A CRITICAL INVESTIGATION INTO THE NATURE AND QUALITY OF IN-SERVICE EDUCATION AND TRAINING PROGRAMMES FOR FURTHER EDUCATION AND TRAINING (FET) MATHEMATICS TEACHERS IN THE GREATER TAUNG AREA

by

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ABSTRACT

The study investigated the nature and quality of in-service education and training programmes organized for Further Education and Training (FET) mathematics teachers in the Greater Taung Area. The researcher is of the contention that more could be done to improve the process and the effectiveness of in-service training in the area. An extensive literature study provides a theoretical foundation and exposes some critical issues for effective in-service training programmes. The qualitative approach is used in the case study.

The data were analysed through inductive analysis. The major research findings are that there are no formal processes of identifying the needs of mathematics teachers and further, teachers are not monitored and supervised after in-service sessions.

It is recommended that the needs of teachers be identified by the school before inset. For effective monitoring and supervision of mathematics teachers after inset, it is recommended that each cluster within the Area Project Office (APO) should have a subject specialist for mathematics.
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Key terms: In-service education and training, professional development, Mathematics Education, content knowledge, monitoring and supervision, continuous development, Mathematics teachers, knowledge and skills, workshops, school-based inset, quality of teachers.

DECLARATION

"I declare that A CRITICAL INVESTIGATION INTO THE NATURE AND QUALITY OF IN-SERVICE EDUCATION AND TRAINING PROGRAMMES FOR FURTHER EDUCATION AND TRAINING (FET) MATHEMATICS TEACHERS IN THE GREATER TAUNG AREA is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE   DATE
(Mr J. Owusu-Mensah)

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CHAPTER 1

GENERAL BACKGROUND AND MOTIVATION FOR THE STUDY

1.1   Introduction

The strength of any education system largely depends on the quality of the teachers. In-service education and training thus focuses on the need for teachers to adjust effectively to rapid changes in the education system. It also helps the process of improving the quality of teachers' content knowledge and methods of instruction in the classroom. According to Bagwandeen and Louw (1993) the teacher is supposed to be the main influence in the classroom and for that matter cannot afford to lag behind continuous professional development.

Walters (1994), claims that the origin of in-service training is rooted in the assumption that a trained teacher is not a finished product. For that matter, in-service training is intended to support and assist the professional development of teachers. It is also an opportunity given to serving teachers to expand their knowledge and improve teaching skills.

The importance of continuous development is emphasised by Bagwandeen and Louw (1993). These authors point out that teachers are under severe threat to improve their expertise, knowledge and skills through in-service education and training. Again they believe that, indeed, for progress in education to be of any value, teachers as professionals must participate in their own intellectual growth.

In-service education and training in mathematics education is aimed at developing mathematics teachers so as to improve their teaching. It also contributes to the teacher's content knowledge, right attitude and techniques of teaching. The training programmes are sometimes used as a platform for teachers to understand the policies,

principles and procedures of the teaching profession. Inset therefore has a key role in developing the skills and capabilities of teachers

In the new South Africa, one often hears the words transformation, change, reform, development and growth. Inset is a professional development programme that is also about transformation, change and reform in the education system. In most cases inset programmes are organized in the form of workshops. These workshops are supposed to develop teachers so as to improve on their classroom practices.

Changes in classroom practices may be attributed to many factors. Among them are the introduction of technology in education, changes in curriculum, reforms in instructional methods and new assessment practices and techniques. Technology forms a greater part of teaching so it is important that teachers are trained to use it. For example the use of scientific calculators, overhead projectors and computers in a mathematics classroom will improve teaching and learning.

Changes in the curriculum, as a result of reforms in the education system, need to be communicated to the teachers. This is one of the reasons that teachers need to be trained to keep abreast with the changes. Assessment, for example is an integral part of teaching and learning, therefore it is necessary that teachers are made aware of the current assessment practices and techniques.

The NCTM 1994 Yearbook states that the professional development of teachers is a highly complex issue that has the potential to transform the entire field of education. It continues to indicate that professional development takes many forms, but true professional development, in the sense of resulting in meaningful and long lasting qualitative change in teachers' thinking and approaches to education, is an autonomous activity chosen by a teacher in search of better ways of teaching and learning mathematics.

1.2   *Why Inset in Mathematics Education*

Currently, changes occur at such an alarming rate that mathematics teachers need to adapt in order to meet the demands and challenges brought about by these. This

necessitates a professional development programme that will ensure that mathematics teachers cope with the current changes. As Hea-Jin (2001:1) puts it:

> Professional development is a critical ingredient of mathematics education reform, and that effective professional development experiences are designed to help teachers build new understandings of teaching and learning through direct experiences with strategies that help students learn new ways.

According to Loucks-Horsely, Hewson, Love and Stile (1998), such development programmes provide opportunities for teachers to build their knowledge and skills. The National Education Policy Investigation Report (1993) reiterates that a majority of South Africa's teachers have been trained in racially segregated colleges of education. Most of these colleges were academically isolated, small, poorly equipped and ineffective in the provision of quality teacher education. The Report further acknowledges that teachers are the primary agents in any educational system. It also emphasizes the development of a quality teaching corps as a primary condition for educational transformation. The report consequently puts more emphasis on the development of mathematics and science teachers. The National Education Policy Investigation Report (1993), means that in-service training in mathematics education is therefore necessary. This should assist teachers acquire new knowledge and skills. Such skills will help them improve on the teaching and learning of mathematics

Furthermore, new approaches to the teaching and learning of mathematics demands that teachers are retrained to deal with such approaches successfully, for example, the use of constructivist approaches in the teaching and learning of mathematics.

1.3 Background to the problem

Greater Taung is a district in the Bophirima Region of the North West Province in South Africa. It is one of the rural areas in the Region with twenty (20) high schools. All the high schools are public schools and they all offer mathematics up to matric level (grade 12)

As a resident, a mathematics teacher and a member of the School Management Team (SMT) in one of the Further Education and Training (FET) schools in this

predominantly rural area for over 12 years, the researcher has taken a critical look at how in-service training programmes are organized for FET mathematics teachers. The following observations were made through informal discussions and interaction with a number of mathematics teachers in the Taung area.

- That most of the in-service training programmes are organized during school terms, either during school hours or after school;
- That most of the in-service training programmes concentrate on grade 12 teachers. However, recently (from 2005) the attention has shifted to grade 10 teachers because of the introduction of the National Curriculum Statement (NCS) in high schools in 2006;
- That most of the training programmes place more emphasise on the methods of teaching and on mathematical content knowledge of teachers;
- That there is no effective need analysis of teachers before an in-service training sessions; and
- That there are no follow-ups after workshop sessions to monitor teachers' performance in their respective classrooms.

The researcher therefore decided to take a critical look at the quality of In-service education and training programmes for FET mathematics teachers in the Greater Taung area.

1.3.1   Problem statement

The basis for the choice of the topic was the fact that mathematics teachers play a key role in the successful implementation of reforms in mathematics education. Therefore, for quality mathematics education, not only committed and dedicated teachers are required, but also teachers with adequate knowledge and skills. Most of the mathematics teachers observed, received their training before the major reforms in mathematics education. Furthermore their training took place before the explosive growth of information and communication technology currently affecting all aspects of education.

In-service education and training in mathematics education is therefore crucial to ensure that teachers' skills and capabilities continue to meet the changing

requirements placed on them. The following are therefore the statements of the problem:

- What is the nature and quality of in-service education and training programmes for FET mathematics teachers in the Taung area?
- In what ways can in-service training programmes be made more effective and serve as strategies for promoting reflection?

1.4   *The rationale for the study*

The study examined the current nature and practices of in-service training programmes for FET mathematics teachers in the Taung area, which is one of the rural areas in the North West Province of South Africa. The mathematics teachers in this area played a leading role in this study. Hea-Jin (2001) emphasizes the important role of teachers in an endeavour to clarify the characteristics of effective professional development in mathematics education. Therefore through personal interviews of a cross-section of FET mathematics teachers in the Taung area, coupled with the researcher's knowledge and experience from other educational systems, a suggested framework for effective in-service training programmes will be established.

The study will therefore serve as a guide to in-service education and training organizers, education authorities and administrators, especially in schools established in rural areas, to choose appropriate strategies for effective and sustainable teacher development.

1.5   *Aims and objectives of the study*

Aichele and Coxford (1994:45) state that "most teachers are motivated to take on professional development programmes because they wish to become better teachers". By becoming better teachers it is believed that their learners will benefit from the knowledge and experience gained. The major aims and objectives of this study therefore were:

- To examine the current practices of in-service education and training programmes for FET mathematics teachers in the Taung area.
- To identify the merits and limitations of in-service training programmes, and

- To develop guidelines for effective in-service education and training programmes for FET mathematics teachers in the Taung area.

1.6   Research methodology

This study was designed to investigate the nature and quality of in-service education and training in improving mathematics education in Taung area. In this investigation the qualitative research method was employed.

1.6.1   Qualitative method

A qualitative research method, as described by De Vos (2002), produces descriptive data such as person's own written or spoken words and observable behaviour. He further identifies the following assumptions underlying qualitative research:

- The researcher is the primary instrument of data collection and analysis;
- The researcher personally goes to people, sites or institutions to observe or record data;
- It is descriptive because meaning and understanding is gained through words or pictures; and
- The method is inductive in that it builds abstractions from logical reasoning.

The researcher used both primary and secondary sources to seek information. The primary source involved an empirical investigation (interview), while the secondary source was the information from relevant literature collected.

Thus in order to investigate the nature and quality of in-service education and training programmes, descriptive data was collected from participants sampled from the target population.

1.7   Sample and sampling techniques

The entire population for this study comprised of all the FET mathematics teachers in the greater Taung area. There are 21 high/secondary schools in this area. In an ideal situation all the mathematics teachers in these schools had to be included in the study, but because of time, distance, finance and logistics constraints 5 of these schools were selected, using the simple random sampling approach for the empirical study. All the mathematics teachers in these selected schools were interviewed.

All the 21 high schools were numbered from 01 to 21, and a table of random numbers was used to select the 5 schools. The application of a random sampling technique was to ensure that each of the 21 schools had an equal and probable chance of being included in the sample. Furthermore the resulting sample could be said to be a fair representation of the target population.

1.8 Data gathering

A direct interaction between the researcher and the participants was very appropriate in such a qualitative research. Such personal interaction assisted in the acquisition of relevant data needed to meet the aims and objectives of the investigation. This view is supported by Leedy (1992:183) who writes, "Qualitative research projects require descriptive and survey methods, where data is obtained by verbal means".

Consequently, personal interviews were used to collect data for the study. Clark M, Riley J, Wilkie T & Wood S (1998) assert that an interview is a form of research and a method of collecting data which is most useful in that it gives researchers insight into how individuals or groups think about their world.

The interview schedule was first pre-tested through a pilot study to ensure that it is both valid and reliable. Based on the outcomes, the final instrument was developed for the data collection. The information collected through the personal interviews was recorded in writing and analysed before writing out a report.

1.9 Delimitation of the study

It would have been appropriate to investigate the nature and quality of in-service education and training for FET mathematics teachers in the whole Bophirima Region of the North West Province, however, time, finance and logistics made it quite impossible. For that matter this investigation was limited to the greater Taung area. This area has as many high schools as most of the districts in the Bophirima Region. Furthermore it is assumed that the situation may be similar to what prevails in other areas in the Region. The findings made from this study may therefore be extended to all districts/ areas in the Bophirima Region.

1.10   Organisation of the study

This investigative study was organized into five chapters with the following content:

Chapter 1

This chapter set the stage for the study and will therefore consists of the introduction, background to the problem, the problem statement, aims and objective of the study, delimitation or scope of the study and chapter divisions.

Chapter 2

This chapter focused on relevant literature study on in-service education and training. In this chapter an extensive literature study was conducted on relevant aspects of the topic. Aspects included here were definitions of in-service training, objectives of in-service training, nature and scope of in-service, and categories of in-service training programmes. Other aspects that were covered are identification of needs, facilitators of in-service training and an overview of selected professional development approaches.

Chapter 3

This chapter contains the research methodology and design. It describes and discusses the methods and techniques for data collection.

Chapter 4

This chapter reports on and analyses the data that were collected from the field, and the findings from the literature study as well as the empirical investigation.

