unwittingly from their social contexts, they are then freed to make choices on their own terms*."(p.4)

Fook (2002) points out that there are two aspects which make reflection critical. These two aspects are that the learning needs to be relatively fundamental so that deep held beliefs and values are reworked and new guidelines for practice are then developed; and it is based on critical analysis of how individual and social contexts are linked. In this way critical reflection becomes transformative as it allows reworking of one's experience. Thus, critical reflection is essential to growth and also an integral part of shaping person's behavior. Adults who cannot critically reflect are dependent on others to bring about change. Mezirow (1997) points out that all adults should be prepared to "*think as an autonomous agent in a collaborative context rather than to uncritically act on the received ideas and judgments of others*" (p.8).

In summary, critical reflection and the ability to critically assess incoming information and being able to develop priorities are important processes for teachers who are engaged in this study as it is through critical reflection that these teachers may be able to entertain new ideas, share their inconsistencies and be open to change in the way they view the world. Without these processes, it would very difficult for teachers participating in the study to relinquish their long held beliefs and practices about the teaching of mathematics.

3.2.3 Rational Discourse

According to Mezirow (1997) learning is a social process and discourse becomes central to making meaning. Mezirow (2003), states that dialogue involves

assessment of beliefs, feelings and values. It is “learner-centered, participatory and interactive and it involves deliberation and group problem solving” (Mezirow, 1997 in Phillipi, 2010, p.45). This implies that discourse during teacher collaboration, facilitates transformational learning individually and collectively. In the literature of transformative learning theory, rational discourse, reflective discourse and dialogue are used interchangeably and in this study, they are used as such. According to Mezirow (2000), discourse is:

> *“… that specialized use of dialogue devoted to searching for a common understanding and assessment of the justification of an interpretation or belief. This according to Mezirow involves assessing reasons advanced by weighing the supporting evidence and arguments and by examining alternative perspectives. Reflective discourse involves a critical assessment of assumptions. It leads toward a clearer understanding by tapping collective experience to arrive at a tentative best judgment. Discourse is the forum in which "finding one's voice" becomes a prerequisite for free full participation”* (p. 10-11).

Dialogue is perceived as an essential medium through which transformation is promoted and developed. However, in contrast to everyday discussions, it is used most often in transformative learning *‘‘when we have reason to question the comprehensibility, truth, appropriateness (in relation to norms), or authenticity (in relation to feelings) of what is being asserted or to question the credibility of the person making the statement’’* (Mezirow, 1991: 77). He further asserts that “*discourse is learner-centered, participatory, and interactive, and it involves group deliberation and group problem solving*” (Mezirow, 1997: 6). Discourse that is open and non-threatening helps learners in reframing the assumptions through critical reflection and discussion as learners can freely comment, critique, and support new ideas, behaviours and frames of reference (Mezirow, 1994).

According to Mezirow (1996) for a dialogue to be effective, there are some necessary conditions to be considered. These include among others:

a) participants having accurate and complete information;
b) being free from coercion and distorting self-deception;

c) being able to weigh evidence and assess arguments as objectively as possible;
d) being open to alternative perspectives;
e) being able to critically reflect upon presuppositions and their consequences;
f) having equal opportunities to question, refute, and reflect and to hear others do the same; and
g) being able to accept an informed, objective, and rational consensus as a legitimate test of validity (p.171).

In transformative learning, *"true change only happens when people ….allow themselves to be open to difficult and sometimes uncomfortable dialogue"* (Shoefstall in Warrell & Kawalilak, 2011:733). It is through collaboration that teachers are able to identify their dilemmas, reflect upon them and engage in rational discourse. For McCommish and Parsons (2013) conflict allows teachers to extend beyond existing frames of reference and creates a potential for transformational learning to occur. Hence, if we truly want teachers participating in this study to change their pedagogical practices it important that collaboration and dialogue become key elements of the LS training and implementation process. For teachers to change their practices, suitable conditions should be created. There are ideal conditions for promoting transformative learning rational discourse, and these are elaborated in the next section.

3.2.4 Conditions Promoting Transformative Learning

As educators, we can never be sure that each individual in our classrooms will become transformed. Therefore, we need to set goals and create conditions of fostering transformative learning. For Gunnlaugson (2007), "*If bringing about such transformation is to be a realistic aim within adult and higher educational contexts, there is a value in establishing practices to cultivate such potentials in our lives"* (p. 147). Some of the conditions include teacher's activities, learning activities and personal experiences of the learner. A teacher can use a range of strategies such as encouraging learners to ask questions. In an effort to promote transformative learning, a teacher could also create a safe, open, and trusting environment that

allows for participation, collaboration, exploration, dialogue, critical reflection and feedback (Baumgartner, 2001). In their teaching, teachers need to expose learners to challenges or views that may be different from theirs.

It is also important that teachers relinquish their authority or position power in the classroom so that learners can feel safe and free to express their views. For transformative learning to take place, learners should feel free from coercion and be comfortable in sharing their views, held knowledge, thoughts and experiences. For Southern (2007) mentoring relationship that foster transformation requires that both adult learner and facilitator be willing and able to grant authority to each other and hold authority in a way that shows responsibility for one's own learning and that of other.

Cranton (2000) recommends that teachers should recognize learners' learning styles in order to help them critically question their assumptions. Group as well individual learning is important in promoting transformative learning. Cranton (2006) argues that the group can provide support to its members and in particular those experiencing transformation in a bad way. The support can also be provided by the teacher. Learners should also be encouraged to self-assess themselves so as to identify their strength and weaknesses.

In promoting transformative learning, emotions, especially the practice of emotional literacy helps in addressing the limitation of rational dialogue (Cranton, 2006). Goleman (1995) cited by Taylor (2001) defines emotional literacy as the development of emotional intelligence where people manage their emotions well and can interpret and deal effectively with other people's feelings. Goleman further indicates that emotional intelligence helps in addressing the limitations of rational discourse through the promotion of emotional understanding in that:

> *"People with well-developed emotional skills are also more likely to be content and effective in their lives, mastering the habits of mind that foster their own productivity, people who cannot marshal some control over their emotional life fight inner battles that sabotage their ability for focused work and clear thought"* (Goleman in Taylor 2001:232).

Thus, when a person has knowledge about his emotions, he can manage them better, develop trusting relationships and acquire better knowledge about himself.

In this study transformative learning theory was employed to provide a platform for teachers to consider the impact of lesson study on the teaching and learning of mathematics as transformative learning theory is suited for introduction of a new strategy such as Lesson Study that may challenge teachers' viewpoints about teaching and learning of mathematics and promoting reflection on their current practices. However, transformative learning theory seems to concentrate more on an individual cognitive development than on the role played by the community in creating the conflict on ones' thinking, assumptions, values, beliefs and actions. Nevertheless, transformative theory has been challenged for its lack of attention to context, its emphasis on rationality, its lack of strong social action agenda and the ethical issues involved in promoting this type of learning (Merriam, 2004: 207).

Resnick (1987) in Merriam (2004) suggests that learning can not only be understood as an individual, internal cognitive process; rather learning is what is constructed by the interaction of people in a particular situation with particular tools and artifacts. Merriam (2004) also illustrates that the context in which learning takes place is crucial to the nature of learning, as are the tools in that setting and the social interaction with others. Situated learning theory explains the part played by the community of practitioners in the learning process. The next section discusses how individuals learn in a community of practice.

3.3 SITUATED LEARNING THEORY

Lesson Study approach is underpinned by situated learning theory, which illustrates that learning is situated within specific activities and is embedded within particular contexts and cultures (Lenski & Caskey, 2009). Thus, situated learning emphasizes that knowledge is situated in the activity of the teacher and it is a product of that activity and forms the context and culture in which it occurs. For Lave and Wenger (1991) socially situated learning states that "learning, thinking, and knowing are

relations among people in activity, with, and arising from the socially and culturally structured world" (p. 51). They posit that learning is a social process in which individuals co-construct knowledge rather than transmit knowledge from one individual to the next.

Situated learning theory was first developed by Lave and Wenger who emphasized that learning is situated within a particular physical setting and social contexts and also as increased participation in communities of practice (Lave, 1993; Wenger, 1998). According to Lave (1993), situated learning theory:

> *emphasizes the relational interdependency of agent and world, activity, meaning, cognition, learning, and knowing. It emphasizes the inherently socially negotiated quality of meaning and the interested, concerned character of the thought and action of persons engaged in activity… this view also claims that learning, thinking, and knowing are relations among people engaged in an activity, with, and arising from the socially and culturally structured world* (p. 67).

Thus, situated learning theory shifts emphasis from individual minds to connections among minds; and from the properties of individual persons or of their environments to the interactions between people, and their environment (Yuan, 2004). For Kirk and Macdonald (1998) 'situatedness' of learning refers to learning that takes place in particular sets of circumstances, in time and space. In other words situated learning theory portrays the process of teacher learning as greatly influenced by the society and cultural contexts in which it occurs rather than an individual teacher learning in isolation. It moves from a notion of learning as an individual cognitive process to learning as a shared enterprise which develops through collaboration among teachers in communities of practice. Cobb (2001) illustrates that:

> *Situated cognition theorists challenge the assumption that social process can be clearly partitioned off from cognitive processes and treated as external condition for them. These theorists instead view cognition as extending out into the world and as being social through and through. They therefore*

attempt to break down a distinction … between the individual reasoner and the world reasoned about (P. Cobb, 2001, p. 14126).

Lewis et al. (2009) indicate that situated learning involves interaction between individuals and others. They further indicate that participation in a community shapes the identity of members, their future actions and commitments, and that members in turn transfer forms of participation (not simply skills) to new settings.

This description resonates well with what Sense (2007) says when he postulates that situated learning theory presumes that most learning occurs on the job in culturally embedded ways, and evolves through the participation and interaction of people and their collective sense-making activities, as they develop their competencies and construct their identities to function effectively within a community or domain of practice. According to Lunce (2006) in Yusoff, Zaman and Ahmad (2010) situated learning is characterised by:

- Learning that takes place in a specific context and the context significantly impacts learning;
- Collaborative process in which the student interacts with other members of a "community of practice" The relationships among members of such communities tend to be peer-based rather than the more formal teacher-student relationship of the classroom;
- The assumed presence of tacit knowledge;
- Everyday cognition is an integral part of situated learning and refers to the process of learning to use a tool or artifact in a real-life situation to accomplish a real-world objective (p.1768).

These characteristics still emphasize the interactive nature of meaning making process within a specific context which in this study was depicted by a group of mathematics teachers who came together as a community sharing the same goal of practicing Lesson Study in their respective schools.

Wenger (1998) states that learning is part of a broader process which places individuals as active participants in the communities of practice. Furthermore, he presents four components which he argues are essential to characterize social participation as a process of learning. Similarly, Kapucu (2012) illustrates that learning is not merely a function of individual efforts nor is it bounded with a concrete start and end, but it is a social process taking place within the context of our daily actions and experiences. These components are meaning, practice, community and identity. The figure 3.1 below shows the relationship between these four components.

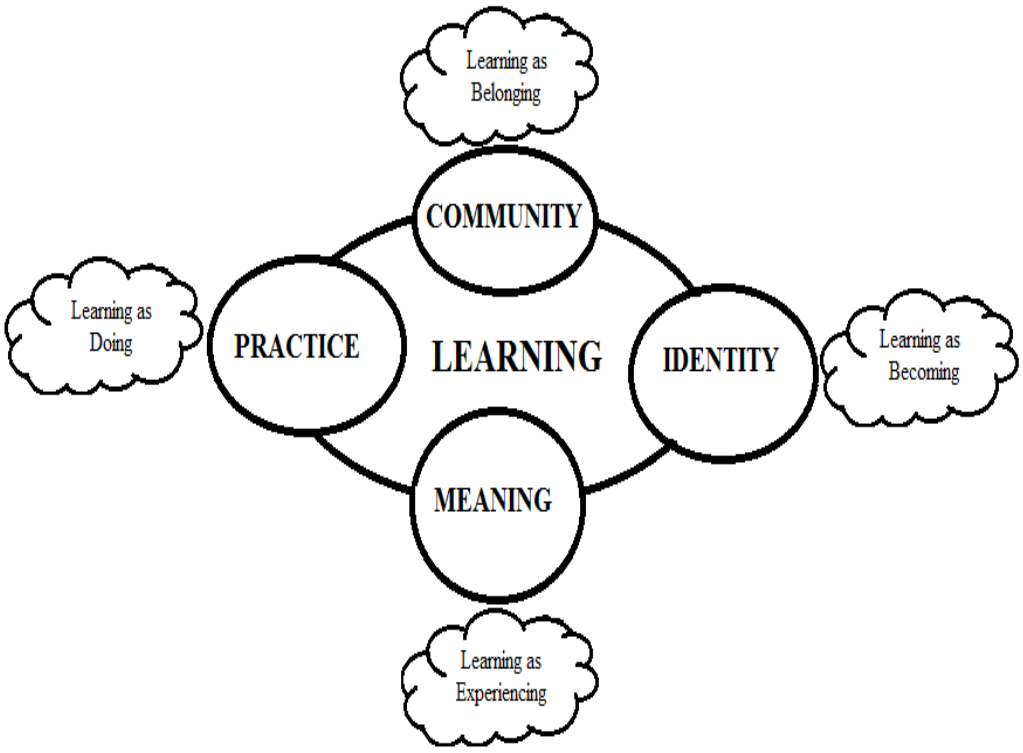

Figure 3.1*:* Components of Wenger's Theory of Learning as Social Practice, 1998:5

i) Meaning: a way of talking about our ability- individually and collectively- to experience our life and the world as meaningful.

ii) Practice: a way of talking about the shared historical and social processes, frameworks, and perspectives that can sustain mutual engagement in action.

iii) Community: a way of talking about the social configurations in which our enterprises are defined as worth pursuing and our participation is recognisable as competence.

iv) Identity: a way of talking about how learning changes who we are and create personal histories of becoming in the context of our communities(p.5)

Wenger (1998) shows that the components presented in the model are deeply interconnected and mutually defining and could switch any of the four peripheral components with learning, place it in the centre as the primary focus, and the figure would still make sense.

In summary, situated learning theory implies that learning is experienced and mediated through relationships with community members or within a community of practice where group members jointly share and develop practices, learn from their interactions with group members, and gain opportunities to develop personally, professionally, and intellectually. It suggests that learning takes place as a result of the relationships between and among people by connecting prior knowledge with authentic knowledge gained in a natural setting. It also involves teachers working collaboratively in the process of meaning-making. It shifts attention from individual minds to connections among minds; and from the properties of individual persons or of their environments to the interactions between people, and between people and their environment.

Situated Learning theory raises an important role played by communities of practice in acquisition of knowledge. The section below discusses in detail the notion of communities of practice in the acquisition of knowledge.

3.3.1 Communities of Practice

According to Lave and Wenger (1991), the community of practice refers to participants who share common actions, procedures and goals. They further indicated that participation in the community of practice gives participants a sense of belonging, and opportunity to share their concerns about a topic thereby deepening their knowledge and expertise through ongoing interaction. For Lave and Wenger (1991) a community of practice is:

> *a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice. A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage. Thus, participation in the cultural practice in which any knowledge exists is an epistemological principle of learning* (p.98).

This view resonates well with what Merriam's (2004) definition of communities of practice in which she regards communities as groups of people who share insights and ideas and who help one another solve problems and develop a common practice. For Merriam a feature of shared meaning acknowledges the importance of dialogue within a community of practice as participants develop a sense of understanding and evolution of ideas through dialogic interactions.

Communities of practice constitute reality in a particular manner and encourage specialized ways of acting and thinking (Wenger, 1998). They are social sites where people participate in activities as they become different people in terms of how much they acquired. Learning occurs constantly in these communities as people participate in activities that are more and more central to the core practice. For Kapucu (2012) bringing individuals together and forming communities of practice is an important tenet of learning, and learning patterns within a community are particularly important because most of the learning occurs due to human practice and interaction with others. For Lave and Wenger (1991) learning is located in the process of co-participation and not in the heads of individuals, and it is also an

interactive process in which learners perform different roles. This changing participation leads participants to take on new identities that are necessarily bound up with new knowledge and skills (Lave, 1996).

Wenger (1998) illustrates that a "community of practice" offers a member the possibility of changing, or adapting, their existing frames of reference, assumptions and theories. It functions as a context and mechanism for change, a way of arriving at a place where we can recognize what we do and what we know, as well as on our ability to connect meaningfully to what we don't do and don't know – that is, to the contributions and knowledge of others". Later Wenger extended the idea of communities of practice as groups of people who share a concern for something they do and learn to do it better as a result of their ongoing interactions (Wenger, 2005). He further points out that engaging in knowledge production with colleagues deepens one's sense of professional identity while at the same time improving one's practice. According to Rosen (2007) in Mills (2011) the way to develop your identity is to

> *pull things out there, get feedback, and adjust accordingly. You develop an internal model for yourself and balance this with reactions from other people…doing this allows you to be more reflective about whom you are. And figuring out who you are, requires being social* (p. 348).

Lulavein (2010) shows that community of practice requires modification, motivation, and willingness to negotiate. She illustrates that embracing struggle and negotiation as part of the entry into a community of practice involves transformation and the surrendering of notions of control and power. For Wenger (1998), external influences are mediated by the communities in which their meanings are negotiated in practice and this negotiation of meaning takes place between individuals as they attempt to make sense of tensions and contradictions.

According to Kerno (2008: 69-70), communities of practice are characterized by the following:

- Learning that occurs within a community of practice is highly interactive, with the individual learner not simply accessing a discrete, static body of abstract knowledge to be transported and reapplied in subsequent contexts and situations. Rather, learning and skill acquisition occur by actually engaging in the desired practice itself, within a participation framework, not an individual mind;
- Learning is distributed among the various individuals who are participating together within the learning context, and is mediated by their differences of perspective;
- Apprentices (those individuals new to a certain community of practice) may gain more in proportion to their knowledge status prior to joining, but masters (experienced community of practice members with socially acknowledged higher levels of expertise) learn, and continue to learn as a direct result of their membership and participation within the community, as well;
- In addition, even in instances where a fixed, immutable doctrine is transmitted from master to apprentice, the ability of such a community to reproduce itself is rooted not in the doctrine, but in the continued maintenance of certain modes of co-participation and community in which the doctrine is embedded.

When teachers take time to interact, study together, discuss teaching, and help one another put into practice new skills and strategies, they grow and their learners' performance improves accordingly. A sense of community, and the "supportive coaching" that it provides, is necessary not only to bring about changes in beliefs but to help teachers develop and maintain a sense of efficacy regarding new teaching strategies (Harwell, 2003). Hence, teachers can improve in their teaching practice when they work within professional learning communities.

Teachers through participation in Lesson Study communities, have spaces within which they share, swap and try new ways of thinking and teaching, while simultaneously reviewing their own pedagogical practices (Wright, 2007). In this study, when teachers are engaged in the process of Lesson Study, they are

collectively examining their teaching practices and function as communities of practice. The Lesson Study approach helps teachers to form communities of practice around plan-do-observe cycle as they construct, organize, share, and refine their knowledge of the lesson. This participation of teachers in the Lesson Study process is a climax of communities of practice, which provides a platform for teachers with common interests to interact with other professionals with similar interests to solve problems and improve practices.

Mayes and de Freitas (2007) in Mills (2011) indicated some implications for both learning and teaching within communities of practice which include the acquisition of habits, attitudes, values, and skills in context and the development of identities and learning relationships. They indicated that the implication for teaching in a community of practice includes support for identity development, facilitation of learning dialogues and relationships, and the creation of safe environments for participation and authentic opportunities for learning.

Though communities of practice are believed to work more effectively because of the synergies of interaction among peers, their creation in a school setting can be difficult due to managerial issues and are time consuming (Wenger, 1998). To effectively sustain a communities of practice, schools should provide support in the form of infrastructure, relevant communities of practice activities and all required processes within the communities of practice that encourage and support the community members' social engagement Tarmizi, de Vreede and Zigurs (2006). In addition, Tarmizi and de Vreede (2005) illustrate that one challenge of creating communities of practice is that they do not produce tangible outcomes as their benefits may not be easy to specify or quantify but can only be perceived on the individual or community level. They also indicated that establishing trust also represents a challenge for communities of practice as lack of it across groups may result in a barrier to effective information sharing activities.

In communities of practice it may not be easy to have interesting and relevant topics especially in the early stage of community formation as some topics may be too broad and create sub-communities within a community, while other topics may be

too narrow and attract few participants (Tarmizi & de Vreede (2005). For Pawlowski, Robey and Raven (2000) another challenge concerns recruiting the right members, for example, knowledgeable members who have enough time for social interaction. According to Wenger (1998), developing communities of practice requires a number of legitimatization of participation and provision of support to those taking part in the community of practice. The next section elucidates the notion of legitimate peripheral participation within the community of practice.

3.3.2 Legitimate Peripheral Participation

Legitimate peripheral participation is another important idea which relates to the communities of practice and social learning theory. Lave and Wenger (1991), define legitimate peripheral participation (LPP) as *a process that*

> *…provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artefacts, and communities of knowledge and practice. It concerns the process by which new-comers become part of a community of practice* (p. 29).

Thus, when newcomers join the community of practice, they get an opportunity to learn from the old members of the community and eventually move towards becoming full members of the community where they can now freely share their knowledge and expertise with the rest of the community members. According to Wenger (1991) learning entails realignment in that newcomers entering a community, will change their practices until their experience reflects the competence of the community, conversely, a newcomer can also pull a community's into the practice he/she brings along and negotiate with the community until it embrace this contribution as a new element of competence or reject it.

Wenger (1998) notes that "*a community of practice is a living context that can give newcomers access to competence and also invite a personal experience of engagement by which to incorporate that competence into an identity of participation"* (p. 214). For Lenski and Caskey (2009) legitimizing participation

entails giving members time to participate in collegial activities and creating an environment that acknowledges the value of communities. Lave and Wenger (1991) indicate that LPP is meant to convey the sense of authentic or genuine participation in which a person's participation in the community of practice is meaningful to them as individuals and to the rest of the members of the group. They further point out that:

> *Legitimate peripheral participation provides a way to speak about the relations between newcomers and old –timers, and about activities, identities, artefacts, and communities of knowledge and practice. It concerns the process by which new comers become part of a community of practice. A person's intentions to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a sociocultural practice. This social process includes, indeed it subsumes, the learning of knowledgeable skills* (p.29).

The notion of legitimate peripheral participation implies that for teachers to understand and implement Lesson Study effectively, they need to have opportunities to experience the actually implementation of Lesson Study process. It is during this process that ongoing discussion could be viewed as a process of legitimate peripheral participation where the researcher (knowledgeable other) *takes the 'expert' role and the teachers the 'apprentice' role"*. In this sense Lesson Study can be used as a tool that will allow teachers to move towards full participation involving teaching with confidence.

In communities of practice, newcomers learn much of the craft by participating with old-timers in legitimate and initially peripheral ways. Eventually they become old-timers themselves. In this study, teachers who participated in Lesson Study started as newcomers, but through practice they could end up as old-timers. Thus legitimate peripheral participation gives a newcomer an opportunity to take part in peripheral aspects of the community of practice and by so doing, they gradually move toward taking more responsibilities as old-timers. It is however important to note that

legitimizing participation entails giving members time to participate in collegial activities and creating an environment that acknowledges the value of communities

This chapter has presented two theories that were adopted in this study. The theories that were used were transformative and situated learning. The significance of transformative theory in the context of this study helped in understanding cognitive process which occurs in the mind of teachers as adult learners during meaning making process. On the other hand situated learning theory illustrated that the process of meaning making is highly collaborative and is distributed across individuals and artefacts and is context-based.

Mezirow asserts that transformative learning theory is a cognitive process in which teachers long held practices, beliefs and attitudes are scrutinized after they have been challenged by something they have never met before (disorienting dilemma). It is through critical reflection that teachers begin to question their long held beliefs, norms, attitudes, and their practices. It is through critical reflection that teachers gradually begin to transform their preconception. In this study it was important that teachers were trained on Lesson Study process so as to trigger their long held beliefs about how mathematics should be taught. Once teachers had been trained then they were assisted in forming mathematics teams in their respective schools.

On the other hand, situated learning shifts learning from individuals to a community of people who strive towards the same goal. In situated learning, it is through collaboration that members of the community get encultured by sharing artifacts, language, different types of teacher knowledge and skills. Once they have acquired all these they become full members of the community (considered as old-timers). Communities of practice are teacher-led activities that have the potential to empower teachers in a variety of ways that can lead to improved learners' learning. Communities of practice provide teachers with an opportunity to determine the course of their own professional growth and improve their practice in a collegial, supportive environment (Desimone, Porter, Garet, Yoon & Birman, 2002). They encourage teachers to focus on their own practice in the context of their own classrooms, while sharing lessons learned in a collaborative setting. In this study as

teachers collaboratively plan research lesson, teach, observe and critique the lesson, they engage in a community of practice.

3.4 CONCLUSION

This chapter has discussed the theories that guide teachers' changes in practice which have 'shown that changes in practices do not happen easily as these are long held beliefs, attitudes and assumptions which one cannot easily part with. However, through effective professional development programs which include reflecting on and evaluating their practices, learners in this study are mathematics teachers who can begin to consider and plan changes in their pedagogical practices. Transformative theory offers the basis on which teachers can transform their pedagogical practices. This theory highlights that the basic elements which can assist in transforming teachers are disorienting dilemma, conflicting beliefs and assumptions, and critical reflections.

Situated learning is another theory that was looked into in trying to understand how teachers may form their knowledge and transform their existing beliefs, attitudes and practices. This theory provides a framework through which teachers can transform. Underpinning situated theory is a notion that learning is situated within communities of practice where knowledge is gained and shared. This theory therefore guides this study in understanding how teachers can improve their classroom practices in teaching mathematics.

