EFFECTIVENESS OF THE MATHEMATICS TEACHER EDUCATION CURRICULUM AT THE UNIVERSITY OF ZAMBIA IN PREPARING SECONDARY SCHOOL TEACHERS OF MATHEMATICS

BY

ROBERT CHANGWE

A Dissertation Submitted to the University of Zambia, School of Education, in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Education in Curriculum Studies

THE UNIVERSITY OF ZAMBIA

LUSAKA

2017

COPYRIGHT

AUTHOR'S DECLARATION

I, **Robert Changwe**, do hereby declare that this dissertation is my own work, and that all the works of other persons used have been duly acknowledged, and that it has never been previously submitted for a degree at the University of Zambia or any other University.

Signature: …………………………………… Date: ………………………………

CERTIFICATE OF APPROVAL

This dissertation of **Robert Changwe** is approved as partial fulfillment of the requirements for the award of the degree of Master of Education in Curriculum Studies by the University of Zambia.

1st Internal Examiner

Name: ……………………………….............

Signature: ……………………………………   Date: …………………………

2nd Internal Examiner

Name: ……………………………………….

Signature: ……………………………………   Date: ……………………………

3rd Internal Examiner

Name: ……………………………………….

Signature: ………………………………………   Date: ……………………………

ABSTRACT

This study sought to investigate whether the mathematics teacher education curriculum at the University of Zambia (UNZA) adequately prepared student teachers in mathematical content knowledge and mathematical pedagogical content knowledge for teaching classroom mathematics in Zambian secondary schools.

The mixed methods design and in particular the concurrent triangulation research design was used. Questionnaires were employed to collect data from UNZA products of mathematics education and fourth year (final year) student teachers who were on the programme. Lecturers of mathematics content and mathematics teaching methods and the Standards Officers for Mathematics including some UNZA products of mathematics education were also interviewed. Mathematics lessons were also observed.

Description and thematic analysis were used to analyse qualitative data while quantitative data was analysed through the use of statistical package for social sciences where independent samples t-tests were employed.

The main findings of the study indicated that the UNZA mathematics teacher education curriculum did not adequately prepare student teachers to teach mathematics. Teachers of mathematics lacked the relevant mathematical knowledge and the mathematical pedagogical knowledge upon graduation. Results also suggested that this could have been one of the factors that had contributed to inappropriate teaching and eventually poor mathematics learner performance in secondary schools.

Hence, it was recommended that the UNZA mathematics teacher education curriculum should be reviewed after conducting a job analysis of the teachers of mathematics. It was also recommended that the Ministry of General Education should conduct in-service training of teachers of mathematics using the already existing continuous professional development structures within the ministry.

DEDICATION

This work is dedicated to my children Cleopatra and Robert. Their presence gave me hope and encouragement both spiritually and emotionally during this study.

To my father, Mr. Kenani Changwe and my mother Mrs. Docus Chungu Changwe, I will always remember the encouragements and hope you gave me more especially when you told me that "my son do not lose hope, remain focused and concentrate on your education for your dreams to be realised." I will always endeavour to uphold your wise counsel. Thank you for believing in me.

ACKNOWLEDGEMENTS

Firstly, I would like to convey my special thanks to my principal supervisor Dr. Innocent M. Mulenga and co-supervisor Dr. Patricia P. Nalube for giving me valuable advice, guidance and counseling during the course of this study. I am indebted to the Head of Department Mr. Ignatio Bwalya and all members of the department of Language and Social Sciences Education for their mentorship and inspiration. The thoughtful and constructive criticism of Dr. Gift Masaiti deserve a special mention in this study. I would like to also thank my kind and loving wife Jeness Kamukwamba and all family members and friends who contributed towards the success of this study. Among them were: Moria Changwe, Kenny Changwe, Jonas Kashala, Christine Mwanza, Misheck Cheli and Brighton Mukata Namushi.

Besides, I would like to appreciate every respondent whose names have been withheld for ethical reasons for having participated and contributed positively to the success of this study.

Lastly, I would like to express my heartfelt gratitude to the University of Zambia Staff Development Office for awarding me the fellowship to undertake this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

BA. Ed	Bachelor of Arts with Education
BEDMAS	Bachelor of Education Mathematics and Sciences (Secondary)
BSC. Ed	Bachelor of Science with Education
CBTE	Competency Based Teacher Education
CPD	Continuing Professional Development
DEBS	District Education Board Secretary
ECZ	Examinations Council of Zambia
HoD	Head of Department
LMT	Learner Mathematical Thinking
MCK	Mathematical Content Knowledge
MKT	Mathematical Knowledge for Teaching
MoE	Ministry of Education
MoGE	Ministry of General Education
NCTAF	National Commission on Teaching and America's Future
NCTE	National Commission of Teacher Education
NECO	National Extension College
PCK	Pedagogical Content Knowledge
UNZA	The University of Zambia

CHAPTER ONE: INTRODUCTION

1.1. Overview

This chapter contains the background of the study, statement of the problem, the aim of the study, research objectives and research questions. It further contains a theoretical framework, the conceptual framework, significance of the study, delimitations, limitations and operational definition of terms.

1.2. Background

Mathematics is one of the most important subjects in any country. In order to show the position that mathematics occupies in any given society, Fatima (2012) cited an English Franciscan Friar, philosopher, scientist and scholar of the 13th century Roger Bacon (1214-1294) who argued that "neglect of mathematics works is an injury to all knowledge, since he who is ignorant of it cannot know the other sciences or the things of the world." The Examinations Council of Zambia (ECZ) (2012: 31) stated that "one of the objectives of teaching the mathematics curriculum is to build up understanding and appreciation of mathematical concepts and computational skills in the learners in order for them to apply them in other subject areas and everyday life." Thus, knowing mathematics can be something satisfying and empowering because of some of the qualities that are fostered by the subject. According to Fatima (2005), one of these qualities is the power of reasoning that improves: analytical skills, creativity, abstract or spatial thinking, critical thinking, problem solving ability as well as effective communication skills.

Although all careers may require their employees to possess basic mathematical knowledge, some may demand for intensive mathematics. Learners need to be exposed to the school curriculum that will prepare them for lifelong work as mathematicians, statisticians, engineers, bankers, tailors, carpenters and architectures (Fatima, 2005). Hence the need for learners in various learning institutions to be given an opportunity and appropriate guidance to learn mathematics with depth and understanding. Similarly, Cockcroft (1982) stated that there could be no valid reason of preventing learners from studying mathematics at school level. It could be because of the importance attached to this subject that had led the Ministry of General Education to consider mathematics as one of the core subjects that is taught in all Zambian secondary schools.

Despite mathematics being one of the most important subjects in the Zambian education system as well as one of the oldest fields of study in the history of mankind, the performance of learners has been unsatisfactory for several years (ECZ, 2016). This assertion is supported by the information shown in table 1.1 as well as the trends in raw mean scores for school certificate results from 2011-2015 (ECZ, 2016) refer to Appendix 6.

Table 1.1: *Provincial Ranking According to Performance in the four Selected Subjects (2015 and 2014)*

Province/ National	Mean Score in %					
	English	Mathematics	Biology	Science	Average for 2015	Average for 2014
Southern	38.7	19.41	23.75	18.61	25.12	24.19
Lusaka	38.83	18.25	22.99	18.76	24.71	24.64
Eastern	34.75	21.16	22.6	19.61	24.53	23.41
Central	35.95	17.49	21.73	18.41	23.39	23.11
National	35.16	17.42	21.59	17.66	22.96	22.78
Muchinga	32.47	18.67	21.99	18.5	22.91	22.36
Northern	33.46	18.89	21.68	17	22.75	21.82
Luapula	32.02	16.51	20.34	16.98	21.46	22.77
Copperbelt	33.52	15.62	20.22	16.18	21.38	21.37
Western	31.93	15.61	20.32	15.92	20.95	20.47
North western	30.68	14.78	19.97	17.11	20.64	21.58

Source: *Highlight of the 2015 Grade 12 Examinations Results Statistics from ECZ*

As can be seen from the statistics shown in table 1.1, it is clear that learners have not been performing very well in mathematics and science countrywide. This calls for the establishment of what could have led to such unsatisfactory performance in the subjects.

Studies that have been done by different scholars such as: Mbugua et al., (2012), Mutai (2010), Mwape and Musonda (2014) as well as Kafata and Mbetwa (2016) have all revealed that high teacher to pupil ratio due to overcrowded classes, negative attitudes and beliefs by learners towards mathematics as well as lack of appropriate teaching and learning materials were among the factors that had led to poor performance of learners in mathematics. Despite the researcher being aware of some of these stated factors, he considered examining the mathematics teacher education curriculum in order to establish if it could have been one of the factors that contributed to teachers' failure to teach classroom mathematics effectively resulting in learners' poor performance in school certificate examinations.

The first major educational policy document in Zambia (MoE, 1977) emphasised that teachers with diplomas should only teach at the junior secondary section while teachers from the university holding degrees to teach the full range of secondary school subjects. However, because of lack of teachers with university degrees in Zambian secondary schools, diploma and advanced diploma holders were asked to teach senior secondary subjects. This meant that learners in various secondary schools were taught by inappropriately qualified teachers. Studies have revealed that teachers' qualifications and methods or ill-prepared teachers, teachers' poor attitudes and their lack of readiness to teach appropriately might affect learners' performance in mathematics (Avong, 2013; Okafor & Anaduaka, 2013).

According to the Zambian education policy document, *Educating our Future* (MoE, 1996: 29) the aim of school education "is to promote the full and well-rounded development of the physical, intellectual, social, affective and spiritual qualities." In this document, there is a strong emphasis that the essential competencies expected in every teacher is to master the material to be taught and a skill in communicating that material to the learners. Besides, teachers of mathematics should be in a position to communicate the required knowledge in a clear, informative and precise manner to their learners (Soer, 2009). It is worthwhile stating that the number of teachers holding university degrees has kept on increasing in Zambian secondary schools but still the performance of learners in mathematics is not pleasing (MoGE, 2015). Table 1.2 shows the number of teachers in secondary schools by sex from 2008 to 2015.

Table 1.2: *Secondary School Teachers in all Schools by Sex from 2008 to 2015*

Year	2008	2009	2010	2011	2012	2013	2014	2015
Male	9 293	9 645	9 843	8 845	10 785	11 273	12 551	12 815
Female	6 119	6 852	6 979	6 078	7 854	8 342	9 867	9 984

Source: *Ministry of General Education (2015) Educational Statistical Bulletin*

As indicated in Table 1.2, it is clear that the number of secondary school teachers has been increasing. MoGE (2015) had revealed that from 12 815 male teachers, 3 329 hold

Education Bachelor's Degree, 116 hold Master's degree, 54 hold Special Education Degree and 220 hold other Bachelor's Degree. Similarly, from 9 984 female teachers, 2 174 hold Education Bachelor's Degree, 79 hold Master's Degree, 40 hold Special Education Degree and 104 hold other Bachelor's Degree.

Based on the 2015 school certificate examination results in Zambia, the Minister of General Education by then, in his speech announced that the performance of candidates in practical subjects was very good while mathematics, science and commerce had recorded the lowest in terms of learner performance. This had prompted the researcher to raise questions such as:

i. Why have the pupils continued failing mathematics in secondary schools when they are taught by university products?
ii. Is there any problem with the mathematics teacher education curriculum at higher institutions of learning in preparing secondary school teachers of mathematics?