Chapter 5

This chapter deals with the summary of the research, recommendations and conclusions.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

Various countries, like South Africa, New Zealand, Mexico, are doing all they can to ensure quality in their education systems. What then constitutes quality in the education system? According to Botha (2000), quality in education refers to factors such as learners' achievement, teaching approaches and the nature of the school, that is the physical, cultural and social settings. School resources such as classroom furniture, physical resources, school amenities, learning resources, and the availability of a range of resources within the school is crucial for improving learning and teaching practices in the classroom.

However some authors have pointed out that having sufficient resources on their own do not necessarily translate into good and effective teaching practices. For example Darling-Hammond (2000:12) puts it that "to believe that mere provision of those necessities, without attention to how they will be used in school and in the classroom, will guarantee a high quality teaching process is unrealistic". Clarke (1995) also believes that quality can be achieved through efficiency and effectiveness. Therefore according to Clarke, quality is a by-product of efficiency and effectiveness.

Accordingly, Dimmock (1990) claims that the teacher, the learner and the curriculum are the three major elements that determine quality in education. This means that even a change in curriculum can enhance quality in education. Consequently Dimmock defines quality in education as entailing one or more of the following elements:

- Improving the standards of teaching and teachers' performance.
- Improving the standard of learning and learners' performance and
- Providing a curriculum that is more relevant to client needs.

Since the National Education Policy (1993) claims that the majority of South Africa's teachers have been trained under ineffective colleges of education, one of the challenges facing the Department of Education in the new South Africa is to provide quality basic education and training for teachers in the aftermath of the apartheid education.

Furthermore, the Department of Education has to deal with the shortage of qualified teachers, especially in the area of Mathematics and Science. Consequently the National Education Policy Investigation Report (1993) concurs that specific attention need to be given to the development of quality mathematics and science teaching within restructured and diverse in-service training activities.

In South Africa, the enormous shortage of qualified mathematics teachers highlights a desperate need for both pre-service and in-service education and training. Furthermore the introduction of the new curriculum in mathematics education, adds more pressure to this need. According to Kriek (2005) it is widely accepted that current curriculum initiatives in South Africa demand that attention be given to teacher support, especially in the field of mathematics, science and technology in the form of in-service education and training.

In-service education and training has been employed in many places with varied intensions. For example Becker and Pence (1996) believe that in-service education and training should create a platform to foster change in teacher behaviour in the classroom. Underlying this belief is the assumption that teachers need to change their existing beliefs, knowledge and practices.

Even though there could be various reasons for in-service training, one reason seems to be a dominant factor: that is to improve the standards of teaching and teachers' performance, which should translate into improving standards of learning and learners' performance.

This chapter will look at the various definitions of in-service training by various authors. There are also many objectives and forms of in-service training and these are covered in this chapter as well. Other areas that will be covered in this chapter include the provision of in-service training, overview of in-service training activities

in other countries, and the evaluation of in-service education and training activities, focusing on its successes and limitations.

2.2   Definitions of in-service education and training.

In-service education and training has been defined in many ways by various authors. According to Bagwandeen and Louw (1993), the definition of in-service education and training depends, to a large extent, the emphasise that is placed on it in terms of its plan and design. In addition, they also believe that generally in-service training includes such aspects as updating teacher knowledge and skills.

Henderson (1979:17) defines in-service education and training as follows:

> "In-service education and training may in the most general sense be taken to include everything that happens to the teacher from the day he takes up his first appointment to the day he retires, which contributes directly or indirectly to the way in which he executes his professional duties".

This definition is all inclusive and supports the view that in-service training embraces all the experiences that a teacher may undergo for the purpose of expanding his professional and personal education.

Brain Cane in Bagwandeen and Louw (1993:21) further provides a purposive definition of in-service training as follows:

> "In-service training is taken to include all those courses and activities in which a serving teacher may participate for the purpose of extending his professional knowledge, interest or skill. Preparation for a degree, diploma or other qualification subsequent to initial is included in this definition".

This definition is seen to be more central in approach towards intended experiences. It presupposes that in-service training activities should be planned in such a way as to effect specific changes that will ultimately result in improving the teacher's performance in school.

In the South African context, Hartshorne (1985:6) suggests a workable definition. He states that in-service training is:

> "The whole range of activities by which serving teachers and other categories of educationalists (within formal school system) may extend and develop their personal education, professional competence, and general understanding of the role which they and the school are expected to play in their changing societies.. INSET further includes the means whereby a teacher's personal needs and aspirations may be met, as well as those of the system in which he or she serves".

From the above definitions it becomes very complex and a formidable task to formulate a single definition of in-service training. Nevertheless, there are some common aspects that come out of the foregoing definitions. These are improvement of competence and skills, broadening of knowledge and professional ability of practicing teachers.

2.3   *Professional development and in-service education and training*

Professional development in education is known by many names, such as professional growth, on-the-job training, continuing education, in-service education and training, human resource development and staff development (Webb, Montello & Norton 1994).

Sparks and Loucks-Horsely (1990:234) state that "staff development for teachers is defined   as those processes that improve the job-related knowledge, skills and attitudes of school employees." According to these authors the most important purpose of staff development is to enhance student learning, and the individuals most responsible for this are the teachers.

According to the OECD (Organisation for Economic Cooperation and Development 1998), professional development signifies any activity that develops an individual's skills, knowledge, expertise and other characteristics as a teacher. These may include personal study and reflection as well as formal courses.

In-service education and training on the other hand, according to the OECD, refers more specifically to identifiable learning activities in which practicing teachers participate. In addition to that, Kriek (2005) also states that in-service education and training is a structural training activity that is intended to develop the skills and capabilities of teachers in a defined area with the purpose of enhancing student learning".

According to Kriek (2005) the terms professional development and in-service education and training are frequently used interchangeably. However, she believes that a logical distinction between these two concepts can be made. Thus professional development relates to a life-long development programme that focuses on a wide range of knowledge, skills and attitudes in order to educate students more effectively. It is a formal systematic programme designed to promote personal and professional growth. In-service education and training on the other hand refers to the acquisition of specific knowledge and skills. As a result it can be regarded as a component of professional development in the broader sense.

In-service training and staff development play important role in improving a teacher's professional growth. Both of them can be conducted in a number of ways and be assisted by many institutions and organizational bodies. Presentation of courses, seminars, conferences, workshops, inter-school meetings, lectures and study groups are all utilized to help the professional development of teachers.

2.4   Objectives of in-service training.

In-service education and training has many objectives and takes many forms. Basically the objectives of in-service could be categorized as specific and general objectives. The specific objectives include learning activities tailored to the development needs of teachers. They help to equip teachers to deal with curriculum and other changes (Education Review Office 2000). The general objectives of in-service training may include the acquisition of general knowledge that may reflect the demands of the changing society.

Most authors, especially Bagwandeen and Louw (1993) believe that one of the objectives of in-service training is consolidation and reaffirmation of knowledge. Considering the educational developments in recent times, it is necessary for even qualified teachers to refresh and improve their skills and knowledge. Furthermore, a teacher can also be equipped to deal with the changes in society, changes in the profession and in the relevant body of knowledge through in-service education and training.

Continual acquisition of new knowledge and skills has also been an objective of in-service education and training. Teachers need to continually update their knowledge, skills and competencies. According to Griffins (1979) one of the requirements of a profession is that its members somehow continue to learn, to grow, and to improve their knowledge, so that their interactions with ideas and with clients are reflective of the best knowledge and skills available to them. Therefore this objective of in-service training, oriented towards continuing education and the acquisition of skills and competencies, must become a routine of professional life.

Another objective of in-service education and training is to give teachers the opportunity to familiarize themselves with curriculum development. Many countries, including South Africa, have found it necessary to amend or expand their existing curricular to cater for the changing circumstances. In-service training programmes can therefore contribute towards assisting teachers in implementing new curriculum materials.

An equally important objective of in-service training is to acquaint teachers with new teaching methods for their respective subjects. For example in mathematics education, the constructivist approach is being advocated. Martin, Simon and Schifter (1993) believe, the constructivist perspective holds the view that understanding is constructed by learners as they attempt to make sense of their experiences. Therefore teachers, more importantly mathematics teachers, need to know their roles in a constructivist teaching and learning environment.

In-service training has also been used in some countries for vertical mobility and promotion. According to Bagwandeen and Louw (1993) in Germany, as an example

of the Western industrial world, in-service education and training is seen as a highly desirable means of obtaining better status, salary, promotion and upward mobility. Also in New Zealand the renewal of a practicing teacher's certificate is dependent on recent teaching experiences satisfactorily completed, which means the teacher is actively involved in professional development (Education Review Office 2000).

The Department of Education's objective of in-service training is to maximize the capabilities and skills of teachers in order to enhance their ability to deliver the curriculum so as to meet the educational needs of learners. From the individual teacher's point, in-service education and training helps to improve their skills and knowledge in order to enhance their job satisfaction, gain promotion, and increase their earning potential (Education Review Office 2000). In South Africa, in-service education and training helps teachers to improve their knowledge and skills, but does not play any meaningful part in gaining promotion or increase one's earnings.

Furthermore, Porter in Bagwandeen and Louw (1993) believes that the foundation of in-service training is to enable teachers to monitor and shape their professional development. In this way it will enable them to reflect and evaluate their own work and attitudes in conjunction with their professional colleagues in other parts of the education service. In addition, it will also enable them to develop criteria that would help them to assess their own teaching roles in relation to a changed society for which the schools must equip their learners.

It is assumed that the objectives of in-service education and training ultimately are to improve learner achievement. However it is seldom possible to demonstrate a clear causal relationship between in-service training and learner achievement. This is partly because of the lack of good objective assessments of learner achievement, and partly because learner achievement is influenced by a range of other factors as well as the quality of in-service training (Education Review Office 2000). Consequently many in-service training programmes define their objectives in terms of improving teacher capabilities rather than improving learner achievements.

2.5 *Nature and scope of in-service education and training*

The world in which a teacher operates is changing rapidly. For instance, the impact of technology on all aspects of life and work is leading to a new emphasis on training teachers for a dynamic society. This involves not just the acquisition of new skills but also a fundamental change in teaching practice and the culture of classrooms. In view of that, there is a need for the teacher to adjust effectively to such changes to ensure the process of improving the quality of teaching and learning. For example in South Africa, mathematics education (and other learning areas) is going through a reform agenda, where mathematics instruction is geared towards teaching mathematics for understanding (Laridon 1993).

In-service training can be described as education intended to support and assist the professional development which teachers ought to continue throughout their teaching careers. This implies that in-service training commences at the time teachers enter the teaching profession and continues until they retire. During this time, in-service training should include all those activities in which serving teachers can participate in order to extend their professional knowledge, skills and interests.

Since such teaching (that is teaching for understanding) cannot be a matter merely of presenting mathematical facts and demonstrating algorithms, and that learning for understanding cannot be a matter merely of memorizing those facts and procedures, reform anticipates classrooms in which teachers' and learners' roles are drastically revised. As Schifter (1998:74) puts it:

> "That teaching is now seen as a matter of engaging students in significant problems and facilitating discussions about these problems, and learning is also seen as a process of formulating conjectures, testing out ideas and exploring alternative approaches".

She concludes that intellectual authority no longer resides exclusively in the teacher and textbook, but it is dispersed among members of the classroom community, who offer defensible arguments. As a result, in-service education and training of teachers is increasingly regarded as the key mechanism to equip teachers and schools to

respond to these new teaching approaches. It should also be noted that for effective implementation of such teaching approaches, the teachers' content knowledge is very important. However many in-service training programmes for teachers have been criticized because they focused on narrow aspects of teachers' activities, namely preparation and presentation of a lesson, without adequately addressing teaching techniques or the teachers' content knowledge of the subject they teach.

In view of that, Shulman (1987:48) has suggested a framework for teacher development programme that includes three major domains:

- **Content knowledge** – This involves the mastery of specific content being taught.
- **Pedagogical knowledge** – thus understanding the theories and principles of teaching and learning, understanding the learner, and the knowledge and principles of classroom behaviour and management.
- **Pedagogical content knowledge** – this involves the ability to blend technique and content, including understanding how the given topics are related to one another and how they are most effectively organized and presented in the classroom.

Kriek (2005) also shares the same views that the scope of any professional development programme should emphasise on subject matter and teaching methods. Consequently in a professional development programme, some activities are primarily to improve teachers' content knowledge of the subject, some to improve general teaching practice, for example classroom management and lesson planning, and some to improve the teachers' pedagogical content knowledge.