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

In undertaking any research, it is important to consider certain standards and principles which guide researcher's actions, perceptions and beliefs in carrying out the study. Most importantly it is beneficial, within the unique context of the research, for the researcher to carefully consider the philosophical background to research, so that informed decisions could be made regarding the methodology to be chosen in seeking to answers the research questions (Jackson, 2014). By strengthening the rationale for the methodology, the researcher is in a better position to justify the research process and defend the outcomes, making 'use of various philosophical tools to help clarify the process of inquiry and provide insight into the assumptions on which it conceptually rests' (Kincheloe and Berry, 2004:8).

In this chapter the methodological approaches adopted in order to answer the research questions in this study are discussed. This study employed mixed research design as one method would not provide complete answers to the research questions. The research was qualitatively driven with a quantitative sequential element. The qualitative foundation focused on research questions: How does the Lesson Study training impact on teachers' pedagogical practice? What are the effects of Lesson Study on learners' understanding of mathematics? Which challenges do teachers experience in implementing Lesson Study? While quantitative approach was used to find the answer to the questions: What are teachers' pedagogical practices before Lesson Study training? The justification for the choice of the quantitative and qualitative approach are explained. A detailed description of the process of data collection and data analysis are also provided.

4.2 RESEARCH PARADIGMS

The term paradigm was first introduced by Kuhn (1962) who defined it as a cluster of believes, which guide a researcher in deciding what should be studied and how the results should be interpreted. According to Jonker & Pennink 2010 in Wahyuni (2012), "*research paradigm is a set of fundamental assumptions and beliefs as to how the world is perceived which then serves as a thinking framework that guides the behaviour of the researcher*" (p. 69). On the other hand Neuman 1991 in Khan (2014) defines a research paradigm as *"a framework or a set of assumptions that explain how the world is perceived where the paradigm of science includes its basic assumptions, the important questions to be answered or puzzles to be solved, the research techniques to be used, and examples of what scientific research looks like"* (p. 224). Similarly, Collins and Hussey (2009) illustrate that a research paradigm is a philosophical framework that guides how a scientific research should be conducted based on people's philosophical and assumptions about the world and nature of knowledge.

Khan (2014) demonstrates that paradigms are based on epistemology, ontology and methodology. He asserts that epistemological perspective is concerned with the way knowledge is acquired while ontology is concerned with the nature of reality. Methodology on the other hand, is concerned with the process and method through which the researcher acquires the knowledge about the world. Thus, paradigms are important in influencing the methodology to be used in the study. Mukherji and Albon (2010) illustrate that the two main paradigms that form the basis of research in the social sciences are the positivist approach and the interpretivist approach. These two paradigms are discussed in more detail in the next section.

4.2.1 Positivism Philosophical Paradigm

Mukherji and Albon (2010), show that the positivist paradigm is one that has its roots in science as it uses a systematic, scientific approach to research. They indicate that the positivist paradigm sees the world as being based on unchanging, universal laws

and the view that everything that occurs around us can be explained by knowledge of these universal laws. Likewise, Cray (2014) argues that positivism was the dominant epistemological paradigm in social science from the 1930s through to the 1960s, with its core argument being that the social world exists externally to the researcher, and that its properties can be measured directly through observation. He indicates that positivist view is that:

- …reality consists of what is available to the senses – that is, what can be seen, smelt, touched, etc. Inquiry should be based upon scientific observation (as opposed to philosophical speculation), and therefore on empirical inquiry.
- The natural and human sciences share common logical and methodological principles, dealing with facts and not with values.

Likewise, Neuman (2003) in Tuli (2010) posits that positivism sees social science as an organized method for combining deductive logic with precise empirical observations of individual behaviour in order to discover and confirm a set of probabilistic causal laws that can be used to predict general patterns of human activity. He further argues that the nature of social reality for positivists is that empirical facts exist apart from personal ideas or thoughts and patterns of social reality which are stable.

According to Morcol (2001) the ontological assumption of positivism view the reality as existing independently from the knowing subject and also makes the assumption that reality is deterministic in nature. He further indicates that this deterministic world view is composed of three layers of assumptions. The first layer assumes that reality is composed of discrete entities and events that can be aggregated hierarchically. The second layer assumes that entities and events are causally connected. The third layer is that the universe is completely determined and totally predictable. According to Krauss (2005) "*science is seen as the way to get at truth, to understand the world well enough so that it might be predicted and controlled. The world and the universe are deterministic, they operate by laws of cause and effect that are discernible if we apply the unique approach of scientific method*."(p.7600)

Epistemology is a theory of knowledge and concern what is considered as acceptable knowledge in a particular discipline (Bryman, 2004). According to Oppong (2013) epistemology focuses on what constitute valid knowledge and how such knowledge can be obtained. He also points out that positivist epistemology is objective, that it exists independent of the subject and is value-free as it is obtained through the application of the scientific method. He further demonstrates that positivist epistemology aims at describing, predicting, controlling and explaining a phenomenon while its overall objective is to produce universal laws or generalize findings.

For Morcol (2001), positivist epistemology separates the knowing subject from the object of their knowledge and assumes that this separation makes objective knowledge possible. He points out that to make sure that knowledge corresponds to reality, positivist epistemology attempts to separate facts from the values of knowing the subject. *"Positivist approach relies on a commitment to the objective discovery of the truth underlying the relations among variables, by means of research that is characterized by the traditional criteria of validity, reliability, and generalizability"* (Leitch *et al*., 2010:72).

According to Kura (2012) positivism is rooted in on atomism, quantification and operationalization. He indicates that atomism implies that a phenomenon exists as an entity separated from the whole world with discrete elements. On the other hand, Morcol (2001) indicates that the discrete element and events of reality can be broken into its parts which can be isolated and analysed to determine the relationships between them.

Elaborating on quantification of positivism methodology, Kura (2012) points out that quantification refers to the variables that can be expressed in terms of numbers and frequencies and also uses mathematical tools to reveal significance for drawing conclusion. He points out that operationalization seeks to define social phenomena as simple behaviours and life experience. The researchers whose views are on positivism perspective explain in quantitative terms how variables interact, shape events, and cause outcomes (*ibid*). For Khakpour (2012), the philosophy behind positivism is that the world exists and is knowable and researchers can use

quantitative methodology to discover the research findings which are usually represented quantitatively in numbers which speak for themselves.

Kura (2012) argues that positivist methodological procedures used in natural science can be adaptable to social science research where methodologies such as experiment, longitudinal studies and surveys can be used. He further shows that positivist methodology produces highly specific and precise data. Krauss (2005) supports by saying that in positivist methodology the data produced and its analyses are value-free and data do not change because they are being observed, thus, the researchers view the world through “one-way mirror”. Kura (2012) asserts that positivism provides interacting links between reality and knowledge obtained from the links with independent assumptions underpinning it and methods used to obtain it.

The positivist research paradigm underpins quantitative methodology. According to Kwadwo and Hamza (2015) in positivists’ methodology the data collection techniques focus on gathering hard data in the form of numbers to enable evidence to be presented in quantitative form. They also point out that truth in positivist inquiry is achieved through the verification and replication of observable findings, variable manipulations of the research objects and the application of statistical analysis. Thus, quantitative methodology aims to measure, quantify or find the extent of a phenomenon (Mukherji & Albon, 2010).

Positivists emphasize the use of valid and reliable methods in order to describe and explain the events. De Villiers (2005) reiterates that positivist research is aimed at producing unbiased, value free and an accurate representation of the phenomena being studied. She further points out that positivist research relies heavily on quantitative methods, where data consist mainly of numbers and measures and that analysis is done through statistical methods. Similarly, Roth and Mehta (2002) indicate that positivist methods seek to find knowledge based on systematic observation and experiment, with the goal of discovering social laws analogous to the natural laws uncovered by the methods of natural science. Positivist analysis seeks to evaluate causal inferences about social phenomena that will be generalizable beyond the specific data analysed.

Validity in positivist view determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Golafshani, 2003). Positivist researchers consider reliability as the extent to which result are consistent over time and an accurate representation of the total population under study (*ibid*). According to Polit and Hungler (1991), generalizability is defined as the degree to which the findings can be generalized from the study sample to the entire population.

Myers 1997 in Levy (2006) also elaborates by pointing out that *"reality is objectively given and can be described by measurable properties which are independent of the observer and his or her own instruments"* (p. 374). Thus, for positivists, both the natural and social worlds operate within a strict set of rules, which science has to discover through empirical inquiry. Carson *at el*. (2001) in Levy (2006) identified a number of characteristics relating to positivism philosophy. These are:

a) The positivist or natural sciences school relates to facts or causes of social phenomena and attempts to explain causal relationships by means of objective facts;
b) Positivist research concentrates on description and explanation;
c) Thought is governed by explicitly stated theories and hypotheses;
d) A research topic is identified through the discovery of an external object of research rather than by creating the actual object of study;
e) Researchers remain detached by maintaining a distance between themselves and the object of research;
f) Researchers try to be emotionally neutral and make a clear distinction between reason and feeling, science and personal experience;
g) Positivists seek to maintain a clear distinction between facts and value judgements;
h) Positivists search for objectivity and strive to use a consistently rational, verbal and logical approach to their object of research;
i) Statistical and mathematical techniques for quantitative processing of data are central to the research methods adopted; and

j) Positivists use a set of formalized techniques for trying to discover and measure independent facts about a single reality which is assumed to exist, driven by natural laws and mechanisms (Carson *et al*., 2001 in Levy, 2006: 374-75).

De Villiers (2005) reiterates that positivist research is aimed at producing unbiased, value free and an accurate representation of the phenomena being studied. She further points out that positivist research relies heavily on quantitative methods, where data consist mainly of numbers and measures and analysis is done through statistical methods.

Though positivism is one of the important paradigms in natural sciences, it has limitations that undermine its usage in social science research. According to Kura (2012:6) positivism oversimplifies the real world into experimental situations that cannot be applicable in reality. He further argues that it is impossible to separate people from their social context and they cannot be understood without comprehending their perceptions. He also points out that capturing a complex phenomenon can be misleading as this can impose certain constraints on results and may neglect important findings. In addition, he indicates that positivists fail to acknowledge that the world is fragmented with disorganised units that are distinct from each other and can only be critically understood through interactions.

Similarly, Collis and Hussey (2009) criticized positivist paradigm by indicating that it is a highly structured research design which imposes constraints on the results and may ignore other relevant findings; researchers are not objective, but part of what they observe as they bring their own interest and values to the research and capturing complex phenomena in a single measure is misleading. These shortcomings of positivist paradigm gave rise to an alternative interpretivist philosophy.

4.2.2 Interpretivist Philosophical Paradigm

An interpretivist perspective sees the world as constructed, interpreted, and experienced by people in their interactions with each other and with wider social systems (Tuli, 2010). According to this paradigm there is no direct, one-to-one relationship between ourselves (subjects) and the world (object). Thus, the world is interpreted through the classification schemas of the mind (Gray, 2013). Thus, interpretivist epistemology views all knowledge and all meaningful reality as being contingent upon human practices and as being constructed in and out of interaction between human beings and their world

Interpretivists believe that it is more likely that people experience physical and social reality in different ways, and, that is why, rather than producing general, predictive laws about human behaviour, they present a rich and complex description of how people think, react and feel under certain contextually specific situations (Cavana, Delahaye & Sekaran, 2001). On the other hand Veal (2005) points out that interpretivist reject the idea that human behaviour can be studied in the same way as non-human phenomena and emphasize the view that the social world is socially constructed and subjective. That is, knowledge creation in interpretivist view is predicated on the argument that there can be no understanding of the social world without human interpretation (Leitch *et al*., 2010).

According to Leitch *et al*. (2010), the purpose of interpretivist research is not to confirm or disconfirm prior theories but to develop bottom-up interpretive theories that are inextricably grounded in the lived world. Rather interpretivist research entails capturing and describing carefully and thoroughly how people experience some phenomena, that is, how they perceive, describe, feel, remember, make sense and talk about this phenomenon with others.

Interpretivist ontological assumption assumes that the world has multiple realities. According to Krauss (2005) interpretivist ontology does not assume that there is a single unitary reality apart from our perceptions. He indicates that different people

experience the world from their own point of view and each of them experiences it differently. He concludes that the issue of multiple realities does exist.

According to Goldkuhl (2012) interpretivist ontology assumes that *"the social world is not 'given' rather the world is produced and reinforced by humans through action and interaction"*. He also points out that interpretivist ontology aims at understanding how members of a social group, through their participation in social processes, enact their particular realities and endow them with meaning, and shows how these meanings, beliefs and intentions of the members help to constitute their actions.

In general, qualitative research is based on a relativistic, constructivist ontology that posits that there is no objective reality. Rather, there are multiple realities constructed by human beings who experience a phenomenon of interest. People impose order on the world perceived in an effort to construct meaning; meaning lies in cognition not in elements external to us; information impinging on our cognitive systems is screened, translated, altered, perhaps rejected by the knowledge that already exists in that system; the resulting knowledge is idiosyncratic and is purposefully constructed (Lythcott & Duschl, 1990).

In terms of epistemology, interpretivism is closely linked to constructivism. Wahyuni (2012) points out that interpretivists believe that reality is constructed by social actors and people's perception of it. He also indicates that interpretivists recognize that individuals with their own varied backgrounds, assumptions and experiences contribute to the ongoing construction of reality existing in their broader social context through social interaction. Interpretivists indicate that the nature of inquiry is interpretive and the purpose of inquiry is to understand a particular phenomenon, not to generalize to a population (Tuli, 2010). Cavana Delahaye and Sekaran (2001) also show that interpretivist paradigm emphasizes inductive reasoning and is usually associated with qualitative methods such as interviews, focus group discussion and observations.

According to Antwi and Hamza (2015) interpretive researchers believe that reality consists of people's subjective experiences of the external world; thus, reality is socially constructed – it is a human construct. They also indicate that interpretivists

assume that knowledge and meaning are acts of interpretation, hence there is no objective knowledge which is independent of thinking, reasoning humans. According to Tuli (2010), interpretive researchers place strong emphasis on better understanding of the world through first-hand experience, truthful reporting and quotations of actual conversation from insiders' perspectives. Thus, interpretivist ontology is subjective in nature as the meaning is socially constructed.

The interpretivist research paradigm underpins qualitative methodology. For Antwi and Hamza (2015) the interpretivist methodology assumes that meaning is embedded in the participants' experiences and that this meaning is mediated through the researcher's own perceptions. They also indicate that researchers using qualitative methodology immerse themselves in a culture by observing its people and their interactions, often participating in activities, interviewing key people, taking life histories, constructing case studies, and analysing existing documents or other cultural artefacts. Similarly, Broom and Willis (2007) point out that qualitative methodologies which emerge from methods such as in-depth interviews and observations, seek to establish an understanding of people's lives, experiences and the subjective meaning that could explain the process of decision making and action. Qualitative methodology is usually more concerned with describing experiences, emphasizing meaning and exploring the nature of an issue (Mukherji & Albon, 2010).

Hence, interpretivists employ data gathering methods that are sensitive to context, which enable rich and detailed, or thick description of social phenomena by encouraging participants to speak freely and understand the investigator's quest for insight into a phenomenon that the participant has experienced. According to Kura (2012) interpretivist uses research methods such as participant and non-participant observation to understand details of interaction in their context. They believe that social reality is based on subjective interpretation of actions.

For Guba (1981), there are four aspects of trustworthiness employed by interpretivists which are credibility, transferability, dependability and confirmability. Credibility in interpretivist research deals with the question *"how congruent are the findings with reality?"* (Shenton, 2004). On the other hand, transferability of findings of interpretivist research *"must be understood within the context of the particular*

characteristics of the organization…and geographical area in which the field work was carried out" (*ibid*, 70). Dependability as one aspect of trustworthiness is closely linked to credibility in that in practice a demonstration of credibility ensures dependability. In order to address dependability, the processes within the study should be reported in detail, thereby enabling other researchers to repeat the work. This will also allow for thorough understanding of the methods employed and their effectiveness (*ibid*). Confirmability in interpretivist research helps to ensure that the findings are the results of the experiences and ideas of the participants rather than the characteristics and preferences of the researcher.

Interpretivist research is criticized for producing findings which lack reliability as it is subjective. In trying to understand the way people make sense of the social world, contradictory and inconsistent explanations may be advanced to explain social phenomena (Nudzor, 2009). Similarly, Starke (2010) indicates that interpretivist research is subjective, personalistic and that its contributions toward an improved and disciplined science are slow and tendentious. He furthermore points out that in interpretivist research new questions emerge more frequently than new answers and that the results pay off little in the advancement of social practice. According to Kura (2012) interpretivist research is criticised about the researcher's intrusion in the lives of the participants since the interpretation rests within the researcher which could be biased.

Through the above discussion on both positivism and interpretivism paradigms, there are a number of differences relating to ontology, epistemology, methodology, methods, issues of validity and reliability between these paradigms. These differences are summarized in the table below.

Table 4.1: The characteristics of Positivism and Interpretivism		
Feature	**Positivism**	**Interpetivism**
Ontology	Researcher and the reality are separate - Objectivist.	Researcher and the reality are inseparable -.
Epistemology	Objective reality exists beyond the human mind.	Knowledge of the world is intentionally constituted through a person's lived experiences.
Methodology	Underpinned by quantitative methodology.	Underpinned by qualitative methodology.
Methods	Observation (close ended), intervention, and survey are used.	Interview, focus group discussion and naturalistic observation are used.
Validity	Certainty- data truly measures reality.	Credibility-measures what is actually intended.
Reliability	Consistency-the extent to which result are consistent and replicable over time	Dependability-the processes within the study are reported in detail to allow for thorough understanding of the methods used and their effectiveness

Table 4.1: Characteristics of Positivists and Interpretivist. Adopted from MIS Quarterly 2004: p.1v

4.2.3 Justification for Choosing the Positivist and Interpretivist Paradigms

In this study, both positivist and interpretivist paradigms were adopted. In the first phase of the study, quantitative method mainly questionnaire was used to address the research question: What are teachers' pedagogical practices before lesson study training? This was done to reveal the factual information about teachers' pedagogical practices before they could be engaged in lesson training without influencing them in any way. The data collected using the quantitative methods was analysed using both descriptive and inferential statistics. Quantitative approach is supported by positivist paradigm as it allows researchers a certain amount of control over data collection and analysis through manipulation of research design parameters and statistical procedures to produce facts and figures (Oates, 2006). For Collins and Hussey (2009) positivist research tends to use statistical analysis and generate quantifiable findings using quantitative data analysis.

In second phase, interpretivist approach was adopted. In justifying the adoption of this philosophical position the researcher believed that through use of interpretive approach, it may be possible to investigate the changes in the teaching strategies used by teachers, establish their perception of LS and their experiences in using LS through their own voice. To obtain this information, the researcher had to use interviews and participant observation to interact with teachers in their natural settings to obtain deeper meanings behind their actions. The researcher used methods of data collection that allowed the meanings behind the actions of teachers under study to be revealed as actions are only meaningful to us in so far as we are able to share their experiences. A large number of our everyday interactions with one another rely on such shared experiences (Cohen, 2003: 22-23).

In summary, interpretivists are concerned with understanding the meanings which people give to objects, social settings, events and the behaviours of others, and how these understandings in turn define the settings.

4.3 RESEARCH METHODS

When carrying a research, there are methods which are used to help the researcher collect data. These methods are guided by the research questions which the researcher wants to address and the type of data to be collected. The section below discusses the methods that were used to collect data in this research.

4.3.1 Quantitative Approach

Quantitative research has been used by most researchers as it was found to be useful in many aspects. According to Walker (2005) quantitative research is depicted as the traditional scientific approach to research that has its underpinnings in the philosophical paradigm for human inquiry known as positivism. Aliaga and Gunderson (2002) define quantitative research as a phenomenon in which numerical data is collected and analysed using statistical methods. According to Antwi and

Hamza (2015) quantitative researchers attempt to operate under the assumption of objectivity and assume that there is a reality to be observed and that rational observers who look at the same phenomenon will basically agree on its existence and its characteristics.

For Antwi and Hamza (2015) in quantitative approach, researchers try to remain as neutral or value-free as they can, and they attempt to avoid human bias whenever possible. They further point out that quantitative researchers attempt to study the phenomena that are of interest to them "from a distance" and use standardized questionnaires and other quantitative measuring tools that are often used to measure carefully what is observed. In judging results, statistical criteria are used to form many conclusions.

Quantitative research has been found to have its own characteristics which distinguish it from other research methods. Thomas (2003) has identified some characteristics of quantitative research as making use of numbers and statistical methods. Furthermore, he indicates that quantitative research tends to be based on numerical measurements of specific aspects of phenomena from which general description is abstracted; and seeks measurements and analysis that are easily replicable by other researchers. In the same breath he points out that quantitative researchers seek explanations and predictions that will generalize to other persons and places. Additionally, he argues that in quantitative research, the researcher's role is to observe and measure, and care is taken to keep the researchers from contaminating the data through personal involvement with the research subject. Researchers' objectivity is of utmost concern. In addition, Kura (2012) identified other characteristics of quantitative research as value-free and objective, seeks precise measurement and analysis of target concepts.

In this study, quantitative method seems to be an appropriate method especially in addressing the following research question: What are teachers' pedagogical practices before lesson study training?

The first research question was meant to establish teachers' knowledge about LS before they could be offered training on LS strategies which would be understood

from the teaching methods teachers normally used in the teaching of mathematics. The aim of asking this question was to find out whether those teaching methods that teachers use have attributes that are found in LS. To answer this question a questionnaire was used to establish teachers' views on the use of certain teaching methods and how frequently they use such methods. The data collected was then analysed using statistical methods and the findings were used to inform the research about the type of intervention to be provided.

4.3.2 Qualitative Approach

Qualitative research is another approach used in social research because of its benefits in research. Joubish *et al*. (2011) indicate that the aim of qualitative research is to help researchers understand the world in which they live and why things are the way they are. They further point out that qualitative research is concerned with social aspects of our world and seeks to answer questions about it. In this way, qualitative research helps researchers in understanding how people feel and why they feel that way in the context in which they live. Denzin and Lincoln (2011) define qualitative research as:

> *"…multi-method 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, observations, historical, interactional, and visual texts-that describe routine and problematic moments and meaning in individuals' lives*" (p. 2).

For Antwi and Hamza (2015) qualitative research methodology often relies on personal contact over some period of time between the researcher and the group being studied. They indicate that building a partnership with study participants can lead to deeper insight into the context under study, adding richness and depth to the

data. Thus, qualitative methodologies are more concerned with deeper understanding of the research problem in its unique context. For Roller and Lavrakas (2015) researchers conduct qualitative research because they acknowledge the human condition and want to learn more, and think differently, about a research issue than what can be gleaned from most numerical quantitative studies. They indicate that unique nature and purpose of qualitative inquiry bring with it a distinctive set of attributes, all of which impact the design of qualitative research one way or the other.

Roller and Lavrakas (2015) indicate that qualitative research is characterized by the importance of context, that is, the data and researcher's interpretation of the data-depend greatly on the contexts from which the data are obtained; the importance of meaning, qualitative researchers derive meaning from the data by way of multiple sources rather than rely on a single data source.

The data collected through these sources are evaluated to make sense of them by organizing these data into categories or themes that cut across all of the data sources. The multiple sources that are used in collecting data are interviews, observations and documents analysis. For Creswell (2007) in the entire qualitative research process, the researchers keep a focus on learning the meaning that the participants hold about the problem or issue, not the meaning that the researchers bring to the research or writers from the literature.

According to Creswell (2007) the research process for qualitative researchers is emergent, which means that the initial plan for research cannot be tightly prescribed, and that all phases of the process may change or shift after the researchers enter the field and begin to collect data. According to Starke (2010) qualitative research is interpretive in nature, which means that researchers make interpretation of what the objects say, what the researchers see, hear and understand, which makes their interpretation inseparable from their personal background and prior understanding of reality. In this study, qualitative research was used because the researcher wanted to answer the following questions:

a) How does the lesson study training impact on teachers' pedagogical practice?

b) What are the effects of lesson study on learners' understanding of mathematics?
c) Which challenges do teachers experience in implementing lesson study?

These could only be established by talking directly to teachers about their experiences in the teaching of mathematics, and observing them as they teach. In the above discussions, the strengths of both quantitative and qualitative research have been clearly articulated. However, there are some limitations regarding each of these methodologies.

In fact, Al-Busaidi (2008) shows that none of these research methods is superior to the other. Each of them has weaknesses and strengths which could be compensated by using both of them. Thus, qualitative and quantitative research methods can indeed be seen as complementary and both are necessary to provide an understanding of a phenomenon being studied. In the same manner, King, Keohane and Verba (1994) draw attention to the fact that neither quantitative nor qualitative research is superior to the other, regardless of the research problem being addressed. They further reveal that good scientific research can be quantitative or qualitative in style. Correspondingly, Sandelowski (2000) mentions that no method is absolutly weak nor strong but rather more or less useful or appropriate in relation to certain purposes. Hence, the combination of both quantitative and qualitative research methods can provide a more reliable and valid data than the use of one of them. The next section therefore discusses mixed method approach.

4.3.3 Mixed Method Approach

In this study the mixed method approach was used as the researcher wanted to address the research questions through the use of both quantitative and qualitative methods in order to overcome the limitations of each method. According to Creswell *et al*. (2003) the use of multiple methods can neutralise or cancel some of the distanvatages of certain methods, for example, the detail of qualitative data can provide insights not available through general quantitative surveys. They further

indicate that mixing different types of methods can strengthen a study. Denscombe (2007) indicates that mixed methods research

> "*… combines alternative approaches within a single reseach project. It refers to a research strategy that crosses the boundaries of conventional paradigms of research by deliberately combining methods drawn from different traditions within different underlying assumptions. At its simplest, a mixed methods strategy is one that uses both qualitative and quantitative methods"* (p. 107).