Although teaching is considered to be an art, Morris, Hiebert and Spitzer (2009) argued that preparing teachers to effectively teach mathematics in secondary schools is one of the most urgent problems encountering researchers who have the passion of improving pupils' learning. Similarly, a study by Mulenga (2015: 1) revealed that;

> *In every discussion that involves teacher preparation what should not be expected to miss out is the judgment about what content knowledge and skills should teachers possess so that they are equipped to teach effectively. In addition, well-prepared teachers are likely to select valuable learning activities, ask productive questions, give good explanation and evaluate pupils' learning.*

According to Ball et al., (2003) and Chapman (2005) there is a strong relationship between teachers' mathematical content knowledge and their ability to teach well in classrooms. It must be pointed out immediately that the mathematical content knowledge that the scholars referred to can only come from an effective and well organised teacher education curriculum.

There are several research works that have been done at the University of Zambia (UNZA) pertaining to teacher education. For example, a study by Banja (2012a & b), Chabatama

(2012), Masaiti and Manchishi (2011), Manchishi (2013) and (2004) as well as Mulenga (2015) had all shown that the quality of teachers that have been produced at the University of Zambia under teacher education curricula lacked knowledge and skills necessary for effective classroom teaching. According to Ogula (1998) an effective teacher education curriculum would appropriately prepare teachers on: "what to teach", "who to teach", "which teaching and learning aids to be used", "how to teach and why teaching what is intended to be taught". Such a curriculum would enable teachers of a subject to teach relevant knowledge, values, attitudes and skills to learners which may eventually reflect in learners' good performance. Despite the above cited scholars not having carried out their studies in mathematics teacher education curriculum in particular, their studies are cardinal for the current study to be well grounded. To be specific, in his doctoral study Mulenga (2015) argued that the English teacher education curriculum at the University of Zambia lacked the relevant skills and knowledge for teaching English language in Zambian secondary schools.

It is important at this point to mention that this study is different from the studies done by different researchers in Zambia in the sense that the researcher looked at the effectiveness of the entire mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics. This was done through collecting data from the lecturers at the University of Zambia, National Standards Officer for mathematics, student teachers of mathematics at UNZA and teachers from the University of Zambia who were teaching mathematics in secondary schools in Lusaka district of Zambia on this matter.

1.3. Statement of the Problem

The overall research problem addressed in this study is that despite mathematics being one of the core secondary school subjects and very key especially to science and business related subjects, it appears the effectiveness of the mathematics teacher education curriculum at the University of Zambia has hardly been analysed. The ECZ (2016) report acknowledged what is stated in the MoE (1996: 53) document that "the overall unsatisfactory performance in school certificates is attributed in large measure to poor performance in mathematics and science." The poor results that the country has continued to record in secondary school mathematics are a clear indication that there are problems that need to be addressed in the teaching and learning of mathematics. If this issue is not treated with the seriousness it deserves, the country is likely to have inadequate and incompetent human resource in the fields of teaching and lecturing of mathematics, engineering, business and many other areas that require the knowledge of mathematics.

1.4. Aim of the Study

The aim of this study was to investigate the effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics.

1.5. Objectives

The researcher in this study intended to achieve the following objectives;

i. to evaluate the extent to which the mathematics teacher education curriculum at UNZA had the appropriate content and teaching methods relevant for teaching mathematics in Zambian secondary schools.

ii. to analyse the UNZA curriculum designers' intentions for the mathematics teacher education curriculum.

iii. to explore respondents' opinions on whether teacher education preparation could affect learner performance in secondary school mathematics.

iv. to suggest the appropriate strategies of improving mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics.

1.6. Research Questions

To achieve the objectives above, the study attempted to answer the following specific questions;

i. To what extent does the UNZA mathematics teacher education curriculum have the appropriate content and teaching methods which are relevant for teaching mathematics in Zambian secondary schools?

ii. What were the intentions of the UNZA curriculum designers for the mathematics teacher education curriculum?

iii. How does teacher education preparation affect learner performance in secondary school mathematics?

iv. What suggestions would be appropriate to improve further the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics?

1.7. Theoretical Framework

This study was guided by content-based and competency-based teacher education curriculum theoretical approaches propounded by Haberman and Stinnett (1973). This was later on used by several other scholars such as: Shulman (1987), Chishimba (2001), Bowles (2012) and Mulenga (2015). If one is to judge the quality or effectiveness of any teacher education programme, one of the criteria that can be used is to examine the content that student teachers are exposed to as well as the products of the programme. Scholars who are behind scrutinising the quality of the product of the education programme namely: Biggs (2001); Cochran-Smith (2005) and Roofe and Miller (2013) have all argued that if the curriculum was designed to clearly achieve defined outcomes then it would increase the likelihood of student teachers to successfully perform well in their future responsibilities of teaching.

Chishimba (2001) described a content-based teacher education curriculum as one that follows a common curriculum which is grounded on the traditionally accepted subject divisions which does not take into consideration the link that exists between theory and practice in teaching. Besides, Shulman (1987) explained further that teacher educational courses in the content-based approach are developed without the consideration of the school curriculum subject matter which the student teacher is being prepared for. It is as a result of the nature of the content-based practice that led Mulenga (2015) to associate such a programme to be an academic, scholarly, irrelevant and remote from classroom teaching. On the other hand, competency- based teacher education (CBTE) curriculum is slightly different from content-based teacher education curriculum. Bowles (2012) explained that a curriculum that has specific competencies to be acquired with explicit corresponding criteria for assessing is the competency-based teacher education curriculum. The competency- based teacher programme development ensures that the competencies to be learned and demonstrated by student teachers are specified in advance (Chishimba, 2001). The CBTE curriculum is based on what is taught in schools which higher institution of learning arrived at through carrying out situational analysis which Mulenga (2015) addressed as job analysis.

Based on these two views, Haberman and Stinnett (1973) stated that many educational administrators and curriculum scholars feel that products of the content-based teacher education curriculum are not adequately prepared for the job of classroom teaching while the products of the CBTE curriculum are likely to acquire the relevant knowledge and skills for classroom teaching. This means products of the CBTE curriculum are effectively prepared for the purpose before them. In the process of trying to find out the effectiveness of the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics, the researcher assessed whether curriculum designers of the mathematics teacher education curriculum followed the content-based teacher education curriculum or the competency-based teacher education curriculum approach. The researcher in the next section describes the conceptual framework of this study.

1.8. Conceptual Framework

The conceptual framework in figure 1.1 illustrates the link between the mathematics teacher education curriculum and what may happen if this curriculum is effective (competence-based) or ineffective (content-based) in preparing secondary school teachers of mathematics and the impact on the development of the country. Similar to what is documented in the MoE (1996), the American Commission on Teacher Education (1996) observed that the quality of a nation entirely counts on the quality of the education level of its citizens. Furthermore, the quality of the nation's education system totally depends on the effective preparation of its teachers. This clearly explains what quality mathematics teacher education curriculum can do to the teachers of mathematics, learners and the entire nation at large.

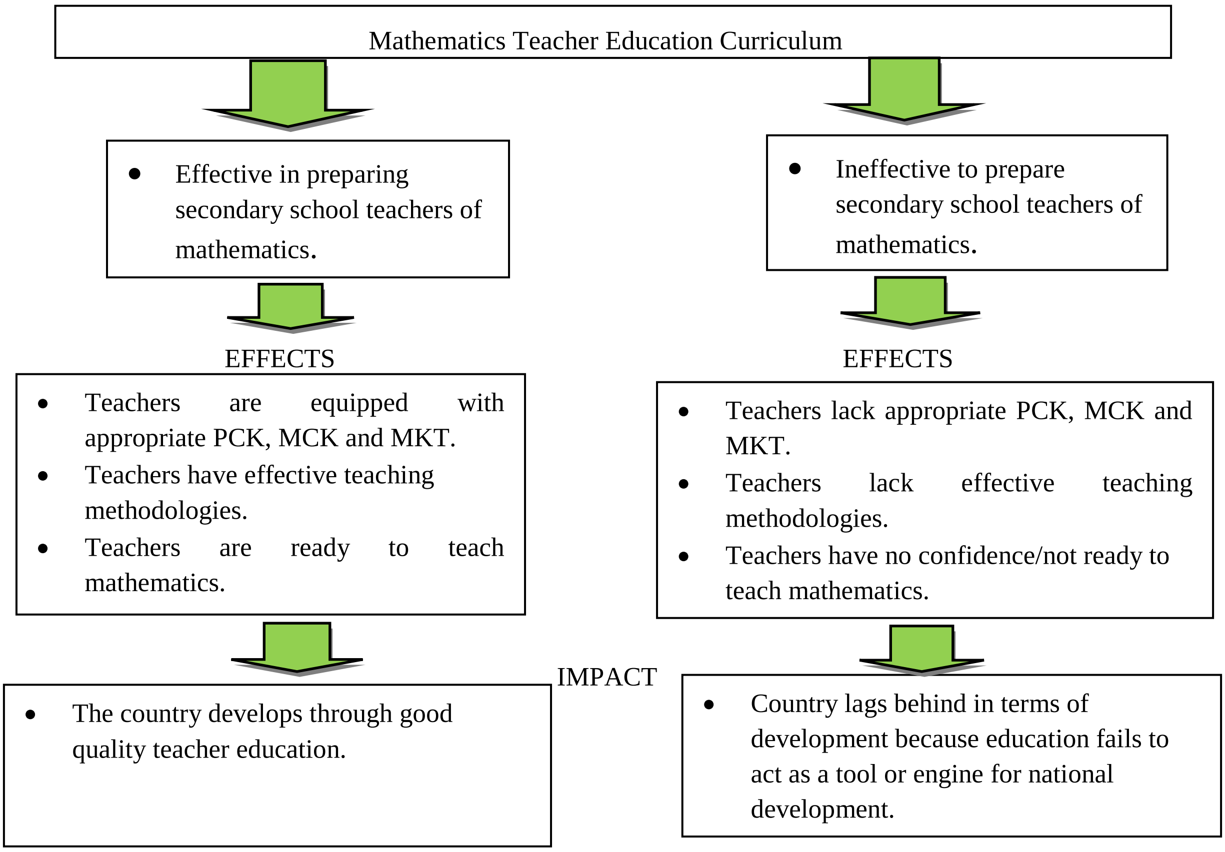

Figure 1.1: *Conceptual Framework*

Effectiveness in this study is defined as the ability of the educational programme to accomplish its designated purpose. When something is effective, it means it is adequate to accomplish the purpose. Ogula (2002: 20) argued that “effectiveness measures the degree of attainment of the pre-determined objectives of the project.” Table 1.3 shows the outline of the attributes of effectiveness that had guided the researcher to determine the effectiveness of the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics.

Table 1.3: *Attributes of Effectiveness*

S/N	ATTRIBUTES	BRIEF GUIDELINE QUESTIONS PERTAINING TO THE ATTRIBUTES
1	Relevance and appropriateness of mathematics content courses to secondary school mathematics.	▪ Is there any link between the content courses offered at UNZA and the mathematics taught in secondary schools? ▪ If there is no link, does the disparity affect the way teachers teach classroom mathematics?
2	Relevance and appropriateness of mathematics methods courses to the teaching of secondary school mathematics.	▪ Are UNZA products able to appropriately use teaching methods that can bring about mathematical conceptual understanding? ▪ Do the methodology courses offered at UNZA help teachers to teach secondary school mathematics well?
3	Ability of student teachers and teachers of mathematics to ask productive questions in mathematics lessons and class tests.	▪ Are student teachers taught good questioning techniques in setting class tests as well as in the teaching and learning of classroom mathematics that can bring about subjective learning?
4	Relevance and appropriateness of teaching experience.	▪ Is the period for teaching experience appropriate for student teachers to have relevant hands on practical experiences?
5	Preparation and use of professional documents.	▪ Are student teachers and teachers of mathematics able to analyse the secondary school syllabus and put it to good use? ▪ Are the student teachers and teachers taught how to prepare and use professional documents such as: schemes of work, records of work, lesson plan, etc.?
6	Ability of teachers to select appropriate learning activities and teaching and learning aids.	▪ Are UNZA products able to select appropriate learning activities, teaching, and learning aids?
7	Confidence of student teachers and teachers to teach secondary school mathematics.	▪ Are UNZA student teachers and teachers confident enough to teach secondary school mathematics appropriately? ▪ How is the teachers' knowledge of the subject matter?
8	The type of theoretical approach to curriculum development used by the curriculum designers when developing the programme (either content-based or competence-based).	▪ Did the designers of the mathematics teacher education curriculum at UNZA use content based or competence based teacher education curriculum theoretical approach?