Furthermore in their study of professional development of teachers in USA and Japan, Collinson and Ono (2000) suggest that professional development (teacher training) must be a continuous job-embedded career-long process. It should also be planned and be specifically focused on improving teacher learning, as well as improving the individual and the school. They further suggest that professional development should involve teacher/school analysis and reflection. It should then be evaluated and ultimately show improved learning and teacher competence.

2.6   Categories of in-service training programmes

In-service education and training means many things to many people, and again there are a variety of forms of study that teachers can engage in during in-service education and training. Continuing education courses, conferences, workshops, television programmes and one-short lectures are few of such forms of in-service education and training.

Therefore there is a wide spectrum of in-service training activities in which teachers at all levels are involved. The categories below are only a selective list from the vast variety of INSET strategies that contribute to the professional development of teachers.

2.6.1   School-based in-service training

School-based in-service education and training can be described as a programme which occurs physically within the school itself. It is planned by the staff for the teachers' professional development. The role of the school in the provision of INSET is very crucial. However the role of the school is often neglected in the process of professional development. Joyce, Hersh and McKibbin (1983:61) state this more forcefully:

> "If the education profession is to flourish and if schools are to be a vital force in the society, it is necessary to rebuild the school into a life-long learning laboratory not only for children but for teachers as well".

The James Report (1972:11) in the United Kingdom also affirms the position of the school in respect of in-service education and training:

> "In-service education should begin in the schools. It is here that learning and teaching takes place, curricular and techniques are developed and needs and difficulties revealed. Every school should regard the continuous training of the teachers as an essential part of its task, for which all members of staff share responsibility".

Olsen (1982) however believes that in-service training, particularly as a school-focused activity, has become the new mode for innovation and for implementing change within the school. For example the concept of Integrated Quality Management Systems (IQMS), where the developmental needs of teachers are first identified through the teacher appraisal system, and then appropriate steps taken by the school to address such needs. In South Africa, the teacher appraisal system, through IQMS, is both developmental and judgmental.

A school-based in-service education and training has three phases. These are the identification and definition of needs, the development and execution of appropriate in-service activities to meet those needs, and evaluation and feedback.

The needs of the school as a whole, the needs of individual teachers and the needs of functional groups should be assessed by the staff, and consensus should be reached on planning strategies and the requirements to satisfy these needs. The development and implementation of in-service training programmes to meet the identified needs must be a highly co-operative venture

In-service training programmes will not be complete without evaluation. The purpose of evaluation is for the school to inform teachers of their progress towards meeting the needs of individual teachers. It will also inform teachers whether to redefine needs or modify the process of implementation. It should be noted that the three phases of school-based in-service education and training should not necessarily be sequential but should continue in parallel, informing one another.

The merits of school-based in-service education and training include the fact that the process of need analysis will be much easier, and that training could be closely matched to the identified needs. Again, when in-service training occurs physically within the school, barriers of implementation could be directly addressed. Some of these barriers may include overcrowding, inadequate resources and support from the school authority.
 Furthermore, Fordyce (1999) adds that the transfer of training from in-service courses to classroom practice is more likely to occur when in-service courses are school based.

2.6.2   Short courses

Bagwandeen and Louw (1993) describe short courses as non award bearing courses and generically constitute one of a rich array of in-service training possibilities, and the most widely used form of in-service training. Rudduck (1981) further identifies the purpose of short courses, and structures that would be appropriate for such courses.

Firstly short courses offer a platform for dissemination of information. The primary purpose of these courses is to communicate a body of knowledge on a structured set of experiences to participants.

Then there is a clinic, which offers an opportunity for teachers to define their own problems within a fairly tight and well-defined framework. This course is further characterized by a limited number, an established code of procedure in which difficulties are described without teachers feeling undermined, and explaining the problem by referring to personal experiences. The course organizer acts as consultant and chairperson.

Rudduck (1981) also regards a seminar as one of the short courses. Here the main mode of communication would be a discussion. No consensus may be reached on some issues of concern, and therefore diverse points of view must be acceptable. The course leader must therefore be diplomatic and skillful at handling controversial issues.

Another form of a short course is where educators undergo a learning process similar in content and style to that which they might subsequently use with their own learners at school. This is referred to as experiential learning situation. Criteria for judging work done must be explicit to enable teachers to understand the principles underlying the procedures. It is important that time is allowed for reflection on the learning experience and its application to the classroom.

2.7   Identification of needs

In-service education and training begins with a thorough needs analysis of teachers. Hea-Jin (2001) asserts that professional growth is possible when professional development programmes respond to teachers' personal needs. Furthermore it can be argued that reform is more likely to occur and become lasting, when teachers are aware of the need for improvement and then have a voice in its planning. This may lead them to derive a real sense of professional satisfaction from implementing the instructional changes.

Most teachers whose personal needs are not addressed in an in-service training programme might usually have a negative attitude towards such programmes. It is therefore imperative that for any meaningful and effective in-service training programme, the starting point is to identify the needs of majority of the teachers.

In order to determine the needs of teachers and identify the areas of deficiency, information needs to be collected from teaches and school administrators. This could be done in the form of interviews, assessment surveys or teacher appraisal system.

According to Hea-Jin (2001), in mathematics education, teacher surveys usually reveal topics that are of greatest difficulty to learners, areas in which teachers feel uncomfortable and strategies for addressing learners' problems. These problems are usually the difficulties they encounter in certain topics.

2.8   Facilitators of in-service training

There is no doubt that facilitators of in-service training play a key role in the success of the programmes. For a successful in-service training programme, the facilitator needs to be well prepared. He or she should know exactly what is to be done in a workshop session and that suitable activities need to be selected. The facilitator needs to encourage participants to get more involved in activities in the training sessions. It is therefore necessary that facilitators choose a combination of tasks and learning activities that best meet the specific goal and context of the workshop.

Furthermore, it is important that in-service training facilitators take account of participants' prior knowledge and experience, and then focus on practical issues facing participants. He or she should be able to create a conducive environment that will enable participants to draw on each other's experiences.

2.9   Overview of selected professional development approaches

Many countries are currently placing increasing emphasise on the importance of in-service training of their teachers. This is probably due to the fact that in-service training is being regarded as a strategy for effecting change throughout educational systems Education Review Office (2000).

In this section, the researcher examines professional development approaches that have been implemented in three countries and found to be reliable. The selected countries represent both developed and developing economies. These countries are Mexico, New Zealand and South Africa.

2.9.1   Teacher education reform in Mexico

Mexican teachers, according to Tatto (1998), not only lack a good preparation that would enable them to successfully teach but also confront a politically turbulent environment, work under poor conditions, and lack decision-making power in school governance. According to a report by the World Bank (1991), only about 50% of the basic education teachers in Mexico have the qualifications that are currently required to teach.

Furthermore, many of these teachers lack basic knowledge of the subject they teach as well as pedagogical skills to appropriately address the learning needs of their pupils. Deficient teacher preparation is more pronounced among those teachers who teach in remote rural or poor areas (Tatto 1999)

Improving the standard of teaching and teachers' performance in Mexico has therefore emerged as a government priority and also as a key factor in the improvement of education across the country. Tatto (1999) reports that, the latest

wave of teacher education reform in Mexico began in the 1990's. The main reasons cited for such reform included poor teaching quality, low efficiency in the basic education system and the need to prepare the next generation for a more active and critical role worldwide.

Focusing on an attempt to develop a more efficient ways to improve the quality of teaching has resulted in the creation of teacher education approaches, which circumvent the traditional routes. These approaches are also supposed to be more responsive to the developmental needs of Mexican teachers. One of such approaches is the teacher education component of the Compensatory Program to Address Educational Lag (Programa para Abatir el Rezago Educativo or PARE). This is part of a comprehensive programme to improve the quality of education in Mexico. The National Council for Educational Advancement (Consejo Nacional de Fomento Educativo or CONAFE) currently implements this program.

2.9.1.1 The PARE project in Mexico

The primary objective of the PARE programme was to improve the quality of education in disadvantaged communities by supplying physical infrastructure, educational materials for the classrooms and more importantly, educational courses for teachers. In addition the PARE project was to provide knowledge, skills and disposition of teachers, especially those in rural areas (Hicks 1993). The PARE'S teacher education component in Mexico is based on a constructivist philosophy, and attempts to offer in-service training to teachers and administrators who work at the elementary level in marginal or rural areas.

Mexico's PARE project seeks to change the traditions and pedagogies of teaching, while simultaneously developing and disseminating information, such as the new curriculum and other materials, in a complex environment. For example the constructivist teaching approach is emphased so as to help pupils develop conceptual understandings of subject matter and a critical view of education.

2.9.1.2 Evaluating the PARE programmes in Mexico

According to Tatto (1999), PARE fell short of its constructivist aims by failing to teach teachers in the manner they were expected to teach pupils. Rather it was more

concerned with efficient accountability instead of implementing a more in-depth training programme for teachers or supervisors. Furthermore, the absence of classroom follow-ups resulted in reversion to traditional ways of teaching.

In spite of the shortcomings, PARE has managed to make a significant impact in a number of areas. Firstly, the World Bank (1994) reports of a significant reduction of dropout rates in the states where PARE programmes took place. According to Tatto M.T. (1999) another independent evaluation by a highly respected Mexican educator showed that the PARE is especially effective in improving pupil's performance in written language and mathematics in bilingual and community schools. The PARE programme, according to Tatto (1999), has raised awareness among teachers and supervisors of the importance of considering pupil's knowledge as a point of departure for building meaningful and contextually relevant learning experiences.

2.9.2 Teacher development programmes in New Zealand

According to a recent survey carried out by the Ministry of Education (1999), the teaching profession in New Zealand is a relatively mature working force. The survey indicates that thirty seven percent of teachers began teaching in the 1970s.

The findings further indicate that most New Zealand teachers received their training before the major reforms in educational administration and curriculum of the last ten years. Again their training was well before the explosive growth of information and communications technologies currently affecting all aspects of education. In-service training is therefore necessary to ensure that teacher skills and capabilities continue to meet the changing requirements placed upon them. Consequently, in-service training programmes in New Zealand are primarily aimed at improving the skills and capabilities of teachers in a defined area.

In-service teacher training in New Zealand is said to be an on-going training of practicing teachers, which is typically arranged by the schools that employ them. The schools are responsible to do need analysis to determine the development needs of every teacher. The Education Review Office (2000) reports that many schools appear to determine training needs by systematic performance appraisal systems that have a professional development component.

According to the Education Review Office (2000) in New Zealand, most of the professional decisions are left in the hands of the schools and the individual teachers. The Education authorities emphasise shared commitment to professional development that involves both teachers and schools. Teachers can enhance their own professional development through academic study, sharing with other teachers and reading widely.

The schools in New Zealand are said to have more discretion about how much and what type of in-service training is carried out. They assist teachers to learn new teaching skills by organizing time for teachers to undertake resource development, and also supporting them to undertake further professional studies. Furthermore the schools arrange for teachers to visit their colleagues' classrooms or observe programmes in other schools. Cardno (1996).

In a survey of recent New Zealand and International literature on the transfer of training from in-service courses to classroom practice, Fordyce (1999) notes that transfer is more likely to occur when in-service courses are school-based.

2.9.3   Teacher development programmes in South Africa

In view of the National Education Policy Investigation report (1993), there is a need for in-service education and training to support the development of teachers, especially mathematics teachers. Consequently, in-service education and training is to help improve the quality of teachers and the standard of teaching so that they can provide quality basic education in the aftermath of apartheid.

The subject advisory services of the state-owned education system are traditionally responsible for in-service training of teachers. However, in mathematics education there are other organizations that are involved in the education of in-service mathematics teachers. Such organizations include the Transnet Foundation and the Programme for Leader Educators in Senior Phase Mathematics Education (PLESME) at the Radmaste Center (Wits University).

Since most of these programmes are subject based, teachers are usually clustered according to their geographical location and the grades in which they teach. For example in the FET band, as far as mathematics is concerned, usually the grade 10 teachers have their sessions separately, whereas the grade 11 and grade 12 teachers usually attend together.

Over the last few years the main focus of mathematics teachers' training programmes were to adequately prepare teachers for the new National Curriculum Statement (NCS) and its assessment standards, which became operational in grade 10 at the beginning of 2006 academic year. This is in line with the views of many educationists, such as Laridon (1993), that any new curriculum is bound to fail unless the teachers who are going to implement it are well trained in content, instructional approach and the assessment procedures.