Venkatesh *et al*. (2013) propose seven purposes for using mixed methods approach as 'completeness' which is meant to ascertain attainment of total representation of experiences; complementary is another purpose for using mixed methods approach. This was meant to obtain mutual viewpoints about similar experiences; another purpose is developmental, where questions are build from one method that materialises from the implication of a prior method- thus, where questions answered qualitatively are informed by the outcomes of the quantitatve approaches or vise versa. Mixed methods approach also allows for expansion in that one method, clarifies or elaborates on the knowledge gained from a prior method, that is, in the case where methods are carried out sequentially. Corroboration is another important reason for using mixed methods approach as it provides a whole picture of what has been experienced from using mixed method approach. By using two different methods, the researcher evaluates the trustworthiness of inferences gained from one method. This in a way counters the weaknesses of one method by employing the other method – thus, compensation.

Creswell and Plano (2011) identified some of the useful characteristics of mixed methods designs. These characteristics include:

- Collecting and analysing persuasively and rigorously both qualitative and quantitative data based on the research questions.
- Mixing or integrating the two forms of data concurrently by combining them, by having one build on the other sequentially or embedding one within the other (concurrent);

- Giving priority to one or both forms of data in terms of what the research emphasises,
- Using these procedures in a single study or in multiple phases of a programme of study,
- Framing these procedures within the philosophical worldviews and theoretical lenses,
- Combining the procedures into specific research design that directs the plan for conducting the study (p. 5)

These listed characteristics of mixed methods designs provide the researcher with an opportunity to examine or view research problems and questions in different ways. Creswell and Plato (2007) point out that the benefit of mixed methods research is its potential to overcome some of the problems associated with quantitative and qualitative research methods. One of the problems associated with quantitative approach is that many important characteristics of people and communities cannot be meaningfully reduced to numbers or adequately understood without reference to the local context in which people live as quantitative approach is equated to numbers (Dudwick, Kuehnast, Jones & Woolcock, 2006 in Choy, 2014; Creswell & Plano, 2011). On the other hand, qualitative approach produces knowledge that cannot be generalized to other people or other settings due to the fact that findings might be unique to the relatively few people included in the research study as qualitative is often equated to text data (Choy, 2014; Creswell & Plano, 2011). Hence, rejecting the incompatibility of different data types and analysis techniques enables the researcher to exhaust all the data available (Creswell *et al*., 2003).

4.4 REASEARCH DESIGN

Mixed methods design was used to gather data which addressed the research questions on the effects of Lesson Study training on Secondary Mathematics teacher's pedagogical practices. Johnson and Onwuegbuzie (2004) define mixed methods design as the class of research where the researcher mixes or combines

quantitative research and qualitative research techniques, methods and approaches into a single study.

The study utilized the mixed methods design in that multiple approaches in answering research questions were used, rather than restricting or constraining researcher's choice to one method (Johnson & Onwuegbuzie, 2004). Reasons for adopting mixed methods design in this study was to ensure that all aspects relating to the research questions were addressed.

According to Venkatesh *et al.* (2013) two of the most widely used mixed methods research designs are concurrent and sequential research designs. They illustrate that in concurrent design, quantitative and qualitative data are collected and analysed in parallel and then merged for a complete understanding of a phenomenon or to compare individual results. For Driscoll and Rupert (2007) in concurrent mixed method, data collection strategies are used to validate one form of data with the other form, to transform the data for comparison, or to address different types of questions. On the other hand, Venkatesh *et al*. (2013) point out that in a sequential mixed methods design, quantitative and qualitative data collection and analysis are implemented in different phases and each is integrated in a separate phase. When the data are introduced in phases, either the qualitative or the quantitative approach may be gathered first, but the sequence relates to the objectives being sought by the researcher (Molina & Cameron, 2010).

According to Cameron (2009) sequential design can employ three designs which are explanatory, exploratory and transformative design. Creswell (2007) indicates that sequential explanatory design operates in two-phases which start with the collection and analysis of quantitative data followed by the subsequent collection and analysis of qualitative data. He explains further that the second, qualitative phase of the study is designed so that it follows from or connects to the results of the first quantitative phase. When quantitative data precede the qualitative data, the intent is to test the variables with a large sample and then carry out a more in-depth exploration of a few cases during the qualitative phase (Molina & Cameron., 2010).

For Creswell (2007) there are two variants of the explanatory design which are the follow-up explanations model and the participant selection model. He indicates that both models have an initial quantitative phase followed by a qualitative phase though they differ in the connection of the two phases, with one focusing on results to be examined in more detail and the other on the appropriate participants to be selected. They also differ in the relative emphasis often placed on the two phases. The follow-up explanations model is used when a researcher needs qualitative data to explain or expand on quantitative results, in this model, the primary emphasis is usually on the quantitative aspects. On the other hand, Creswell (2007) shows that participant selection model is used when a researcher needs quantitative information to identify and purposefully select participants for a follow-up, in-depth, qualitative study and in this model, the emphasis of the study is usually on the second, qualitative phase.

Creswell (2007) points out that explanatory Design is the most straightforward of the mixed methods designs as the researcher conducts the two methods in separate phases and collects only one type of data at a time which means that a single researcher can conduct this design alone; the final report can be written in two phases, making it straightforward to write and provide a clear delineation for readers and the design also lends itself to multiphase investigations. Though explanatory design sounds so appealing when conducting a study, it has certain challenges. This design requires a lengthy amount of time for implementing the two phases and researchers should notice that the qualitative phase will take more time than the quantitative phase (Creswell, 2007).

Exploratory sequential design is another mixed method design which employs qualitative and quantitative approaches. According to Molina and Cameron (2010) in exploratory design, qualitative data collection precedes the quantitative data collection, the intent is to first explore the problem under study and then follow up on this exploration with quantitative data that are amenable to studying a large sample so that results might be inferred to a population (Refer to fig. 4.1).

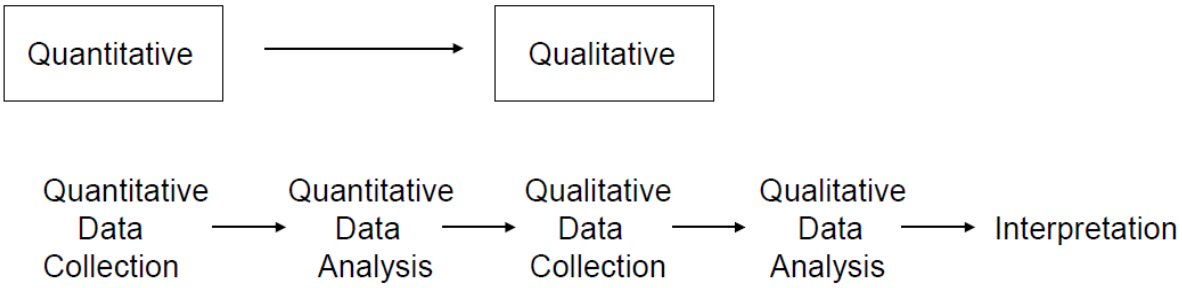

Figure 4.1: Exploratory Sequential Design Model Adopted from Terrell-2012:263

For Creswell (2007) the exploratory design also has two-phases in which the results of the qualitative method can help develop or inform the quantitative method. This design which is best suited for exploring reality begins with qualitative approach of collecting data followed by quantitative method. Creswell (2007) illustrates that exploratory design is used in the first phase to explore the topic qualitatively and develop themes from the qualitative data collected, the researcher then develops an instrument based on these results and subsequently uses this instrument in the second, quantitative phase of the study (Refer to figure 4.2). The exploratory design is particularly useful when a researcher needs to develop and test an instrument because one is not available or identify important variables to study quantitatively when the variables are unknown (Creswell, 2007). It is also appropriate when a researcher wants to generalize results to different groups, to test aspects of an emergent theory or classification, or to explore a phenomenon in depth and then measure its prevalence (*ibid*).

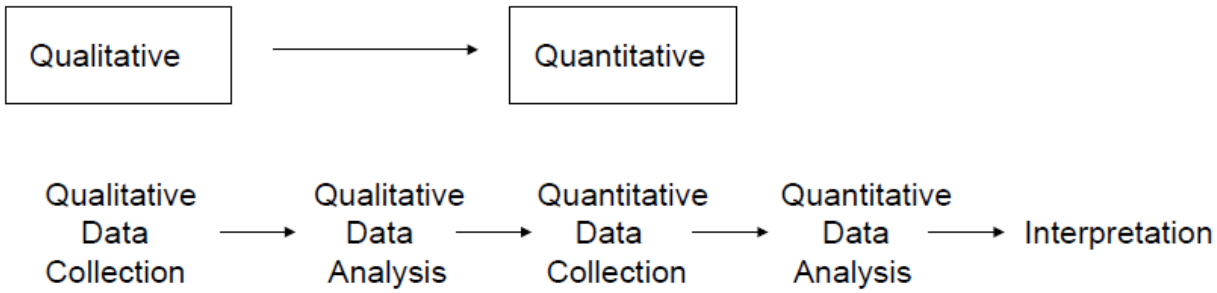

Figure 4.2: Explanatory Sequential Design Adopted from Terrell-2012:261

Just like in the case of explanatory, the exploratory design has two common variants which are the instrument development model and the taxonomy development model and each of these models begins with an initial qualitative phase and ends with a quantitative phase (Creswell, 2007). These two designs also differ in the way the researcher connects the two phases and in the relative emphasis of the two methods in terms of which method carries more weight. In this design, the qualitative and quantitative methods are connected through the development of the instrument items. Researchers using this variant often emphasize the quantitative aspect of the study.

Exploratory Design like other designs has advantages and disadvantages. For Creswell (2007) the advantages of exploratory design are that separate phases make this design straightforward to describe, implement, and report and that it is easily applied to multiphase research studies in addition to single studies. However, there are a number of challenges associated with the exploratory design and these are the two-phase approaches which require considerable time to implement. Researchers need to recognize this factor and build time into their study's plan; again it is difficult to specify the procedures of the quantitative phase when applying for initial internal review board approval for the study (*ibid*).

This study adopted transformative mixed method design. Transformative design consists of two distinct phases of data collection namely quantitative and qualitative. According to Creswell, Plano-Clark, Gutmann, and Hanson (2003) either method may be used first and the priority may be given to either quantitative or qualitative phase and the results of these two phases are integrated during the interpretation phase. In this study, the first phase comprised of quantitative data collection through the use of questionnaires and this was followed by qualitative data collection phase where classroom observations were made and interviews conducted. Quantitative data was analysed independently of qualitative data, however the results were integrated during interpretation phase. Figure 4.3 shows the process that was followed when carrying out this study

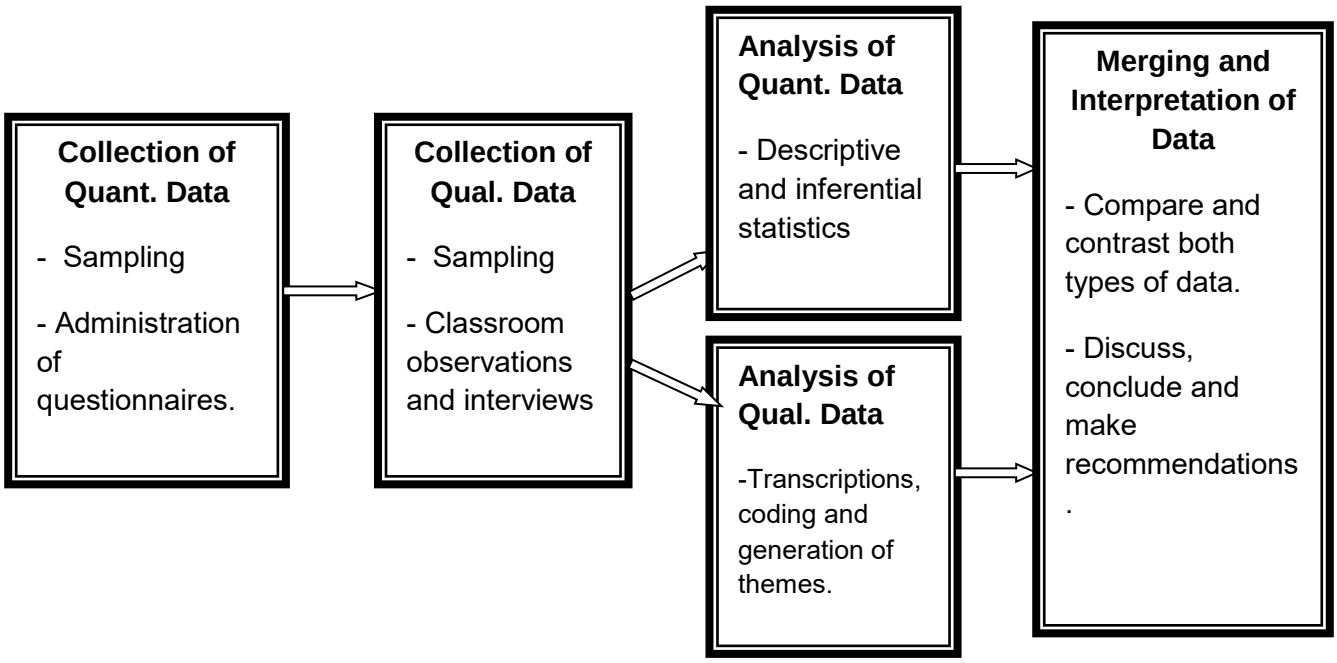

Figure 4.3: Sequential Transformative Mixed Method Design-Adapted from Cresswell *et.al*, 2003:180.

In order to collect both quantitative and qualitative data participants had to be identified and selected. The type of participants who took part in this study is discussed below.

4.5 PARTICIPANTS

Thirty-five secondary schools in Maseru were randomly selected from ninety-eight schools. Questionnaires were administered to two hundred teachers from these schools. All teachers who filled the questionnaire were mathematics teachers. Four schools were purposively selected from these schools to participate in the second phase of the project. Only two teachers from these four schools were requested to attend the workshop on LS. Teachers who actually attended the workshop were selected by the school principals as per letter of invitation by the researcher. Participants in the second phase comprised of six young teachers in terms of age and 2 mature teachers in their fifties. There were two male and six female teachers with differing experiences. Three teachers had Diploma in Mathematics and Science Education, four had Bachelor of Science Education and one had Honours Degree.

When the sample has been selected then teachers who were going to participate had to be trained on LS as it was a new concept to them. The next section discusses how the workshop was conducted.

4.6 OVERVIEW OF LESSON STUDY WORKSHOP

Phase 1

All the teachers who were involved in this study were not familiar with the use of LS as an approach of teaching/ learning of mathematics, the researcher had to conduct a workshop on LS. The aim of the workshop was to introduce secondary mathematics teachers in Lesotho to Lesson Study approach and how Lesson Study can facilitate teaching and learning of mathematics. Therefore, 8 teachers from four secondary schools in Maseru were invited by the researcher by writing letters to the school principals requesting the release of any two mathematics teachers to attend the workshop. Since the school principals already knew the researcher (the researcher introduced and sought permission to work with teachers while administering the questionnaires), the release of teachers to attend the workshop was not a problem.

The purpose of inviting two teachers from each of the four schools was that these teachers were expected to assist each other in setting up the LS research teams in their prospective schools and also to share with their colleagues the knowledge they gained from the workshop. This workshop was to be followed up by the school-based workshop where all mathematics teachers in that school would be invited by the researcher and the knowledgeable other to be given a thorough training on aspects of the LS. Therefore, it was important to involve these teachers from the beginning so that they could help in disseminating this approach and to maintain it especially in the absence of the researcher.

The objectives of the workshop were as follows:

By the end of the workshop, participants should be able to:

- Explain the LS process
- Describe the importance of LS in the teaching/learning of Mathematics;
- Identify the aspects of lesson study in a lesson;
- Describe in their own words what LS is/is not;
- Assist teachers on how to use LS as a means of improving their teaching practices;
- Help teachers on how to use LS to improve learners learning;
- Discuss with teachers how LS supports the professional development of teachers at their work place.

The workshop was conducted in Maseru, the capital town of Lesotho on Wednesday the 11th September 2013 from 8:00 am to 5:00 pm.

Upon arrival, participants were registered and provided with the course files containing lined paper, a pen, pencil, rubber, a ruler and copies of the Junior Certificate mathematics syllabus. A program showing the events of the workshop can be found in Appendix C. An introduction and welcome remarks were made by the researcher who highlighted the aims and objectives of the workshop. The researcher also introduced the knowledgeable other and explained the role she will play in the workshop. The teachers also introduced themselves, the schools they come from and the subjects they teach. Following the introduction and welcome remarks, the next hour was spent on teachers' reflections about their classroom practices in terms of what teaching methods they use, any collaboration activities they engage in, workshops they attend and any activities that they engage in that assist them in their teaching.

From their reflections, one teacher indicated that:

> "*I have been teaching for 5 years now but I have not attended any mathematics workshop nor visited by inspectors. Our school is normally visited by people from abroad who gave us very good mathematics books and*

have also constructed a laboratory and some classes. Due to the number of learners in my class, I normally use group work in my teaching and to be honest, there isn't much collaboration going on in the school except when scheming and setting common tests."

Another teacher, who was the most experienced in the group, indicated that

"*there are a number of workshops I have attended, I cannot even remember how many they are, but really, most of them did not help that much in the teaching of mathematics. We used to have weekly workshops in the 1990s where we would come together as teachers from the same region to discuss the problems we encounter in the teaching of mathematics and also seek for assistance regarding problematic topics but this has just died. Currently we don't have any means of collaboration, either in the school or outside the school. We only collaborate at the beginning of each school session when we scheme and also when preparing for common tests. As for teaching methods that I use, uhm, I basically use different methods in my teaching*."

From these reflections, it was evident that teachers do not collaborate except when scheming and setting tests.

In the next session, A "knowledgeable other" who was a mathematics lecturer at teacher training institution and who attended numerous workshops/courses on LS in countries such as Singapore, Malaysia and Ireland introduced the concept of LS in terms of what it is – teacher-led professional development programme which is school based; its origins – originated in Japan in the Meiji period (1860s – 1930s): how it works – seven stages of LS cycle and how the countries using it benefitted – generally mathematics performance in such countries has improved. This presentation was followed by 15-minutes break during which teachers were asked to reflect and digest on the presentation. After tea break, teachers were given one hour to ask questions and commend on the presentation.

For the next one and half hours, a video which was outlining the LS process was shown in which teachers were asked to identify the stages of LS process as it unfolded in the video by indicating what actually happened at each stage. Thereafter,

teachers broke for one hour lunch. Over the next hour teachers formed two groups to compare and discuss what they have seen in the video especially in relation to LS cycle. For the next hour, groups were requested to present their video observations to the rest of the group and this was followed by the whole group discussion.

Over the last hour teachers were requested to select a research lesson topic that was to be taught after the school based workshop. The topic that was agreed upon was linear equations at Form B level. Teachers were encouraged to inform their colleagues about LS approach and also to set up a LS team in preparation for the school-based workshop. The researcher closed the workshop by thanking all the teachers who participated in the workshop and indicated that this workshop was the first of many to come. She pointed out that once the research teams have been set up, the dates for the second phase would be communicated. Finally, an evaluation form (Appendix F) was issued and completed by teachers. The feedback from the evaluation form indicated that teachers were looking forward to the second phase of the training except teachers from one school that showed no interest in joining the project. Teachers were then reimbursed their transport costs.

Phase 2

Training and Lesson Preparation

The second phase of the project focused on training the rest of the school team on LS approach. This was followed by planning a research lesson on the agreed topic (linear equations). This lesson was to be taught on the next visit. The activities started at 9.00 am to 1:00 pm. Since there were three schools remaining, the dates of the workshop for the schools were as follows; 23rd September, 2013, 24th September, 2013 and 27th September, 2013. The researcher who has attended some LS courses, trained the school teams with the help of two teachers who attended the initial training. In the first school, the team consisted of 3 teachers, head of Mathematics and Science department who was also teaching mathematics, the deputy principal and the researcher. In the second school, the team was made up of 4 teachers, head of Mathematics and Science department who was also teaching mathematics and the researcher. In the third school where the principal of the school

seemed to be very positive about the initiative, there were 9 mathematics teachers, one science teacher who came as an observer and the researcher.

The next stage was preparation of the research lesson by the team. In preparing the lesson, the following aspects were considered; the objectives of the lesson which should be clear and measurable, the best way of introducing the lesson which would arouse learners' interest, appropriate teaching methods/strategies for the concept to be taught, teaching/learning materials which would help in clarifying the concept, questions to be asked to elicit learners understanding, activities that would stimulate thinking processes of learners as reflected by their answers, products, presentation of their work. Finally, one member of the team was asked to volunteer to teach "the research lesson". Some members of the team were requested to prepare the suggested teaching/learning materials and make a clean copy of the lesson plan. Teachers from all the teams agreed to combine all the streams (e.g. Form $B^{1,}$ Form B^{2} etc). The teams also agreed that the research lesson would be taught a week later due to researcher's commitments.

Teaching of Research LS

On the day that was agreed upon, the research lesson was taught as planned. The rest of the team members observed and collected data using observation form found in Appendix D. Each of the observers had to record the questions asked by the teacher/learners, answers given by the learners, how the teacher handled learners' questions, learners' reactions towards the lesson and the presentation of their work.

Reflection Session

After the research lesson had been taught, the team met for debriefing. During this session, the teacher who, taught the lesson was the first to be given an opportunity to evaluate the lesson, giving attention to what went well during the lesson and the challenges met. From there, each member of the team was given a chance to present his/her observations. The researcher as the member of the team also shared with the team what she had observed. The team deliberated on how the research

lesson could be improved, and such improvements were made leaving the lesson plan ready to be taught. The teacher who presented the research lesson was thanked by the team. Lastly the team was given the liberty to prepare on their own another research lesson on the topic of their choice and agreed with the researcher when that would be taught.

It was at this stage where teachers from the third school requested the researcher to train them on one mathematical topic which they found difficult. This topic had just been introduced in the new mathematics syllabus, and all teachers were not familiar with it, hence why they requested the researcher to provide them with content knowledge and observe them as they teach that lesson on the new topic (Linear programming). The team together with the researcher agreed on when that workshop could be held. The team was trained on linear programming.

The team was then given an opportunity to prepare a research lesson on the topic they had just been trained on. After planning the research the team agreed that two teachers should teach the lesson where one teacher would introduce the lesson and the other one develop it. The lesson was taught as agreed with the rest of the team observing the lesson and collecting information on how the lesson unfolded. The idea of team teaching was also observed in the second school where teachers agreed that one teacher introduce the lesson and the other one develop it. In this study both quantitative and qualitative approaches were to be used to collect data. The section below presents the procedure that was used to collect both quantitative and qualitative data.

4.7 DATA COLLECTION PROCEDURE

In this study, data was collected through use of questionnaires, non-participant observation and structured interview. The first step of data collection involved administration of questionnaires to two hundred secondary mathematics teachers.

The questionnaire that was used in quantitative data collection was adapted with modifications from a previous study of the research which was on teachers' pedagogic practices in the teaching of mathematics. The first section of the questionnaire was on participants' biography. The second section was about teachers' pedagogical practices – which teaching methods they used in the teaching of mathematics and why, the role played by learners during mathematics lessons. The third section was on the support system available for teachers in the form of workshops, collaboration mechanisms available within or outside the school and how important the support systems were in the teaching of mathematics. Two hundred questionnaires were hand delivered to teachers in thirty five schools and were later collected. Out of 200 questionnaires given to teachers, 122 were returned and 5 of which were spoilt giving a return rate of 58.5%.

The second step involved classroom observations. The researcher observed one research lesson from each school which gives a total of three classroom observations. Before observations, the researcher requested a copy of the research lesson to be presented. In all the observations, the researcher played the role of a non-participant observer, though during the lessons she moved around to take evidence of learners' learning. Observation schedule was used in all the observations. Observation schedule focused on the following aspects of the lesson; introduction of the lesson, teaching methods/strategies used, teaching/learning materials used, questions asked by the teacher to elicit learners understanding, how the teacher handled learners questions and responses, learners' activities, learners' presentation of their work, learners' thinking and understanding as depicted by the questions they asked and how they answered the questions asked. After the lesson observation, the researcher joined the debriefing session where once again she played the non-participant observer who was just taking notes.

In these three schools the status of the research teams which took part in the LS cycle was as follows:

Table 4.2: Particulars of Participants				
School	Males	Females	Qualifications	Age Range
1st	3	1	1 masters in Education 1 Bachelor of Science Education 2 Diplomas	3 teachers -(25-30yrs) 1 teacher - 60+
2nd	2	3	4 Bachelor of Science Education 1 Honors	1 teacher-(25-30 yrs) 2 teacher (35-40yrs) 2 teacher 50+
3rd	3	6	9 Bachelor of Science in Education	3 teachers-(25-30 yrs) 2 teachers-(30-35 yrs) 2 teachers-(35-40yrs) 2 teachers 50+

The third step involved interviewing one teacher from each of the three teams. This was carried out using interview schedule (Appendix C). The questions asked were on whether teachers enjoyed participating in LS and whether their participation in the project influenced their teaching of mathematics; how they could describe the behaviour of the learners during the teaching of the research lesson; what they liked about LS and the challenges they encountered in implementing LS in their teaching; suggestion on how LS could be improved and whether they would recommend that LS be extended to other schools and why. In order to get this information, a variety of data collection methods have to be used. The data collected using these different methods was also meant to address different research questions. The section below discusses the methods used to collect different types of data.

4.8 DATA COLLECTION METHODS

The study employed a variety of data collection methods which included questionnaire for quantitative data, interviews and observations for qualitative data. The next section will discuss why each of these methods were used.