1.9. Significance of the Study

It is the wish of the researcher that through observing some classroom mathematics lessons, interviewing the National Standards Officer for mathematics, lecturers of mathematics as well as through the use of questionnaires amongst students and teachers of mathematics, the study has brought out findings that may contribute to the existing literature on the preparation of teachers of mathematics globally and on mathematics teacher education curriculum at UNZA in particular. The study may have direct implication in the way trainee teachers are handled during their teacher education programme not only at UNZA but also in many universities and colleges of education. Additionally, the results of the study may play a key guiding role to the Ministry of General Education, Ministry of Higher Education, teacher educators, university and College of Education administrators on how secondary school teachers of mathematics are prepared for effective teaching of classroom mathematics. Education researchers may also use the results to build on many more studies that might be carried out on teacher education curricular in various institutions of learning. This may in turn strengthen future efforts in preparing secondary school teachers of mathematics who will effectively serve the Ministry of General Education through delivering of quality mathematics education in the classroom.

1.10. Delimitations

The study was confined to the University of Zambia and ten selected secondary schools in Lusaka district. The reason for this scope of study was firstly, the University of Zambia is the first highest institution of learning in Zambia and most of the teachers of mathematics in most secondary schools in Lusaka district were products of the mathematics teacher education curriculum offered at UNZA. Secondly, most lecturers in most Zambian universities and Colleges of Education were products of the University of Zambia. Based on this information, the researcher was confident that data would be collected from the right respondents.

1.11. Limitations

1. The study would have been further enriched if there was an inclusion of student teachers' assessment test based on secondary school mathematics. This could have shown whether student teachers were able to solve and evaluate some secondary school mathematics which they were expected to go and teach after going through the mathematics teacher education curriculum at UNZA. This was not done because of the busy schedule of student teachers who were preparing for their continuous assessment tests in various courses as well as the researcher's limited time in which to conduct the current study. However, the researcher had to rely on the data collected from the use of questionnaires. Third year student teachers were not involved in the study because during the time of data collection they had not done their school teaching experience.

2. Although the researcher had involved teachers who had left the University and had

taught secondary school mathematics for several years, lesson observation that was done could have been influenced by several years of their teaching experience and a number of school in-service activities that they were engaged in such as lesson study cycle through Continuing Professional Development (CPD) programmes. This was taken care of by triangulation in the research process.

3. This study would have been all-inclusive if it had involved all the universities which offer mathematics teacher education programmes in Zambia. Due to limited time available, the researcher could not carry out a study of such a magnitude. This restricted the results of this study to be generalised beyond the population of the study.

1.12. Operational Definition of Terms

To ensure uniformity and understanding of this study, the following definition of terms used in the study have been provided:

Effectiveness: The ability of the educational programme to accomplish its designated purpose.

Teacher Education: The concept that describes the complete process of developing and producing a trainee teacher in various ways of facilitating and managing the teaching and learning processes.

Curriculum: All the planned learning experiences offered to the learner or student under the guidance of the educational institution.

Mathematical Content Knowledge (MCK): Specialised body of knowledge that helps the teacher to assess learners' mathematical thinking in order to offer appropriate guidance.

Pedagogical Content Knowledge (PCK): A skill that enables the teacher to present the fundamental mathematical concepts and teaching methods to the learner in a comprehensive manner.

Mathematical Knowledge for Teaching (MKT): The body of mathematics that is important for teachers to know in order to be able to successfully manage the mathematical demands of their professional practice in classroom.

Situational Analysis: The process that involves comprehensive understanding of knowledge and skills contained in the subject to be taught which exist in the learning environment where the curriculum is to be introduced.

1.13. Summary

In chapter one what has been presented is the background of the study which has set the context of the study and a justification of why this study was important to be carried out. The background led to the description of the statement of the problem. Furthermore, the researcher explained the aim of the study, objectives, research questions, theoretical framework where the study was grounded, conceptual framework, significance of the study, delimitations, limitations and operational definition of terms. The chapter that follows will focus on reviewing of related literature that provided gaps and background to this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview

Literature review has been presented according to the following themes: basic information on three major Zambian educational policy documents on the role of the teacher, meaning of teacher education, mathematical content knowledge (MCK), pedagogical content knowledge (PCK), mathematical knowledge for teaching (MKT) and effective preparation of teachers of mathematics.

The researcher intended not only to examine literature on studies done in Zambia which had provided the gap for this study, but also to consider studies done outside Zambia in order to address the research objectives. Studies done in Zambia were used to provide specific background to this study. Additionally, studies done internationally provided additional general background as well as helped the researcher to compare various research findings on how teachers of mathematics were prepared to effectively teach secondary school mathematics.

2.2. Basic information on three major Zambian educational policy documents on the role of the teacher

Since independence, the education system in Zambia has been guided by three major educational policies namely; "*The Educational Reform* of 1977," "*Focus on Learning* of 1992" and "*Educating Our Future* of 1996."

In the Educational Reform document, teachers were considered as key human resource in the entire educational system and programme of the country (MoE, 1977). Hence, teachers were entrusted with the responsibility of communicating desirable knowledge in a manner that could help learners to develop both the desire and ability to learn. This called upon teachers to possess subject matter knowledge for teaching and to effectively establish the learning needs of the learners and assess their educational progress as a way of helping them realise their hidden potential and eventually achieve them. Based on the teacher education curriculum, in the 1977 *Educational Reform* it is documented that;

> *The curriculum should concentrate on enabling trainee teachers to understand the objectives of the school curricula and the underlying principle of learning in the choice and use of teaching materials* (MoE, 1977: 67).

As earlier stated in the background, to maintain quality in the provision of secondary education, the 1977 Educational Reform document empowered degree holders to be teaching all the grades in secondary schools according to their area of specialisation while teachers with diplomas were to teach at the junior secondary section. This did not work very well due to few or no teachers with the university degrees in most Zambian secondary schools as a result diploma holders were also asked to teach at senior secondary section (MoE, 1977). Studies carried out by Avong (2013) and Okafor and Anaduaka (2013) have revealed that teachers' qualifications and ill-prepared teachers make teachers ineffective to appropriately teach secondary school mathematics which eventually affects learners' performance. According to ECZ (2016: 3) "performance of learners in mathematics at all levels over the years, has been poor. The major challenge faced by most learners is a lack of masterly of content." ECZ (2015, 2016) recorded that learner performance in mathematics and science had continued to pose challenges to candidates with higher proportions of candidates failing the subjects at 51.64 and 46.64 per cent in 2014 examinations, 50.6 and 48.6 per cent in 2015 examinations respectively. In terms of the mean score percentages for some selected subjects, refer to figure 2.1 below:

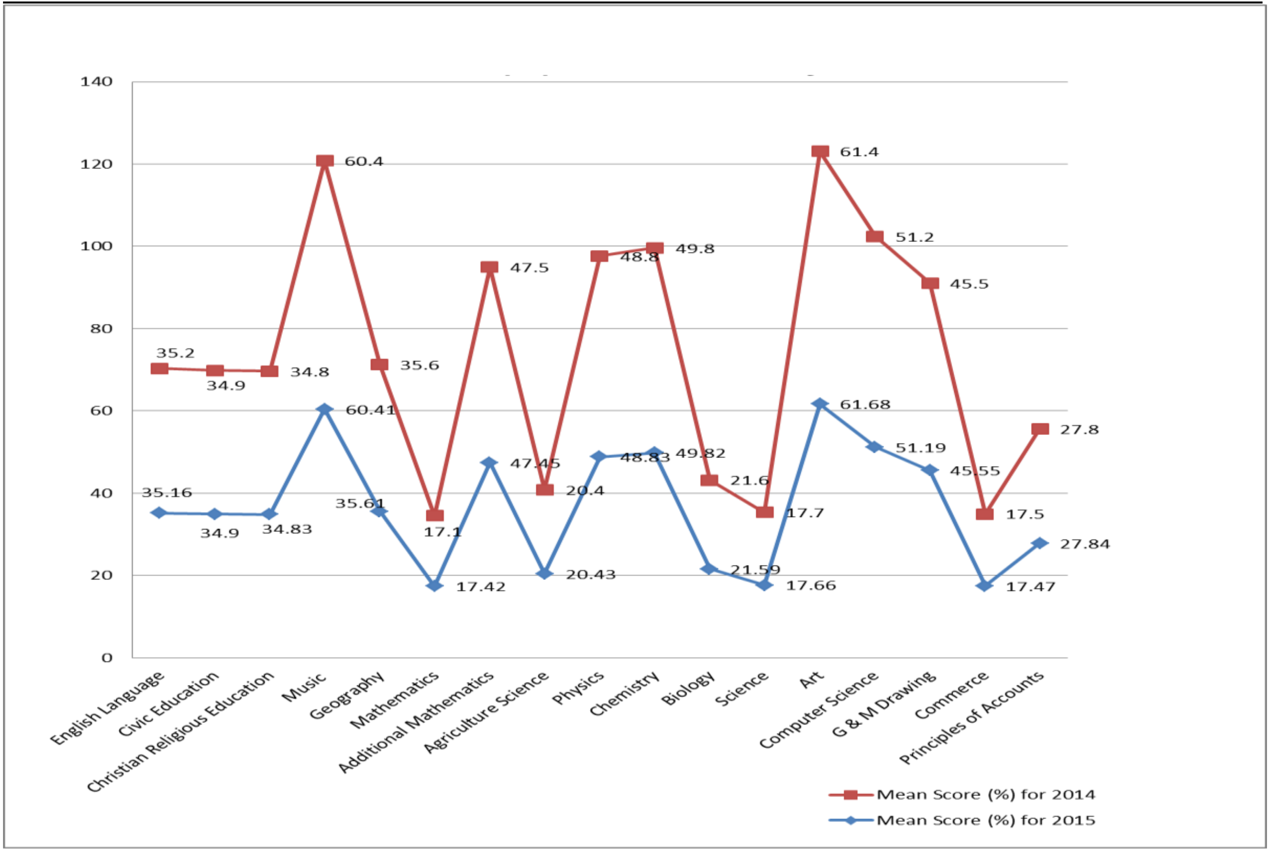

Figure 2.1: *Examination Results for 2014 and 2015 Mean Scores (%) in Selected Subjects*

The findings and assertions by Avong, Okafor and Anaduaka as well as the Examinations Council of Zambia made the researcher to critically scrutinise the mathematics teacher education curriculum at UNZA.