Most of these training sessions are in the form of one-to three-days' workshops usually held in the afternoons. However, there are occasions where teachers attend workshops for a week during school holidays. Invitations to the workshops are always given in advance, and they specify who is supposed to attend: thus either grade 10 or grade 11 and grade 12 teachers.

2.10   *Evaluation of in-service training programmes.*

Evaluation entails a well-developed range of techniques that may include review, audit, monitoring and assessment. There is a wide variation in the extent to which different schools formally evaluate the impact of in-service education and training. For example in some schools, the primary measure of whether in-service training is effective is when learners' performance improves. Other schools consider that training has been effective when teachers can apply their new learning, whereas in some schools in-service education and training is deemed to be successful when teachers 'talk about the changes' (Education Review Office 2000).

The fundamental objective of in-service education and training is to equip teachers with knowledge and skills required to improve teaching and learning in their classrooms. Evaluation is therefore important to provide assurance that teachers are actually putting into practice what they have learned. This of course depends on

effective supervision and monitoring system. But in most cases there appears to be no systems in place for supervising and monitoring not only of in-service training programmes but also other aspects of school management.

The Education Review Office (2000) asserts that many schools do not regard evaluating in-service education and training programmes as important and further considers it too hard to judge effectiveness. Consequently, one of the major limitations of in-service education and training programmes is the lack of monitoring or follow-ups on teachers in their classrooms after workshops. Other limitations or impediments that may affect the maximum application of new skills, knowledge and attitudes learnt during in-service education and training in the classrooms are discussed in the next section.

2.10.1   Limitations of in-service training.

New skills and new knowledge learnt during in-service education and training are sometimes not easy to implement in the classroom. This may happen as a result of the presence of some of the following contextual factors. These are difficult situations that teachers may have to deal with. They include overcrowded classes, inadequate resources, time constraints and the problem of language.

- Over-crowded classes

From this researcher's experience as a school teacher, there are a number of difficulties that are encountered in implementing mastery learning in an over-crowded classroom. Among other things, the teacher has to deal with a wide range of learners. This is one of the characteristics of schools in most of the previously disadvantaged communities where there are more than fifty learners in a class. It is difficult to control learners' noise level in such classes. Again in such classes, the teacher is forced to use large groups during group activities.

- Inadequate resources

In some of the disadvantaged communities, parents cannot afford scientific calculators and mathematical instruments for their children. This makes learners participation in most class activities very limited.

- Time constraints

Lack of sufficient time has always been a problem as far successful implementation of reform agenda is concerned. Many teachers see the curriculum reform and its method of assessment as an increase of their workload. Teachers feel that they are pressurised by the lack of time to fulfil the expectations of in-service activities.

- Problem of language

Most people believe that since mathematics mainly involves symbols, it is relatively independent of language. However, assimilation and processing abstract concept requires fluency in the language in which these concepts are taught.

> "Mathematics and science are often taught through a medium of instruction that is not a mother tongue. Where it is taught in national language there is often a transition point to an international language. Many problems of mathematics and science learning may be associated with lack of language fluency"
> (Lewin 2000:35).

Consequently, learners who are taught mathematics in a second language usually have problem of reading and understanding of concepts in that language.

According to Cuevas (1984:140) "there is a dearth of research on the relationship between language, in general, and the learning of mathematics, as well as the role language plays in assessing mathematical concepts and skills". Language therefore plays an important part in the learning of mathematics, and that a second language learner's underachievement in mathematics is likely to be due in part to language factors. This problem could be addressed at in-service training sessions by asking teachers to encourage learners who do mathematics in English as a second language to learn the language through frequent practice.

- Lack of follow-up after training

Another problem of putting into practice what has been learned at in-service education and training session is lack of follow-up after training. According to Warwick (1975) a serious problem of in-service education and training is the failure to prepare teachers adequately to meet the difficulties they will encounter in their

classrooms on their return from such courses. In addition to that, the absence of systematic procedures for monitoring and supervision in our schools is also a major concern. This situation may be due to the fact that the central position of schools in any system of in-service training has been overlooked.

- Other factors

There are of course other factors that contribute negatively to the quality and effectiveness of the teaching and learning of mathematics at school level. Botha (2000) mentions a few of them such as inadequate salaries of teachers, the low professional status of teachers in South African society and teachers resigning to take up other, often better paid and less stressful, jobs.

Teacher workload can also be a barrier to effective in-service education and training. Most teachers are unwilling to participate in training programmes because of their workload.

2.11 Summary of Chapter

In this chapter, various definitions of in-service education and training by various authors have been given. These definitions basically include the improvement of competence and skills of teachers, as well as broadening their knowledge and professional ability. The similarities between the concept of professional development and in-service training have also been explained in this chapter.

The chapter also looked at the objectives of in-service education and training. Whereas the ultimate objective of in-service education and training of teachers is to improve students' achievement, it is not always possible to demonstrate a clear relationship between in-service training and student achievement. Hence many in-service programmes state their objectives in terms of improving teacher capabilities.

The main areas of teacher development in an in-service training programme have been described. These include the content knowledge, pedagogical knowledge and pedagogical content knowledge. School based in-service education and training and its advantages have been discussed in the chapter.

The chapter also covers the general overview of teacher development approaches in selected countries. These countries are Mexico, New Zealand and South Africa. The chapter concludes with the process of evaluation of in-service activities, where various factors hindering the successful implementation of new skills, knowledge and attitude learned during in-service courses in the classroom have been identified.

In the next chapter the research design will be explained, and the methods and techniques of data collection will be described.

CHAPTER 3

RESEARCH METHODOLOGY AND DESIGN

3.1   Introduction

The role of in-service education and training in the education system cannot be over emphasized. In-service training is geared towards the developmental needs of teachers. It also equips teachers to deal with curriculum changes. Changes in the society that impact on education, demands that teachers constantly up-date their knowledge. Therefore through in-service training programmes, teachers are able to up-date their knowledge and also to improve upon their skills.

Authorities of education also believe that the purpose of in-service training is to maximize the capabilities and skills of teachers in order to enhance their ability to deliver the curriculum, so as to meet the educational needs of learners. However, in order for in-service training programmes to meet these demands, depends largely on the nature and quality of the programmes. In order to evaluate the nature and quality of in-service training programmes for FET mathematics teachers in the Taung area, interviews were conducted.

3.2   Research methods

Research methods refer to the approach or strategy followed in finding out more or studying a phenomenon in order to obtain information. Basically there are two research methodologies: these are the qualitative and quantitative research methods. The choice of any of these methods depends on the purpose of the study. In this investigative study, the researcher employs the qualitative research approach.

3.2.1   Qualitative research approach

Qualitative research produces descriptive data such as persons' own written or spoken words and observable behaviour. In a qualitative research approach, the researcher is not merely gathering data, but he or she is approaching the empirical world in a specific manner. Therefore in order to investigate the nature and quality of in-service education and training programmes, data was collected from persons in the form of

written and spoken words. This basically calls for the reason why the qualitative research approach was used in this study.

3.2.2 Rationale for qualitative approach

The rationale for the choice of the qualitative research approach comes from the purpose of the study. Thus in order to investigate the nature and quality of in-service training programmes for FET mathematics teachers, descriptive data will be collected from person's own spoken words. Another reason for the choice of qualitative approach is that in qualitative approach the researcher's choices and actions will determine the strategy (de Vos 2002).

The qualitative approach is suitable for a research of this nature which seeks to understand the concept of in-service training, and how it can be improved in mathematics education. The qualitative approach also allows participants to use their natural language in order to come to a genuine understanding of their world.

Furthermore the choice of qualitative approach for the research is the fact that the research design is flexible and unique. There are no fixed steps that are followed and the design cannot be exactly replicated (de Vos 2002).

3.2.3 Reliability of qualitative approach

Bostwick and Kyle (1981:113-120) define reliability as "the accuracy or precision of an instrument: as a degree of consistency or agreement between two independently derived sets of scores". In this research the instrument used in data collection from respondents is personal interviews. The instrument used for the interview can be said to be reliable because a pilot study was done on the preliminary questions. This was done by pretesting, that is trying it on a small number of FET mathematics teachers in the Taung area. The final questions were then produced after some adjustments based on the pilot study. The use of the pilot study was based on the argument that a common error among researchers is not piloting or pretesting what they intend investigating (Mouton 2001)..

3.2.4　Validity of qualitative approach

A valid measuring instrument, according to Bostwick and Kyle (1981) is described as doing what it is intended to do, thus measuring what it is suppose to measure. In this study the interview questions were developed with the intention of describing the nature and quality of in-service education and training programmes for FET mathematics teachers in the Taung area. The validity of the instrument is thus determined by the items which were included in the questionnaire. The questionnaire is divided into the following sections: 1) Profile of teachers, 2) workshop sessions, 3) facilitators of workshops, 4) evaluation of workshop sessions and 5) application of knowledge and skills acquired.

3.2.5　Researcher's role in qualitative approach

De Vos (2002) states that, in a qualitative research approach, the researcher is directly involved in the setting. He or she interacts with the people, and he is the 'instrument'. For that matter no qualitative report can exclude the researcher's own perspectives. This of course contributes a lot in how events are shaped and interpreted. Marshall and Rossman (1995) maintain that the extent to which the researcher plans his or her participation in the study, or outlines his role should determine the extent to which his own perceptions will be reflected in the report.

The researcher needs to establish rapport with the subjects in order to gain information from them. This is necessary in a qualitative research where personal interviews are conducted. Such a harmonious relationship with the participants will encourage them to give relevant and detailed information without feeling intimidated.

3.3　Research design

The research design, according to De Vos (2002) is a logical strategy for gathering evidence for an investigation. Therefore in collecting data to investigate the nature and quality of in-service training programmes for FET mathematics teachers in Taung area, an appropriate research design was followed. The research design here outlines the techniques for data collection and the kind of sampling that will be used.

3.3.1　Design process

According to Henning (2004: 143), in a design process the researcher should:

- explain why he/she investigates in certain methods and gives the reasons why research were sampled in a particular;

- mention the methodology of the design;

- indicate how the data will be analysed, he/she therefore argues the reasons for analyzing data according to a certain paradigm;

- define the data management procedures that will be applied in the study.

3.3.2   Data collection instruments

In order to collect data for the study, interviews were conducted.

3.3.2.1   Personal interviews

Cooper and Schindler (2003:323) describe a personal interview as "a two-way conversation initiated by an interviewer to obtain information from a participant". In this study, mathematics teachers from five selected high schools in the Taung area were interviewed. Where there is more than one mathematics teacher, all of them were interviewed in the form of a focus group. The focus group interview could be meaningful in this study since the researcher wishes to explore thoughts and feelings and not just behaviour. Again in a focus group, the group dynamics could be a catalytic factor in bringing information to the fore.

Clark, Riley, Wilkie and Wood (1998) assert that an interview is a form of research and a method of data collection that is most useful, since it gives researchers insight into how individuals or groups think about their world. In other words interviews give the interviewer an understanding of meanings that interviewees attach to the issues or situations that are under investigation.

The personal interviews, for the purpose of this study, seek to collect objective information in the form of facts and also some subjective information which might depend on attitudes, beliefs and opinions on the topic. The information collected through the interviews were recorded, in writing, and scrutinized to establish validity and reliability before writing the final report.

Despite the fact that research interviews are time consuming, expensive and often difficult to arrange, it has the opportunity of giving full and detailed explanation of

the purpose of the study to the respondents. It also ensures that the latter fully understands what is required of him or her.

3.3.2.2 Limitations of interviews

The following limitations of interview are highlighted (de Vos 2002):

- interviews are time consuming, expensive and often difficult to arrange;
- the interview provides information that is purely the views and opinions of the interviewees;
- it provides information in a designated place rather than the natural field setting;
- the researcher's presence could result in biased responses,
- not all people are equally articulate and perceptive to situations.

A researcher may minimize 'interviewer biases' by applying some of the following strategies as suggested by Clark et al (1998):

- repeating or rephrasing questions where interviewees do not seem to understand:
- encouraging interviewees to think further through statements like 'could you explain further', or 'tell me more about it', and so on.
- allowing interviewees to decide when to continue after they have paused, without rushing them.

3.3.2.3 Types of interviews

Patton (in Berry, 1999:1) describes three basic approaches of conducting qualitative interviews.