4.8.1 Questionnaire

Questionnaires are any written instruments that present respondents with a series of questions or statements to which they are to react either by writing out their answers or selecting from among provided answers (Brown, 2001). According to Caro, Eddy, Kan, Kalttz, Patel, and Eldessouki (2014) questionnaires can help the researcher anticipate the outcomes she can expect if she implements the interventions in her setting and also provide her with the information she needs for making informed decision. For Harris and Brown (2010), a questionnaire is an important means of obtaining direct responses from participants about their understandings, conceptions, beliefs, and attitudes. They further indicate why questionnaires are usually viewed as a more objective research tool that can produce generalizable results because of large sample sizes, and in that, it permits a wide range of responses, of, perhaps, a more cognitively dispassionate nature.

Gillham (2007) has enlisted a number of advantages of using a questionnaire as a method of collecting data as follows:

- It saves time – many questionnaires can be administered at the same time. Responses to a large-scale questionnaire can be pulled within a short time.
- Respondents can complete the questionnaire when it suits them – The researcher can leave a questionnaire for participants to complete at their own convenient time. It reliefs respondents from pressure for an immediate response.
- Analysis of answers to closed questions is relatively straightforward – for analysing closed questions the number in which the responses come up can be counted and be displayed using frequency tables, charts, and any other statistical representation.
- Respondent anonymity – some people will undoubtedly feel freer in an anonymous style of responding.

Though there are some advantages in using a questionnaire as data collecting technique, there are some disadvantages associated with this technique. Gillham

(2007:6) illustrates the following as some of the disadvantages of using a questionnaire:

- Problems of motivating respondents – only few people are motivated by questionnaires unless they can see it as having personal relevance.
- Misunderstandings cannot be corrected – one of the most frustrating things for the researcher is to find that a question has been misunderstood which in turn may generate unexpected responses or may be left unanswered.

In this study the questionnaire was employed to collect data at the very initial stage of the study. The questionnaire was used to provide information about teachers' understanding of LS and to find teachers' pedagogical practice before training which would in turn be used to inform the researcher about the kind of intervention to be provided.

4.8.2 Observations

Boswell and Cannon (2011) define observation as a method of collecting descriptive and behavioural data where one can observe behaviour as it occurs. They further say that frequently what a person says and does can be two different pieces of information, hence observation allows for the confirmation of what is said by viewing specific behaviours and activities.

In this study, observation of the research lesson was the main method of collecting data. According to Starke (2010) many qualitative researchers prefer observation data as the information can be seen directly by the researcher or heard or felt. He also indicates that the eye sees a lot, simultaneously noting who, what, when, where, and particularly relating them to the research questions. Curry, Nembhard and Bradley (2009) indicate that observational data collection involves the systematic, detailed observation of people and events to learn about behaviours and interactions in natural settings. They also point out that such study designs are useful when the study goal is to understand cultural aspects of a setting or phenomenon; when the

situation of interest is hidden from the public, or when those in the setting appear to have notably different views than outsiders.

For observation to be done effectively, Creswell (2007) indicates that during an observation, the observer uses an observational protocol which usually includes headings giving information about the observational session, the protocol after observation should show recorded information which includes "descriptive notes" of activities useful, information on how activities unfolded during the class session. There are also "reflective notes" a section for notes about the process, reflections on activities, and summary conclusions about activities for later theme development. For Starke (2010) an active form of observation is a participant's observation where the researcher joins in the activity as a participant, not just to get close to the others but to try to get something of the experience they have written on paper.

Observation as method of data collection has its own advantages and disadvantages. Sapsford and Jupp (2006) outline the advantages of observation as follows:

- Information about the physical environment and about human behaviour can be recorded directly without having to rely on the retrospective or anticipatory accounts of others.
- The observer may be able to see what participants cannot see such that many important features may be ignored by the participants.
- It can provide information on the environment and behaviour of those who cannot speak for themselves and therefore cannot take part in the interviews.
- Data obtained from observation can be a useful check on, and supplement to, information obtained from other sources(p.59)

The disadvantages of using observation are summarized as follows by Sapsford and Jupp (2006:59):

- The environment, event or behaviour of interest may be inaccessible and observation may simply be impossible or very difficult.

- People may, consciously or unconsciously, change the way they behave because they are being observed and therefore observational accounts of their behaviour may be an inaccurate representation of how they behave naturally.
- The researcher may only be able to observe a small sample of behaviour that is of interest and as a result, the representation of observations may be in doubt.

For Boswell and Cannon (2011) observation method provides highly detailed information from an external perspective on what actually occurs in reality. They assert that the depth of the information obtained is the primary benefit from collecting data using observation method. They further indicate that observation as a data collection process is an effective method for understanding important related items of a designated setting and it can also be used with any individual regardless of educational preparation. However, Boswell and Cannon (2011) point out that the limitations of observation method include time-consumption, labour-intensive, and it is expensive.

Again they indicate that without the assurance that the observer is knowledgeable about the entire process, the reliability of the data may be questioned. In using observation as a method of collecting data, there are four ways in which an observer may gather data. The four roles of an observer during observation are:

- **Complete participant**: the observer takes the role of a member within the sample and operates covertly, concealing any intention to observe the setting. In this case the members of the group are not informed about the data collection process.
- **Participant-as-observer:** the observer who forms relationships and participates in activities, but makes no secret of his or her intentions to observe events. In this case the members of the group are aware that the observer is taking on dual roles of member of the group and spectator.
- **Observer-as-participant**: the observer who maintains only superficial contact with the people being studied. The observer works from within the group, but

spends more time in the role of spectator, instead of being a member of the group and collects data in an overt manner.

- **Complete observer:** the observer who merely stands back and eavesdrops on the proceedings. In this case the observer is totally in the role of watcher and collects data in a covert manner (Boswell & Cannon 2011, Meyer, 2001)

In collecting data through observation the researcher assumed the role of participant-observer as teachers were aware that she is observing them and collecting data as they teach. During the observation process the researcher used an observation protocol. The observation of the research lesson helped the researcher to see how learners' understanding of mathematical concepts was dealt with by the teacher when conducting the lesson, that is, what questions were asked, how they were responded to by learners, and how the teacher handled their responses.

In this study, observation was used to answer the following research questions: Were learners' understanding of mathematical concepts considered during teaching of the research lesson? What LS attributes were used in the teaching of the research lesson after training? Using observation was the only effective method that could help the researcher to establish learners' understanding of mathematical concepts as this was apparent during the lesson when learners ask questions, respond to questions, and through presentation of their work. Furthermore, in determining LS attributes which teachers retained after training, observation was also an appropriate method to use as some of these attributes would be evident as the lesson unfolds.

4.8.3 Interviews

Kvale (1983) in Cassell and Symon (2004) defines research interview as; '*an interview, whose purpose is to gather descriptions of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena' (*p.11*).* On the other hand, Alsaawi (2014) defines an interview as a "*narrative device which allows persons who are so inclined to tell stories about themselves*". He also shows

that interview is a tool that brings contextual meaningful information to the real world and allows in-depth interviewers to unravel the complexity of other people's worlds. According to Cassell and Symon (2004) the goal of any interview is to see the research topic from the perspective of the interviewee, and to understand how and why they come to have this particular perspective. For Wahyuni (2012), the main feature of an interview is to facilitate the interviewees to share their perspectives, stories and experiences regarding a particular social phenomena being observed by the interviewer. Gill, Stewart, Treasure and Chadwick (2008) show that the purpose of interview is to explore the views, experiences, beliefs and/or motivations of individuals on specific matters. For Ritchie and Lewis (2003) interview permits the researcher to explore fully all the factors that underpin participants' answers; reasons, feelings, opinions and beliefs that furnish the explanatory evidence which is an important element of qualitative research.

Starke (2010) points out that there are a number of reasons why interviews are used in qualitative research, some of these are to obtain unique information or interpretation held by the person being interviewed, collecting a numerical aggregation of information from many persons and finding out about "a thing" that the researchers were unable to observe. The interview is generative in the sense that new knowledge or thoughts are likely, at some stage, to be created though this may vary depending on the research questions, but it is likely that the participants will at some point direct themselves, or be directed by the researcher, down avenues of thoughts they have not explored before (Ritchie & Lewis, 2003). Interviews are, therefore, most appropriate where little is already known about the study phenomenon or where detailed insights are required from individual participants (Gill *et al*. 2008). In research there are three types of research interviews which are structured, semi-structured and unstructured.

For Gill *et al*. (2008) structured interviews are, essentially, verbally administered questionnaires, in which a list of predetermined questions are asked, with little or no variation and with no scope for follow-up questions to responses that warrant further elaboration. Similarly, Alsaawi (2014) demonstrates that structured interview is a pre-planned interview where the researcher writes down the interview questions before conducting the interview. He also alluded to the fact that such a format is an effective

way to keep the interview tightly focused on the target topic. However, this type of interview lacks richness and limits the availability of in-depth data and that the variation among responses is limited due to the strict interview format that is used (*ibid*). The benefit of using this type of interview lies with researchers who know exactly what they are looking for.

According to Gill *et al*. (2008) unstructured interviews do not reflect any preconceived theories or ideas and are performed with little or no organization while semi-structured interviews consist of several key questions that help to define the areas to be explored, but also allow the interviewer or interviewee to diverge in order to pursue an idea or response in more detail. For Alsaawi (2014) the flexibility of unstructured interview is wide open such that the interviewees can elaborate on what they are asked, leading to unpredictable directions. He illustrates that this type is similar to a conversation in which the interviewer might ask a single question and then the interviewee has the choice with regard to the extent to which s/he responds as the interruptions on the part of the interviewer are kept to a minimum. This type of interview is suitable for researchers who want specific information in details.

According to Harris and Brown (2010) in a semi-structured interview, interviewers begin with a small set of open-ended questions, but spend considerable time probing participant responses, encouraging them to provide detail and clarification; these data are generally analysed qualitatively. Alsaawi (2014) indicates that semi-structured interview is a mix of structured and unstructured interview, where the questions are pre-planned prior to the interview but the interviewer gives the interviewee the chance to elaborate and explain particular issues through the use of open-ended questions. This type is appropriate to researchers who have an overview of their topic so that they can ask questions (*ibid*).

When using interview techniques there are certain advantages and disadvantages encountered. For Alsaawi (2014), interviewing is more convenient if the researcher's aim is to understand the meaning people involved make of their experience where non-verbal cues are of merit for the interviewer as they may help the interviewer to understand the message being given. He further points out that interviews are an excellent way to obtain insight into social issues by exploring the individuals'

experience regarding these issues. For Cassell and Symon (2004) interview can be used to tackle different types of research question by structured, semi-structured and unstructured interviews making it one of the most flexible methods available thus, addressing focused questions and unfocused questions.

Most scholars have observed that interviews are time-consuming. For Alsaawi (2014), interviews are time consuming, as the researcher needs to go through a long process, starting from establishing access to making contact with participants, conducting the interview followed by transcribing the data and making use of it. Interview is also time consuming on the part of the interviewee such that the researcher may encounter problems in recruiting participants.

In this study semi-structured interviews were conducted with three teachers who participated in the LS from each of the three schools in which LS was practiced. The interviewee were teachers who had volunteered to be interviewed after their participation in LS. The reasons for conducting interview were to elicit a deeper understanding from a few individuals' about their experiences with Lesson Study, with regard to their feelings, opinions, and beliefs as the researcher had some little knowledge about teaching methods teachers used which was gathered from questionnaires used at the initial stage of the study. Furthermore, in determining LS attributes which teachers retained after training, an interview was also considered as an appropriate method to use as some of these attributes would be evident from the teachers responses. When quantitative and qualitative data has been collected, then analysis of that data has to be done. The procedure that was followed in analysing both quantitative and qualitative data is presented below.

4.9 DATA ANALYSIS

The data collected in this study was both quantitative and qualitative as questionnaires were used, and interviews and observations were done. Quantitative data and qualitative data were analysed separately because of the purpose they served. The results of the quantitative data were used to find teachers classroom

practices over a large scale while qualitative data was used to gain more insights into views from the participants of the study.

4.9.1 Quantitative data analysis

Accurate data analysis that effectively answers research questions is fundamental for any research. In the first phase of the study the data that was collected using questionnaire was analysed using descriptive and inferential statistics to describe variables such as gender, ethnicity, teaching experience, and the teaching methods that teachers used in the teaching of mathematics and the support systems they got either from within the school or from outside. In this phase of the study the data was analysed with descriptive and inferential statistical techniques using the Statistical Package for the Social Sciences (SPSS).

The analysis using descriptive statistics was employed to identify relationships between variables which were meant to show the pattern that would lead to generalization. Frequency distributions, means, standard deviations, and Chi-square in this package were used to interpret the results, aiming at summarizing the result which in turn would give the generalization of the behaviour. Inferential statistics were also used to draw conclusions about the characteristics of the population from which the sample is drawn. This process allowed the researcher to make predictions and explanations of participants' behaviour as provided by the results of analysis of the data.

4.9.2. Qualitative data analysis

According to Starke (2010) much qualitative research is based on the collection and interpretation of episodes which are personal knowledge more than aggregated knowledge. He further indicates that episode has activities, sequence, place, people, and context, some of which are more useful-appearing episodes, the ones we think of as "patches," need to be studied, analysed, their parts seen and seen

again. In this study, the researcher used interviews and observations to collect qualitative data.

The interviews with individuals, observations of people, places and actions/interactions, immersion in settings were used to help the researcher understand the what, how, when and where of the social structure (Tewksbury, 2009). According to Boeije (2010) in Wahyuni (2012) performing data analysis on qualitative data basically involves dismantling, segmenting and reassembling data to form meaningful findings in order to draw inferences. During the observation of the research lesson using observation protocol and interviews schedule, the researcher was recording the required information.

After collecting the data, the researcher had to analyse it using qualitative analysis. This was done by transcribing the interviews, reading through them for several times and cutting the codes that conveyed the same idea. According to Driscoll, Appieah-Yeboah, Salib and Rupert (2007) codes are multidimensional, meaning they can and do provide insights into a host of interrelated conceptual themes or issues during analysis and can also be revisited during analysis in an iterative analytic process to allow for the recognition of emergent themes and insights. The process of coding was necessary as it provided the researcher with a formal system to organize the collected data, uncovering and documenting additional links that emerged within and between concepts and experiences described in the data. The codes with similar ideas were put together to form a cluster from which the themes emerged. Table 4.3 shows how the researcher generated themes.

Table 4.3: Examples Themes Generated		
THEMES	**INSTRUMENT**	**Examples of teacher responses**
Teaching Effectiveness	Interview	• There are some of the topics that you find that you are not comfortable with so you are able to share ideas…. • I now have simpler techniques of teaching maths which I gained from my colleagues. • Even the way the concept is presented may be different from the way I would present it. Hence it helps me to have different approaches for teaching a specific concept • During planning, the discussion that occurred made me think about my own teaching. • Hahaha (laughter) lesson study has made reflect on daily teaching. I am now able to see my strengths and weakness in my teaching.
Teacher Collaboration	Interviews & observation	• It helped us to share ideas… • Sharing ideas with teachers with different experiences and backgrounds has helped improve my teaching. • It builds team spirit • Team teaching was used where one teacher introduced the lesson and the other developed it. • Teacher confident about judging content accuracy • What I felt about it is it improved my confidence
Impact on Learners' Learning	Interviews & Observation	• Students are participating more than before… • learners were required to explain or justify their answers • As learners were working in groups, teachers were moving around to provide assistance where necessary. • Learners were supporting each other- those who got the answers first helped those who were struggling. • my students impressed me by actively participating • During the teaching of LS lesson my learners were motivated, even those who do not normally participate took an active role during LS
Barriers to Lesson Study implemetation	Interviews & Observation	• The teacher could not finish the lesson on time. • Lack of teaching and learning materials. • To be honest it consumes time, it is not in all the cases where teachers are able to attend, though we do not prepare a research lesson for every lesson. • It is about timing- as teachers are preparing a research lesson and observing their classes/students are left unattended. • Teachers in the team spent more time helping learners than taking the notes on learners' learning.

TABLE 4.3: Themes emerged

In this research a variety of instruments were used to collect data. The purpose of using multiple instruments was to address the issue of producing data that can be relied upon. The section below presents how validity and reliability of data was addressed.

4.10 VALIDITY AND RELIABILTY OF DATA

One important attribute of an instrument is that it measures the concept being studied in an unwavering and consistent way, and to achieve this, validity and reliability of an instrument should be taken into consideration. According to Coughian, Cronin and Ryan (2007) validity is described as the ability of the instrument to measure what it is supposed to measure and reliability is the instrument's ability to consistently and accurately measure the concept under study. As with any research validity stems more from the appropriateness, thoroughness and effectiveness with which the research methods are applied and the care given to thoughtful weighing of the evidence than from the application of a particular set of rules or adherence to an established practice (Bazeley, 2004). For addressing issues of trustworthiness in the qualitative approach of collecting data the criteria used by researchers look into the credibility, dependability confirmability and transferability of data collected.

For Coll and Kalnins (2009) credibility can be judged from the degree match between individual’s views of reality, and this can be addressed by ensuring that the results of an inquiry have not been subject to influence by the investigator. They further indicate that factors which can improve credibility involve prolonged engagement, persistent observation, peer debriefing, negative case analysis, member checks, and progressive subjectivity. Hence data collected and the process used to reduce data or coding it; is made available to the reader in the form in which it was collected. To attain credibility, the researcher used observation and peer debriefing as these are the most important aspects of LS.

According to Coll and Kalnins (2009) dependability is concerned with the stability of data over time and it is perhaps on the issue of dependability that the researcher

finds that methodological changes and shifts in construction are the very life-blood of interpretive research. They indicate that these changes are seen as an integral part of the inquiry process, rather than representing flawed methodology. What is critical is that the changes and shifts in thinking become clearly identified and fully described, they should be “tracked and traceable” (Coll and Kalnins, 2009). The description of the interviews which showed how teachers felt about LS were done and the recordings of those descriptions are kept for reference sake in a very safe place.

Coll and Kalnins (2009) illustrate that confirmability seeks to ensure that the results of an inquiry have not been subjected to influence by the investigator. With qualitative data, the confirmability of the data rests on the data themselves as the raw data and the process used to reduce them or code them are made available to the reader as they are. Coll and Kalnins (2009) show that in this process of confirmability the researcher may describe how the interviews were conducted, provide the actual questions asked, and provide substantial portions of interview transcriptions to show how the interviews were actually conducted. In this study, the description of data collected during analysis have been written using participants’ own words and the questions asked which were meant to answer the main questions have been provided.

Finally, Coll and Kalnins (2009) show that transferability sampling is intentionally purposive in nature which suggests that the nature of interpretive inquiries is such that the researcher describes the context of the inquiry and provides detailed descriptions of methodology and interpretation; it is then up to the reader to decide if the findings are relevant or pertinent to their own situation**.** According to Etikan, Musa and Alkassim (2016) purposive sampling is the deliberate choice of a participant due to the qualities the participant possesses. They further indicate that it is a non-random technique that does not need underlying theories or a set number of participants. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience For selecting the sample, purposive sampling was used and a detailed account of how the study was carried

out was given showing how the data was collected and how it was analysed. When collecting qualitative data, the researcher interacted with participants and it is therefore important to protect these participants in many ways. The section below discusses the ethical considerations that were observed when collecting data in this research.

4.11 ETHICAL CONSIDERATION

According to Whiting (2007) ethical issues are a priority when people are being interviewed; it is therefore important that all the necessary processes are adhered to, and this includes acquisition of informed consent, and provision of details to the interviewee about distribution of the research findings and the interview process. Confidentiality is another important aspect of ethical issues. Polit and Beck (2006) in Whiting (2007) describe confidentiality as: "*Protection of study participants such that individual identities are not linked to information provided and are never publicly divulged*." Burns and Grove (2005) in Whiting (2007) indicate that all participants have the right to privacy, anonymity and confidentiality, however, they also stress that true anonymity exists only if the participant's identity cannot be linked to the data, even by the researcher. Beauchamp and Childress (2001) in Coughian *et al.* (2007) identify one of the fundamental moral principles as autonomy.

According to Coughian *et al.* (2007 autonomy infers that an individual has the right to freely decide to participate in a research study without fear of coercion and with a full knowledge of what is being investigated. In this study, permission to allow participants to take part was sought from the principals of respective schools. The liberty to take full participation in the study was discussed with teachers after training on LS was done, and after interviews the two parties reached an agreement to keep all the information about the participants confidential. An agreement that the information each participant shares with the researcher should not be passed on to others in any form, unless specific consent has been given was reached. During the research process, no participants were harmed or abused socially, physically or psychologically, the researcher together with the participants made an effort to create conducive working conditions. When carrying out this research there were

some limitations that were observed, the next section presents some of those limitations.

4.12 LIMITATIONS

When conducting this study, the researcher experienced some challenges which could not be resolved easily, and these included the sample size, time factor, finances and un-returned and spoiled questionnaires. When collecting quantitative data, questionnaires were distributed but quite a large number of them were not returned, and this resulted in the findings not reflecting the true picture of the sample. On the other hand, the size of the qualitative sample was small as two members decided to withdraw from the study leaving only six participants.

Though the purpose was not to generalize the results to the whole population, a larger sample would have provided more valid results. Another limitation to this study was the time factor, the researcher did not have enough time to observe participants over extended period of time to see which of the LS aspects had been maintained and also to see how the performance of the learners in mathematics would be like when LS was practiced for a longer period of time by the teachers. Lack of finances posed another challenge as the researcher was self-sponsored and could not make some of the things which could make the study to be more of a success.

4.13 CONCLUSION

This chapter offered a detailed account of the research philosophical view and both positivist and the interpretivist paradigms adopted by this study. The stance taken by this research study in terms of the methodological approaches that were employed and the methods used to collect data have also been discussed. The procedure of how the data was collected and which research questions were addressed by each method of data collection was outlined. A mixed-methods approach which employed

sequential transformative mixed-design to the data collection and its analysis drawing upon qualitative and quantitative data collection techniques was outlined.

This chapter has also explained the data gathering methods, the selection of participants which will address the research questions the study intends to answer, and data analysis procedures that will help the research to get an in-depth understanding of the ideas being researched. This study has used an appropriate methodology to investigate participants' perceptions of LS and their teaching practices in the teaching of mathematics. The techniques employed in this study include questionnaires, interviews, and observations. In data collection process, the researcher was the one collecting all the data using the techniques mentioned. The researcher analysed the data by using interpretive and descriptive methods of analysis. Ethical considerations have been taken into account to ensure trustworthiness of the study.

CHAPTER 5

DATA ANALYSIS AND INTERPRETATION

5.1 INTRODUCTION

This chapter presents the results and analysis of data that was collected using multiple methods of data collection. Different methods were used to address the issue of reliability of the results. The findings from the data are going to be used to answer the research questions that this study is trying to answer. The first section of this chapter presents findings and analysis of the data that was collected from a survey. The data collected from this survey is meant to answer the question “What are teachers’ pedagogical practices before lesson study?

A total of 117 responses were received from a targeted 200 respondents which gives a response rate of 58.5%. This chapter starts by providing the background to the respondents by analysing their biographical data. This is followed by an analysis of descriptive data. Factors derived from the Scree plot are analysed using cross tabulation and the Chi square test. Tables and diagrams are used for presenting data, analysing it and for ease of reading the data. The section below shows quantitative data collected through the use of questionnaire and how it was analysed using descriptive and inferential statistics.

5.2 QUANTITATIVE DATA ANALYSIS

5.2.1 Biographical Data

This section presents the biographical data for teachers who participated in the study according to their ages, highest qualification, teaching experience, subjects taught, classes taught and a number of learners per class. The section also provides frequencies, percentages and cumulative percentages.

5.2.1.1 Age of Respondents

Out of the 117 respondents, one did not indicate the age category in which he/she falls. There were 43 respondents in the category of 20-30 years, 42 respondents were in the category 31-40, and 18 respondents were between 41-50 years of age while 13 respondents were 51 and above. Looking at the ages of the respondents, it showed that 73% of them were below 40 years of age while only 27% was 40 years and above (Ref. Table 5.1).

Table 5.1: Age of respondents, (N=117)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20 - 30 years	43	36.8	37.1	37.1
	31 - 40 years	42	35.9	36.2	73.3
	41 - 50 years	18	15.4	15.5	88.8
	51 and above	13	11.1	11.2	100.0
	Total	116	99.1	100.0	
	Missing	1	0.9		
Total		117	100.0		

5.2.1.2 Qualifications of Respondents

With regard to respondents' qualification, the response rate was 98.3%. Only two respondents did not show their highest qualification. A low percentage of respondents (4.3%) had Secondary Teachers Certificate (STC) while 27.0% held Diploma in Education secondary. The majority of the respondents (44.3%) had Bachelor of Science Education qualification. The data collected show that 71% of the respondents held diplomas and degrees. Respondents with Honours degree in Education and Masters in Education accounted for 4.3%. It is worth mentioning that 20% of the respondents held qualifications other than teaching. See Table 5.2 for details.

Table 5.2: Qualifications of Respondents (N=117)				
	Frequency	Percentage	Valid Percentage	Cumulative Percentage
STC	5	4.3	4.3	4.3
DIP	31	26.5	27.0	31.3
BSC ED	51	43.6	44.3	75.7
BED HONS	3	2.6	2.6	78.3
MED	2	1.7	1.7	80.0
OTHER	23	19.7	20.0	100.0
Total	115	98.3	100.0	
Missing	2	1.7		
Total	117	100.0		

5.2.1.3 Teaching Experience

Data on teaching experience in Table 5.3 shows that 47 respondents which constitute 40.5% were in the category 0 -5 years. In the category 6-10 years, there were 24 respondents who made up 20.7% of the respondents. There were 18 respondents (15.5%) who were in the category 11-15 years, while 27 respondents (23.3%) had teaching experience of 16 years and above. There was one respondent who did not indicate his/her teaching experience.