The second educational policy document *Focus on Learning* 1992 also considered teachers as leaders in every society as far as where the development and formation of the future generation of adults was concerned. This was based on the teachers' capability to teach learners relevant and desirable knowledge, values, attitudes and skills. Based on the expected quality of teachers graduating from colleges and universities, the MoE (1992:97) observed that;

> *The quality of Zambian's schools reflected the quality of the teachers manning these schools, while the quality of the teachers reflects the effectiveness of the institutions that train them. The focus of concern in an effective teacher education institution is on transforming its students into competent and committed teachers. The programme for teacher education, therefore, must be kept under constant review to ensure that it responds to the real needs of Zambian schools.*

The aspect of the quality of teachers reflecting the effectiveness of the institution that trained them motivated the researcher to carry out this study at UNZA because UNZA is the first highest institution of learning in Zambia and teacher education has been among the programmes offered at the institution. In the same document MoE (1992) it is clearly stated that schools need to have enough teaching and learning resources for both teachers and learners for the appropriate teaching and learning process. Its emphasis on quality and constant reviewing of the teacher education curriculum in order for education to effectively address the real needs of Zambian schools made Focus on Learning to be of great importance to the Zambian education system and particularly to this study.

The policy document, *Educating Our Future* of the MoE (1996) has some things in common with Focus on Learning as it emphasises on the need for an education system to bring about good morals, values, knowledge, attitudes and skills. In the same document it is explained that everything that learners learn in schools need to be related to real life situations. As a way of relating theory to practice, it is emphasised in the document that active participation of employers in curricular development for higher institutions of learning is important. In *Educating Our Future* (MoE, 1996: 29) it is stated that the aim of school education "is to promote the full and well-rounded development of the physical, intellectual, social, affective and spiritual qualities." In order to have this attained, competency in every teacher in mastering the material to be taught and a skill in communicating that material to the learners is cardinal. This could be the reason why the quality and effectiveness of an education system heavily depends on the quality of its teachers' competence, commitment and resourcefulness (MoE, 1996).

The advancement in technology has brought about a number of changes in the way of doing things and understanding the world. According to the MoE (1996: 96) "the speed with which knowledge and techniques are growing requires that the curriculum for higher level institutions be regularly updated. Failing this, the world for which students are prepared will be the world of the past, not that of the future."

It was not clear whether the mathematics teacher education curriculum at the University of Zambia had been effectively responding to the country's needs and aspirations so that well motivated, committed, competent and high quality teachers of mathematics are produced. This is what the current study tried to explore.

2.3. Teacher Education

Mulenga (2015) explained that teacher education and teacher training are two terminologies that are interchangeably used by many writers. Mulenga's observation is very true as teacher training may involve teaching specific skills to student teachers for the short period of time. Teacher education on the other hand takes a reasonable period of time and encompasses several skills, knowledge, values and attitudes that make trainee teachers effective and competent when they graduate as teachers (Mulenga, 2015). According to NCTE (1998) teacher education is a programme that is related to the development of teacher proficiency and competency that would enable and empower the teacher to meet the requirements of the profession and face the challenges therein.

Scholars such as Turney (1977) argued that teacher training was slowly being substituted by teacher education after realising that effective preparation of teachers involved much more than what was involved in teacher training. This could be one of the reasons why most of the teacher training colleges in Zambia are now being addressed as colleges of education. The basic principle behind this fact is that classroom teachers are expected to undergo teacher education not teacher training because they are prepared to teach and handle human beings who are complex and have the intellect. This clearly indicates that teacher training had very narrow goals with limited scope which focused only on skill training**.** This has been supported by Mulenga (2015) who asserted that teachers who are prepared through teacher education are expected to master their subject matter as intellectuals and professionals. It was in this view that he considered teacher education as a concept that describes an all-round development of a person who is an intellectual, skilled and reflective practitioner of the teaching and learning process.

Teacher education as stated earlier is made up of teaching skills, pedagogical theory as well as professional skills. Teaching skills involve exposing student teachers to techniques, approaches and strategies that would enable them acquire didactic competence (NCTE, 1998). Mulenga (2015) explained in line with the famous scholar of teacher education Darling-Hammond (2004) that educational psychology, educational philosophy and educational sociology should not be left out at any point in every teacher education programme. These disciplines are cardinal to teachers because they provide a sound basis for practising the teaching skills as well as to effectively understand the learning process of learners (pedagogical theory). Furthermore, student teachers are taught professional skills that may include soft skills such as counseling skills, interpersonal skills and above all lifelong learning skills (Khan, 1983; Kohli, 1992).

Additionally, teacher education is based on the theory that teachers are made, not born contrary to the assumption that stipulates that teachers are born and not made. This confusion exists because of the failure to distinguish teaching from telling, helping or showing (Ball & Forzani, 2009; Mulenga, 2015). These researchers have asserted that teachers are exposed to the learning of pedagogical methods in order to acquire relevant knowledge and skills in the art and science of teaching unlike telling, helping and showing which does not demand for any specialised knowledge and skills for classroom work. This somehow contradicted the study by Cohen (2009) who considered teaching to be natural. Mulenga (2015) as well as Ball and Forzani (2009) argument is true in the sense that telling, helping and showing can be done by individuals who have never been to a formal college of education such as: older members of the family, pastors, peers and the so called untrained teachers. Mostly, the kind of helping by untrained teachers is centred on passing of the final examinations not for acquiring of relevant and desirable knowledge, values, attitudes and skills by the learners as demanded by the national school curriculum.

The researcher considered reviewing the concept of teacher education because it is the base of the entire study which the researcher carried out. Based on the explanation given in the previous section, the researcher used the term teacher education in this study to investigate the effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics. The next section will focus on different views of scholars on mathematical content knowledge student teachers were exposed to during their teacher education programme.

2.4. Mathematical Content Knowledge (MCK)

Mathematical content knowledge (MCK) is simply the level of knowledge of mathematics that is expected in the teacher of mathematics. This knowledge can either be effective or ineffective based on the teacher education programme that a particular teacher had undergone. Ma (1999) described MCK as a comprehensive understanding of mathematics which has breadth, depth, connectedness and thoroughness. Several studies that have been undertaken have not suggested what it takes to effectively teach mathematics, they simply talk about the importance of the subject matter knowledge which student teachers of mathematics should be equipped with (Monk, 1994).

Mathematical content knowledge and pedagogical content knowledge (PCK) are two cardinal concepts that are interchangeably used. Fennema and Franke (1992) distinguished the two concepts by stating that knowledge of mathematics and knowledge of mathematics presentations are related to MCK while the knowledge of students and knowledge of teaching are related to PCK. The study in Turkey by Tumuklu and Yesildere (2007) revealed that having a deep understanding of mathematics knowledge is necessary but not sufficient to effectively teach mathematics well. The scholars argued that it is impossible to teach mathematics well without having MCK. Hence, the need for the mathematics teacher education programmes to educate student teachers of mathematics in both MCK and PCK.

The arguments by Tumuklu and Yesildere are very true because having only relevant subject matter knowledge without the knowledge of how to present that knowledge and bring it to the comprehensible level of the learner is worthless. On the other hand, the scholars did not clearly explain what MCK student teachers of mathematics should possess as well as how to effectively teach that knowledge to the learner in a classroom situation. The researcher in this study addressed this aspect as he tried to find out the appropriateness and relevance of content and teaching methods in the mathematics teacher education curriculum at the University of Zambia.

Knowledge is cardinal to teachers and the MCK that teachers should have after the teacher education programme is important for two main reasons, these are: teachers' knowledge influences the mathematical achievement of their learners and the knowledge that student teachers gain may be a key indicator of the success of their teacher education programme (Baumert et al., 2010; Hill, Rowan and Ball, 2005). These researchers could have shown how teacher's knowledge can influence the mathematical achievement of the learner. This study sought to explore teachers', student teachers' and teacher educators' opinion on whether teacher education preparation could affect learner performance in secondary school mathematics.

Other studies done in different countries have indicated that student teachers and teachers of mathematics education lack mathematical content knowledge which also leads to lack of confidence when teaching mathematics (Ambrose, 2004; Kajander, 2005; Tsao, 2005;

Tumuklu and Yesildere, 2007; Norton, 2010 and Hine, 2015). In addition, Hurrel (2013) argued that if society requires effective learning, then effective teaching is necessary and inevitable. It is worthwhile stating that if there is an effective teaching in teacher education programmes, then there could be a likely hood of effective learning of mathematics which may lead to the appropriate acquisition of desirable knowledge, values, attitudes, skills and eventually improved national results in mathematics. Based on these assertions, the researcher in this study wanted to investigate how teachers of mathematics were prepared at UNZA to teach secondary school mathematics.

The United States of America department of Education (2008: 36) noted that "teachers must know in detail the mathematical content they are responsible for teaching and its connections to other important mathematics, both prior and beyond the level they are assigned to teach." In addition, Banner and Cannon (1997: 7) documented that "in order to teach mathematics well they must know what they teach and how to teach it; and in order to teach effectively, teachers must know deeply and well." This equally reflected in Masters (2009) report on the 2008 Queensland NAPLAN performance [Ministerial Council on Education, Employment, Training and Youths Affairs (MCEETYA), 2008: 4] where it was revealed that;

> *Highly effective teachers have a deep understanding of the subjects they teach. These teachers have studied the content they teach in considerably greater depth than the level at which they currently teach and they have high levels of confidence in the subjects they teach. Their deep content knowledge allows them to focus on teaching underlying methods, concepts, principles and big ideas in a subject, rather than on factual and procedural knowledge alone.*

It is clear from what was reported that teachers really need to have the appropriate mathematical content knowledge both on what they are expected to teach and beyond learners' mathematical knowledge. This definitely builds confidence in the teacher but the aspect of how effective this classroom mathematics is taught to student teachers during teacher education programme matters most. The current study assessed the level at which mathematics was taught to trainee teachers and whether it made them ready to effectively teach secondary school classroom mathematics.

The Teacher Education Ministerial Advisory Group (TEMAG) (2014) revealed that the teacher education providers in Australia were not effectively applying the professional standards for teachers. This meant that teachers' preparation for effective classroom teaching was not done according to the expected standards. This could be the same experience that led Mansfield (1985) and Ball and Wilson (1990) to conclude that teacher educators must know how to apply and teach student teachers mathematics that has a direct link to a classroom situation. Besides, Southwell and Penglase (2005) disclosed that in every teacher education programme, MCK is required for PCK to have any comprehensible impact. Such emphasis is in accordance with several researchers' view who strongly argued that student teachers require a firm grasp of MCK in order to facilitate pupils' learning (Whittington, 2002; Wilburne and Long, 2010; Stohlmann, Moore & Cramer, 2013). Besides, the study by Ball, et al., (2003) as well as Chapman (2005) indicated that there is a strong relationship between teachers' MCK and their ability to teach well in classrooms.

Despite having cited a number of arguments by scholars on the teaching and learning of mathematics, the researcher was aware of some of the factors that might have contributed to poor performance of learners in mathematics. Mbugua et al., (2012) and Kafata and Mbetwa (2016) considered student factors which included learners' entry behaviour, motivation and attitude. They also put into consideration the socio economic factors which include the education level of parents and their economic status as well as school based factors which include availability and usage of teaching and learning facilities. The appropriate teaching and learning resources in the teaching and learning of mathematics are important because the process of learning is complete if the sense of hearing is accompanied by the sense of sight (Fatima, 2005).