- Informal conversational interview

This type of interview resembles a chat, during which participants may sometimes forget that they are being interviewed. Most questions asked will flow from the immediate context.

- General interview guide approach, also known as guided interview.

When employing this approach for interviewing, a basic checklist is prepared to make sure that all relevant topics are covered. This type of interview approach is useful for eliciting information about specific topics.

- Standardized open-ended interview.

Researchers using this approach prepare a set of open-ended questions, which are carefully worded and arranged for the purpose of minimizing variation in the questions posed to participants. Participants are thus asked the same questions in the same order to reduce bias of the interviewer.

3.3.2.4   Choice of interview type

The standardized open-ended interview was used for this study. This type of interview was chosen because of the following reasons:

- The standardized interview allows the interviewer to be a neutral facilitator in the interview process as the respondents give their responses;
- If used strictly according to its methodological principles of neutrality and objectivity it yields information "as it is",
- The data obtained by this type of interview are regarded to be credible and believable;
- The content of the responses is believed to be the "real thing" as presented by the participant;
- The interviewer avoids asking leading questions;
- The interviewer guides the interviewee without interference.

The standardized interview however has the following limitations:

The interviewer has little or no freedom to deviate from the schedule (Huysamen 1994:144)

- The interviewer needs to be familiar with the interview schedule so that he/she reads them fluently or asks them from memory (Huysamen 1994:144)
- Standardized wording of questions limits the naturalness and relevancy of responses (McMillian & Schumacher 1993:426); and
- The interview process involves an interviewer and a respondent who are engaged with each other, therefore the data produced cannot be completely neutral (Henning 2004: 54).

3.3.2.5   The interview questions

The study seeks to investigate the nature and quality of in-service training programmes for FET mathematics teachers in the Taung area. The questions for the interview therefore cover the following aspects:

- Profile of teachers
- School-based in-service training programmes
- The main focus of workshops;
- Training of facilitators
- Supervising and monitoring of teachers after workshop sessions; and
- Application of knowledge and skills.

3.3.3   Sampling

Sampling, according to Kerlinger (1986) means taking any portion of a population or universe as representative of that population or universe. In this study, the target population will be described as all the mathematics teachers in all the twenty high schools in the Taung area. Since all of them cannot be reached because of time constrains and other logistics problem, a representative sample was therefore selected.

A sample, as Arkava and Lane (1983:27), put it, "comprise the elements of the population considered for actual inclusion in the study". The sample is then studied in an effort to understand the population from which it was drawn. Since results obtained from the sample could also be said about population, it is important that the sample is selected in such a way that it be fair representation of the population.

3.3.4   Types of sampling

There are two major groups of sampling procedures, which are probability and non-probability sampling.

3.3.4.1   Probability sampling

According to Clark et al (1998) probability sampling is a sampling technique in which each person or other sampling unit in the population has the same known

probability of being selected. It is the most effective way in which a sample can lead to legitimate generalizations about the population from which the sample is drawn.

3.3.4.2 Non-probability sampling

Non-probability or purposive sampling is regarded as a sampling technique where the chance of selection for each element in a population is unknown or zero for some elements. According to de Vos (2002) non-probability sampling is done without randomization.

In this study, probability sampling was used and the simple random sampling technique was applied in the selection of the sample. A table of random numbers was used to select five schools. This method was employed so that each high school in the Taung area will have an equal chance of being included in the sample.

3.3.5 Sampling frame

Babbie and Mouton (2001) describe a sampling frame as a list of elements composing the study population. The sampling frame of this study was made up of all the secondary/high schools in the Taung area. The table below is the list of all the high schools in the Taung area

Table 3.1   List of High Schools in Greater Taung Area

NAME OF SCHOOL	LOCATION
Reivilo high school	Reivelo
St Pauls high school	Taung
Thabasikwa secondary school	Thabasikwa
Totonyane secondary school	Madipelesa
Mankuroane tech & comm. high	Taung
Lephatsimile high school	Molelema
Majeng high school	Majeng
Batlhaping high school	Taung
Walter Letsie high school	Manthe
Gabobidiwe high school	Buxton
Pinagare high school	Taung
Reivilo combined public school	Reivilo
Pampierstad high school	Pampierstad
Bogosing high school	Maphoitsile
Kgomotso secondary school	Pampierstad
P.H Moeketsi Agric high school	Taung
Maribusing secondary school	Cokonyane
Mothelesi secondary school	Kokomeng
Keseokile secondary school	Khudu-tlou
Joseph Saku secondary school	Magogong village
Kgosetsile Lethola sec. school	Taung

3.3.6   Seeking permission to conduct interviews

The data collection activities of this study, which was mainly interviews, took place in schools. Permission was therefore applied for from both the Area Project Office (APO) manager and the principals of the five selected schools. Letters to this effect were written and delivered personally by the researcher. Permission was granted to the researcher either verbally or telephonically.

3.3.7   Research conditions

Permission for the use of empty classrooms or offices that were quiet was sought for from the principals of the schools where the research interviews were to be conducted. The interviews were conducted during normal working days and where possible the teachers were interviewed during their free periods. This was to ensure that lessons were not disturbed in the participating schools.

3.3.8   Research language

The interviews were conducted in English. Some of the respondents tried to answer some of the questions in their home language, but unfortunately since the researcher does not understand, they were asked to translate into English.

3.3.9   Duration of the study

The researcher used the interview method to collect data for this study. One of the major limitations of this method is the fact that interviews are time-consuming. The researcher has to arrange appointments that will be suitable to both the interviewer and the participants. The interview itself takes a lot of time because sometimes questions need to be repeated or rephrased.

It was the intention of the researcher to complete the whole process of the interview in a period of about four weeks. Unfortunately because of time delays and rescheduling of appointments, it was not possible to meet the intended time frame. The interview therefore continued as long as it took until all the required data were collected.

3.3.10   Data collection

3.3.10.1   Research sites

Taung is predominantly a rural area in the Vryburg district in the North West Province. There are twenty-one secondary/high schools in the area. The researcher personally visited all the sampled schools to deliver application letters and to acquaint himself with the mathematics teachers, who will be interviewees.

3.3.10.2   Roles of the researcher

The researcher played the following roles in the study.

3.3.10.3 Permission from the APO manager

The researcher wrote an application letter to the APO (Area Project Office) manager to obtain permission to conduct research in the selected schools. The letter briefly specified the following (Appendix A)

- The number of school sites to be visited
- The objectives of the study
- Research subjects
- The duration of the data collection procedures; and
- The researcher's institution.

3.3.10.4 School site visits

The researcher paid personal visits to the five schools that were selected to inform the principals that their schools had been randomly selected for the research. Letters asking for permission to conduct research in their schools were delivered to the principals. The letters also requested for permission to release the mathematics teachers to participate in the research. The letters (Appendix B) had detailed information about:

- The objectives of the study;
- The research subjects;
- The duration of the data collection procedures; and
- The researcher's institution.

3.3.10.5 Interviewer attributes

In conducting the interviews, the researcher at al times adhered to the following useful attributes:

- establishing rapport: by establishing good rapport between himself and the participants, the researcher was more than likely to get detailed answers to his questions;
- non-directive: since the researcher wanted to learn more about the participants' views and beliefs, he was therefore non-directive and let them provide the answers to his questions;

- naïve: the researcher set aside his assumptions and assumed a learner's role. He therefore became a learner and let the participants enjoyed the satisfaction of being interviewed; and
- patient: the researcher concentrated on being patient in order to get complete answers from the participants without using probes.

3.4   Ethical considerations

Research code of ethics is concerned with researcher's desire and attempt to respect the rights of others. In line with acceptable codes of ethics the researcher:

- met the participants and obtained their consent voluntarily. They were also informed about the research objectives and the method of recording their responses (de Vos 2002).
- informed the participants about their freedom to withdraw from the research at any point without penalty (de Vos 2002)
- gave an assurance to the respondents that their confidentiality and protection of their privacy will be respected (de Vos 2002).

3.5   Summary of chapter

In this chapter the research methodology has been described. A brief statement of what research method is has been given. The method used in this research has been indicated as the qualitative approach. The rationale for the choice of this approach has been dealt with in the chapter. The validity and reliability of the qualitative approach have also been described. The role of the researcher in a qualitative research approach has also been dealt with.

The research design, which involves a logical strategy for gathering evidence for a research, has been described in this chapter. The instruments used in the data collection for the research have also been described. A representative sample was selected for the study. The method applied in the selection of the sample has been explained. In the following chapter the data collected are analysed, interpreted and research findings given.

CHAPTER 4

ANALYSIS OF RESULTS AND RESEARCH FINDINGS.

4.1   Introduction

In chapter 3, a detailed description of the research methodology and design of the investigation have been given. In this chapter the collected data are analysed, interpreted and research findings given.

4.2   Conducting interviews

The researcher conducted the interviews on different days for the various participants. The participants were all interviewed at their respective schools at convenient places allocated by the principals. The interviews were conducted in English and all the participants responded in English. The researcher recorded the responses in writing. A total of fifteen high school mathematics teachers participated in the interview.

An interview schedule was used to ask interviewees similar open-ended questions. The questions were asked in the same sequence in order to reduce bias as much as possible (de Vos 2002). In situations where respondents did not understand the questions or did not hear the questions properly, such questions were repeated or rephrased.

Basically, analysis of data entails breaking the data down into constituent parts in order to obtain answers to research questions. Kerlinger in de Vos (2002) further elaborates, by stating that analysis means the categorizing, ordering, manipulating and summarizing of data to obtain answers to research questions. The purpose of analysis is therefore to reduce data to an intelligible and interpretable form so that relations of research problems can be studied tested and conclusions drawn (de Vos 2002).

Qualitative data analysis is primarily involves the process of organizing data into categories and identifying patterns among the categories. According to Henning E (2004:103) it is "a relatively systematic process of coding, categorizing and interpreting data to provide explanation of a single phenomenon of interest".

The researcher transcribed the responses of the interviewees verbatim. The interim analysis was done by first grouping all the responses to a particular question under

that question. The responses were then coded according to the themes in the responses. The interview data were then organized in order to get an overview of what they revealed.

4.3   Research analysis

The main categories of the analysis were identified as the main themes on which respondents' views were sought. They constitute the building blocks of the interview schedule. The subcategories were identified from the responses of the interviewees. The number of subcategories for each category therefore depends on different views of the interviewees.

Table 4.1   Categories and subcategories

CATEGORIES	SUBCATEGORIES
Qualifications	University Diploma in Education (Secondary)
	U.D.E (Secondary) + ACE
	Bachelor of Education (Mathematics)
Highest level of study in mathematics	3rd year college level
	3rd year college + ACE
	4th year university (Honours)
Reasons for pursuing further studies in mathematics	To gain more knowledge in mathematics
	Not interested in further studies
School-based in-service training	No school-based in-service training
	Inset organised at APO level
	Teachers contribute during inset sessions organised by the APO.
	Individual teachers consult colleagues for help.
Identifying in-service needs of teachers	No formal procedures followed
	Individual teachers do self evaluation
	Needs are addressed during inset sessions
Main focuses of mathematics workshops	Mathematics content knowledge
	Method of teaching
	Assessment techniques
Motivation to attend in-service training programmes	Catering for the needs of teachers
	Providing some form of incentives to teachers

Facilitators during in-service training	Facilitators are selected from experienced local teachers.
	Usually use group work during inset sessions.
	Facilitators encourage participants to take active part in discussions
Monitoring and supervision of teachers after in-service training	Principals and HODs do visit teachers in class
	Subject specialist visits teachers in class
	HOD is not a mathematics specialist
	Monitoring teachers' and learners' portfolios by Principals / HOD / subject specialist
Motivating maths teachers to change their 'old ways' of teaching.	Regular monitoring and supervision by HOD / Principal / subject specialist
	Classroom visit and coaching by the subject specialist
	Providing support materials in the form of teaching and learning aids
	Improving mathematics classroom settings and Facilities
Factors that hinder the maximum application of knowledge and skills gained at inset sessions	Lack of resources
	Over crowded classes
	Teachers under pressure to complete syllabus
	Learning mathematics in a second language.