Table 5.3: Teaching experience of Respondents (N=117)				
	Frequency	Percentage	Valid Percentage	Cumulative Percentage
0 - 5 Years	47	40.2	40.5	40.5
6 - 10 years	24	20.5	20.7	61.2
11 - 15 years	18	15.4	15.5	76.7
16 and above	27	23.1	23.3	100.0
Total	116	99.1	100.0	
Missing	1	0.9		
Total	117	100.0		

5.2.1.4 Subjects Taught

The data in Table 5.4 show that the response rate was good as 99% of the respondents answered this question. Table 5.4 below highlights that the majority of the respondents (95%) who completed the questionnaire were teaching mathematics

Table 5.4: Subjects Taught

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Maths	110	94.0	94.8	94.8
Science	6	5.1	5.2	100.0
Total	116	99.1	100.0	
Missing	1	.9		
Total	117	100.0		

5.2.1.5 Classes that are currently being taught by respondents

The data illustrates that 90% of the respondents were teaching mathematics at junior level (Form A – C) with the remaining 10% teaching at the senior secondary level (Form D – E). For reference, see Table 5.5.

Table 5.5: Classes currently taught

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Form A	60	51.3	51.3	51.3
Form B	29	24.8	24.8	76.1
Form C	16	13.7	13.7	89.7
Form D	11	9.4	9.4	99.1
Form E	1	0.9	0.9	100.0
Total	117	100.0	100.0	

5.2.1.6 Number of learners per class taught by the respondents

The data shown in Table 5.6 illustrates that majority of the respondents (62%) had the class size of between 41 and 60 learners. It also reveals that 21% of the respondents had classes of 61-80 learners while 5% of the respondents had 81-100 learners per class. The table further reflects that 1% of the respondents had more than 100 learners per class.

Table 5.6: Number of learners per class

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
21 - 40 Learners	13	11.1	11.2	11.2
41 - 60 Learners	72	61.5	62.1	73.3
61 - 80 Learners	24	20.5	20.7	94.0
81 - 100 Learners	6	5.1	5.2	99.1
101 and above	1	0.9	0.9	100.0
Total	116	99.1	100.0	

5.2.2 Descriptive Data

Data on the teaching methods used by the respondents in the teaching of mathematics were presented in this section. Different strategies used and the reasons for using them in the teaching of mathematics were outlined.

5.2.2.1 Teaching Methods

Table 5.7 shows some of the teaching methods used by teachers in the teaching of mathematics in the Lesotho secondary schools.

Table 5.7: Teaching Methods

Teaching Methods	Total	Never		Seldom		Often		Always		Mean	Std. Dev.
		Freq.	%	Freq	%	Freq	%	Freq	%		
Guided Discovery	117	3	2.6	34	29.1	49	41.9	31	26.5	2.92	0.811
Exposition	102	5	4.9	34	33.3	43	42.3	20	19.6	2.76	0.823
Cooperative learning	111	1	1	10	9	53	47.7	47	43.3	2.76	0.674
Discussion	115	0	0	12	10.4	50	43.5	53	46.1	3.36	0.665
Investigation	113	12	10.6	48	42.5	44	38.9	9	8	2.44	0.790
Question and answer	113	4	3.5	16	14.2	33	29.2	60	53.1	3.32	0.848

Guided discovery

The data in Table 5.7 shows that all the respondents answered this question. The majority of the respondents (97.4%) who responded to this question showed that they used guided discovery in the teaching of mathematics though not to the same level. The data shows that 29.1% of the respondents used this method seldomly in their teaching, quite a good number of respondents (41.9%) often used this method while 26.5% of the respondents indicated that they always used guided discovery in mathematics teaching. The mean for this question is 2.92 which is between 2 (seldom) and 3 (often) indicating that respondents often used guided discovery method. The standard deviation of 0.811 shows that the responses are scattered around the mean in a wider range.

Exposition

A considerable percentage of the respondents (87.2%) attempted this question. Most of the respondents (95.1%) highlighted that they used exposition as a method of teaching mathematics with 33.3% of these using it seldomly, 42.3% indicated that they used it often while 19.6% showed that they always use it. The mean for this question is 2.76 and lies between 2 (seldom) and 3 (often) which illustrates that respondents use exposition in teaching mathematics. The standard deviation is 0.823 which indicates that the responses are widespread around the mean (See Table 5.7).

Cooperative Learning

This question was answered by a substantive percentage of respondents (94.9%). Only 1% of the respondents indicated that they never used cooperative learning in teaching mathematics while 9% of the respondents used this method seldomnly in their teaching. The remaining 91% of the respondents used cooperative learning in

their teaching in which 47.7% of this often used this method and 43.3% of the respondents indicating that they always used it. The mean for this question is 2.76 and is between 2 (seldom) and 3 (often) which indicates that the respondents often use exposition method. The standard deviation for this question is 0.674 which shows that responses are spread in narrow range within one standard around the mean (Refer to Table 5.7).

Discussion

Table 5.7 shows that almost all the respondents (98.3%) attempted this question. All respondents who answered this question showed that they used discussion method in teaching mathematics. The data shows that 10.4% of the respondents used discussion seldomnly while 43.5% of the respondents often used this method. The majority of respondents (46.1%) demonstrated that they always used discussion in the teaching of mathematics. The use of discussion method is also reflected by the mean which is 3.36 and is found between 3 (often) and 4 (always) indicating that almost all teachers use discussion method. The standard deviation of 0.665 shows that responses were clustered in a narrow range within one standard deviation around the mean.

Investigation

A large percentage of respondents (96.6%) answered this question. The majority of the respondents (53.1%) showed that they used investigation minimally with 10.6% of this indicating that they did not use investigation at all in their teaching of mathematics and the remaining 42.5% seldomnly using it. The data demonstrates that 38.9% of the respondents often used this method in their teaching and only 8% always using it. The mean for this question is 2.44 and lies between 2 (seldom) and 3 (often) which indicates that teachers, seldomnly use investigation and the standard deviation of 0.790 shows that responses were scattered around the mean in a wider range inside one standard deviation about the mean (Refer to Table 5.7).

Question and answer

The data in Table 5.7 indicate that the response rate for this question was 96.6% which indicates that most respondents answered the question. The data shows that only 3.5% of the respondents never used question and answer method in their teaching of mathematics. The data also indicates that 14.2% of the respondents seldomnly used question and answer while 29.2% often used it. The majority of the respondents (53.1%) indicated that they always used question and answer when teaching mathematics. The mean of 3.32 which is between 3 (often) and 4 (always) illustrates that teacher use question and answer when teaching mathematics though the standard deviation of 0.848 shows that those responses are wide-ranging within one standard around the mean.

5.2.3 Reasons for Choice of Teaching Methods

There are a number of reasons teachers gave for using different teaching methods when teaching mathematics some of which are presented in Table 5.8.

Table 5.8: Reasons for choice of teaching method

Reasons for choice of teaching method	Total	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Mean	Std. Dev
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%		
Methods that give me enough time to explain	110	2	1.8	9	8.2	26	23.6	38	34.5	35	31.8	3.86	1.018
Method that gives learners chance to explore.	115	2	1.7	3	2.6	10	8.7	44	38.3	56	48.7	4.30	0.868
Method that allows collaboration between learners.	116	2	1.7	9	7.9	13	11.2	39	33.6	53	45.7	4.14	1.012
Method which saves my preparation time.	114	12	10.5	32	28.1	37	32.5	25	21.9	8	7	2.87	1.093
Method that gives me opportunity to check learners' understanding.	115	2	1.7	0	0	3	2.6	60	52.2	50	42.7	4.36	0.703
I do not know about other teaching methods	106	50	47.7	31	29.2	18	17	4	3.8	3	2.8	1.88	1.018

Methods that give enough time to explain

The response rate for the statement “methods that give enough time to explain” was 94%. The minority of the respondents (10%) indicated that they did not select their teaching based on the given reason and 1.8% of this indicating that they strongly disagreed with this reason while the remaining 8.2% illustrated that they disagreed. Quite a good number of respondents (23.6%) indicated that they were neutral about this reason. On the other hand, the majority of the respondents (66.3%) indicated that one of the reasons for selecting a teaching method in the teaching and learning of mathematics was that it gave them enough time to explain. Specifically, 34.5% of this demonstrated that they agreed with the reason put forth and the remaining (31.8%) indicated that they strongly agreed. The mean for this question is 3.89 and lies between 3 (neutral) and 4 (agree) which shows that respondents agree with the reason used in selecting the teaching method. The standard deviation for this question is 1.018 which demonstrates that responses are scattered around the mean in a wider range inside one standard deviation around the mean (Refer to Table 5.8).

A method that gives learners chance to explore

Table 5.8 demonstrates that almost all respondents (98.3%) attempted the statement “method that gives learners chance to explore”. A very small number of respondents (1.7%) illustrated that they strongly disagreed that the reason for selecting a teaching method to be used in the teaching of mathematics was that it gave learners a chance to explore. The data also shows that 2.6% of the respondents disagreed with that reason while 8.7% are neutral. The majority of the respondents (87%) indicated that when selecting a method for teaching they chose it because it gave learners a chance to explore mathematical ideas, 38.3% of this illustrated that they agreed with that criteria of selecting a method while the remaining 48.7% strongly agreed. The mean of 4.3 for this question which lies between 4 (agree) and 5 (strongly agree) reveals that respondents use a method that gives learners chance to explore when selecting their methods of teaching mathematics, the standard deviation of 0.868

reveals that the responses are dispersed around the mean in a wider range within one standard deviation.

A method that allows collaboration between learners

The data in Table 5.8 indicates that almost all respondents (99.1%) answered the statement “method that allows collaboration between learners”. Of interest to this question is that 20.8% respondents indicated that they did not use collaboration between learners as a reason for selecting their teaching methods when teaching mathematics. The minority of respondents (1.7%) strongly disagreed with the reason while 7.9% illustrated that they disagreed and 11.2% demonstrated that they were neutral. The vast majority of the respondents (79.3%) indicated that one of the reasons for their choice of teaching methods was based on whether it allowed collaboration between learners, 33.6% of this showed that they agreed with the reason while the rest of the respondents (45.7%) illustrated that they strongly agree. The mean for this question is 4.14 and is between 4 (agree) and 5 (strongly agree) and it suggests that when selecting a teaching method respondents use it because it allows collaboration among learners. The standard deviation of 1.012 is indicative of responses being widely distributed around the mean within one standard deviation.

A method which saves my preparation time

The response rate for the statement “method which saves my preparation time” was 97.4%. Most respondents (38.6%) pointed out that they did not select a teaching method because it saved them preparation time, 10.5% of the respondents strongly disagreed with this reason while 28.1% of the respondents disagreed. A significant number of respondents (32.5%) which is slightly below those who disagreed showed that they were neutral about this reason. The least number of respondents (28.9%) accounted for those who agreed that one reason for selecting a teaching method is so that it saved their preparation time. To be specific, 21.9% of the respondents agreed with the reason while the remaining 7.0% strongly agreed. The mean for this

question is 2.87 which lies between 2 (disagree) and 3 (neutral) which suggests that respondents do not choose methods for teaching based on whether it saves their preparation time. The standard deviation is 1.093 which reveals that the responses are scattered in a wide range around the mean inside on standard deviation (Refer to Table 5.8)

A method that gives me opportunity to check learners' understanding

Table 5.8 shows that there were 98.3% respondents who answered the statement "method that gives me opportunity to check learners' understanding". It is noteworthy that a small percentage (4.3%) of respondents indicated that when selecting a teaching method, they did not base themselves on a method that gave them an opportunity to check learners' understanding, and 2.6% of this showed that they were neutral about this reason. The vast majority of respondents (97.4%) illustrated that one of the reasons for choosing the method of teaching mathematics was that it gave them opportunity to check learners' understanding, out of this 52.2% agreed with this reason while 42.7% of the remaining strongly agreed. The mean of 4.36 which lies between 4 (agree) and 5 (strongly agreed) for this question indicates that respondents use the methods that give them opportunity to check learners' understanding. The standard deviation for this question is 0.703 shows that responses are scattered in a wider range within one standard deviation around the mean.

I do not know about other teaching methods

The statement "I do not know about other teaching methods" was attempted by 90.6% of the respondents. A substantive percentage of the respondents (76.9%) demonstrated that they knew about other methods of teaching mathematics. To be precise 47.7% of the respondents indicated that they *strongly disagreed* that they did not know about other teaching methods, 29.2% illustrated that they disagreed with the statement. On the other hand, 17% of the respondents were *neutral*. A small

percentage of the respondents (6.6%) indicated that they did not know about other methods of teaching mathematics, 3.8% of this *agreed* with the statement while the rest *strongly agreed*. The mean for this question is 1.88 and is between 1(strongly disagree) and 2 (disagree) which illustrates that respondents disagree that they do not know about other teaching methods. The standard deviation of 1.018 for this question shows that the responses area widely scattered within one standard deviation around the mean (Refer to Table 5.8).

5.2.4 Teachers' Classroom Practices

There are a number of classroom practices teachers engaged in the teaching of mathematics. Some of these practices are reflected in Table 5.9

Table 5.9: Teachers' classroom practices

Teachers' classroom practices	Total	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Mean	Std. Dev
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%		
I effectively prepare for mathematics lesson	115	0	0	1	.9	10	8.7	54	47.0	50	43.4	4.33	0.672
During teaching I identify learners' misconceptions of mathematical concepts.	116	0	0	0	0	18	15.5	57	49.1	41	35.3	4.20	0.688
I use questioning to elicit learners' thinking and learning of Mathematical concepts.	116	0	0	3	2.6	16	13.8	56	48.3	41	35.3	4.16	0.757
During group work I observe peer interaction among my learners for meaningful discussion.	117	0	0	2	1.7	14	12.0	48	41.0	53	45.3	4.30	0.746
I provide my learners with activities which incorporate individual and group accountability.	115	0	0	3	2.6	18	15.7	59	51.3	35	30.4	4.10	0.749
I give my learners opportunity to explain or justify their thinking.	116	0	0	1	.9	10	8.6	55	47.4	50	43.1	4.33	0.670
Learners show expressions of excitement during mathematics lessons	114	1	.9	13	11.4	38	33.3	50	43.9	12	10.5	3.52	0.865
Learners provide quality explanation of the mathematical concept under discussion	115	1	.9	18	15.7	51	44.3	38	33.0	7	6.1	3.28	0.833

I effectively prepare for mathematics lesson

The data in Table 5.9 shows that a significant number of respondents (98.3%) attempted to an item “I effectively prepare for mathematics lesson”. Quite a small number of respondents (.9%) indicated that they *disagreed* that they prepared for their mathematics lessons effectively while 8.7% of the respondents were *neutral*. The majority of the respondents (90.4%) illustrated that they prepared for their mathematics lesson effectively, 47.0% of this demonstrated that they *agreed* with the statement while the remaining 43.4% *strongly agreed*. The mean for this question is 4.33 which lies between 4(*agree*) and 5 (*strongly agree*), this suggests that respondents effectively prepare for their mathematics lessons. The standard deviation for this question is 0.672 which shows that the responses are clustered around the mean within one standard deviation.

During teaching I identify learners’ misconceptions of mathematical concepts

Table 5.9 indicates that the response rate for the statement “During teaching I identify learners’ misconceptions of mathematical concepts” was 99.1%. Of interest to this question was that no respondents *disagreed* with the statement rather 15.5% of the respondents were *neutral*. On the other hand, an overwhelming majority of the respondents (84.4 %%) indicated that they identified learners’ misconceptions of mathematical concepts during their teaching. To be precise, 49.1% of the respondents *agreed* with the statement while the rest (35.5%) *strongly agreed*. The mean of 4.20 which lies between 4 (*agree*) and 5 (*strongly disagree*) indicates that the respondents identify learners’ misconceptions of mathematical concepts during their teaching, while the standard deviation of 0.688 shows that the responses are close to the mean within one standard deviation.

I use questioning to elicit learners' thinking and learning of mathematical concepts

The majority of the respondents (99.1%) attempted the statement "I use questioning to elicit learners' thinking and learning of mathematical concepts". Quite a small number of respondents (2.6%) *disagreed* that they used questioning to elicit learners' thinking and learning of mathematical concepts while 13.8% of the respondents are *neutral*. Most of the respondents (48.3%) *agreed* with the statement and 35.3% of the respondents *strongly agreed* with the statement. The mean for this question is 4.16 which lies between 4 (*agreed*) and 5 (*strongly agree*) and this suggests that respondents use questioning to elicit learners' thinking and learning of mathematical concepts. The standard deviation is 0.757 which indicates that responses are moderately spread around the mean (Refer to Table 5.9).

During group work I observe peer interaction among my learners for meaningful discussion

The data in Table 5.9 indicates that all the respondents (100%) attempted the statement "during group work I observe peer interaction among my learners for meaningful discussion". A very small number of respondents (1.7%) indicated that they did not observer peer interaction among their learners for meaningful discussion, to be specific none of the respondents (0%) demonstrated that they *strongly disagreed* with the statement while only 1.7% respondents *disagreed* with the statement. The data shows that 12.0% of the respondents were *neutral* about the statement. The vast majority of the respondents (86.3%) demonstrated that during group work they observed peer interaction among their learners for meaningful discussion. To be precise 41.0% of the respondents *agreed* with the statement while 45.3% of the respondents *strongly disagreed* with it. The mean of 4.3 for this question which lies between 4 (*agree*) and 5 (*strongly disagree*) reveals that during group work most teachers observe peer interaction among their learners for meaningful discussion, while the standard deviation of 0.746 suggests that responses are scattered around the mean in a wider range.

I provide my learners with activities which incorporate individual and group accountability

A significant number of respondents (98.3%) answered a question on “I provide my learners with activities which incorporate individual and group accountability”. The least number of respondents (2.6%) pointed out that they did not provide their learners with activities which incorporate individual and group accountability. The data indicates that 15.7% of the respondents were *neutral* about the statement, while quite a good number of respondents (51.3%) *agreed* with the statement and 30.4% of the respondents *strongly agreed* with the statement. The mean for this question is 4.10 and is between 4 (agree) and 5 (strongly agree) and indicates that respondents do provide their learners with activities which incorporate individual and group accountability. The standard deviation of 0.749 shows that responses are dispersed around the mean in a wider range (Refer to Table 5.9).

I give my learners opportunity to explain or justify their thinking

Table 5.9 indicates that an overwhelming majority of respondents (99.1%) tried a statement “I give my learners an opportunity to explain or justify their thinking. Of interest to question was a number of respondents (0.9%) who indicated that they did not give their learners an opportunity to justify their thinking. A very small number of respondents (8.6%) indicated that they were *neutral* about the statement. On the other hand, most respondents (90.5%) illustrated that they gave their learners an opportunity to explain or justify their thinking, and of this 47.4% *agreed* with the statement while 43.1% accounted for those who *strongly agreed* with the statement. The mean for this question is 4.33 which is between 4 (*agree*) and 5 (*strongly agreed*) suggests that respondents give their learners an opportunity to explain or justify their thinking. The standard deviation for this question demonstrates that respondents are scattered narrowly around the mean.

Learners show expressions of excitement during mathematics lessons

The data in Table 5.9 show that a substantive number of respondents (97.4%) attempted a statement “Learners show expressions of excitement during mathematics lessons”. The data reveals that 0.9% of the respondents *strongly disagreed* with the statement while 11.4% of the respondents *disagreed*. There was a considerable number of respondents (33.3%) who indicated that they were *neutral* about the statement. Quite a good number of respondents demonstrated that they agreed with the statement and the remaining (10.5%) pointed out that they *strongly agreed* with the statement. The mean for this question is 3.52 which is between 3 (*neutral*) and 4 *(agree*) and this reveals that learners showed expressions of excitement during mathematical lessons. The standard deviation of 0.865 indicates that the responses are scattered in a wider range.

5.2.5 Teachers’ Support Systems

In the schools there are a number of support structures available for teachers especially for those who teach mathematics. One of the reasons could be that mathematics is one subject which is not performed well by quite a number of learners. Table 15 show some of these support structures.

Table 5.10: Teachers' support systems											
Teachers' support systems	**Total**	**None**		**Small**		**Moderate**		**Large**		**Mean**	**Std. Dev**
		Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**		
I collaborate with my colleagues on issues related to teaching of mathematics.	117	2	1.7	7	6.0	48	41.0	60	51.3	3.42	0.685
We formulate learning goals with my colleagues.	116	9	7.8	23	19.8	41	35.3	43	37.1	3.02	0.942
We design mathematics lessons with my colleagues as a team	114	30	26.3	28	24.6	36	31.6	20	17.5	2.40	1.062
In my school I participate in peer observation and coaching, as part of a formal school arrangement	115	35	30.4	27	23.5	29	25.2	24	20.9	2.37	1.126
I participate in a network of teachers formed specifically for the professional development of teachers	113	40	35.4	22	19.5	30	26.5	21	18.6	2.28	1.138
In my school I participate in a team that supports newly trained teachers.	115	32	27.8	15	13.0	31	27.0	37	32.2	2.63	1.202
I attend workshops/INSET organized by the Ministry of Education and Training	115	41	35.7	12	10.4	28	24.3	34	29.6	2.48	1.250

I collaborate with my colleagues on issues related to teaching of mathematics.

Table 5.10 demonstrates that all the respondents (100%) attempted the statement "I collaborate with my colleagues on issues related to teaching of mathematics". The least number of respondents (1.7%) highlighted that they did not collaborate with their colleagues on issues related to teaching of mathematic while 6.0% showed that they did, though to a *small* scale, and 41% indicated that they *moderately* used it while 51.3% showed that they *always* use it. The mean for this question is 3.42 and lies between 3 (moderate) and 4 (always) which illustrates that respondents do collaborate with their colleagues on issues related to teaching of mathematics. The standard deviation is 0.685 which indicates that the responses are spread in around the mean in a close range.

We formulate learning goals with my colleaques

The data in Table 5.10 indicate that an overwhelming number of respondents (99.1%) answered a statement “we formulate learning goals with my colleaques”. The smallest number of respondents (7.8%) pointed out that they did not formulate goals with their colleaques while 19.8% indicated that to a *small* extent they did. Quiet an encouraging number of respondents 35.3 % demonstrated that they *moderately* used formulated learning goals with their colleaques while 37.1% showed that they *always* did. The mean for this question is 3.02 and lies between 3 (moderate) and 4 (always) which suggests that respondents do formulate learning goals with their colleagues. The standard deviation is 0.942 illustrating that the responses are widely scattered around the mean.

We design mathematics lessons with my colleagues as a team

A significant number of respondents (97.4%) attempted a question on “we design mathematics lessons with my colleagues as a team”. Just over a quarter (26.3%) of respondents indicated that they did not design mathematical lessons with their colleagues as a team while 24.6% illustrated that they did, but to a *small* scale. The majority of the respondents (31.6%) showed that they *moderately* used to engage in designing mathematical lessons with their colleagues as a team and 17.5% of the respondents demonstrated that they *always* did. The mean of 2.4 for this question which is between 2 (small) and 3 (moderate) indicates that respondents do design mathematical lessons with their colleagues as a team though to small degree. The standard deviation for this question is 1.062 which illustrates that the responses are widely scattered around the mean (Refer to Table 5.10).

In my school I participate in peer observation and coaching, as part of a formal school arrangement

Table 5.10 shows that a substantive number of respondents (98.3%) answered a statement on “in my school I participate in peer observation and coaching as part of a formal school arrangement”. A large number of respondents (30.4%) reported that they did not agree with the statement while 23.5% of the respondents showed that they agreed, but to a *small scale*. About a quarter of the respondents (25.2%) showed that they *moderately* participated in peer observation and coaching as part of formal school arrangement while only 20.9% agreed to a *large extent* with the statement. The mean for this question is 2.37 and lies between 2 (small) and 3 (moderate) which revealed that respondents do participate in peer observation and coaching as part of a formal school arrangement but to a small degree. On the other hand a standard deviation of 1.126 suggests that responses are widely dispersed around the mean.

I participate in a network of teachers formed specifically for the professional development of teachers

Quite a good number of respondents (96.6%) attempted a statement “I participate in a network of teachers formed specifically for the professional development of teachers”. Most of the respondents (35.4%) showed that *none* of them agreed with the statement while 19.5% reported that they agreed with the statement but to a *small extent*. Just over a quarter of the respondents (26.5%) demonstrated that they moderately agreed with the statement while 18.6% of the respondents illustrated that they always did what was indicated by the statement. The mean of 2.28 which is between 2 (small) and 3 (moderate) for this question suggested that respondents to a small scale participate in a network of teachers formed specifically for the professional development of teachers. The standard deviation of 1.138 reveals that responses to the statement are scattered widely around the mean (Refer to Table 5.10).

In my school I participate in a team that supports newly trained teachers

The data in Table 15 demonstrate that the response rate for the statement "in my school I participate in a team that supports newly trained teachers" is 98.3%. A considerable number of respondents (27.8%) reported that *none* of them agreed with the statement whereas 13.0% of the respondents indicated that they agreed with the statement though to a *small* degree. Quite a good number of respondents showed that they *moderately* agreed with the statement while the majority of the respondents indicated that they *always* participated in a team that supports newly trained teachers. The mean for this question is 2.63 and lies between 2 (small) and 3 (moderate) which demonstrates that respondents do agree with the statement but to a certain degree. The standard deviation for this question is 1.202 which suggests that the responses are widely scattered around the mean.

I attend workshops/INSET organized by the Ministry of Education and Training

The vast majority of respondents (98.3%) attempted a statement on "I attend workshops/INSET organized by the Ministry of Education and Training". The majority of the respondents (35.7%) showed that *none* of them agreed with statement while 10.4% illustrated that they agreed with the statement though to a *small* extent. There were 24.3% respondents who revealed that they agreed with the statement *moderately* whereas 29.6% of the respondents indicated that they *always* attended workshops/INSET organized by the Ministry of Education and training. The mean of 2.48 which lies between 2 (small) and 3 (moderate) indicates that the respondents do agree with the statement but to a limited extent while the standard deviation of 1.250 shows that the responses are dispersed around the mean in a wide range (Refer to Table 5.10).