It is also important to note that different views that learners are exposed to in their environment enables them to establish beliefs regarding mathematics. For example, members of society who have heard negative views about mathematics and have failed mathematics before may consider the subject as something that is very abstract and difficult to learn. Richardson (1996: 103) defined beliefs as "psychologically held understandings, premises or propositions about the world that are felt to be true." It could be the beliefs that learners have towards mathematics that brings about negative attitude towards the subject. For example, most learners lack confidence and interest in the ability to learn and perform well in mathematics (Mutai, 2010). Besides, the belief most societies hold that mathematics is for males and not females make most female learners to approach mathematics with a defeated mind (Ma and Xu, 2004). McLead (1994) asserted that if a learner has a negative attitude towards mathematics, this will negatively impact upon his or her learning. This assertion is supported by Mutai (2010) who explained that there was need to consider a successive connection among attitudes, learning, performance and practical utility of mathematics.

Although studies that have been cited have pointed out some of the factors that lead to learners' poor performance in mathematics, the researcher considered the mathematics teacher education curriculum as a major factor to be scrutinised. If there is lack of clear emphasis on how teachers of mathematics are supposed to develop mathematical concepts in the mind of a learner as well as the failure to bridge the gap between theory and practice during teacher education programme, the result might be having trained teachers without competence in teaching what they were trained to teach (Idowu, 2015). A well-designed mathematics teacher education curriculum would be in a likely position to prepare competent teachers of mathematics who may find a better way of addressing some of the beliefs and attitudes learners might have on the subject. In addition, the ineffective mathematics teacher education curriculum may produce unqualified teachers who may not be in position to do their job appropriately (Avong, 2013; Okafor & Anaduaka, 2013). The final result is possibly having learners who have phobia for the subject in their entire school lifetime. The issues addressed by different scholars enabled the researcher to look at the appropriateness of the mathematics teacher education curriculum at the University of Zambia.

Most of the studies that have been done so far have shown that student teachers including graduates whose major teaching subject is mathematics had gaps in their content knowledge in knowing how to apply and teach the secondary school mathematics (Mansfield, 1985; Ball and Wilson, 1990; Monk, 1994 and Bryan, 1999). These findings have been supported by scholars who argued though from a general perspective that most teachers lacked either adequate background knowledge in the subjects they were supposed to teach or enough skills that were needed for them to teach effectively which eventually affected the teaching and the learning process (Shulman, 1987; National Research Council, 1996 and 1997; Darling-Hammond, 2000; Roofe and Miller, 2013). The scholars' assertions may lead to question the effectiveness and practicability of the mathematics teacher education curriculum to the classroom situation.

Besides, the National Commission on Teaching and America's Future (NCTAF) (1996, 2003) revealed that a good teacher is judged by the possession of a deep knowledge base of the subjects he or she is prepared to teach in order to effectively work with the learners. The deficiencies that were noticed in teacher education curricula could be the thing of the past if teacher educators ensured that every student teacher of mathematics, before going into the actual teaching, is equipped with a sound and coherent knowledge of the mathematics appropriate to the level he or she is expected to teach. Matthew, Rech and Grandgenett (2010) asserted that mathematical content courses in teacher education are an effective way of enhancing the mathematical knowledge that elementary teachers might require for their classroom mathematics. Despite all these arguments, the question that still remains unattended to is how effective are the mathematics content courses in preparing secondary school teachers? This was what the researcher through this study sought to establish at the University of Zambia.

It should be pointed out that as long as teachers continue having the above mentioned gaps of MCK and PCK in their teaching, the quality of mathematics to be taught and above all the quality of education is likely to be compromised. Mulenga (2015) argued that the quality of teacher education curriculum designing, determines the quality of the teacher who graduates from such a programme. This means that the way the mathematics teacher education curriculum is designed at UNZA determines the quality of its products. Furthermore, based on teachers of history graduating from UNZA, Chabatama (2012: 14) asserted that "there seems to be no link between knowledge and skills the graduates from UNZA go with and the school syllabuses." This clearly shows that there is no point in teacher education programmes to graduate thousands of teachers of mathematics at the expense of quality. In this line of thought, Goma (1984) offered a caution;

> *If the University of Zambia is to make meaningful contributions to the development of our country, it cannot do so from a position of mediocrity. If the training of its graduates is poor in quality, their contribution to society will be inferior and counter-productive. It is therefore essential to demand excellence in the performance of both the staff and the students of the university ...to establish an intellectual and actual strength...to stand apart from sheer utilitarianism* (Goma, 1984: 71).

Goma's argument is very valid and fits well in this study because if the nation continues asking for graduate teachers of mathematics who are incompetent to teach secondary school classroom mathematics, the results would be counter-productive in several areas of national development where mathematics is always essential for programmes such as: engineering, economics and many more business studies. Besides, countries that have invested in science and technology like China and United States of America have greatly developed and mathematics is a science that cuts across all areas of technology (Kafata and Mbetwa, 2016). This was one of the reasons this study explored the effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics.

In different colleges and universities in the United States of America as well as Europe, research has shown that teacher education programmes had been criticised for equipping student teachers with content knowledge that had little or no bearing on the real classroom situation (Korthagen et al., 2006; Grossman and McDonald, 2008; Ball and Forzani, 2009; Ball and McDiarmid, 2010; Lampert, Beasley, Ghousseini, Kasemi and Franke, 2010). Besides, Hodgson (2001: 509) asserted that within teacher education programmes, student teachers of mathematics "have no explicit occasion for making connections with the mathematical topics for which they will be responsible in school, or looking at these topics from an advanced point of view." Such a problem tends to exist as a result of teacher education curricula designers' failure to bridge up the gap between theory and practice.

In trying to explain different forms of curricula, Chishimba (2001: 15) revealed that content based teacher education curriculum "is that follows a common curriculum which is based on the traditionally accepted subject divisions which does not take into account the link that exist between theory and practice in teaching." Shulman (1987) explained that such kind of a curriculum is mostly developed without the consideration of what student teachers are taught during teacher education programme and what they are expected to present to their learners in classrooms. After a critical analysis, Mulenga (2015) in his doctoral study which was based on designing of the English language teacher education curriculum at UNZA noted that the gap that was created between theory and practice made the preparation of secondary school teachers to be ineffective. Could this be the same situation with the mathematics teacher education curriculum at UNZA? This was what the researcher in this study sought to establish.

Considering the role of teachers in every part of the world, content-based teacher education curriculum seems to have serious repercussions in teacher education programmes. Such a curriculum is likely to defeat one of the greatest aims of education that is "promoting the full and well-rounded development of the physical, intellectual, social, affective and spiritual qualities" (MoE, 1996: 29). Besides, the Zambian education system would fail to act as the engine for the development of the nation.

In addition to content based teacher education curriculum, Bowles (2012) revealed that Competency Based Teacher Education (CBTE) approach to curriculum design shows specific competencies to be acquired by the student teachers. Chishimba (2001: 16) amplified further by stating that "the competency based teacher education approach to programme development ensures that the competencies to be learnt and demonstrated by student teachers are specified in advance." Looking at Bowles' and Chishimba's views, Mulenga (2015) explained that competence based teacher education approach to curriculum development can be effectively implemented through conducting a job or situation analysis. He further stated that to avoid gaps in the subject content taught in secondary schools and teacher education programmes at UNZA, job analysis was the solution.

Currently, there are so many worries as to why learners have continued failing mathematics in Zambia despite being taught by teachers who are degree holders. Could it be that the mathematics teacher education curriculum at the University of Zambia had been designed using the content based or the competency based teacher education theoretical approach? The studies by Chishimba (2001), Bowels (2012) and Mulenga (2015) were worth being considered in this study for they provided the basis for finding out if at all this was the case for the mathematics teacher education curriculum at UNZA.

2.5. Pedagogical Content Knowledge (PCK)

Shulman (1987) looked at pedagogical content knowledge (PCK) as an important aspect of teaching that allow teachers to effectively relay and make the subject matter and curricula knowledge comprehensible to learners. Besides, Park and Oliver (2008: 264) considered PCK as;

> *Teachers' understanding and enactment of how to help a group of learners understand specific subject matter using multiple instructional strategies, representations and assessments while working within the*

contextual, cultural, and social limitations in the learning environment.

The scholars cited above are very right because PCK comes in as a result of good understanding of mathematical content knowledge by the teacher. It is only the teacher with the good subject matter who may find better means of making his or her subject comprehensible to his or her learners of different abilities. This could be one of the reasons both Shulman (1986) and Chick (2012) considered MCK and PCK to be a well-integrated parts of an effective mathematics instruction.

It should be stated that knowing and understanding mathematics and having the skill of how to effectively teach it to learners are two different things. In addressing this concern, Shulman (1987) identified three aspects of pedagogical reasoning and these are: comprehension where the teacher first need to understand the set of ideas to be taught and how they are related to other ideas within the subject and other subjects. The second stage is making sure that the comprehended ideas are transformed into a well arranged manner if they are to be taught and learnt. The third stage involves reflection. This is where teachers are expected to look back at the teaching and learning that has occurred and reconstructs. In order for Shulman (1987) to articulate and justify his findings, he laboured to respond to four questions stated below:

(i) What are the sources of knowledge base for teaching?
(ii) In what forms can these sources be conceptualised?
(iii) What are the processes of pedagogical reasoning and action?
(iv) What are the implications for teaching policy and educational reform?

The study by Shulman influenced educational practitioners, scholars and policy makers on how best to understand teaching as well as how teachers were to be trained and evaluated. Despite this study being very good, it however leaves a gap for it did not target specific subject in teacher education for effective preparation of teachers. It was the task of this study to contribute to this gap with a focus on mathematics.

The continued poor performance of learners in mathematics had brought about doubts on whether student teachers of mathematics were effectively taught methodology courses. ECZ (2016) documented that the poor performance in mathematics at all levels could be partly accredited to the way teachers mark classwork and provide feedback to the learners.

According to the study by Luangala and Mulenga (2011) the lesson or lessons are said to be taught if learning has taken place amongst the learners. The results of well taught and learnt lessons can be seen through learners' change in behaviour which may be in terms of: values, attitudes, knowledge, skills as well as performing well in various modes of assessments. The researcher in this study had to find out the relevance attached to methodology courses trainee teachers of mathematics were exposed to during their teacher education programme at UNZA.

Additionally, the study by Shulman (1987) revealed that teachers who are ready to teach do not only manage their classrooms very well but also need to manage different issues within class dialogue. He strongly argued that teaching should not be reduced to knowledge transmission from an active teacher to a passive learner but it must involve learners' learning how to understand and solve problems, learning to think critically and creatively as well as learning facts, principles and rules of procedure. In his doctoral study Mulenga (2015) explained just like Shulman that a teacher with PCK would know how to effectively sequence the teaching and learning materials and formulate very good questions that probe for alternative views. This means that for the learner to effectively learn something from the teacher, the teacher has a responsibility of understanding what is to be learnt and how it is to be taught bearing in mind learners' misconceptions as well as their ways of thinking. Besides, the teacher with very good subject matter knowledge and PCK is likely to analyse the mathematics syllabus for him or her to logically and psychologically sequence the topics (Zapata, 2005). Logical sequencing involves the teacher to critically analyse the topics and justify why a particular topic should be taught earlier than the other while in psychological sequencing the teacher has to decide on whether his or her learners would understand if a particular topic is taught earlier than the other (Zapata, 2005). In the latter, the decision is based on the learners' abilities.

Despite the above cited scholars having not looked at mathematics teacher education curriculum, the current study considered their work to be vital in every teacher education programme. These studies however, did not show whether teachers' inability to critically analyse the syllabi and effective sequencing of teaching and learning materials can affect learners' performance in secondary schools. This was also one of the areas this study tried to explore.