4.3.1 Qualification.

The question on qualification was to find out whether teachers have the relevant qualifications to teach mathematics at the FET (Further Education and Training) phase

Table 4.2   Qualifications

Subcategory	Frequency
University Diploma in Education (Secondary)	8
University Diploma in Education & Advanced Certificate in Education.	4
Bachelor of Education (Mathematics)	3

From the table, twelve of the participants have University Diploma in Education (UDE), Secondary level, which were obtained from Colleges of Education. Out of this number only four of them have further done the Advanced Certificate in Education (ACE). Only three of the participants have Bachelor in Education (BEd) degree and this represents twenty percent of the respondents

In the literature study, Tatto (1999) mentioned that teachers need to have basic knowledge of the subject they teach as well as pedagogical skills to address the learning needs of learners.

4.3.2   Highest level of study in mathematics

The question on the highest level of study in mathematics was asked in order to find out whether teachers are pursuing further studies in mathematics after their training.

Table 4.3   Highest level of study in mathematics.

Subcategory	Frequency
3rd year college level	8
3rd year college plus ACE	4
4th year university (Honours)	3

From the table, eight of the participants have studied mathematics up to third year college level. Three of the participants have studied mathematics up to the fourth year university (equivalent to Honours degree). The response indicates that out of the fifteen participants only four of them have pursued further studies in mathematics after initial training. However from the interview conducted, many of them expressed

interest in pursuing further studies in mathematics. From the literature study, Hartshorne (1985) mentioned that teachers need to extend and develop their personal education and professional competence.

4.3.3 Interest in further studies in mathematics

Through further studies teachers expand their content knowledge in mathematics and make them more confident in teaching mathematics at all levels in the FET phase. There are those who also feel that they can make a better contribution if they undertake further studies.

Table 4.4   Reasons for pursuing further studies in mathematics.

Subcategory	Frequency
Gain more knowledge in mathematics	12
Not interested in further studies	3

From the table twelve of the participants indicated their interest in pursuing further studies in mathematics. The main reason which they gave was that they would like to gain more knowledge in mathematics. This is in line with what Griffin (1979) believes as one of the requirements of a profession (paragraph 2.4). Among the three participants who showed no interest in further studies, one of them said that she did not get any reward for what she has already done.

4.3.4 School-based in-service training

The question on school-based in-service training was asked in order to ascertain the involvement of the school in the provision of in-service training for mathematics teachers.

Table 4.5   School-based INSET programmes

Subcategory	Frequency
No school-based inset	15
Inset at APO level	15
Teachers contribute during inset sessions organised by the APO	15
Individual teachers consult colleagues for help	3

All the participants mentioned that there is no school-based in-service training in their respective schools and that all in-service training programmes are organized by the Area Project Office (APO). Three of the participants mentioned that in addition to the inset sessions teachers do consult their colleagues if they have problems.

Teachers do not have much say in the organisation of inset programmes by the APO, but during the inset sessions they have the chance of contributing ideas to the topic under discussion. It was also found that mathematics teachers in the Taung area are prepared to contribute and share ideas with colleagues. They are not only prepared to help, but they do actually help those who may have little knowledge on particular topics such as Statistics and Probability and Transformation Geometry, which are new areas as far as the FET mathematics curriculum is concerned.

It appears that school-based in service training is not very popular in the schools within Taung. This could be attributed to the fact that there are very few mathematics teachers in these schools. Many of the high schools in the Taung area have up to two mathematics teachers and therefore organising in-service training is not realistic. In addition to that, it is not always easy to get the subject specialist to a school.

However, from the literature study it was realised that inset begins in the schools where learning and teaching takes place, and needs and difficulties of teachers revealed (James Report 1972) This is also supported by Olsen (1982) who believes that school-based in-service training has within the last few years become the new mode for innovation and for implementing change within the school.

4.3.5 Identifying in-service needs of teachers

For in-service training to be meaningful, it has to address the needs of the teachers. This is supported by Jin-Lee (2001) in the literature study (see page 23). Hence it is necessary that such needs are first identified. By including this question the researcher would like to find out the process used in schools to identify the needs of mathematics teachers.

Table 4.6   Identifying in-service needs of teachers.

Subcategory	Frequency
Individual teachers do self-evaluation	15
No formal procedures followed	15
Needs are addressed during inset sessions	11

From the table, all the fifteen participants mentioned that individual teachers do self evaluation to identify their weaknesses and needs, and that there are no formal procedures in their schools to determine the needs of teachers. According to the teachers after they have identified their weaknesses they seek assistance from colleagues or from the subject specialist. In-service training sessions organised by the APO also serve as a forum in addressing these problems.

There are no formal processes of identifying the needs of mathematics teachers in the Taung area. Individual teachers identify their needs through self assessment. But it is difficult to determine whether the teachers do genuine self assessment.

4.3.6 The main focuses of mathematics workshops.

The question, "what are the main focuses of mathematics workshops?" was asked in order to establish the modus operandi of in-service training programmes.

Table 4.7   Main focuses of mathematics workshops.

Subcategory	Frequency
Content knowledge	15
Method of teaching	14
Assessment techniques	3

Almost all the participants mentioned that mathematics workshops normally focus on the teachers' content knowledge as well as the method of teaching. Only three of them added that assessment techniques are also dealt with during workshop sessions. With the changes in the mathematics curriculum, it is not surprising that mathematics workshops focus on content knowledge of teachers. This supports the views of Kriek (2005) that professional development programmes should emphasise on subject matter and teaching methods (paragraph 2.5).

Participants mentioned that they are sometimes given the chance to decide on the topics to be treated at inset, and on other occasions the facilitators also decide on what is to be done. According to the participants, in-service training sessions do address both the new topics in the curriculum as well as some of the old ones such as Transformation Geometry, Probability and Euclidean Geometry.

Most of the teachers indicated that the most important aspect of an inset session is the group discussions where each one is given the opportunity to express his or her views freely. In such situations participants learn a lot from one another. Again it was realized that when teachers meet they also talk about practical problems which they face in the classroom situation. Teachers do benefit from such discussions because they share their experiences on how to deal with issues such as overcrowding and learner discipline in the classroom. Teachers who were interviewed mentioned that they now feel confident to teach topics like Transformation Geometry and Linear Programming.

Teacher development programmes usually focus on content knowledge, pedagogical knowledge and pedagogical content knowledge (Shulman 1987). This was also supported by the views of other educationists, such as Laridon (1993) who says that any new curriculum is bound to fail unless the teachers who are going to implement it are well trained in content and methods of instruction.

In the Taung area, mathematics workshops focus on improving the teachers' content knowledge as well as the method of teaching. Local teachers who are more experienced in various topics do volunteer to facilitate the workshops.

4.3.7   Motivation to attend in-service training programmes.

From the literature study, Hartshorne (1985) mentioned that in-service education and training is a means whereby a teacher's personal needs and aspirations may be met. Teachers were therefore asked to mention what will motivate them to attend in-service training programmes.

Table 4.8   Motivation to attend INSET programmes

Subcategory	Frequency
Catering for the needs of teachers	13
Providing some form incentives to teachers	15

From the table, thirteen out of the fifteen participants mentioned that catering for the developmental needs of teachers during workshops will motivate them to attend workshops. All fifteen participants mentioned provision of incentives. Some of the forms of incentives that were mentioned are paying for transport costs, catering and decent accommodation where necessary.

Most of the teachers indicated that the in-service training programmes they attend for mathematics have not been a waste of time because they gained some knowledge that helps them to develop their personal education and professional competence. Others also claim that the contributions they make let them feel satisfied. This really supports what Hartshorne (1985) has said in the literature study in paragraph 2.2.

4.3.8   Facilitators during in-service training sessions

The facilitation team during in-service training sessions usually includes some local teachers. These teachers volunteer to handle topics that they feel more comfortable.

Table 4.9   INSET facilitators.

Subcategory	Frequency
Facilitators selected from experienced local teachers	15
Usually use group work during inset sessions	15
Facilitators encourage participants to take active part in discussions	15

From the table, all fifteen participants said that the facilitators of mathematics workshops are selected from the pool of experienced local teachers in addition to the subject specialist. During inset sessions participants work in small groups of three or four teachers per group, and each is allowed to express his or her views without any intimidation.

For better participation in discussions during in-service training sessions, most participants indicated that they should be reminded of the topics to be dealt with before the sessions, so that they can familiarise themselves with the topic in advance. All the participants mentioned group work as the main format used by facilitators during in-service training sessions, and that they also use the same method in their respective classrooms.

4.3.9 Monitoring and supervision of teachers after in-service training programmes

The purpose of in-service education and training is to equip teachers with knowledge and skills required to improve teaching and learning in their classrooms. Evaluation is therefore important to provide assurance that teachers are actually putting into practice what they have learned. This evaluation however depends on effective monitoring and supervision of teachers after they have attended inset sessions.

Table 4.10   Monitoring and supervision of teachers after INSET

Subcategory	Frequency
Principals and HODs do visit teachers in class	3
Subject specialist visits teachers in class.	0
HOD is not a mathematics specialist	11
Monitoring teachers' and learners' portfolios (by Principals/ HODs/ Subject specialist)	15

Only three out of the fifteen participants mentioned that their Principals or Heads of Departments (HODs) do visit them in their classes. Teaches reported that subject specialist has not visited any of the teachers to monitor their classroom practices, but only that their portfolios and those of the learners are checked twice in a year. From

the responses it was revealed that most of the HODs are not mathematics specialists and therefore not in a position to offer much assistance to mathematics teachers.

From the responses, it can be realized that in most cases monitoring and supervision after in-service training is minimal. Principals and HODs do not undertake class visits and the subject specialist is also far from most of the high schools and therefore not possible to reach all of the mathematics teachers in the APO due to problems related to logistics. Therefore on the whole there are no follow-ups after in-service training sessions. This is one of the major limitations of in-service education and training. Tatto (1999) states emphatically that the absence of effective classroom follow-ups after in-service education and training may result in teachers reverting to the traditional ways of teaching.

Monitoring and supervision of mathematics teachers in the Taung area after they have attended inset programmes are not effectively done in schools. Most of the principals and the HODs have little to offer to the mathematics teachers and the subject specialist seldom visits schools. Most of the teachers who were interviewed mentioned that the subject specialist visits their schools only once in a year.

4.3.10 Motivating mathematics teachers to change their 'old ways' of teaching

From the literature study, Becker and Pence (1996) mentioned that in-service training should create a platform to foster change in teacher behaviour in the classroom. The reason for including this question is therefore to ascertain if teachers still cling on to the traditional ways after attending in-service training. Teachers were then asked to mention how they will be motivated to change their 'old ways' of teaching after attending in-service training programmes.

Table 4.11   Motivating mathematics teachers to change their 'old ways' of teaching

Subcategory	Frequency
Regular monitoring and supervising of teachers by HOD/ Principal/ Subject specialist	10
Classroom visit and coaching by subject specialist	15
Providing support materials in the form of teaching and learning aids	12
Improving mathematics classroom settings.	11

As seen from the table, participants mentioned some factors that will motivate mathematics teachers to change their 'old ways' of teaching after attending in-service training programmes. These are regular classroom monitoring and supervision by the subject specialist or the head of departments, and classroom visit and coaching by the subject specialist. The others are provision of teaching and learning materials and improving mathematics classroom settings or facilities.

Even though the responses confirm what Tatto (1999) alluded to earlier on, mathematics teachers are suppose to adapt by themselves and not to be policed all the time. Professional teachers do not need to be monitored regularly before they change their 'old ways'.

4.3.11   Factors that hinder the maximum application of knowledge and skills.

Very often teachers find it difficult to implement new knowledge and skills effectively as result of the presence of contextual factors. These are the factors which are beyond the control of the teacher. Teachers were therefore asked to mention such factors that might hinder the maximum application of knowledge and skills in their schools.

Table 4.12   Factors hindering the maximum application of knowledge and skills.

Subcategory	Frequency
Lack of resources	15
Over-crowded classes	9
Teachers under pressure to complete syllabus.	8
Learning Mathematics in second language.	8

The responses from the participants indicate four main factors that hinder the maximum application of knowledge and skills acquired during in-service training. These factors are lack of resources and/or facilities, over-crowded classes, teachers under pressure to complete work schedule and learners learning mathematics in a second language.