5.2.6 Summary of Descriptive Findings

Findings from descriptive statistics revealed that most teachers (72%) who participated in the study aged between 20 and 40 with only 11% aged above 50 years. With regard to teachers' qualifications, 30% of teachers had certificates and diplomas while 48% had degree in education. However, there was about 20% of teachers who did not have a teaching qualification. Most teachers (about 41%) who took part in the study, had a teaching experience of 0-5 years, while 38.5% accounted for teachers who had more than 10 years teaching experience. The average number of learners per class for these teachers was 54.

The findings also revealed that teachers who took part in the study mostly used discussion, question and answer, and guided discovery while investigation was minimally used. Teachers illustrated that the choice of these strategies depended on whether the strategies give learners' an opportunity to check their understanding, a method that gives learners a chance to explore and allows collaboration between them, and the method that gives teachers enough time to explain. Looking at teachers' classroom practices, they agreed that they effectively prepare for mathematics lesson, and also give learners an opportunity to explain or justify their thinking through use of question and answer and in the process are able to identify learners' misconceptions. They also illustrated that they provide activities that incorporate individual and group accountability. However, teachers showed that learners do not normally show expression of excitement during mathematics lessons and also do not provide quality explanation of mathematical concepts under discussion.

On the issue of support mechanisms available for teachers, they indicated that they formulate learning goals together and collaborate with their colleagues on issues related to the teaching of mathematics. Nevertheless, teachers illustrated that they do not normally design mathematics lessons with their colleagues as a team, they do not participate in peer observation and coaching as part of a formal school

arrangement, they do not participate in a network of teachers formed specifically for the professional development of teachers and they do not participate in a team that supports newly trained teachers.

5.3 FACTOR ANALYSIS

Factor analysis is concerned with whether the covariance or correlations between a set of observed variables can be explained in terms of a smaller number of unobservable constructs known either as *latent variables* or *common factors* (Landau & Everitt, 2004). Similarly, Williams, Brown and Onsman (2012) argue that factor analysis reduces a large number of variables into a smaller set of variables and it also establishes underlying dimensions between measured variables and latent constructs, thereby allowing the formation and refinement of theory. Application of factor analysis involves determining the number of common factors needed to adequately describe the correlations between the observed variables, and estimating how each factor is related to each observed variable (Landau & Everitt, 2004).

5.3.1 Extraction of Factors

According to Ho (2006) the major aim of factor analysis is the orderly simplification of a large number of intercorrelated measures to a few representative constructs or factors; in short factor analysis allows the researcher to reduce large set of data to a fewer representative factors which can be used for subsequent analysis. The question is how are these factors reduced to a smaller manageable size? In this study, two methods had been used to extract factors. The first criterion used was the Kaiser-Eigenvalue Criterion, Courtney (2013) indicated that the eigenvalue-greater-than-one rule suggested that only factors that have eigenvalues greater than one should be retained while all factors with eigenvalues of less than one should be ignored. Out of 53 factors, there are only 25 factors with eigenvalue of more than one as shown in Table 5.11.

The second criterion used was a scree test which is a visual representation of descending eigenvalues associated with each factor. Ho (2006) indicated that the graph will show a steep slope between large factors and the gradual trailing off of the rest of the factors, and the point where the curve first begins to straighten out is considered to indicate the maximum number of factors to extract. In this study, 53 factors were extracted but those which had eigenvalues greater than one were only seventeen. Even though there were seventeen factors with eigenvalue greater than one, the scree plot however, showed that the graph started to flatten after the sixth factor.

Scree plot is used in the analysis of principal components and factor analysis to visually assess which components or factors explain most of the variability in the data. The scree plot presents the eigenvalues of each factor in descending order, and helps determine where there is a rapid drop in the proportion of variance explained. The scree plot in Fig. 4 shows the curve for the 53 factors that were extracted. Of the 53 factors, the scree plot flattened after the sixth factors suggesting that factors after the sixth one were rubble that was discarded.

Table 5.11: Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.729	18.356	18.356	9.729	18.356	18.356	4.710	8.886	8.886
2	3.958	7.467	25.823	3.958	7.467	25.823	3.653	6.893	15.779
3	3.552	6.703	32.526	3.552	6.703	32.526	2.770	5.227	21.006
4	2.700	5.094	37.619	2.700	5.094	37.619	2.657	5.012	26.018
5	2.661	5.021	42.640	2.661	5.021	42.640	2.648	4.996	31.014
6	2.391	4.511	47.150	2.391	4.511	47.150	2.616	4.935	35.949
7	1.993	3.760	50.910	1.993	3.760	50.910	2.532	4.777	40.726
8	1.839	3.469	54.380	1.839	3.469	54.380	2.376	4.483	45.209
9	1.663	3.137	57.516	1.663	3.137	57.516	2.027	3.825	49.034
10	1.630	3.075	60.591	1.630	3.075	60.591	2.027	3.825	52.859
11	1.509	2.847	63.438	1.509	2.847	63.438	2.027	3.824	56.683
12	1.415	2.669	66.107	1.415	2.669	66.107	2.013	3.798	60.481
13	1.368	2.580	68.687	1.368	2.580	68.687	1.999	3.771	64.252
14	1.275	2.406	71.093	1.275	2.406	71.093	1.982	3.739	67.992
15	1.219	2.300	73.393	1.219	2.300	73.393	1.734	3.271	71.263
16	1.080	2.038	75.431	1.080	2.038	75.431	1.732	3.267	74.530
17	1.041	1.965	77.395	1.041	1.965	77.395	1.519	2.865	77.395
18	.981	1.850	79.246						
19	.931	1.757	81.003						
20	.861	1.624	82.627						
21	.858	1.619	84.246						
22	.792	1.494	85.741						
23	.754	1.422	87.163						
24	.663	1.251	88.413						
25	.565	1.067	89.480						

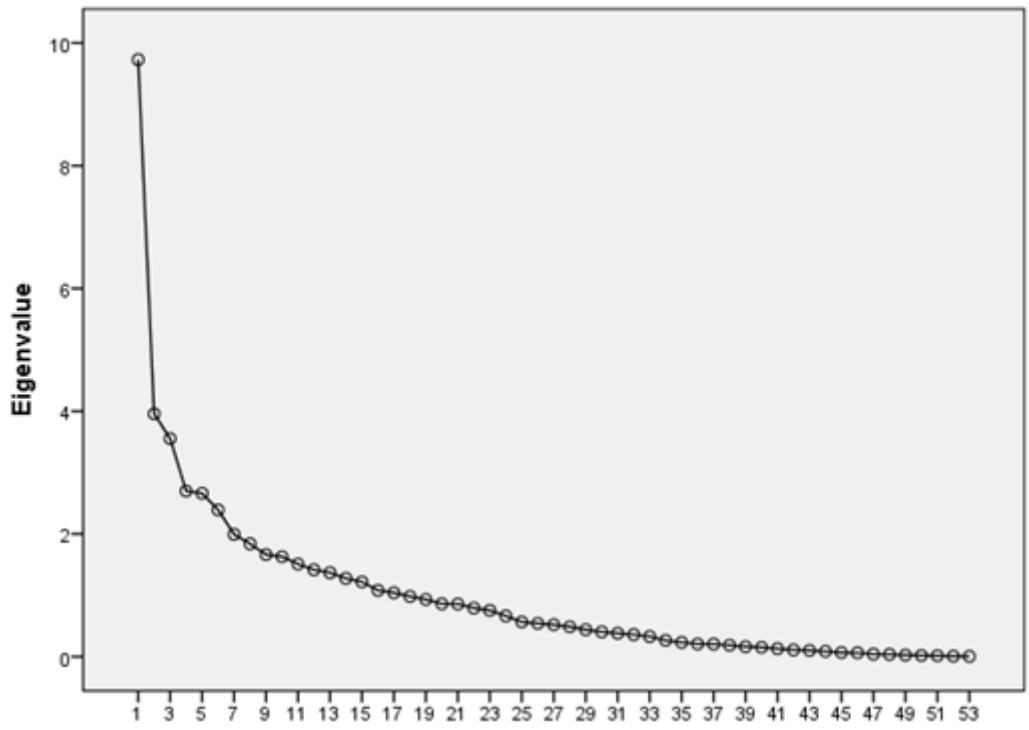

Figure 5.1: Scree Plot

The Table 5.16 below was extracted from Rotated Component Matrix. The components which were related and had factor loading from 0.5 were taken and used to formulate factors. The components which were extracted from the matrix, their factor loadings and factors that were formulated are shown in the table. These factors which were generated followed what had been suggested by the scree plot in which 6 factors are outstanding. The naming of the factors was done by looking at the main idea.

Table 5.12: Extracted Factors		
Factor	**Component**	**Factor Loading**
F1 (Reasons for Choice of Methods)	Learners provide quality explanation of the mathematical concept under discussion	0.796
	Learners are able to give appropriate examples of the concept under discussion	0.732
	Learner show the ability to use mathematical concept appropriately in a new situation	0.676
	Learners give well thought-out comments during mathematics lessons	0.744
	Learners explain why the procedure works or does not work	0.693
F2(Teacher participation)	I participate in a network of teachers formed specifically for the professional development of teachers	0.632
	In my school I participate in a team that supports newly trained teachers.	0.855
F3 (Teacher Support)	We design mathematics lessons with my colleagues as a team	0.637
	I collaborate with my colleagues on issues related to teaching of mathematics	0.626
	We design mathematics lessons with my colleagues as a team	0.823
F4 Consultation	Learners request to know/find more about the topic under discussion	0.585
	In my school I participate in peer observation and coaching, as part of a formal school arrangement	0.710
F5 (Enhancing Learners' Understanding of Mathematics)	I feel prepared to develop my learners conceptual understanding of mathematics	0.682
	I understand how learners think mathematically	0.579
	Learners are actively engaged in discussions during mathematics lessons	0.668
F6 (Learner-centred Teaching Methods)	Guided discovery	0.522
	I effectively prepare for mathematics lesson	0.516
	I provide my learners with activities which incorporate individual and group accountability.	0.766

5.3.2 Factors Identified

There are six factors identified. Factor 1 was loaded with five components. Table 5.12 shows that the five components all related to learners' behaviour during mathematics lesson. This factor loaded onto Learners quality explanation of the mathematics concept under discussion, type of examples they provide during

discussion, their ability to apply mathematical concept in a new situation, type of comments they provide during mathematics lessons and the explanation they give in support of their responses. This factor was named, “reasons for the choice of teaching methods”.

Two components loaded onto Factor 2 (Refer to Table 5.12). These components represented teachers’ participation in learning communities. This factor loaded onto teachers’ participation in networks formed specifically for the professional development and participation in teams that support newly trained teachers. This factor was named, “teacher participation”.

Table 5.12 shows that factor 3 was loaded with three components which all characterized team work amongst teachers. This factor loaded onto teachers designing mathematics lessons as a team and collaboration amongst teachers on issues related to teaching of mathematics. This factor was named, “Teacher support”.

There are two components that were loaded onto Factor 4 which were as identified the consultation amongst teams (Refer to Table 5.12). Learners consult with other learners to know/find more about the topic under discussion and teachers also participate in peer observation and coaching, as part of learning process. This was named, “Consultation”.

Table 5.12 indicates that factor 5 was loaded with three components which were all related to learners’ engagement in mathematics class. This factor loaded onto development of learners’ conceptual understanding of mathematics, their mathematical thinking ability and involvement in discussions during mathematics lessons. This factor was named, “Enhancing learners’ understanding of mathematics”.

The three components that were loaded on Factor 6 represented teaching methods which actively involve learners. This factor loaded on guided discovery, effective teacher preparation and provision of activities which incorporate individual and group accountability. This factor was named, “Learner-centred teaching methods” (Refer to Table 5.12).

5.4 INFERENTIAL STATISTICS

Both cross-tabulations and Chi square tests at $p < 0.05$ level were used to show the relationship between different variables. The cross-tabulations were used to show the relationships within the groups. In this section the relationships between biographies of teachers, their teaching practices and support systems are discussed.

Table 5.13 (a) Age * I participate in a network of teachers formed specifically for the professional development of teachers

Age		I participate in a network of teachers formed specifically for the professional development of teachers		Total
		Yes	No	
20 - 30 years	Count	18	25	43
	% within Age	41.9%	58.1%	100.0%
	% of Total	15.9%	22.1%	38.1%
31 - 40 years	Count	22	18	40
	% within Age	55.0%	45.0%	100.0%
	% of Total	19.5%	15.9%	35.4%
41 - 50 years	Count	10	8	18
	% within Age	55.6%	44.4%	100.0%
	% of Total	8.8%	7.1%	15.9%
51 and above	Count	7	5	12
	% within Age	58.3%	41.7%	100.0%
	% of Total	6.2%	4.4%	10.6%
Total	Count	57	56	113
	% within Age	50.4%	49.6%	100.0%
	% of Total	50.4%	49.6%	100.0%

Table 5.13 (b): Chi Square			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.086[a]	3	.555
Likelihood Ratio	2.094	3	.553
Linear-by-Linear Association	1.539	1	.215
N of Valid Cases	113		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.95.

Table 5.13(b) shows that there is no significant relationship between age and teachers' participation in networks formed specifically for the professional development at $p<0.05$ level as $p=0.555$. Cross-tabulation shows that generally the number of teachers who participate in networks is more or less equal to the number of teachers who do not participate in these networks. However, within the groups, teachers aged 20-30 years were the ones who did not participate more (Table 5.13 (a)).

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Table 5.14 (a) Age*I attend workshops/INSET organized by the Ministry of Education and Training					
Age		I attend workshops/INSET organized by the Ministry of Education and Training			Total
		Yes	No	Missing	
20 - 30 years	Count	19	23	1	43
	% within Age	44.2%	53.5%	2.3%	100.0%
	% of Total	16.7%	20.2%	.9%	37.7%
31 - 40 years	Count	29	12	0	41
	% within Age	70.7%	29.3%	0.0%	100.0%
	% of Total	25.4%	10.5%	0.0%	36.0%
41 - 50 years	Count	12	5	0	17
	% within Age	70.6%	29.4%	0.0%	100.0%
	% of Total	10.5%	4.4%	0.0%	14.9%
51 and above	Count	8	5	0	13
	% within Age	61.5%	38.5%	0.0%	100.0%
	% of Total	7.0%	4.4%	0.0%	11.4%
Total	Count	68	45	1	114
	% within Age	59.6%	39.5%	.9%	100.0%
	% of Total	59.6%	39.5%	.9%	100.0%

Table 5.14(b): Chi Square			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.229[a]	6	0.222
Likelihood Ratio	8.566	6	0.199
Linear-by-Linear Association	3.406	1	0.065
N of Valid Cases	114		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 0.11.

The Chi square test shows that there is no the relationship between age and attendance of workshops organised by the Ministry of Education and Training at $p<0.05$ level as $p=0.222$ (Refer to Table 5.14(b)). Cross-tabulation results revealed that 60% of teachers do attend workshop, though a fewer number (44%) of teachers aged 20-30 seemed to attend these workshops (Refer to Table 5.14 (a)).

Table 5.15 (a) Highest Qualification *I collaborate with my colleagues on issues related to teaching of mathematics.				
Highest Qualification		I collaborate with my colleagues on issues related to teaching of mathematics.		Total
		Yes	No	
STC	Count	4	1	5
	% within Highest Qualification	80.0%	20.0%	100.0%
	% of Total	3.5%	.9%	4.4%
DIP	Count	30	1	31
	% within Highest Qualification	96.8%	3.2%	100.0%
	% of Total	26.5%	.9%	27.4%
BSC ED	Count	50	0	50
	% within Highest Qualification	100.0%	0.0%	100.0%
	% of Total	44.2%	0.0%	44.2%
BED HONS	Count	3	0	3
	% within Highest Qualification	100.0%	0.0%	100.0%
	% of Total	2.7%	0.0%	2.7%
MED	Count	2	0	2
	% within Highest Qualification	100.0%	0.0%	100.0%
	% of Total	1.8%	0.0%	1.8%
OTHER	Count	22	0	22
	% within Highest Qualification	100.0%	0.0%	100.0%
	% of Total	19.5%	0.0%	19.5%
Total	Count	111	2	113
	% within Highest Qualification	98.2%	1.8%	100.0%
	% of Total	98.2%	1.8%	100.0%

Table 5.15 (b): Chi Square			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.323[a]	5	0.045
Likelihood Ratio	6.262	5	0.282
Linear-by-Linear Association	2.890	1	0.089
N of Valid Cases	113		

The information from cross tabulation Table 5.15 (a) indicates that teachers with highest qualifications are the ones that are collaborating most while teachers with certificates and diplomas seem to collaborate less. The association as shown in Table 20(b) is significant at $p<0.05$ as $p=0.045$).

Table 5.16(a) Teaching Experience *I collaborate with my colleagues on issues related to teaching of mathematics.

Teaching Experience		I collaborate with my colleagues on issues related to teaching of mathematics.		Total
		Yes	No	
0 - 5 Years	Count	47	0	47
	% within Teaching Experience	100.0%	0.0%	100.0%
	% of Total	41.2%	0.0%	41.2%
6 - 10 years	Count	24	0	24
	% within Teaching Experience	100.0%	0.0%	100.0%
	% of Total	21.1%	0.0%	21.1%
11 - 15 years	Count	16	0	16
	% within Teaching Experience	100.0%	0.0%	100.0%
	% of Total	14.0%	0.0%	14.0%
16 and above	Count	25	2	27
	% within Teaching Experience	92.6%	7.4%	100.0%
	% of Total	21.9%	1.8%	23.7%
Total	Count	112	2	114
	% within Teaching Experience	98.2%	1.8%	100.0%
	% of Total	98.2%	1.8%	100.0%

Table 5.16 (b): Chi Square

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.560[a]	3	.087
Likelihood Ratio	5.878	3	.118
Linear-by-Linear Association	4.471	1	.034
N of Valid Cases	114		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .28.

The cross tabulation Table in 5.16(a) shows that experienced teachers do collaborate, though not as much as inexperienced teachers. The relationship is not significant at $p<0.05$ level as $p = 0.087$(Refer to Table 5.16(b)).

Table 5.17 (a) Teaching Experience * I attend workshops/INSET organized by the Ministry of Education and Training

Teaching Experience		I attend workshops/INSET organized by the Ministry of Education and Training			Total
		Yes	No	Missing	
0 - 5 Years	Count	20	26	1	47
	% within Teaching Experience	42.6%	55.3%	2.1%	100.0%
	% of Total	17.5%	22.8%	.9%	41.2%
6 - 10 years	Count	17	7	0	24
	% within Teaching Experience	70.8%	29.2%	0.0%	100.0%
	% of Total	14.9%	6.1%	0.0%	21.1%
11 - 15 years	Count	13	4	0	17
	% within Teaching Experience	76.5%	23.5%	0.0%	100.0%
	% of Total	11.4%	3.5%	0.0%	14.9%
16 and above	Count	18	8	0	26
	% within Teaching Experience	69.2%	30.8%	0.0%	100.0%
	% of Total	15.8%	7.0%	0.0%	22.8%
Total	Count	68	45	1	114
	% within Teaching Experience	59.6%	39.5%	.9%	100.0%
	% of Total	59.6%	39.5%	.9%	100.0%

Table 5.17(b): Chi Square

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.668[a]	6	0.099
Likelihood Ratio	11.116	6	0.085
Linear-by-Linear Association	6.788	1	0.009
N of Valid Cases	114		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 0.15.

Cross tabulation Table 5.17(a), shows that teachers with six years and above of teaching experience were the ones attending more workshops organised by the Ministry of Education and Training than those with less than six years of teaching experience. The Chi square test shows that there is no significance at $p<0.05$ level as $p = 0.099$ (See Table 5.17 (b)).

Table 5.18(a) Teaching Experience * In my school I participate in a team that supports newly trained teachers.

Teaching Experience		In my school I participate in a team that supports newly trained teachers.				Total
		None	Small	Moderate	Large	
0 - 5 Years	Count	16	6	15	9	46
	% within Teaching Experience	34.8%	13.0%	32.6%	19.6%	100.0%
	% of Total	14.0%	5.3%	13.2%	7.9%	40.4%
6 - 10 years	Count	5	3	7	9	24
	% within Teaching Experience	20.8%	12.5%	29.2%	37.5%	100.0%
	% of Total	4.4%	2.6%	6.1%	7.9%	21.1%
11 - 15 years	Count	4	2	4	7	17
	% within Teaching Experience	23.5%	11.8%	23.5%	41.2%	100.0%
	% of Total	3.5%	1.8%	3.5%	6.1%	14.9%
16 and above	Count	7	4	5	11	27
	% within Teaching Experience	25.9%	14.8%	18.5%	40.7%	100.0%
	% of Total	6.1%	3.5%	4.4%	9.6%	23.7%
Total	Count	32	15	31	36	114
	% within Teaching Experience	28.1%	13.2%	27.2%	31.6%	100.0%
	% of Total	28.1%	13.2%	27.2%	31.6%	100.0%

Table 5.18(b): Chi Square

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.389[a]	9	0.700
Likelihood Ratio	6.670	9	0.671
Linear-by-Linear Association	1.926	1	0.165
N of Valid Cases	114		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is 2.24.

Cross-tabulation Table 5.18 (a) shows that generally teachers participated in teams that supports newly trained teachers but to a limited extend. The Chi square test shows that there is no significant difference at p<0.05 as p = 0.700 (Refer to Table 5.18

Table 5.19 (a) No of learners per class * I participate in a network of teachers formed specifically for the professional development of teachers

No of learners per class		I participate in a network of teachers formed specifically for the professional development of teachers		Total
		Yes	No	
21 - 40 Learners	Count	3	10	13
	% within No of learners per class	23.1%	76.9%	100.0%
	% of Total	2.7%	8.8%	11.5%
41 - 60 Learners	Count	39	30	69
	% within No of learners per class	56.5%	43.5%	100.0%
	% of Total	34.5%	26.5%	61.1%
61 - 80 Learners	Count	8	16	24
	% within No of learners per class	33.3%	66.7%	100.0%
	% of Total	7.1%	14.2%	21.2%
81 - 100 Learners	Count	5	1	6
	% within No of learners per class	83.3%	16.7%	100.0%
	% of Total	4.4%	.9%	5.3%
101 and above	Count	1	0	1
	% within No of learners per class	100.0%	0.0%	100.0%
	% of Total	0.9%	0.0%	.9%
Total	Count	56	57	113
	% within No of learners per class	49.6%	50.4%	100.0%
	% of Total	49.6%	50.4%	100.0%

Table 5.19(b): Chi Square

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.269[a]	4	0.024
Likelihood Ratio	12.161	4	0.016
Linear-by-Linear Association	1.620	1	0.203
N of Valid Cases	113		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is 0.50.

Cross tabulation Table 5.19(a) shows that generally teachers with a large number of learners in a class were the ones attending networks of teachers formed specifically for the professional development of teachers more than the ones with a fewer number of learners in a class. The Chi square test indicates that there is a significant relationship between the number of learners in a class and teachers' participation in a network formed specifically for the professional development of teachers at $p<0.05$ level (Refer to Table 5.19(b)).

5.5 SUMMARY OF INFERENTIAL STATISTICS FINDINGS

Cross tabulations and Chi square tests were used to show the relationships between different variables. The findings showed that teachers' participation in networks formed specifically for the professional development of teachers was not related to teachers age. The findings also showed that there was a positive relationship between teachers' qualification and collaboration with colleagues on issues related to mathematics teaching. However, within groups, teachers with diplomas and certificates were the ones who collaborated less. The findings further demostrated that there was a high relationship between teachers' teaching experience and collaboration with colleagues on issues related to mathematics teaching, the results however showed that within the groups, teachers with more experience (15 years or more) were the ones who did not collabrate more.

The findings on teachers' teaching experience and their participation in teams that supports newly trained teachers showed that there was no relationship between the two. Furthermore, the findings revealed that there was positive relationship between the number of learners in a class and teachers' participation in a network of teachers which was formed specifically for the professional development of teachers. But within the groups, teachers who seemed to participate more in a network of teachers which was formed specifically for the professional development of teachers were the ones who had more than 80 learners in a class.

5.6 INTERPRETATION OF QUANTITATIVE RESULTS

The findings revealed that most teachers who participated in this study were young inexperienced teachers. The results showed that these teachers were using learner-centred teaching strategies more than teacher-centerd teaching strategies. The results also illustrated that teachers' choice of these strategies depended on whether they offered learners an opportunity to actively participate in the teaching-learning process. Though teachers showed that they fully involved learners in the teaching-learning process, it is surprising that they indicated that their learners did not show expression of any excitement. This may suggest that though teachers claimed that they were using learner-centred strategies, they might not have used them for the purpose mentioned.

On the issue of support mechanisms available for teachers, it was clear from both descriptive and inferential results that there was a minimal support mechanisms available for teachers within the school. These results further indicated that teachers who collaborated were those with first and post-graduate degrees, while one would think that those who had certificates and diplomas would be the ones collaborating more, because of looking at the amount of content they had gained from their training. Furthermore, the results illustrated that teachers who supported each other were those with large numbers of learners in their classes. This is understandable as teachers would have to share ideas on how to handle and to teach certain concepts in large classes.

5.7 QUALITATIVE FINDINGS

This section presents the results of the qualitative data from interviews, observations and open-ended questions from the questionnaire. The findings from the qualitative data yielded four themes namely: Teacher effectiveness, teacher collaboration, impact on learners' learning and barriers to LS implementation. The data classified in these themes are going to help to answer the research questions: How does the LS training impact on teachers' pedagogical practice? What are the effects of LS on learners' understanding of mathematics? Which challenges do teachers experience in implementing LS? In presenting the results the background of both

teachers, context of the schools from which the data was collected and general results are presented.