The importance of a teacher education programme cannot be overemphasised as studies in the United States of America (USA) and many other countries had indicated. Ball and Forzani (2009) explained that teachers are key to the learning process of learners and the improvement in learners' learning counts on how teachers are prepared and supported in terms of MCK and PCK. The scholars argued that the initiatives that were taken in USA which focused on teacher recruitment and retention as well as developing of new pathways to teaching were inadequate without deep-rooted renovations to the professional teacher education curriculum. This could be the same situation in Zambia today where currently the two career pathways have been introduced in schools and teachers have been recruited in most subjects. The question which may require a response is that is there any critical analysis that has been done on the effectiveness of the mathematics teacher education curriculum at UNZA to address such an urgent challenge? In the following section, the researcher presents different views from the reviewed literature on the type of mathematical knowledge that different scholars felt was better for the classroom teacher of mathematics.

2.6. Mathematical Knowledge for Teaching (MKT)

Mathematics is one of the most interesting subjects that should be enjoyed by both the teacher as well as the learner. Kajander (2010) carried out a study at Lakehead university on pre-service teachers using a pre-test and post-test survey of procedural and conceptual knowledge of mathematics expected by elementary teachers. His research findings showed that pre-service teachers were weak in conceptual understanding of basic mathematics concepts needed for teaching. The researcher also pointed out that there was lack of consensus in the literature as to what student teachers needed to know about mathematics in order for them to teach it well to the learners. The study by Kajander is important to the current study as it pointed out the weaknesses in student teachers' conceptual understanding of basic mathematics concepts for effective teaching. However, Kajander's study left a gap for this study for he did not clearly specify what had led to those weaknesses in student teachers of mathematics. This was one of the issues this study addressed.

In addition, Gadanidis and Namakasa (2007: 17) argued that "the starting point for mathematics education for student teachers should be a sophisticated and deep exploration of mathematics." However, the scholars did not specify how sophisticated and deep this mathematics should be. Despite a number of scholars having not agreed on what it takes to teach mathematics very well, Grossman (1990) asserted that the mathematical knowledge to teach teachers during teacher education programme for their effective success in classrooms needed to be scrutinised.

Several studies that have been done outside Zambia have indicated that the mathematics content and pedagogical knowledge which teachers learnt during teacher education programme was normally not the knowledge most useful for teaching secondary school mathematics (Ball and Bass, 2000; Hill, Lewis and Ball, 2000; Graham, Portnoy and Groundmeier, 2002). Based on the scholars' findings, it is clear that no suggestion of what they thought could be the best mathematics content and pedagogical knowledge for secondary school teachers was made. Besides, their findings acted as a basis where the current study was to be grounded as the researcher tried to ascertain the effectiveness of MCK and PCK that student teachers of mathematics were exposed to at UNZA as they were being prepared to teach secondary school mathematics.

In addition, Ball, Thames and Phelps (2008) argued that despite the concept of PCK being widely used, it lacked clarity of definition and its potential had not been fully realised. This view had received enormous support by Schneider and Plasman (2011). Due to lack of the right direction on the type of mathematics content and pedagogical knowledge in teacher education that could produce an effective classroom teacher of mathematics, Hill et al., (2008) commended for the construction of mathematical knowledge for teaching (MKT) which came as a result of scholars' effort of trying to expand on Shulman's construct of PCK. This kind of mathematics has been described as the most influential and reconceptualisation of teachers' PCK within mathematics education (Depaepe, Verschaffel and Kelchtermans, 2013).

Besides, Hurrel (2013) appreciated the good work by Shulman (1986) on PCK and Hill et al., (2008) regarding MKT. His article however, aimed at arguing for reconceptualisation of Hill et al., (2008) PCK model on MKT to make it as informative as possible for teachers and teaching. He felt that it was unreasonable to suggest unclear MKT as a way of improving teacher effectiveness. He came up with some reservations regarding Hill et al.'s (2008) model. He argued that the "line" between the common content knowledge (CCK) and the specialised content knowledge (SCK) was not clear and it was difficult to tell where one domain ends and where the other one begins. Secondly, he noted that the sizes of the regions occupied by each of the domains were different and it was not clear whether the differences in the areas occupied by each domain represented the degree of importance of the respective domain. Thirdly, Hurrel (2013) criticised the use of the term pedagogical content knowledge (PCK) by Hill et al., (2008) to describe the domains regarding pedagogical concerns. He felt that the scholars could have used pedagogical knowledge (PK) because of the strong argument that PCK only occurs at the overlap between the subject matter knowledge (SMK) and PK. The fourth and the final reservation he made was that the model did not clearly show the degree of interactions amongst the domains. However, Hurrel in the third reservation he overlooked the importance of content in the teaching and learning process. It is inappropriate in the process of teaching and learning to only focus on how to teach (PK) without embracing both how to teach and what to teach (content) hence the importance of PCK.

Through asking of several questions on what constitutes the professional knowledge required for teaching mathematics effectively, Hurrel came up with the revised model to improve teacher effectiveness for MKT after correcting the shortfalls he noticed in the six domains of Hill et al., (2008) model. Ball, Thames & Phelps (2008) described these domains as: common content knowledge (CCK) which is based on mathematics knowledge and skills used in general settings, specialised content knowledge (SCK) which concerns the mathematical skills and knowledge which is particular to teaching, knowledge of content and students (KCS) is the knowledge which emphasises on knowing and understanding both learners and the actual classroom mathematics. Furthermore, knowledge of content and teaching (KCT) is based on the combination of knowing about mathematics and how to teach, while knowledge of mathematical horizon (KMH) and knowledge of content and curriculum (KCC) are regarded as interim placements which may need revision and refinement as both can run across several categories on their own. Figure 2.2 and 2.3 shows Hill et al., (2008) PCK model on MKT and the revised MKT model by Hurrel (2013) respectively.

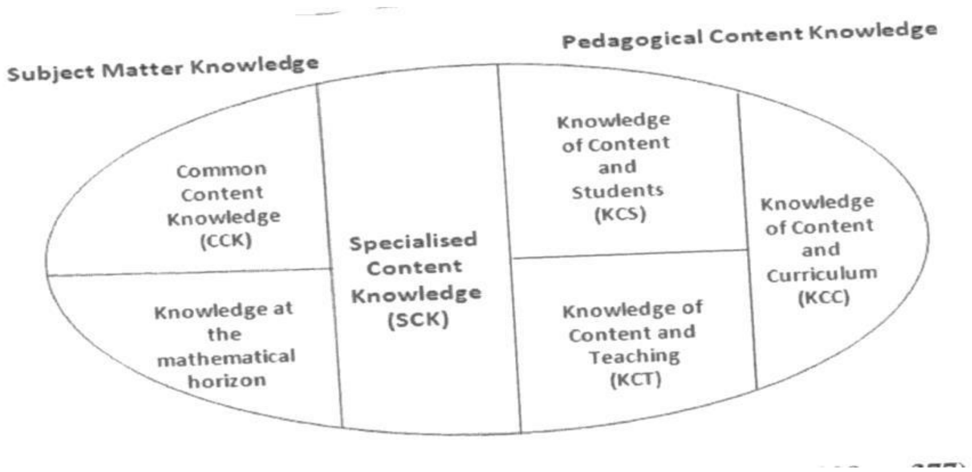

Figure 2.2: *Domains of Mathematical Knowledge for Teaching (MKT) by Hill et al., (2008)*

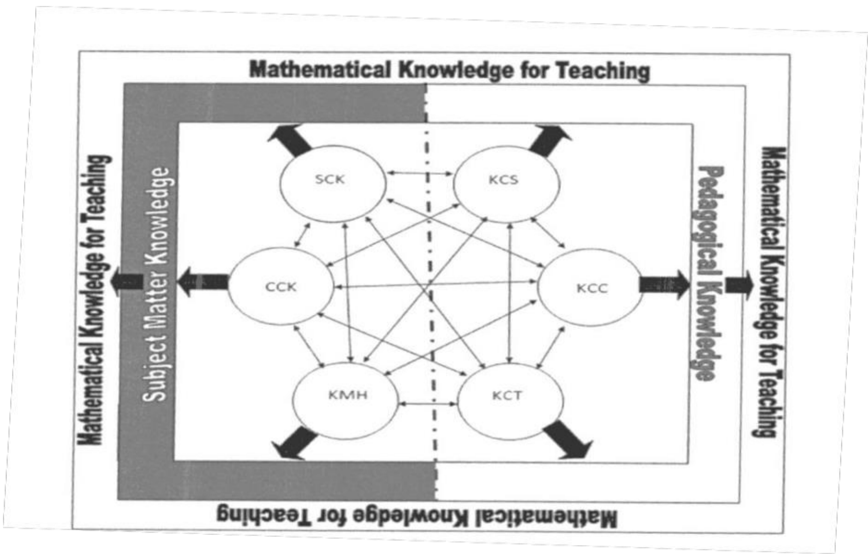

Figure 2.3: *Revised Model for Mathematical Knowledge for Teaching by Hurrel (2013)*

From the two figures 2.2 and 2.3, it is clear that Hurrel (2013) did not bring in the aspect of PCK and the sizes of the region where each domain belonged to are of the same size. Besides, he indicated the degree of interaction amongst the domains through the arrows. He also emphasised that each of the domains is important but circumstance determines which domain or domains have priority.

Hurrel (2013) explained that each of the domains has a cardinal role to play in teachers. He adapted Ball, Thames & Phelps (2008) domains of knowledge and supporting questions where it was revealed that CCK may help teachers in good selection of textbooks for learners and detect mistakes and misconceptions in learners' work. SCK may help teachers to: provide answers to learners' questions that require critical thinking, give real life mathematical examples, sequencing of topics in a comprehensible manner and use mathematical notations and language and critiquing its use. Additionally, KCS may guide teachers to: anticipate what learners are likely to think, anticipate what learners will find interesting and motivating when choosing an example, anticipate what learners will find difficult and easy when completing a task and recognise and articulate misconceptions that learners might have about some mathematical concepts. KCT may guide teachers to select mathematics content and in selecting good examples that would take learners deeper into mathematical content. The scholar further explained that KMH is capable of helping teachers to make connections across the topics in mathematics and articulate how the mathematics that is to be taught fits the mathematics which are yet to be taught. Unlike other domains, KCC may guide teachers of mathematics to articulate the strands of curriculum as well as articulating the proficiencies from mathematics curriculum.

Considering the study by Hill et al., (2008) it may still be deduced that the scholars did not clearly specify the actual mathematics content and pedagogical knowledge that should be taught to student teachers for them to effectively teach secondary school classroom mathematics neither did Hurrel (2013) mentioned where the six domains are supposed to be learnt from by student teachers. What appears to be clear in their studies is that for one to be a competent teacher of mathematics he or she must be capable of interpreting, organising and teaching according to the curriculum as well as being able to understand the learning of the learners and develop their own teaching. The current study had a responsibility of investigating on the intentions of the curriculum designers for the mathematics teacher education curriculum using relevant research instruments to contribute to this gap.

Mathematics Knowledge for Teaching is the body of mathematics that is important for teachers to know in order to be able to successfully manage secondary school mathematics (Andreas et al., 2014). The scholars further argued just like other scholars that the mathematics that student teachers are exposed to in teacher education is neither necessary nor sufficient for secondary school teaching. Hence, the need to have topics which are exactly the same as those taught at a secondary school but give a deeper understanding of the same topics from an advanced point of view. In a similar manner, Davis and Simmit (2006) argued that a common approach for teachers' preparation is to have student teachers to take a set of "stock" courses such as calculus, linear algebra, discrete mathematics and introductory statistics. The arguments by the scholars are very important to the current study.