From the table, all the participants mentioned lack of resources and/or facilities such as textbooks, calculators, classrooms and furniture (tables and chairs). These resources/facilities are supposed to be provided by the Department of Education. Sometimes they are provided but not enough for all the learners. Most of the parents also find it difficult to buy calculators for their children. Where possible, teachers have been improvising and also using practical demonstrations to teach certain mathematical concepts in class, for example solving 3-dimensional problems in Trigonometry. Nine of the participants indicated over-crowded classes while eight said that teachers are under pressure to complete the year's work schedule. The problem of learners who have to learn mathematics in a second language was mentioned by nine of the participants.

The problem of over-crowding is never addressed at in-service training sessions and no one gives an advice on how to handle over-crowded classes. Teachers who are faced with this problem struggle to use the group work approach in such classes.

Most of the schools in Taung area have common characteristics of over-crowded classes and inadequate resources for teaching and learning mathematics. From the

literature study, in paragraph 2.10.1, it can be deduced that over-crowded class makes effective teaching and learning difficult.

One of the teachers interviewed lamented that in his class of fifty-one learners only ten of them have calculators. This situation also makes teaching and learning of some mathematical concepts very difficult.

4.4   Key findings

The above analysis and interpretation of data revealed the following findings:

- The majority of the mathematics teachers in the Taung area have UDE (Secondary) certificates obtained from Colleges of Education. This confirms the National Education Policy report (1993) in paragraph 1.2..

- The new curriculum reform initiatives in South Africa demands that attention be given to teacher support, especially in the field of mathematics and science in the form of in-service training (Kriek 2005). This was further iterated in the literature study that attention be given to the development of quality mathematics and science teaching within restructured and diverse in-service training activities.

- The ultimate purpose of in-service education and training is to improve the standards of learning and learners' performance (Education Review Office 2000).

- Teacher development programmes usually focus on content knowledge, pedagogical knowledge and pedagogical content knowledge (Shulman 1987). It was also revealed in the literature study by the views of educationists such as Laridon (1993) that any new curriculum is bound to fail unless the teachers who are going to implement it are well trained in content, instruction approach and assessment procedures.

- Professional development must be a continuous job-embedded career-long process (Collinson and Ono 2000). Again teachers can enhance their own professional development through academic study, sharing with other teachers

and reading widely (Education Review Office 2000).This evidence was actually confirmed by eighty percent of the teachers who were interviewed. They indicated that teacher development is a life-long process and that by doing further courses they increase their knowledge and that puts them in a better position to help others.

- In-service education and training should begin in the schools where learning and teaching take place, and needs and difficulties of teachers revealed (James Report 1973). The provision of inset for teachers begins with a process of needs identification, but from the research it was found that there is no process of needs identification for mathematics teachers in Taung area. This probably confirms the fact that monitoring and supervision of mathematics teachers are not effective in the Taung area. In fact, relying solely on teachers self assessment can sometimes be misleading.

- Professional growth is possible when professional development programmes respond to teachers' personal needs (Hea-Jin 2001). When teachers' personal needs are not addressed during inset sessions; they usually have a negative attitude towards such programmes. It is therefore imperative that for any meaningful and effective in-service training programmes, the starting point is to identify the needs of majority of the teachers.

- The absence of effective classroom follow-ups after in-service education and training may result in teachers reverting to the traditional ways of teaching (Tatto 1999). This situation was confirmed through the interviews, where ten out of the fifteen teachers alluded to the fact that regular class monitoring of teachers could help to change their 'old ways' of teaching.

- Language plays an important part in the learning of mathematics, and that a second language learner's underachievement in mathematics is likely to be due in part to language factors. The learner-centred approach of teaching and learning mathematics demands that learners be actively involved in the lessons. Teachers only guide and direct them where necessary. More than fifty percent of the

teachers who were interviewed mentioned that learners who are taught mathematics in a second language find it difficult to cope with the subject.

4.5   Summary of chapter

This chapter analysed and interpreted the data that were collected from five high schools in the Taung area. A total of fifteen mathematics teachers were interviewed to obtain the data. The information obtained from the participants revealed that there are no formal procedures of identifying the needs of teachers in the schools. There is no school-based in-service training; teachers however do attend training sessions organized by the Area Project Office (APO).

Monitoring and supervision of teachers after they have attended inset sessions are not done effectively. Principals and Heads of Departments (HODs) do not visit teachers in class and the subject specialist only visits the schools occasionally, in some cases once in a year. The next chapter, which is the final section, gives the summary of the research, researcher's recommendations and conclusion.

CHAPTER 5

SUMMARY OF RESEARCH, RECOMMENDATIONS AND CONCLUSION

5.1   Introduction

In chapter 4 the data collected were presented, analysed and research findings given. This chapter is the final section of the research project where the investigation is summarized, recommendations are given and conclusions are drawn.

5.2   Summary of the research

In this study the researcher set out to investigate the nature and quality of in-service education and training programmes for FET mathematics teachers in the Taung area and further recommend ways in which such programmes could be made more effective.

In order to obtain data for the investigation, the following facets of in-service training were considered:

- Profile of mathematics teachers (qualifications and highest level of study in mathematics).
- School-based in-service education and training
- Identifying in-service needs of mathematics teachers
- The main focuses of mathematics workshops
- The frequency of mathematics workshops in a year
- The training of facilitators for in-service education and training
- Monitoring and supervision of teachers after in-service training
- Motivation of teachers to attend INSET programmes
- Motivation to change 'old ways' of teaching mathematics
- Factors hindering the maximum application of knowledge and skills.

Chapter 2 gave a detailed literature study on in-service education and training. In this chapter an extensive literature study was conducted on relevant aspects of the topic.

Some of the aspects included definitions and objectives, nature and scope, and categories of in-service training programmes. Other aspects that were covered are identification of needs, facilitators of in-service training and evaluation of in-service training programmes.

In Chapter 3 the research methodology and design were given where the qualitative research method was chosen. The personal interview method of data collection was used in order to obtain information for the study. Fifteen mathematics teachers from five randomly selected high schools in the Taung area were interviewed.

The collected data were presented, analysed and findings given in Chapter 4. The data were coded through inductive analysis in order to avoid enforcing connections between them but to allow them to 'speak for themselves'. The analysis and the interpretation of the data revealed the following findings:

- Most of the mathematics teachers have UDE (Secondary) qualifications which were obtained from the Colleges of Education
- There are no school-based in-service training programmes in any of the schools visited by the researcher.
- Most of the teachers do self evaluation to determine their weaknesses;
- Mathematics workshops focus mainly on improving teachers' content knowledge and the approach of teaching;
- There is a need to provide some form of incentives in order to motivate teachers to attend professional development programmes;
- Facilitators of workshops are trained, but only for workshops that are based on National Curriculum Statement (NCS) policies and guidelines;
- Monitoring and supervision of mathematics teachers are not effectively done in schools;
- Teachers still cling to their 'old ways' of teaching mathematics in schools; and
- Factors that affect the effective application of knowledge and skills, especially in rural area schools, include lack of resources and /or facilities, overcrowded classes, teachers under pressure to complete the year's work schedule and learners doing mathematics in a second language.

5.3   Recommendations

- Qualifications

Teachers of mathematics, as key elements in assuring quality in mathematics education, should possess an adequate knowledge of subject matter beyond the scope of the secondary school curriculum. This is confirmed by Laridon (1993), who claims that any new curriculum is bound to fail unless the teachers who are to implement it are well trained in content and in instructional approaches. The introduction of a newly structured degree courses for mathematics teachers to train more and better qualified mathematics teachers is therefore recommended

As mentioned in the literature study, seminars, conferences, workshops, inter-school meetings, lectures and study groups are utilized to help the professional development of teachers. It is therefore recommended that teachers enhance their own professional development through academic study, sharing with other teachers and reading widely.

- School-based in-service training

Schools should consider taking school-based in-service training seriously, because that is where teaching and learning takes place, and needs and difficulties of teachers revealed. Most of the professional decisions should be left in the hands of the schools and the individual teachers. There need to be shared commitment to professional development involving both teachers and school authorities.

- Identifying in-service needs

In addition to the self evaluation method of identifying needs and weaknesses of a teacher, there is a need for classroom visits to determine further in-service needs of teachers.

- The focus of mathematics workshops

In addition to content knowledge and method of teaching, mathematics workshops must also focus on the teachers' ability to blend technique and content. This includes understanding of how the given topics are related to one another and how they are most effectively organized and presented in the classroom.

- Frequency of mathematics workshops

Professional development must be a continuous process. It is therefore recommended that mathematics teachers enhance their own professional development through academic study and networking with other teachers.

- Providing incentives for professional development

The Department of Education should provide some form of incentives such as monetary payment or promotion, to teachers who successfully engage themselves in professional development initiatives. The question of finance for in-service training is one of the most critical and at the same time the thorniest issue in education. But since it is generally accepted that in-service education and training is vital for educational development, it is recommended that the Department of Education allocates as part of its budget a completely separate amount for in-service training.

- In-service training facilitators

It is recommended that those who are engaged as providers of in-service education and training should themselves receive some form of training to update them on techniques, methodology and the required knowledge to impart to participants.

- Monitoring and supervision of mathematics teachers

For effective monitoring and supervision of mathematics teachers, it is recommended that more subject specialists for mathematics be appointed. Each cluster within an APO should have one mathematics specialist, considering the fact that some heads of department for mathematics in some schools are not mathematics teachers.

In order to evaluate the effectiveness of in-service programmes, the HOD or the subject specialist should check the teachers' and the learners' portfolios. It is also suggested that occasionally there should be class visits by the HOD or the subject specialist.

- Factors hindering application of knowledge and skills

Based on the findings, it is recommended that the North West Department of Education should provide teaching and learning materials such as textbooks,

calculators and mathematical instruments. More classrooms should also be provided by the communities with assistance from the Department of Education.

More contact time is needed so that more topics could be covered. To do this, extra lessons could be arranged especially during afternoons and weekends. Learners who do mathematics in English as a second language, need to be encouraged to learn the English language through frequent practice.

Suggested framework for in-service training of Mathematics teachers in the greater Taung Area

SUBJECT SPECIALIST (MATHEMATICS)

AREA PROJECT OFFICE MANAGER

Seeking permission for teachers to participate in INSET

Send letters of invitation providing dates

PRINCIPALS OF SCHOOLS

Report requests of teachers

Scheduling INSET according to year plan

Inform

Venue

Provide

Monitoring teachers' attendance

HEAD OF DEPARTMENT

Monitoring and supervision after INSET

Food

Certificate of attendance

Transport costs

Inform

Identify problem areas

TEACHERS

Class visits

Teaching portfolios

From the framework above, teachers have to identify problem areas in relation to the year's work schedule. They then inform their heads of department about their problems. The heads of department reports teachers' requests to the subject specialist, who then organises in-service training for the teachers.

Following this, the subject specialist has to seek permission to conduct in-service training from the Area Project Office manager and request for a venue. Letters of invitation are then sent to the school principals so that teachers can be released in time for the training.

After the in-service training, teachers should be monitored and supervised by their principals and heads of department. The subject specialist occasionally monitors and supervises teachers. This should be done by visiting teachers in class and checking the portfolios of both teachers and learners.

5.4   Limitations of the study

In the study, a sample of mathematics teachers in the FET phase from Greater Taung area was chosen. This sample may not be a good representation of all the mathematics teachers in the area, and hence a limitation to the study. Another limitation may also arise from the fact that some of the responses from the interviews could be subjective and may not actually reveal what really happens in schools as far as in-service programmes are concerned.

5.5   Conclusion

This research was aimed at investigating the nature and quality of in-service education and training for F.E.T (Further Education and Training) mathematics teachers in the Taung area. This was done through interviews of mathematics teachers in five randomly selected high schools in the area. The researcher also did a literature review that provided a theoretical foundation and some important guidelines for effective in-service programmes.

It was revealed from the literature study that even though the ultimate objective of in-service training of teachers is to improve students' achievement, it is not always

possible to demonstrate a clear relationship between in-service training and learners' achievement. Therefore in-service training programmes usually state their objectives in terms of improving teacher capabilities.

Data collected from the participants revealed that there are no formal processes of identifying the needs of mathematics teachers in the Greater Taung area, and again teachers are not properly monitored and supervised after in-service training sessions.

The research concludes that the quality of the in-service training in the Taung area is undermined by the fact that most of the knowledge and skills acquired during training are not applied in the classroom.

The researcher is of the opinion that more could be done to improve the process and effectiveness of in-service training in the area by adhering to the recommendations given above. For instance the subject specialist, the principal and the head of department should have major roles to play in determining the in-service needs of a teacher. Teachers should also enhance their own professional development through academic study.