School A

The school is about 20km from the city centre. Though the school was established in the 1980's it is still under-developed. The principal's office is very small and does not even have furniture except for a table and a chair. In this school there is no mathematics room nor library and there is only one staffroom which is fully packed. In the classroom in which a lesson was observed there was a shortage of furniture. However, the school hall which was funded by donors was in the process of being completed. Few mathematics books which were donated to the school are kept in the science laboratory which makes it impossible for learners to access them.

In this school there were four teachers in the mathematics and science department and all of them participated in this study. There were three male teachers and one female. Of these four, three had teaching experience of six years or less while the other teacher is a pensioner who is working on contract basis. Two of these teachers had diplomas, one had a Bachelor of Science without education and the last one had Bachelor of Science in education.

School B

This school is right at the city centre and it is one of the well-resourced schools in town. The Principal's office is well furnished; there are three staff-rooms one of which belongs to the mathematics and science teachers, a big modern school hall, and a well-resourced library with a librarian who works on full-time basis. All classrooms are well furnished except that they are over-crowded.

In this school there are nine mathematics and science teachers out of which only five teachers participated in this study as the rest of them did not show interest. Three of these teachers were females and the other two were males. Of these teachers, one

had honours degree while four of them had Bachelor in Science education. Two teachers had an experience of more than twenty years, one had less than ten years of experience and the other two had less than five years of experience.

School C

The school is about 2km from city centre and was established in the early nineties however, it is one of the best developed schools. The school principal's office was well furnished; there is a well-resourced library, two staffrooms and well-furnished classrooms.

In this school there were nine teachers who teach mathematics out of which eight fully participated in this study. Six of the teachers were females while two were males. All these teachers had Bachelor of Science in education. Three of these teachers had more than twenty years teaching experience, one had more than ten years teaching experience and the rest had less than five years of experience.

5.7.1 Teacher Effectiveness

According to Komba and Nkubi (2008) the effectiveness of the teacher depends on her academic and pedagogical competence, commitment to her work, ability to manage her work load and learning resources. Through LS process, teachers get an opportunity to broaden content knowledge, develop new instructional techniques, refine their practice and broaden themselves both as teachers and as individuals. By engaging in LS, teachers get an opportunity to carefully consider what and how they are teaching, and to reflect on their actions to determine what works best for their learners. All the above-mentioned attributes of LS are central to an effective teacher. The theme "teacher effectiveness" has been divided into three sub-themes, namely: improved content knowledge, developed pedagogical knowledge and teacher reflection.

5.7.1.1 Improved Content Knowledge

Lesson Study process involves teachers working in teams in which they collaborate with each other in planning and discussing the content to be taught during the research lesson. It is during this process that teachers look deeply into content that they have as they have to present it to other teachers. Teachers also identify gaps in their own understanding and develop new insights about content. Teachers who have participated in this study have reported that LS has helped them to fill up their content knowledge gaps. For example, a teacher from school A pointed out that:

> *There are some of the topics that you find that you are not comfortable with so you are able to share ideas…. If a teacher has a problem about a certain topic, learners already have a problem*

Likewise the teacher from school C pointed out that:

> *There are some mathematics concepts which the teacher may think that he/she knows them, only to discover during preparation of a research lesson that he/she did not fully understand those concepts…*

A teacher from school B similarly alluded that:

> *Teachers in my team have helped me to look at the content from different angles, during planning, my colleagues came up good ideas that clarified some of the mathematical concepts that I could not have seen on my own.*

The above quotations show that teachers' content knowledge has improved as a result of their participation in LS. The improvement in teachers' content knowledge suggests that teachers would now be able to competently diagnose and address learners' mathematical misconceptions and computational limitations.

5.7.1.2 Developed Pedagogical Knowledge

Pedagogical knowledge is a basic form of knowledge that applies to teaching and learning process in general. Pedagogical knowledge requires teachers to have deep knowledge about cognitive, social and developmental theories of learning and how

these impact on learners' learning. Pedagogical knowledge is important to teachers as they need to understand how learners come to acquire knowledge. Teachers who participated in this study confirmed that engaging in LS has improved their pedagogical practices. A teacher from school A had confirmed that by participating in LS, she had improved her pedagogical knowledge. She indicated that:

> *I now have simpler techniques of teaching mathematics which I gained from my colleagues. Participating in LS has really improved my teaching…*

The teacher from school B also corroborated that:

> *Even the way I prepare myself is different from what I would do, I prepare in a different manner as I now have to look at different ways of presenting content and also to anticipate what kind of questions learners might ask.…*

Similarly, a teacher from school C also was of the same view that:

> *Even the way the concept is presented may be different from the way I would present it. Hence, it helps me to have different approaches for teaching a specific concept*

In promoting learners' learning, teachers' content knowledge is not sufficient on its own as they should also be familiar with suitable pedagogical approaches which can help them deliver that content effectively. Furthermore, teachers must know not only their subject content and its related pedagogy, but should also know the learners to whom they wish to teach that content. Knowing learners' thinking would help a teacher to use appropriate methodologies that will address individual learners' needs. Once a teacher can be able to reach this stage; such a teacher becomes highly effective.

5.7.1.3 Reflection

Reflection is a vital practice as it enables teachers to think, consider, develop and articulate many aspects of their practice thereby increasing their own knowledge base. Thus, reflection enables teachers to link theory and practice (Suratno & Iskandar, 2010). Lesson Study is one tool that encourages teachers to reflect upon

their practices as they engage in LS process. Teachers who participated in this study also asserted that LS gave them an opportunity to reflect on their own practices. A teacher from school B indicated that "*during planning, the discussion that occurred made me think about my own teaching"*. If LS affords teachers an opportunity to reflect on their practices, this means that they have a chance to improve their teaching practices which in turn would improve learners' learning. A similar view was expressed by a teacher from school C who also said, "*hahaha (laughter) LS has made me reflect on my daily teaching. I am now able to see my strengths and weakness in my teaching".*

The above quotations illustrate that as teachers engage in LS process they improve their effectiveness. An effective teacher is the one who reflects on his/her practices such that he/she can be able to identify his/her strengths and weaknesses in time and make modification accordingly.

5.7.2 Teacher Collaboration

Lesson study is a tool that fosters teacher collaboration. Through LS, teachers have an opportunity to participate in collaborative inquiry which allows them to grow professionally. In LS, the contributions made by each teacher can enhance the learning of everyone taking part as they talk about content knowledge, pedagogical knowledge and their learners' learning. Collaborative efforts brought by LS resulted in high degree of accomplishment by teachers who participated in this study. The evidence of this is found from what a teacher from school A said:

> *During the planning session we were able to share ideas… If the teacher is not at school, other teachers are able to help the learners. I think it is also important to share ideas with teachers from other schools especially because they come from different school backgrounds*

Equally, the teacher from school B was of the same view that LS:

> *…helps me to be with other teachers and teach a uniform lesson. It encourages team work which is lacking in our schools, even now there are some teachers who refused to participate in LS, I pity them. I can now share my problems regarding problematic topics with my colleagues and I know that they will be willing to help me at any time. They can even teach the class for me… (laugh)*

In the same manner, the teacher from school C was also of the same opinion that:

> *…lesson study builds team spirit. For the years I have been in this school, I have never seen teachers working together like this. We now consult amongst ourselves at any time. Even teachers from other departments are now organizing themselves to do the same. Our principal also loves this and has agreed to give all mathematics teachers an afternoon off on Wednesdays for preparing research lessons.*

During the observation of the research lesson, teachers were working collaborately. Teachers from schools A and C used team teaching where one teacher introduced the lesson and the other developed it. During the lesson, the rest of the members of the team moved from one group to another marking and helping learners where necessary. Though teachers in school B did not use team teaching, but during the lesson, they moved from one group to another still marking and assisting learners.

The evidence provided by these teachers show that the collaborative nature of LS has helped the secondary mathematics teachers to break classroom walls and open doors for other teachers to come and jointly improved one another's teaching practices. In engaging in LS, teacher isolation is reduced. Another importance of collaboration is that it increases teacher confidence. Engaging in LS, teachers get an opportunity to develop new teaching approaches, share ideas with colleagues on how to improve learners' learning and improve their content knowledge. As a result, their confidence in teaching increases. The increased teachers' confidence as a result of their engagement in LS has also been evidenced by teachers who participated in this study. A teacher from school A illustrated that:

> *Before participating in LS, I used to like teaching science than mathematics, but now I enjoy teaching mathematics more that science. Lesson Study has helped me realize that teaching mathematics is not bad after all*

The teacher from school B also said:

> *What I felt about it is that it improved my confidence. I can now confidently teach in front of my colleagues which is something I could not do before participating in LS. Even if inspectors can come now I can teach without any fear… (laugh)*

Thus, through collaboration, the sharing of ideas and cooperation with colleagues, seem central to the positive learning of teachers. By combining their intellectual resources, members of a group are able to address a shared problem and pursue a common goal more effectively than they could alone. In collaboration teachers have an opportunity to learn, diagnose learners' problems through systematic data gathering and through the sharing of ideas in their discussions at all the stages of LS. Hence, LS process offers teachers opportunities to develop their expertise through collaboration leading to greater confidence to make changes in their classroom practices and also willingness to take risks.

5.7.3 Impact of Lesson Study on Learners' Learning

Lesson Study model places learners' learning at the heart of professional development activity. During the planning phase teachers focus on learners' learning by developing lessons that build on learners' prior knowledge, and also anticipate learners questions and the problems they might have about the concept to be taught. Anticipation of learners' responses allows teachers to be better prepared to deal effectively with questions and misconceptions that learners might have during the lesson. One of the LS strength is that it enhances learners' motivation and confidence thereby increasing their participation and satisfaction with their work.

Teachers who participated in this study attested that LS improved learners' participation in the class. A teacher from school A said:

> *Learners are participating more than before… even those who never participate are now actively involved in discussions… they now ask questions and make arguments.*

The teacher from school B, the teacher indicated that

> *…my learners impressed me by actively participating, though this is an active class, but with a team of teachers surrounding them they become more excited and participate more…maybe they want to impress other teachers (laugh laugh)*

Lesson Study allows teachers to prepare more engaging lessons which anticipates learners' questions and the possible answers. During planning session, all learners' possible responses are taken into consideration hence learners feel safe to participate and give their views during the lesson.

5.7.4 Barriers to Lesson Study Implementation

Lesson Study has numerous benefits for both teachers and learners; however there are major challenges that impede its implementation in schools. Some of the challenges of implementing LS is the process which involves teachers coming together to prepare, teach, analyse and revise the lesson if there is a need for that. This requires a lot of time from all teachers participating in LS. In Lesotho where classrooms are packed, there is also a challenge of materials to be used. For this study, teachers who participated also had a feeling that though LS has helped them to view teaching from a different perspective it has some challenges. On the issue of time teacher B said:

> *To be honest it consumes time, it is not in all the cases where teachers are able to attend, though we do not prepare a research lesson for every lesson.*

It is about timing- as teachers are preparing a research lesson and observing their classes/learners are left unattended

A teacher from school C also alluded to the fact that

Time factor was a big challenge because sometimes only two teachers would show up for the meeting while the rest would be attending their class. We did not have the same free period for which we could meet.

A normal mathematics lesson lasts 40 minutes while a double lesson is 80 minutes long. In all the classes observed, lessons which were 80 minutes long took two hours. While teachers have cautioned that they have a challenge of having a common time for research lesson preparation, another obvious challenge of time was that the teaching of the prepared lesson took more than expected. Though LS has numerous benefits, the issue of creating a common time for all teachers concerned seemed to be a biggest challenge. In Lesotho mathematics and science teachers already have packed timetables and heavy workloads which do not allow manoeuvring their timetable to engage in the lesson process and they also have a challenge of leaving their classes unattended.

5.8 SUMMARY OF QUALITATIVE FINDINGS

The qualitative findings revealed that LS promoted teacher effectiveness by improving both their content and pedagogical knowledge. The results also showed that LS encouraged teachers to reflect on their practices and fostered teacher collaboration. The findings further indicated that teachers who participated in LS, improved in their confidence as mathematics teachers and they also observed that during the teaching of the research lesson, learners showed increased motivation and participation.

Though LS has been found to have many benefits, the findings showed that time was a serious challenge experienced by teachers during the implementation of LS. Teachers showed that their time-tables could not allow them to have a common time

for LS meetings. During observation, it was also observed that lessons prepared could not be completed within a scheduled time.

5.9 INTERPRETATION OF QUALITATIVE RESULTS

The results of the qualitative data showed that teacher effectiveness improved as a result of their participation in LS. Improved teacher effectiveness was based upon their improved content and pedagogical knowledge, improved reflective practice, increased confidence, and their enhanced ability to collaborate amongst themselves on issues pertaining to the teaching and learning of mathematics. Lesson Study affords teachers an opportunity to collaboratively plan a research lesson in which they firstly decide on the content to be taught, think critically about the content and come together to plan a research lesson. It is during this phase that teachers share ideas about how best they could present the content, which materials should be used, what type of questions should be asked, anticipate learners' questions and come up with possible responses for such questions. As teachers deliberate about all these issues, they learn from each other's expertise thereby closing the gaps in their knowledge.

During the presentation of the lesson, teachers also get the opportunity to see how the prepared lesson unfolds which results in teachers being confident about the lesson they have prepared. During the debriefing session, teachers reflect about whether the planned lesson has met the set learning outcome, whether learners responded positively towards the lesson, and whether the lesson made learners' thinking visible. Then teachers deliberate about how the lesson could be improved. The collaborative nature of LS enables teachers to critically review their content and pedagogical knowledge on the basis of what other team members bring to the discussion group and also think critically about their own contribution. The fact that learners' questions were anticipated during the planning of the lesson, the possible responses were noted and also the appropriate methodologies were used which might have motivated learners to actively participate in the lesson. Lesson Study process is very demanding in terms of time. Getting a common time for all team

members to come together to prepare the research lesson, present and reflect upon it, requires a lot of time. In this study lack of time seemed to be a serious challenge facing the teachers.

5.10 CONCLUSION

In this chapter both quantitative and qualitative results were presented. Quantitative data that was collected through the use of the questionnaire which was basically looking at teachers' biography, the teaching methods they use in the teaching of mathematics, teachers' classroom practices and the support teachers get in their teaching profession. In analysing this data, frequencies, means and standard deviation were used. The same information was again analysed using factor analysis in which six factors were extracted from the rotated component matrix. Cross tabulations and Chi-square were also made use of to see significance of the presented information. In analysing this information the results revealed that teachers used different teaching methods in the teaching of mathematics. The results also showed that teachers had good classroom practices however, the support they get from other teachers was minimal.

The qualitative data presented was collected by interviews and classroom observations after teachers were trained on issues related to LS. The interviews from three teachers in which lesson study was practiced were transcribed, coded and classified under different categories. The qualitative analysis revealed aspects of LS which made positive changes in teachers' classroom practices, change in their knowledge, and the challenges teachers experienced in implementing LS. Evidence of change on learners' participation, motivation and understanding during the teaching of the research lesson was also presented. However, teachers showed that time was a serious challenge to them during implementation of LS as they did not have common time for lesson study meetings.

Looking at both quantitative and qualitative results, prior to LS training, teachers indicated that their learners did not show any excitement during mathematics lessons though they claimed to be using learner-centred approaches such as guided discovery, discussion, and question and answer (cf. 5.2.1.3, 5.2.1.1). However, after training, teachers demonstrated that during the teaching of the research lesson, learners were motivated and participated more than they usually did (cf. 5.3.4). The quantitative results further showed that teachers were getting minimal support from colleagues as there were no formal support mechanisms available for professional development of teachers (cf. 5.2.1.4). However, after participating in LS, teachers valued collaboration amongst them and indicated that through these collaborative activities, they had improved their content and pedagogical knowledge and also improved their ability to reflect on their practices. These had resulted in teachers' improved confidence.

The next chapter will presents the summaries of all the chapters in this study, conclusions reached from the quantitative and qualitative findings and the recommendations made.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

Lesson Study is a form of professional development programme which fosters communication amongst teachers and involves active learning amongst teachers as they challenge their existing ideas about teaching and learning (Smith, 2013). It is through LS that teachers develop new knowledge and skills informed by data collected through presentation of research lessons (*ibid*). This study was carried out to improve teachers' pedagogical practices in secondary schools in Maseru Lesotho. The chapter starts by summarising all the chapters in this study, it then provides the conclusions drawn from both quantitative and qualitative results and finally makes recommendations based on the findings of this study.

6.2 SUMMARY OF CHAPTERS

In Chapter 1 the background of the study on how the performance of mathematics in schools has been like in the past years and the initiatives that were taken by Lesotho Government through the Ministry of Education and Training to provide professional development programmes in an attempt to address failure rate were discussed (cf. 1.1). The research problem which illustrated that the Ministry of Education and Training in Lesotho had provided professional development programmes for mathematics teachers in an attempt to improve learners' performance in mathematics, but no significant change had been observed (cf. 1.2). The research questions, the aim and objectives of the study were also discussed (cf. 1.3 &1.4). Significance of the study which was supported by literature was also given. The chapter also outlined the methodology, research design and data analysis adopted in this study (cf. 1.7). Limitations of the study also formed part of this chapter. Definitions of terms and summary of chapters were also presented.

Chapter 2 reviewed the literature on teachers' professional development programs specifically looking into the differences between traditional and job-embedded professional development programmes and the benefits of job-embedded PD over traditional PD (Joyce & showers, 2002). The discussion suggested LS as a suitable form of teacher professional development programme which has the attributes of job-embedded professional development programme (Oliver, 2005). The characteristics which make LS to be more effective are that it is on-going, on-side and school-based, focuses on learner achievement, it centres on teacher collaboration and it is sensitive to teachers' learning needs (Hawley and Valli (1999) in Drago-Severson, 2007). The lesson study cycle which consists of six stages was discussed in relation to what happens at each stage of the cycle. (cf. 2.2 & 2.3).

The chapter further discussed the four types of knowledge which mathematics teachers should have. These types of teachers knowledge are, content knowledge, pedagogical knowledge, pedagogical content knowledge and mathematical content knowledge (cf. 2.4). When the teacher possesses these types of knowledge he/she becomes an effective teacher. Hence, the chapter also discusses factors which promote teacher effectiveness (cf. 2.5). Furthermore, the chapter elaborated on how LS improve teacher effectiveness (cf. 2.6). Research evidence which supports the importance of LS in the teaching and learning of mathematics has also been presented. The benefits of LS discussed in this chapter were teacher-related and leaner-related (cf. 2.7.1 & 2.7.2). Finally, the chapter presented research-based evidence on the challenges of implementing LS in schools (cf. 2.8).

Chapter 3 presented the theories underpinning the study. The purpose of the theories is to help the researcher to make sense of the world, guide on how people should behave and to predict what might happen next. This study was guided by two theories, namely, transformative and situated learning theories. Transformative learning theory which was developed by Mezirow, is defined as learning that transforms problematic frames of reference to make them open, reflective and emotionally able to change (cf. 3.2.1). This theory has two major categories which are critical reflection and rational discourse. The discussion of both categories

formed part of this chapter (cf. 3.2.2, & 3.2.3). The chapter also presented conditions that promote transformative learning (cf. 3.2.4). In addition, the chapter looked at situated learning theory which was developed by Lave and Wenger. This theory emphasises that knowledge is situated in the activity of the teacher and it is a product of that activity and forms through the context and culture in which it occurs (Lave & Wenger, 1991). The situated learning theory shifts the emphasis from individual learning to collaborative learning which is the main goal of LS (cf. 3.3). This theory has two important components which are communities of practice and legitimate peripheral participation. These two components also formed part of this chapter (cf. 3.31 & 3.3.2).

Chapter 4 elaborated on paradigms which guide the researcher in making decisions on how to carry out research and influences the way knowledge is studied and interpreted. A paradigm consists of ontology, epistemology, methodology and methods. Each of these components were discussed in this chapter. First, both positivist and interpretive paradigms were elaborately discussed as these two formed the basis for this study (cf. 4.2.1 & 4.2.2). In this study, positivist paradigm was used to establish facts about teachers' pedagogical practices without influencing them in any way. Hence, the researcher was objective and detached from the subject throughout the whole process. However, establishing teachers' pedagogical practices without knowing the reasons behind the usage of such practices would not give the researcher a true picture of why such practices are being used. Hence, the use of interpretive paradigm. The paradigms adopted in this study informed the methodology to be employed in carrying out the research.

The study used mixed method approach as both quantitative and qualitative approaches were employed. These methods formed part of this chapter (cf. 4.3.1, 4.3.2 & 4.3.3). The use of the two quantitative and qualitative approaches was to overcome the weaknesses of each of the methods. Creswell et al. (2003) illustrated that the use of multiple methods can cancel some of the disadvantages of each other (cf. 4.3.3). Since the study adopted a mixed method approach, it followed the sequential transformative design where quantitative data was collected first, followed

by qualitative data. The chapter also presented different types of mixed method research designs that are used in research (cf. 4.4).

Since the data was collected in two phases, different types of participants who took part in each phase also formed part of this chapter (cf. 4.5). In the second phase of the study, participants were provided with a LS training workshops where the first workshop was provided outside the schools premises and the second one was school-based. The overview of the workshops formed part of this chapter (cf. 4.6). The procedure followed in collecting data and the instruments used were also presented in this chapter (cf. 4.7 & 4.8). The process followed for analysing both quantitative and qualitative was also presented (cf. 4.9). Furthermore, issues of reliability and validity of data, ethical considerations and the limitations experienced in conducting this research were presented in this chapter (cf. 4.1., 4.11, & 4.12).

Chapter 5 presented data analysis and interpretation of the results. First, the quantitative data was presented in which respondents biographical data was given (cf. 5.2.1). The data on different teaching methods used by teachers and the reasons behind the use of these strategies were also examined (cf. 5.2.2 & 5.2.3). Furthermore, the chapter looked at teachers' classroom practices which include how teachers plan their mathematics lesson, what kind of questions they ask, and what kind of responses learners give (cf. 5.2.4). Types of support systems teachers engaged in also formed part of this chapter (cf. 5.2.5). In addition, the chapter examined the results of factor analysis in which twenty-five out of fifty-three factors were extracted. The factors extracted included the reasons for choice of teaching methods, teacher-collaboration, and support systems available for teachers (cf. 5.3.1 & 5.3.2).

The results obtained from cross-tabulations and Chi-square tests at $p < 0.05$ were also presented in this chapter (cf. 5.4). These results revealed that there was no relationship between teacher-participation in networks that are formed to support teacher professional development and the age of teachers, which means that

teachers regardless of their age do not participate in collaborative activities. The summary and interpretation of statistical data were also presented.

The second part of Chapter 5 presented qualitative findings and the interpretation of the results on the basis of the themes emerged. The themes that emerged were teacher effectiveness, teacher collaboration, impact of LS on learners' learning, and the barriers to LS implementation (cf. 5.7.1, 5.7.2, 5.7.3 & 5.7.4). The summary of qualitative findings and the conclusion which merged the findings from both quantitative and qualitative results were also discussed (cf. 5.9 & 5.10).

Chapter 6 offered the summary of all chapters in this study. It also presented the conclusions drawn from the findings of the study. The conclusions were presented on the basis of the objectives that were to be achieved in this study. The chapter also outlined the LS model emerged from the findings and the description on how to use it in the teaching of mathematics. The recommendations from the findings were also made.

6.3 CONCLUSION

This section presents conclusion drawn from the findings based on the research questions that the study wanted to answer. The conclusions were made based on the findings from both quantitative and qualitative findings.

6.3.1 What are teachers' pedagogical practices before lesson study training?

The conclusion drawn from quantitative findings showed that teachers prior to LS training were already using learner-centred approaches such as discussion, question and answer, cooperative learning and guided discovery. However, they showed that they were using investigation minimally (cf. 5.2.2.1). They further indicated that teachers' choice of these strategies largely depended on whether the strategy gives teachers an opportunity to check learners' understanding of mathematical concepts, methods that give learners a chance to explore and allow collaboration between

them (cf. 5.2.2.2). Generally the quantitative findings revealed that teachers were using effective instructional practices such as planning effectively for mathematics lessons, identifying learners' misconceptions and dealing with them accordingly, and eliciting learners' thinking by use of questioning (cf. 5.2.4).

On the issue of support systems available for teachers, the findings showed that teachers did not have any formal support systems available within the school and from outside the school (cf. 5.2.5). The conclusions drawn showed that teachers did not plan together as a team, they did not observe each other teaching, and they did not take part in induction programme for newly trained teachers. Though findings on teachers practices indicated that teachers plan effectively, attend to learners difficulties, give learners time to explain their thinking, but teachers did not seem to be very active in activities that promote teacher-professionalism. Lack of planning together, learning from one another through observation, sharing ideas in a collaborative and democratic setting which allow individuals to freely engage in discussions and willingness to support which had been displayed by teachers who took part in this study showed lack of effectiveness in their teaching (cf. 2.5.5).

6.3.2 How does the Lesson Study training impact on teachers' pedagogical practice?

The conclusion drawn from qualitative findings showed that teachers' pedagogical practices changed significantly. Prior to training, teachers showed that they did not plan their lessons as a team, and did not observe each other. These activities which teachers did not seem to engage in offer teachers opportunities to reflect upon their own practices. Reflection is an important component of teaching and learning as it helps teachers to review their practices and act accordingly where necessary.

Dewey (1933) illustrated that reflection emancipates teachers from impulsive and routine activity, as it enables them to direct their activities with foresight and to plan according to ends-in-view or purposes of which they are aware of (cf. 3.2.2). In addition, Cimer *et al*. (2013) suggested that for effective reflective practice, teachers

need to be supported by colleagues who can assist with teachers' analytic reflection and can reflect, analyse and dialogue about their own practice. They further indicated that reflection is mostly likely to be demonstrated when critical colleagues or collaborative discussions in a supportive and trusting environment are adopted (cf. 2.5.5). Since teachers prior to LS training did not engage in communication, participation, and collaborative activities, there is no way in which they would reflect effectively on their practices. Hence, the effectiveness of these teachers is questionable.