However, the scholars needed to bring out clearly the actual content and the appropriate level of presenting the material to the trainee teachers. Nevertheless, their contributions were vital to this study as the researcher was trying to find out whether the mathematics teacher education curriculum at UNZA was effectively preparing teachers of mathematics for them to teach well and pupils to learn well classroom mathematics.

Shulman (1987) revealed that MKT cannot just be effective on its own but requires the accompaniment of both the content and pedagogical knowledge. Besides, the MKT helps student teachers to become mathematically proficient and eventually learn to teach in the manner that can equally help their learners to become mathematically proficient (Hiebert, Morris and Glass, 2003). Similarly, Silvernam and Thomson (2008) looked at MKT as the profound knowledge of mathematics and methods of representing it to the learners. This clearly shows that there is need for MCK and PCK in teacher education curriculum to reflect the real classroom mathematics of course with some few advanced mathematical concepts for the MKT to be easily implemented. Fennema and Franke (1992) asserted that the conceptual understanding of mathematics by teachers influence classroom instruction in a positive way, hence the need for MKT. Although the study by Fennema and Franke targeted pre-service primary school teachers of mathematics in United States of America, the study was cardinal to the current study because it provided the background to assess on whether the mathematics teacher education curriculum at UNZA contributed to conceptual understanding of secondary school classroom mathematics amongst student teachers.

Mathematics is perceived by several people to be a difficult subject at both tertiary levels as well as in secondary schools. This is as a result of people associating the subject with the composition of a large set of highly related abstraction. Based on this notion, Fennema and Franke (1992: 153) argued that “if teachers do not know how to translate the mathematical abstractions into a form that enable learners to relate the mathematics to what they already know, they will not learn with understanding.” This clearly shows that mathematics is not a difficult subject but it is not clear on how teachers are prepared during teacher education to enable the translation of the mathematical abstractions. This was what this study tried to investigate on.

Mathematical knowledge for teaching may help student teachers to understand effectively the mathematics they would teach after their teacher education programme. The National

Council for Teacher Quality (2007) revealed that teachers cannot teach what they do not understand and what they do not know. This is supported by several studies that have been done where researchers have argued that everything student teachers are taught in terms of knowledge and skills during their teacher education programme must be in line with the work they are going to do in their respective classrooms (Darling-Hammond, 2000; Chishimba, 2001 and Mulenga, 2015). Similarly, Manchishi (2007) did a study in which he analysed the teacher education programme in Zambia starting from: the pre-colonial era from 1983 to 1923, the colonial era from 1924 to 1963, the post-independence era from 1964 to 2004 and what was to happen in some years to come. In his study, he wondered as to why UNZA which is the first highest institution of learning and the major provider of teacher education had teacher education curriculum which was not in line with the curriculum offered in secondary schools. He questioned that:

> *...how does one expect the graduate teacher to implement the school curriculum which is not in harmony with what they went through?* (Manchishi, 2007: 129).

It is worthwhile at this point to state that what the scholars cited in the above paragraph were referring to, was the need to have a good link in values, skills, attitudes and knowledge that trainee teachers were to acquire during their teacher education programme and the curriculum they were to implement in schools. This means that before designing any educational curricula for teachers, it is important to critically analyse the school syllabi so that there is a good linkage between what student teachers are expected to be taught in tertiary institution and what they are supposed to go and teach in the actual classroom. This could be the reason Mulenga (2015) emphasised on carrying out a situational analysis before designing the teacher education curriculum for it unveils the needed skills and responsibilities that future teachers need for their effective classroom teaching. The study by Chishimba (2001) and Manchishi (2007) did not study the effectiveness of the mathematics teacher education curriculum in preparing secondary school teachers of mathematics, but the observation was based on the general perspective of programmes offered at UNZA, more especially in the School of Education. Additionally, Manchishi never clearly explained the extent of the variance between the university curriculum and the school curriculum as well as how the disparity affected learners in a classroom. The current study assessed whether the mathematics teacher education curriculum designers at UNZA did carry out job analysis when designing the mathematics teacher education curriculum to enhance its effectiveness.

In United States of America, two reports that were released described key issues in mathematics teacher education programme. The report of the National Mathematics Advisory Panel (2008: 21) stated that “teachers must know in detail and from a more advanced perspective the mathematical content they are responsible for teaching.” The point of how advanced the mathematical content should be, needed to be critically analysed and be specified in the report so that this mathematics is not distanced from the actual classroom mathematics. Besides, another report on teacher preparation by the National Council on Teacher Quality (2008:40) revealed that “teachers need to acquire a deep conceptual knowledge of mathematics and demonstrate a deeper understanding of mathematics content than is expected of children.” This is true because teachers need to be more knowledgeable than learners for them to confidently interact with mathematical concepts and in turn guide their learners effectively.

It should be mentioned that when student teachers acquire a deep conceptual knowledge as well as demonstrate a deeper understanding of mathematics, they will have the appropriate coverage and understanding of the classroom mathematics unlike learning mathematics by memorisation (Kajander, 2010). Additionally, Mewborn (2001) in his study ‘ Teachers Content Knowledge, Teacher Education and Effects on the Preparation of Elementary Teachers’ argued that although some pre-service teachers were able to successfully solve mathematical problems, many were unable to explain the concepts and procedures they performed. This is really supposed to make teacher educators worried on the type and relevance of knowledge they teach future teachers who cannot explain the mathematical concepts and procedures well to the learners. This study tried to determine if that could be the same situation with the mathematics teacher education curriculum at UNZA.

The studies done by Kajander (2010) as well as Masaiti and Manchishi (2011) had indicated that during teacher education programme more time was spent on content courses than on methodological courses. From the scholars’ findings it is clear that what to teach is not superior to how to teach the concepts but the two should be considered to be of the same weight. Based on this fact, Chamberlain (2007: 895) argued that “pedagogical strategies that support students’ making sense of the material are cardinal in the teaching and learning process.” In addition, Shulman (1986) noted that what matters in teaching and learning process is not necessarily the content but what the teacher does with the content he or she had acquired. As earlier stated, to make mathematics practical and be learned in classrooms, several scholars support the development of a specialised MKT as part of teachers' development (Ball and Bass, 2003; Ball, Bass and Hill, 2004). These studies provided the vital background to the current study where the researcher wanted to find out whether the mathematics teacher education curriculum at UNZA was in line with such a specialised knowledge of mathematics.

2.7. Effective Preparation of Teachers of Mathematics

The researcher under this section may in a way talk about MCK and PCK which have been discussed already as a way of emphasising and summarising the effective preparation of teachers of mathematics. It is important to mention that effective mathematics teacher education programme cannot exist without the mention of MCK and PCK.

2.7.1. Relevance of the Courses to the Teaching Profession

Several studies that have been done in the United States of America, Europe, India, Zambia to mention but a few had clearly revealed that teacher education preparation programmes in tertiary institutions of learning were not effectively done as they were based on courses that were unrelated to what was actually taught in classrooms (Shulman, 1986; UNESCO, 1990; Ball and Forzani, 2009; Ball, Sleep, Boerst and Bass, 2009; Grossmann, Hammerness and McDonald, 2008; Hodgson, 2001; Lampert, Beasley, Ghousseini, Kazemi and Franke, 2010; Pandey, 2009; Banja, 2012a and b, Chabatama, 2012; Masaiti and Manchishi, 2011; Manchishi, 2013; Hine, 2015 and Mulenga, 2015).

Masaiti and Manchishi (2011) carried out a study titled 'The University of Zambia Pre-service Teacher Education Programme: is it Responsive to Schools and Communities' Aspirations?' In their study they used face to face interviews and focus group discussions amongst UNZA products who were teaching in different Zambian secondary schools in Kafue, Chongwe and Lusaka districts. Data was analysed using constant comparative method from the emerging themes. This means that the study was purely qualitative. The research findings indicated that student teachers at UNZA were exposed to broad content which in some cases were not related to what they were expected to go and teach in secondary schools. In addition, UNZA students had difficulties in terms of teaching methodologies and professional ethics were not part of the teacher education programme. Despite having not singled out a particular teacher education programme offered at UNZA, the study by Masaiti and Manchishi (2011) provided the background to the current study. This study was different for it did not give the general overview of the teacher education programme but the researcher specifically looked at the relevance of the mathematics courses that student teachers were exposed to during their teacher education programme in relation to their future career. Besides, this study enabled the researcher to physically go into the sampled schools to conduct school/lesson observation pertaining to the teaching and learning of mathematics which the cited scholars did not do.

Besides, Hine (2015) carried out a study on mathematics student teachers completing graduate diploma of secondary education at the University of Notre Dame in Australia. The study aimed at investigating on the self-perception of pre-service primary and secondary teachers in a mathematics education unit as they engage with and consolidate their mathematics content using survey. He asked his respondents to complete two questionnaires; one before and the other one after their teaching internship. The research findings indicated that less than half of the respondents he sampled stated that they felt confident in teaching mathematics but the rest of the respondents indicated that there was need to still strengthen both their MCK and PCK. The study by Hine was vital to the current study because of slight similarities in research objectives. However, his study was different to the current study in terms of the context in which it was done, research methods used and the researcher did not venture into explaining whether the university mathematics teacher education curriculum contributed to the student teachers having varying degrees of readiness to teach secondary school mathematics.

2.7.2. Teaching Experience

One of the most cardinal components in every teacher education programme is teaching experience which is in most cases wrongly referred to as teaching practice. According to the Canadian Report (2008) on teacher education and development studies in mathematics, over 60 per cent of the respondents were of the view that the knowledge they gained from their mentors during their teaching experience helped them to improve their teaching methods and they were able to understand the abilities of their learners than what they had learnt during their teacher education programme. Banja (2012b) carried out a qualitative study where he examined the relevance and adequacy of university education to occupational demands. From this study it was revealed that the kind of education students at both the University of Zambia and the Copperbelt University were exposed to was inadequate to meet the occupational demands of the industry. The researcher explained that the kind of education was so theoretical that it did not provide enough hands on practical experiences during university education such as effective peer teaching and reasonable period of teaching experience.

Similarly, Goos (2006: 6) disclosed that the survey carried out by the Australian Secondary Principal found out that “many beginning teachers felt their university pre-service programme had not prepared them adequately for the challenges of the classroom, and that their in-school training was far more effective than anything they learned in university classes.” Furthermore, Bull (1987) who concentrated on the reform of teacher preparation in the state of Washington indicated in his article that schooling and teacher preparation were naturally connected. He was very much concerned about what and how children in schools were taught and in turn, what and how their teachers had been educated during their teacher education programme. From his observation, he concluded that the period for teaching experience in Washington (i.e. 8 weeks) was inadequate for teachers to have good hands on practical experience.

Despite having brought out a number of positive aspects on teaching experience, most scholars cited above such as: Banja (2012b), Goos (2006), Bull (1987) as well as the Canadian Report (2008) did not narrow down their studies to a single programme but gave a general view of the ineffectiveness of the teaching experience.

Major and Tiro (2012) investigated the perceptions of student teachers regarding their teacher education programme in Botswana. They used in depth semi structured interview to collect data from 17 respondents in one Primary College of Education. The study indicated that the teacher education programme did not address the quality and the relevance that was expected to reflect in a trainee teacher as one joins the teaching profession. In addition, the scholars strongly argued that the teacher education programme contributed very little in as far as the development of an effective teacher was concerned. The respondents indicated that too much of time was spent on exploring theory and less time of hands on experience such as teaching experience.