BIBLIOGRAPHY

Aichele, D & Coxford, A. (Eds) 1994. Professional development for teachers of Mathematics: NCTM Virginia: 1994 Yearbook of the NCTM.

Arkava, M.L & Lane, T.A. 1983. Beginning social work research. Boston. Allyn and Bacon

Babbie, E & Mouton, J. 2001. The Practice of Social Research: contributions by Voster, P & Prozesky, B. South African Edition. Cape Town. Oxford University Press.

Bagwandeen D.R and Louw W.J.1993. The theory and practice of In-service Education and Training for teachers in South Africa. J.L van Schaik

Becker, J, and Pence, B. 1996. Mathematics teacher development: connections to change in teachers' beliefs and practices. Proceedings of the 20th International Conference for the Psychology of Mathematics Education 1(1), 103- 107.

Berry, R.S.Y. 1999. Collecting data by in-depth interviewing: www.leads.ac.uk/educo/documents/000001172htm

Bostwick, G.J. & Kyte, N.S. 1981. Measurement, In Grinnel R.M (Ed). Social work research and evaluation. Itasca II Peacock.

Botha J. 2000. Quality and effectiveness in mathematics education: the role of professional mathematics teacher/educator. In South Africa Journal of Education 20(2), 135- 142.

Brain Cane 1969. In-service training. A study of teachers' views and preferences. National Foundation for Education Research in England and Wales, Slough.

Cardno C. 1996. Professional development: A holistic approach. In New Zealand Journal of Educational Administration. 1(3), 35-61

Clarke D. 1995. Quality mathematics. How can we tell? Mathematics Teacher 8(3), 67-81

Clark, M, Riley J, Wilkie T & Wood S. 1998. Researching and writing dissertation in hospitality and tourism. London. International Thompson Business Press.

Collinson Y and Ono Y. 2000. The professional development of teachers in the United States and Japan. In European Journal for Teacher Education. 24(2):223-246.

Cooper, D.R. & Schindler P.S. 2003. Business Research Methods. Eighth edition. McGraw Hill, New York.

Cresswell, J.W. 1994. Research Design: Qualitative and Quantitative Approaches. California: Sage Publishers, Inc.

Cuevas, C.J. 1984. Mathematics learning in English as a second language. Journal for research in Mathematics Education. 15 (2): 134-144.

Darling-Hammond L. 2000. "Teacher quality and student achievement: A review of state policy evidence" Retrieved September 4, 2005, from http://epaa.asu.edu/epaa/v8n1

De Vos, A.S. 2002. Research at Grass Roots for the social sciences and human service professions. Van Schaik Publishers:.Pretoria.

Dimmock C. 1990. Managing for Quality and accountability in Australian education. Education Review 42(2), 197- 208.

Education Review Office. 2000. In-service Training for Teachers in New Zealand Schools.

Fordyce, S. 1999. The significance of social support on School-based In-service transfer of training in New Zealand. Unpublished M Ed thesis.

Griffins G.A. 1979. Guidelines for the implementation of staff development programmes, in Leiberman A and Miller L. (Eds) Staff development: new demands, new realities, and new perspectives: Teachers College Press, Teachers College. Columbia University, New York.

Hartshorne K.B. 1985. INSET in South Africa. The HSRC report. Urban foundation seminar. 17- 18 July 1986.

Hea-Jin L. 2001. Enriching the Professional Development of Mathematics Teacher ERIC. Clearinghouse for Science, Mathematics and Environmental Education. Columbus OH.

Henderson E.S. 1979. The concept of School-focused in-service education and training. In British Journal of teacher Education. 5(1), 17- 25.

Henning, E. 2004. Finding Your Way in Qualitative Research with Van Rensburg, W & Smith, B. Pretoria: Van Schaik Publishers: Pretoria.

Hicks G.E. 1993. Estudio evaluativo sobre actualization de maestro's e incentives al docente del progama par abatir el resago educativo (PARE) Reporte final mimeo, Mexico, D.F. Cosenjo Nacional de Fomento Educativo Banco Mundial.

Huysamen, G. K. 1994. Methodology for the Social and Behavioural Sciences: Halfway House: Southern Book Publishers.

James Lord. 1973. The James Report's Third Cycle. In Watkins R(Ed). In-service training: Structure and content. Wardlock International, London.

Joyce B.R, Hersh R.H. and McKibbin M. 1983. The structure of school improvement. Longman New York.

Kerlinger, F.N. 1986. Foundations of behavioural research. 3rd edition. Port Worth, Harcourt.

Kriek J. 2005. Construction and evaluation of holistic model for the professional development of Physics teachers via Distance Education. Unpublished dissertation, University of South Africa.

Laridon P. 1993. Towards transforming mathematics education in South Africa. Pythagoras. 31(1), 41-68.

Leedy, P.D. 1992. Practical Research, Planning and Design. New York Prentice Hall.

Lewin, K.M. 2000. Mapping Science Education in Developing countries. Washington DC. World Bank Human Development Network Education Group.

Loucks-Horsely, Hewson, Love and Stile 1998. Models on Staff Development: Handbook of Research on Teacher Education. Macmillian. New York.

Marshall C & Rossman, G.B. 1995. Designing a qualitative research, 2nd edition, Thousand Oaks: Sage.

Martins, A. Simons R & Schifter D. 1993. Towards a constructive perspective: The impact of a mathematics teacher in-service programme on students. In Educational Studies in Mathematics. Kluwer Academic Publishers. Netherlands.

McMillan, J.H. & Schumacher, S. 1993. Research in Education: A Conceptual Introduction. Third Edition. New York. Harper Collins Publishers.

Mouton, J. 2001. How to succeed in your master's and doctorial studies: A South African guide and resources book. J.L van Schaik: Pretoria.

National Education Policy Investigation Report. 1993. The Framework Report. Cape Town. Oxford University Press.

Organisation for Economic Cooperation and Development (O.E.C.D). 1998. Staying ahead: In-service training and Professional development.

Olsen T.P. 1982. School-based in-service education. Utopia or model. In Salmon A. (Ed). The evolution of in-service education and training. Swets and Zeitlinoer Lisse.

Porter B. 1975. In-service education of teachers and the colleges of education. In Adams E. (Ed) In-service education and teachers' centers. Pegamon Press. Oxford.

Rudduck J. 1981. Making the most of the short in-service course. Metheun Educational. London.

Schifter D. 1998. Learning mathematics for teaching: from a teachers' seminar to the classroom. Journal of Mathematics Teacher Education. 1(1), 47-55.

Shulman L.S 1987 Knowledge and teaching: Foundations of the new reform. Harvard Educational Review 57, 1-22. .

Sparks D. and Loucks-Horsely S. 1990. Models on staff development. In Houston W.R (Ed). Handbook of Research on teacher education. Macmillan. New York.

Tatto M.T. 1999. Improving teacher education in rural Mexico. The challenges and tensions of constructivist reform. In teaching and teacher education.15 (1), 12-35.

Walters MJ. 1994. In-service training: Structure and content. Ward Lock Educational, London.

Warwick D. 1975. Teaching in-service education. Oliver and Boyd. Edinburgh.

Webb, L.P, Montello, P.A .and Norton M.S. 1994. Personnel Administration in Education. New issues and needs in human resource management. 2nd edition. Ohio.

World Bank 1991. Basic Education in Mexico. Trends, issues and policy recommendations: Report number 8950 ME, Washington D.C. Human Resource Operations Division. County Department II. Latin America and the Caribbean Regional Office.

World Bank. 1994. Second primary project. Report 12529 ME. Washington DC Human Resources Operations Division. County Department II. Latin America and the Caribbean Regional Office.

Appendix A

1	Profile of teacher:

What academic qualifications do you have?

What is your highest level of study in mathematics?

Do you have any interest to further your studies in mathematics? Give reasons.

2	How is school-based in-service training programme organised at your school? Do you have a say in the organization of inset session? Would you like to be part of the organization of inset session? Have you ever been asked to contribute to an in-service training session? Do you think you can make a contribution to the community of mathematics teachers in this district?

3	How are the in-service needs of teachers identified in your school? Have your own needs ever been addressed at an inset session?

4	What are the main focuses of mathematics workshops? Who decides on the topics that will be dealt with at an inset session? Have you ever had a say in the topics to be addressed? Do the inset sessions address the new topics in the curriculum? Do you feel confident to teach new topics such as Transformation Geometry or Statistics and Probability? What in your opinion is the most important aspect of an inset session?

5	How often do you think mathematics workshops should be organized in a year? Give reasons.

Do you sometimes feel that the inset programme was a waste of time?

Do the in-service training sessions sometimes inspire you to take on further studies in mathematics teaching? If yes, what do you have in mind?

6	Do facilitators of in-service training undergo some form of training? How do you know?

What in your opinion can the facilitators do to improve on the inset sessions?

Do you sometimes feel that they "talk over your head"?

What is the main format that the inset sessions take on?

Is it group-work, or does the facilitator do most of the talking? Which method of instruction do you prefer?

Do you use the same method of instruction in your class? Do you allow learners to take part or sit passively at their desks?

What resources would you like to have in your mathematics classroom?

Are you provided with these resources, or are you being guided to make your own resources? Have you ever been inspired after an inset session to make your own resources? If so, what did you make? Was it successful in the teaching of the concept you intended it to be?

Can you give an example of what you did in your classroom that was different from before, after you attended an inset session?

7   How are teachers monitored and supervised after they have attended in-service training programmes?

Does the Principal or HOD carry out some follow up after inset sessions in the form of discussions or class visits? If there is follow up please tell me what you can recall of the last time where you were involved in a form of follow up after in-service training session.

8   What do you think will motivate mathematics teachers to change their "old ways" of teaching after attending in-service training programmes?

Can you tell me of one or more training sessions that made such an impression on you that you changed your classroom practices the very next day? If this was the case, do you still adhere to these practices? Do you feel that you need more support to keep it up? If so, who should give you the support?

9   Please mention the factors in your school that might hinder the maximum application of the knowledge and skills acquired during in-service training

Are these factors being addressed in the inset sessions? Are you given any advice of how to handle, for example large classes, or shortage of textbooks?

Appendix B

Letter to the Area Project Office (APO) Manager

P.O. Box 9113
Magogong
8575
12th April 2007

The APO Manager
Taung
Dear Sir,

APPLICATION FOR PERMISSION TO CONDUCT RESEARCH

JAMES OWUSU-MENSAH (Student no. 0851 233 7).

I hereby apply for permission to conduct research in schools in the APO. I am currently registered for the MEd Degree in Mathematics Education at UNISA.

My research topic is "A critical investigation into the nature and quality of in-service education and training programmes for FET mathematics teachers in Taung area.

A sample of five schools in the APO will be involved in the research. The five schools will be selected by means of the simple random sampling method. The research procedures, inter alia, involve:

Applying for permission from Principals of the five schools that would be selected:

Obtaining informed consent from the mathematics teachers in the selected schools to participate in the research process:

Interviewing the mathematics teachers:

Interviewing them during working hours, but preferably during their free periods:

In cases where some teachers do not have free periods, I will arrange with them to have them interviewed at times that will be convenient to them.

I intend to conduct interviews from 16th April to 4th May 2007.

I would be thankful if you could grant this permission.

Yours truly,

J. Owusu-Mensah.

Appendix C

Letter to the principal

<div align="right">
P.O. Box 9113
Magogong
8575
12th April 2007.
</div>

The Principal
XXXX High School
Private Bag XYZ
Taung

Dear Sir or Madam,

APPLICATION FOR PERMISSION TO CONDUCT RESEARCH

I hereby apply for permission to conduct research in your school. I am currently registered for the M.Ed Degree in Mathematics Education at UNISA. My research topic is "A critical investigation into the nature and quality of in-service education and training programmes for FET mathematics teachers in the Greater Taung Area". A sample of five schools will be involved in the research. Your school is one of the five schools that have been selected by means of the random sampling method.

The research procedures involve:

Obtaining informed consent from the mathematics teachers to participate in the research process.

Interviewing them during working hours but preferably during their free periods, and in cases where the teachers do not have any free periods, I will arrange with the individual teachers to have them interviewed at times that will be convenient to them.

I intend to conduct interviews from 16th April to 4th May 2007. A maximum of two days for each school is anticipated for the interview.

I would be thankful if you could grant this permission.

Yours faithfully,

J. Owusu-Mensah