However, after training, teachers engaged in LS which allowed them to communicate, participate and collaborate with one another. It was during these activities that a teacher from school B illustrated that during planning of research lesson, the discussion that occurred made her to think about her own teaching. Similarly, a teacher from school C also expressed the same view that LS made her reflect on her daily teaching as she was now able see the strengths and weaknesses in her teaching (cf. 5.7.1.3). Furthermore, teachers showed the importance of LS in building team spirit. A Teacher from school B illustrated that LS had encouraged team work in her school which was lacking. She further indicated that she can now share her problems regarding problematic topics with her colleagues as she knew that they would be willing to help her at any time. Hence, teachers' participation in LS has improved their pedagogical practices.

The findings further revealed that LS had improved teachers content and pedagogical knowledge. This was evident in what a teacher from school A said as she indicated that there were some topics which she was not comfortable to deal with and through LS she was able to share ideas with other teachers. She further illustrated that if a teacher has a problem with any content, learners already have a problem. Hart *et al*. (2011) also illustrated that knowledge of the subject matter is important as a teacher cannot teach what he/she does not know (cf. 2.4.4). This teacher further pointed out that she now had simpler techniques for teaching mathematics which she gained from her colleagues (cf. 5.7.1.2).These comments

showed that teacher's knowledge base has improved as a result of participating in Lesson Study.

The fact that teachers' reflective practice, teachers' knowledge base, their practices such as collaboration and communication had improved, resulted in an improved confidence (cf. 2.5.4). This was evidenced by a teacher from school B who showed that participation in LS had improved her confidence as she can now teach confidently in front of her colleagues which was something she would not do before (cf. 5.7.2). Similar results were observed in a study carried out by Rock and Wilson (2005). In general, teachers' participation in LS has positively impacted on their pedagogical practices.

6.3.3 What are the effects of lesson study on learners' understanding of mathematics?

Lesson Study has not only been found to have positive impact on teacher, but to learners as well. Findings of the study illustrated that learners' understanding, participation and motivation had also improved enormously. A teacher from school A illustrated that learners were participating more than they usually did. She demonstrated that even those who never participated before were now actively involved in discussions, asking questions, and making arguments. The same sentiments were shared by a teacher from school B who showed that her learners were very impressive during the teaching of the research lesson as they were actively participating and as they saw a team of teachers surrounding them, they became more excited and participated even more (cf. 5.7.3). The impact of LS on learners was supported by Burghes (2010) who illustrated that LS enhances learners' motivation and confidence thereby increasing their participation and satisfaction with their work.

6.3.4 Which challenges do teachers experience in implementing lesson study?

Though LS has been found to have numerous benefits, but its implementation has some challenges. In this study, one big challenge that was experienced by teachers was the time factor. Teachers had a challenge of having a common time for LS meetings as their time-tables were not blocked such that they could have common free periods. Similar findings were observed in a study carried out by Gardner *et al*. (2012) in which they established that it had been difficult for the teams to meet soon after the teaching of the research lesson due to timetable constraints (cf. 2.8.1). Another challenge that was evidenced was that during the teaching of the research lesson, classes of the team observing the research lesson were left unattended (5.7.4).

6.4 THE EMERGENT MODEL OF LESSON STUDY

The LS model that emerged (fig. 6.1) from the results of this study showed five phases which teachers had to undergo in implementing LS in their classrooms. The model comprised of pre-planning, collaborative planning, observation and team-teaching, sharing classroom experiences and improvement of the lesson. These phases are elaborated in the next section.

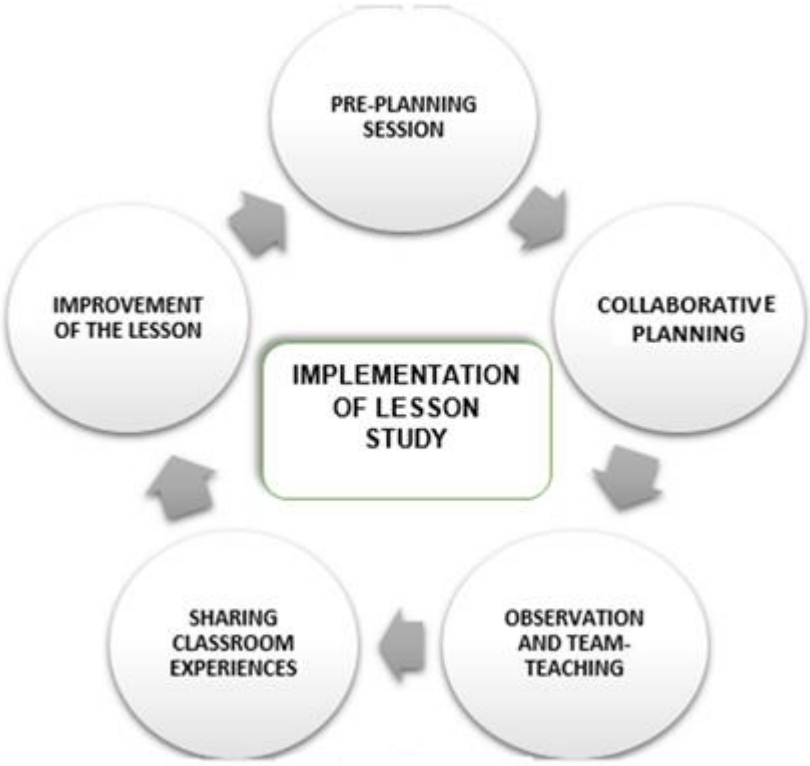

Figure 6.1: Emerged Model of Lesson Study

6.4.1 Pre-planning session

During the first phase of the lesson study cycle, teachers have a meeting of all teachers who are going to take part in Lesson Study. In this meeting, teachers discuss about problems/concerns and challenges in teaching specific topics paying special attention to problematic topics, what is problematic about these topics, or topics that are new to the curriculum and which most teachers are not comfortable with (Cerbin & Kopp, 2006). At this stage they agree on the learning outcomes of the lesson to be taught in terms of what they would like learners to know and be able to do as a result of the lesson. They also decide on the information to be collected about the topic, and also think about the suitable strategies and materials that could be used to teach it. The team finally agrees on the time on which they will meet to plan the research lesson. Selecting a problematic topic or the one which is new in the syllabus is at the heart of the successful lesson study as it leads to a research focus that can be maintained over several years (Doig & Groves, 2011).

6.4.2 Collaborative Planning

The team meets to plan the research lesson**.** It selects the most appropriate strategies for presenting the content and the materials to be used. Since the content has already been identified the team then establishes what learners already know (prior knowledge). The team plans the research lesson by drawing from their past experiences about teaching the same concept in terms of what worked and did not work; by using textbooks; their teachers' guide and other resources they may find useful (Doig & Groves, 2011). Ferreira and Ono (2010) illustrated that developing lesson plans requires teachers to have a good understanding of their learners' needs, pre-knowledge and misconceptions. The team develops the appropriate activities that address the learning outcomes. As the team develops learners' activities, it looks at the key concepts and questions to be asked to elicit learners' understanding and anticipate learners' responses. It also anticipates leaners' thinking and the questions they might ask, and how the questions might be answered.

Ferreira and Ono (2010) demonstrated that teachers are encouraged to anticipate the challenges learners may encounter in the lesson and be prepared with appropriate strategies to help them. Then the team decides on how the lesson is going to be introduced. At this stage, the team agrees on how to evaluate leaners' learning, which tools to use and how to use them, and the most important opportunities to look for in the lesson. They finally agree on who are going to teach the lesson.

6.4.3 Observation and Team Teaching

In all the three participating schools teachers decided to do team teaching instead of the usual form of LS where one teacher teaches the research lesson while the rest of the team observes learners' learning, thinking, engagement, behaviour, and other attributes that they had agreed upon. In two schools, the lesson was introduced by the more experienced teacher, while the less experienced teacher developed the lesson. This idea of an experienced teacher introducing the lesson was to create a conducive environment and to set the stage for the less experienced teacher.

The collaborative activity seemed to reduce stress for the less experienced teacher when being observed by other team members during teaching. Furthermore, classes were overcrowded and the team decided to team teach so that they could help the teacher conducting the lesson in marking and collecting evidence of learners' learning at the same time. In the process of marking and attending to learners' problems, the team had an opportunity to find exactly what learners' misunderstandings were as they had a chance to communicate with them. The other reason for using team teaching was to allow learners to see their teachers teaching together and supporting one another, which is also important for learners to see that they too can work collaboratively. Team teaching gives the teacher presenting the lesson a supportive environment (Goetz, 2000)

6.4.4 Sharing Classroom Experiences

During this phase the team shares the evidence gathered as the research lesson was being presented. The team focuses on the evidence of whether the lesson has achieved the set objectives. The teacher who presented the lesson should be given the opportunity to speak about how the lesson went, which strengths and weaknesses he/she noticed as the lesson was being presented, the changes made to the original lesson plan and why they were made, the surprises that came up, and the evidence that the lesson objective has been met (Hurd & Lucciardo-Musso, 2005). The other team members follow with their comments on what they observed, learners' reactions towards the lesson, and what they found as they were marking and assisting learners. These include learners' misconceptions and how they helped learners to overcome such misconceptions.

6.4.5 Improvement of the Lesson

It is at this stage where the lesson is improved on the basis of the comments made during the debriefing session. After improving the lesson, it can now be taught in other streams or be kept for future use as it is not possible to reteach the same lesson in the same stream given the amount of work to be covered in a specified time (Lewis, 2002).

6.5 RECOMMENDATIONS

The recommendations that are presented in this section are based on the findings of this research study and are directed towards different stakeholders in the education system of Lesotho.

Ministry of Education and Training

- Though Lesson Study has been found to improve teachers' teaching practices, LS is a new concept in Lesotho and needs to be thoroughly understood for its effective implementation. It is therefore recommended that the Ministry of Education and Training should engage a consultant/agency which is knowledgeable about Lesson Study concept to train MoET personnel, teacher training institutions and Heads of Mathematics Department (HoD) and some teachers where possible on issues pertaining to LS.
- It is also recommended that the Ministry of Education and Training in consultation with the consultant should develop a "Lesson Study Module" that will assist teachers in understanding what Lesson Study is, and how it can be implemented (Ministry of Education Republic of Zambia, 2007).
- Lesson Study has been found to improve teachers' knowledge base thereby enhancing their confidence. Given that new content has just been introduced in the Lesotho Secondary syllabus of which not all teachers might be competent with, it is recommended that the Ministry of Education and Training helps schools in establishing learning communities as it is through these communities that teachers will work collaboratively in helping one another. For Wenger (1991) participation in the community of practice gives participants sense of belonging, and opportunity to share their concerns about a topic thereby deepening their knowledge and expertise through ongoing interaction. Since not all teachers can be trained, it is further recommended that Heads of mathematics and science department be the ones trained first so that they can facilitate this process in their respective schools.

Principals

Teachers who participated in this study have shown time as their biggest challenge regarding implementation of LS in their schools. For effective implementation of LS, teachers need common time for planning the research lesson, observing and to reflecting on it. Teachers can only be able to perform these activities if their timetables are drawn in such a way that they all have a common time for these activities. The issue of adjusting weekly time-table by administrators is supported by Chew and Lee (2011) who illustrated that school principals should draw the school timetables in such a way that all teachers involved in LS have common time to all of them so that they can use it for LS activities.

Head of Mathematics Department

For Kapucu (2012) before Lesson Study teams can be created and be functional, clear leadership should be established for the initiation and continuation of the process. This is where the HoDs come into play, as they are better positioned to initiate, develop, manage, and monitor the LS activities. It is therefore recommended that the head of the department should be the one facilitating all the LS activities within the department or with neighbouring schools. In facilitating the smooth implementation of LS in their schools, HoDs could perform the following: setup weekly meeting for LS teams, facilitate the selection of the class and the topic to be taught, facilitate selection of suitable dates for teaching of the research lesson be taught. Finally, the HoD should facilitate the allocation of tasks for respective team members.

6.6 LIMITATIONS

The sample of the study comprised of Secondary mathematics teachers in Maseru. Since this sample was small, the findings could not be generalized to a large population. However, the issue of transferability can still hold because this was an in-depth study on how LS impacted on teachers' pedagogical practices. Time was another issue which limited the scope of the study. The researcher had to finish this study within a limited time frame and as such could not prolong the study outside the

available time frame. This resulted in the researcher not being able to see the impact of LS on learners' achievement.

Another limitation experienced by the researcher was funding of the study. The researcher had to train teachers, provide them with lunch, and pay their transport from their schools to and from the workshop venue. The expert who assisted in the training of teachers on LS had to be remunerated. Visiting of teachers in their schools to establish LS teams, plan and support was very costly. The financial constraints experienced impacted on the sample size as it would be even more expensive to have a larger sample. Furthermore, this has also impacted on the number of visits the researcher had to make to the schools. Last but not least, the researcher played the facilitator's role throughout the LS sessions, this may have caused some dishonesty in the study's findings where teachers may have been overly positive in their statements during interviews just to please the researcher as there was a strong bond between the participants and the researcher.

6.7 RECOMMENDATIONS FOR FURTHER RESEARCH

Since the present study had limitations in terms of time, sample and financial resources, the following recommendation are made for future research:

- An in-depth study should be carried out with a larger sample from other districts of Lesotho.
- The study which looks at the impact of LS on learners' performance in Lesotho be carried out.
- The impact of the refined research lesson on learner's understanding be carried out.
- A follow-up study to find out if professional learning communities still exist in the schools where LS was practiced and if teachers still participate in them.

6.8 CONCLUSION

This chapter provided the summaries of all the chapters in this study, and the conclusions drawn from the findings based on the research questions. These

conclusions were that: teachers' content and pedagogical knowledge had improved as a result of their participation in LS; improved teachers' collaboration and confidence had also been observed. In addition, learners whose teachers participated in LS also showed significant improvement in their mathematical understanding, motivation and participation. The chapter further presented some challenges teachers encountered in implementing LS in their schools. The major challenge which emerged from this study was lack of common time for the teams to carry out LS activities. The chapter also presented a LS model which emerged from this study. The LS model which emerged had five components, namely, pre-planning, planning, observation and team-teaching, sharing classroom experiences and improvement of the lesson. The recommendations arising from the findings were also presented. Limitations of the study and recommendations for further research also formed part of this chapter.

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APPENDIX A: CONSENT LETTER

I am a PHD student registered with the Central University of Technology. I am conducting a study to establish the effects of Lesson Study on teachers' pedagogical practices in Lesotho Secondary School. The results of this study will assist the researcher to find out if lesson study can be used as a strategy to improve teachers' effectiveness in the teaching of mathematics. I therefore invite you to participate in this research study by completing the attached questionnaire as honestly as possible.

Your participation in this study is voluntary and you can terminate it at any stage of the research process. The information that you will provide will be treated as confidentially and anonymously as possible. On completion of the study, a report will be compiled and made available to you on request.

Your cooperation will be highly appreciated.

APPENDIX B

QUESTIONNAIRE ON TEACHERS' PEDAGOGICAL PRACTICES

SECTION A: GENERAL BACKGROUND INFORMATION

Please tick in the appropriate box or supply the answer in the space provided. Please use a tick to indicate:

1. **AGE**

20 – 30 years [ ] 31 – 40 years [ ] 41 – 50 years [ ] 51 years and above [ ]

2. **HIGHEST QUALIFICATIONS**

STC [ ] DIP [ ] BSc Ed [ ] BSc Hons [ ] M. Ed [ ] Other [ ]

3. **TEACHING EXPERIENCE**

0– 5 Years 6 – 10 years 11 – 15 years 15 years and above [ ]

4. **Which subjects do you teach:** Mathematics [ ] Science [ ] Other

5. **Which classes are you currently teaching?**

FORM A [ ] FORM B [ ] FORM C [ ] FORM D [ ] FORM E [ ]

6. **On average how many learners do you teach in mathematics classes? Please fill in the number of learners for each.**

Class	Number of learners
A	
B	
C	
D	
E	

SECTION B: INFORMATION ABOUT YOUR CLASSROOM PEDAGOGICAL PRACTICES

1. How important are teaching methods to you as a teacher?

_____

2. Please indicate the frequency with which you use the following methods of teaching when teaching mathematics

	Always	Often	Sometimes	Seldom	Never
Guided discovery					
Exposition					
Cooperative learning					
Discussion					
Investigation					
Question and Answer (Socratic)					

Other, please specify and indicate frequency_____

3. Please indicate with a tick how you would rate yourself (**using the scale below**) with regard to the reasons for your choice of teaching method :

1 = strongly disagree 2 =disagree 3 = neutral 4 = agree 5 = strongly agree

	1	2	3	4	5
4.1 It gives me enough time to explain	1	2	3	4	5
4.2 It gives learner chance to explore	1	2	3	4	5
4.3 It allows for collaboration between learners	1	2	3	4	5
4.4 It saves my preparation time	1	2	3	4	5
4.5 It gives me an opportunity to check learners' understanding	1	2	3	4	5
4.6 I do not know about other methods	1	2	3	4	5

Other, please specify_____

4. Please indicate with a tick how you would rate yourself (**using the scale below**) with regard to the following:

1 = strongly disagree 2 =disagree 3 = neutral 4 = agree 5 = strongly agree

	1	2	3	4	5
5.1 I effectively prepare for mathematics lesson	1	2	3	4	5
5.2 I feel prepared to develop my learners conceptual understanding of mathematics	1	2	3	4	5
5.3 I understand how learners think mathematically	1	2	3	4	5
5.4 During teaching I identify learners' misconceptions of mathematical concepts.	1	2	3	4	5
5.5 I allow my learner to reflect on what they have learned in the previous lessons.	1	2	3	4	5
5.6 I use questioning to elicit learners' thinking and understanding of mathematical concepts.	1	2	3	4	5
5. 7 I use a variety of means to gather learner's knowledge and feedback on what they know/have learned.	1	2	3	4	5
5.8 During group work I observe peer interaction among my learners for meaningful discussion.	1	2	3	4	5
5.9 I allow my learners to approach me about something they do not know in mathematics.	1	2	3	4	5
5.10 At the beginning of the lesson, I communicate guidelines for collaborative group work to my learners.	1	2	3	4	5
5.11 I provide my learners with activities which incorporate individual and group accountability.	1	2	3	4	5
5.12 I give my learners opportunity to explain or justify their thinking.	1	2	3	4	5
5.13 I encourage my learners to focus on process more than on answer.	1	2	3	4	5
5.14 I encourage learner-to-learner questions in mathematics lessons	1	2	3	4	5

5. Please indicate with a tick how you would rate your learners (**using the scale below**) with regard to their participation during mathematics lessons :

1 = strongly disagree 2 =disagree 3 = neutral 4 = agree 5 = strongly agree

	1	2	3	4	5
6.1 Learners are actively engaged in discussions during mathematics lessons	1	2	3	4	5
6.2 Learners request to know/find more about the topic under discussion	1	2	3	4	5
6.3 Learners show spontaneous expression of curiosity or interests during mathematics lessons	1	2	3	4	5
6.4 Learners show expressions of excitement during mathematics lessons	1	2	3	4	5
6.5 Learners provide quality explanation of the mathematical concept under discussion	1	2	3	4	5
6.6 Learners are able to give appropriate examples of the concept under discussion	1	2	3	4	5

6.7 Learner show the ability to use mathematical concept appropriately in a new situation	**1**	**2**	**3**	**4**	**5**
6.8 Learners show quality/logical presentation as they carry out mathematical activities or procedure	**1**	**2**	**3**	**4**	**5**
6.9 Learners give well thought-out comments during mathematics lessons	**1**	**2**	**3**	**4**	**5**
6.10 Learners explain why the procedure works or does not work	**1**	**2**	**3**	**4**	**5**
6.10 Learners continue with mathematics activities even in the face of confusion or difficulty	**1**	**2**	**3**	**4**	**5**
6.11 Learners have the ability to synthesize knowledge from different sources	**1**	**2**	**3**	**4**	**5**
6.12 At the end of the lesson learners are given a chance to summarize their learning, to highlight major ideas or procedures learned	**1**	**2**	**3**	**4**	**5**

SECTION C: INFORMATION ABOUT SUPPORT SYSTEM

1. Part I: For each question, make a choice between "**Yes**" and "**No**".

Participation	**Yes**	**No**
1.1 I collaborate with my colleagues on issues related to teaching of mathematics.	**Yes**	**No**
1.2 We formulate learning goals with my colleagues.	**Yes**	**No**
1.3 We design mathematics lessons with my colleagues as a team	**Yes**	**No**
1.4 In my school I participate in peer observation and coaching, as part of a formal school arrangement	**Yes**	**No**
1.5 I participate in a network of teachers formed specifically for the professional development of teachers	**Yes**	**No**
1.6 In my school I participate in a team that supports newly trained teachers.	**Yes**	**No**
1.7 I attend workshops/INSET organized by the Ministry of Education and Training	**Yes**	**No**

Part II: For each question, make a choice between "**None**" ,"**Small**", "**Moderate**" and "**Large**" to indicate how much impact support had upon your development as a teacher

	Impact			
	None	**Small**	**Moderate**	**Large**
2..1 I collaborate with my colleagues on issues related to teaching of mathematics	**None**	**Small**	**Moderate**	**Large**
2.2 We formulate learning goals with my colleagues	**None**	**Small**	**Moderate**	**Large**
2.3 We design mathematics lessons with my colleagues as a team	**None**	**Small**	**Moderate**	**Large**

2.4 I participate in peer observation and coaching, as part of a formal school arrangement	**None**	**Small**	**Moderate**	**Large**
2.5 Participate in a network of teachers formed specifically for the professional development of teachers	**None**	**Small**	**Moderate**	**Large**
2.6 In my school I participate in a team that supports newly trained teachers.	**None**	**Small**	**Moderate**	**Large**
2.7 I attend workshops/INSET organized by the Ministry of Education and Training	**None**	**Small**	**Moderate**	**Large**

1. What type of professional development has been most beneficial in shaping your teaching practices?

_____

_____

_____

_____

_____

_____

2. What is it about this professional development experiences that have been influential?

_____

_____

_____

_____

_____

APPENDIX C: TRAINING PROGRAMME

Time	Activity
8:00 – 8:15	Registration of Participants
8:15 – 8:30	Introduction and welcome Remarks
8: 30 – 9:30	Teachers' Reflections on their practices when teaching mathematics.
9:30 – 10:30	Introduction to Lesson Study • What it is • How it is used • Why it is used
10:30 – 10:45	**Tea Break**
10:30 – 11:30	Discussions and Questions
11:30 – 1:00	Lesson Study Video
1:00 – 2:00	**Lunch**
2:00 – 3:00	Group discussion based on the video
3:00 – 4:00	Group Reports and Discussions
4:00 – 5:00	Way forward: • Selection of the research topic and the level at which the topic should be taught. • Assignments for participants Closing Remarks Evaluation of the workshop

APPENDIX D

OBSERVATION SCHEDULE

Name of School: _____

Name of teacher: _____

Topic of lesson: _____

Length of lesson observed: _____

Date: _____

Lesson Study Team members: _____

How is the Lesson Plan?

- Objectives are clear
- Teaching/learning materials are available
- Teaching methods are indicated

Comments:

How is the lesson Introduced?

- Question/answer
- Statements/explanations
- A brief revision of the last lesson
- Generally brief

Comments:

Was mathematics content information accurate?

- Content was correct
- Teacher comfortable with and knowledgeable with mathematics content
- Teacher confident about judging content accuracy

Comments:

How is the teacher's presentation or clarification of mathematics content?

- Teacher provided explicit clear explanation when answering questions
- Explanation of core content was clear and easy to follow
- The teacher was able to clarify learners' confusion

Comments:

Were the key mathematics ideas discussed in depth?

- Discussions occurred in small groups or as a whole class
- Learners were actively engaged in discussions
- learners given an opportunity to write, think and talk in the lesson
- Learners wrote to explain or justify their thinking

Comments:

Were team members noting evidence of learners learning?

- Teachers move around groups taking notes on what learners are doing.
- Teachers take note of learners questions and their response

Comments:

APPENDIX E

INTERVIEW SCHEDULE

1. Did you enjoy participating in Lesson Study? Why?
2. How has your participation in lesson study influenced your teaching of mathematics?
3. How was the behavior of the learners during the teaching of the lesson prepared by the team?
4. What did you like about lesson study?
5. What challenges did you encounter in implementing LS?
6. What can be improved in lesson study? Suggest how it can be improved?
7. Would you recommend that this type of training be extended to other teachers? Why?

APPENDIX F

LESSON STUDY - WORKSHOP EVALUATION FORM

Presenter(s):…… Workshop Location:……Date:……

Please respond to the following statements by ticking the most appropriate option.

1. Strongly disagree, 2. Disagree, 3. Agree, 4. Strongly Agree

Statements	1	2	3	4
1. Workshop objectives were clearly stated,				
2, Workshop objectives were sufficiently met				
3. The workshop loved to my expectations.				
4. The workshop was well planned.				
5. The information presented was relevant and useful to my teaching of mathematics.				
6. The presenter(s) allowed me to work with and learn from my colleagues				
7. The presenter(s) were well prepared and fluent with the workshop content				
8. The materials provided were useful and appropriate for the workshop.				
9. The workshop influenced me to reflect on my assessment practices				
10. I will be able to apply what I learnt in this workshop confidently				
11. The presenter(s) provided adequate time for questions and answer them satisfactorily.				
12. The activities in this workshop gave me sufficient practice and feedback				

13. What were the most beneficial aspects of this workshop?

_____

_____

_____

_____

_____

14. What were the least beneficial aspects of this workshop?

_____

_____

_____

_____

_____

14. If you were to improve this workshop what recommendations would you make?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

THANK YOU FOR YOUR VALUABLE TIME