Still based on teaching experience, many research findings have clearly shown that student teachers were not given enough time to do their peer teaching and real life teaching experience in schools. This greatly compromised their didactic competence and denied them hands on practical experience that would make them better teachers when they graduate from the teacher education programme (Ghani, 1990; Darling-Hammond, 2006; Ball and Forzani, 2009; Masaiti and Manchishi, 2011 and Major and Tiro, 2012). The importance of teaching experience is supported by Artique et al., (2001) when they argued that due to time constraints, teacher preparation may not focus on everything that a teacher may require but some aspects can be learnt during the actual practice of teaching. This would then make one to question on how an effective teacher can be prepared if trainee teachers are denied real classroom experience through well organised peer teaching as well as enough period of time for teaching experience. From the scholars' point of view, it would suffice to state that if the university mathematics content is tailored to secondary school mathematics curriculum and the period for teaching experience is prolonged reasonably, better and effective teachers would be produced in several university teacher education programmes.

The studies cited in this section for example, the study by Major and Tiro (2012) concentrated on primary teacher education in Botswana; the findings were general as the study did not target any of the teaching subjects. Besides, qualitative approach was used despite its limitations. This however, made it very difficult to have the research findings generalised to a larger population.

Although the study by Masaiti and Manchishi (2011) involved pre-service and secondary school teachers from UNZA using qualitative approach, the study was general in nature as it touches on several issues and no single subject was entirely studied. These studies were cardinal for the current study to be well grounded. This study was different in the sense that it enabled the researcher to specifically look at the mathematics teacher education curriculum at UNZA. Besides, the study investigated the way teaching experience was organised and done at UNZA if at all it did provide enough time for student teachers to acquire relevant hands on experiences.

2.7.3. Teachers' Readiness to Assume their Teaching Career

Effective teacher preparation requires student teachers to be fully equipped with MCK and PCK which would bring about MKT in a real classroom environment. Tumuklu and Yesildere (2007) did a study in Turkey to determine the pre-service primary teachers' competency of PCK in mathematics. Data was collected by the means of four open ended questions from 45 primary pre-service teachers of mathematics where responses were analysed based on pre-determined criteria. Their findings indicated that student teachers lacked enough MCK and PCK hence, the duo recommended for teacher educators to equip primary school trainee teachers of mathematics with both appropriate MCK and PCK. Their finding is supported by Brown and Borko (1992: 232) who in their study in USA revealed that "novice teachers are sometimes not developmentally ready to assume the roles required of them as good teachers of mathematics."

Similarly, Hurrel (2013) argued that many teachers exhibited weaknesses and lack of a deep conceptual understanding of mathematics. The same findings reflected in the studies done by: Ball, Hill and Bass, 2005; Hill et al., 2008; Ma, 1999 and Tsao, 2005. All these findings are very important for any teacher educator to critically look at them so that no teacher education institution in future will simply be in a hurry to graduate incompetent teachers of mathematics. This could be the reason Grouws and Schulz (1996) emphasised on exposing teachers of mathematics to various ways of thinking so that their teaching can be based on existing mathematical conceptions and misconceptions of the learners.

Despite studies done by Tumuklu and Yesildere (2007), Brown and Borko (1992), Hurrel (2013) and many more others that have been cited gave good affirmation on mathematics teacher education, the scholars did not clearly explain on what led to: lack of enough MCK and PCK in pre-service teachers, trainee teachers exhibiting weaknesses and lack of conceptual understanding of mathematics as well as unpreparedness of trainee teachers to assume the roles required of them as good teachers of mathematics. These were among the gaps this study sought to offer some contributions though from the Zambian context.

The importance attached to teacher preparation was noted in the study done by Ball and Forzani (2009). The scholars argued that student teachers need to be effectively prepared for them to teach well because teaching is unnatural. They explained that effective teaching requires the acquisition of specialised values, attitudes, knowledge and skills. Cohen (2009) considered any other forms of teaching to be informal as they mostly involved showing, telling or helping as earlier stated. In addition, Ball and Forzani (2009: 509) pointed out that "there is need for the general public to acknowledge that teaching is hard work that many people need to learn to do well, and build a system of reliable professional preparation." Based on these assertions, this study investigated student teachers' acquisition of appropriate competencies for teaching secondary school mathematics.

Considering the role of teacher educators in teaching mathematics to student teachers, Shulman (1987: 406) noted that;

> *Whether we call ourselves Professors of education or Professors of mathematics, to the extent that in our classrooms day after day sit men and women who subsequently go out and teach youngsters, we are teacher educators. To the extent that they are likely to teach both what and as they have been taught, unlike any other subjects in your classes, the future teachers are, if you will, carriers. Whatever understandings or misunderstandings you infect them with, both about the content and regarding the pedagogy, they will carry to generations of young people whom they will subsequently teach, and who themselves will eventually appear at your doorstep.*

The argument by Shulman is very valid because if teachers are not effectively prepared they are expected to teach wrong concepts to the learners and learners will proceed to tertiary institutions of learning with the same wrong concepts. Besides, researchers of the second International Mathematics and Science Study attributed the poor performance of United States learners to uneven exposure of student teachers to the mathematics topics that are taught in secondary school classrooms. Just like other scholars, Beisiegel et al., (2013) asserted that mathematics and statistics departments have the responsibility to ensure that future teachers of mathematics have a deep and connected understandings of the mathematics they will teach. The question still remains as, how effective is the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics? This was what this study tried to address.

The challenges in the effective preparation of teachers worldwide were among the critical topics of discussion that a number of researchers were addressing (Matthews, Rech and Grandgenett, 2010 and Hine, 2015). It should be made clear at this point that any capable individual can undergo mathematics teacher education programme at any recognised institution of learning but what counts is the effectiveness of the mathematics teacher education curriculum that is used to prepare trainee teachers to effectively teach secondary school mathematics. Based on this notion, Hutchinson (1997) got disappointed upon seeing teachers of mathematics with degrees facing problems in teaching which were largely due to their inadequate preparation in MCK and PCK. Similarly, Hungerfold (1994) reported that the Mathematics Association of America had revealed that no link existed between what the mathematics student teachers were exposed to during their teacher education programme and the actual mathematics that was taught in secondary schools. The researcher in this study sought to establish if at all this was the same situation with the mathematics teacher education curriculum at UNZA.

Khan (2012) carried out a study in Pakistan which aimed at exploring the opinion of teachers about the content of mathematics courses in teacher education programmes. Khan sampled trained teachers of mathematics using a questionnaire developed on five points likert scale for knowing teachers' opinion. He used analysis of variance (ANOVA) for finding out the impact of category and gender on teachers' satisfaction about content of mathematics courses in teacher education programmes. His research findings revealed that mathematics courses in teacher education programme were not preparing student teachers for conceptual teaching as a result most students ended up joining the teaching career with poor content knowledge and pedagogical skills. He further argued that this resulted in teachers teaching learners exactly the way they were taught when they were in school as pupils. This meant that the kind of teaching learners were exposed to had to depend on academic qualifications at the expense of professional qualifications. This assertion is what Doerr (2004: 269) referred to as the "dilemma of experience." She stated that teacher educators had a huge responsibility "to simultaneously build on pre-service teachers' experience as pupils in schools and to break the mould of that experience." Although the study by Khan was well done, however, the researcher never clearly indicated on how learners were affected due to the identified challenges in teacher education. This was one of the areas the current study tried to address regarding the mathematics teacher education curriculum by sampling; UNZA lecturers, Standards Officers for mathematics, student teachers of mathematics and teachers of mathematics from UNZA.

In addition, Khan (2012) indicated that teaching in the 21st century had changed from meyer transmission of theories or facts to the learners to become more comprehensive, multifaceted and complex phenomenon. This implies that for any teacher to effectively communicate mathematical knowledge to the learners he or she needed to be self-motivated and competent in his or her subject area. Based on the current study, the question that still demanded a quick response was that, if the mathematics teacher education curriculum at UNZA had been effectively producing teachers who were self-motivated and competent in teaching and on how mathematics can be better learnt by learners of different abilities, why has the country continued recording poor results in mathematics? This was one of the issues the current study tried to provide answers in order to contribute to the gap.

Slightly contrary to the findings by Khan (2012) and many other researchers, Cavannah and Prescott (2007) noted that despite student teachers being exposed to progressive pedagogical approaches during their teacher education programme, they always resort to use traditional teaching approaches when they begin their teaching career. This means that as trainee teachers graduate as teachers of mathematics, they are converted by the old teachers they find in schools who had been teaching using the traditional means of communicating knowledge, values, skills and attitudes to the learners instead of them introducing the new techniques they had acquired during their teacher education programme to the teachers they find in schools. Peressini et al., (2004) supported this argument when they explained that learning to teach mathematics does not only emerge in one way but in many different situations such as: during the mathematics teacher education courses, pre-service field teaching experiences as well as during the day to day teaching in schools of employment. These scholars could be right because some teachers tend to keep on referring to the old exercise books that they used during the time they were at the secondary school as pupils and mostly lecture method of teaching is used. Besides, through professional interactions in school meetings and seminars, teachers are introduced to new ways of teaching. These studies were important to the current study because they enabled the study to be well focused by not only looking at the courses offered to students during teacher education programme but to have a view that a well refined classroom teacher of mathematics comes from his/her active participation in the above cited sites over time.

It should be stated that effective preparation of teachers cannot be entirely depend on student teachers being competent in MCK and PCK. Darling-Hammond (2004) and Mulenga (2015) explained that in every teacher education programme, Sociology of Education, Education Psychology, and Philosophy of Education should be among the vital courses to be offered to student teachers. The researchers were very right because apart from students being competent in their subject matter, the cited courses would help them to understand: society very well where their learners come from, how children learn by learning from various theories and human behaviour as well as inculcating the aspect of critical thinking in student teachers. All these if well done during teacher education programme may in a way contribute to the better preparation of the teacher of mathematics who would be in a better position to understand diverse learners' learning abilities as well as how best to enhance mathematical conceptual understanding amongst his/her learners.

The study by Mulenga (2015) revealed that an effective teacher is capable of selecting good learning activities and ask productive questions in his or her lesson. It is not clear whether during the teacher education programme at UNZA, student teachers of mathematics were taught how to set tests by formulating appropriate test items. It is important for teachers to assess learners on the materials learnt through oral and written questions. This study tried to find out whether student teachers were taught how to formulate effective questions using Bloom's Taxonomy as well as if the types of questions teachers ask during mathematics lessons and tests do affect learners in their learning of mathematics.

Mkandawire (2013) did a study in Petauke district in Eastern Province of Zambia to investigate teachers' questioning practices in mathematics at Grade 11 level in four selected secondary schools using mixed methods approach. His sample comprised 24 teachers of mathematics, 4 heads of mathematics department and 120 Grade 11 pupils. In order for him to collect data from pupils and teachers of mathematics, questionnaires and focus group discussions were employed. Qualitative data was analysed using constant comparative method while quantitative data was analysed by the variety of statistical tests. From the study, the researcher found out that the majority of the questions teachers ask in mathematics lessons do not help learners to think critically because they are in the low cognitive level category of Bloom's Taxonomy. The researcher argued that asking of low level questions as well as questions that do not probe learners for critical thinking and problem solving tend to depreciate the quality of the actual classroom teaching. Besides, Ornstein (1995) and Mkandawire (2013) pointed out that when teachers have a good orientation on how best to ask questions, they would always ask questions where learners will have no chance of simply checking for solutions at the back of the textbooks. This is critical for mathematics because if teachers of mathematics simply ask learners direct questions from the textbooks, learners are likely to be limited in their thinking hence defeating the purpose of education of producing learners who are critical thinkers and problem solvers (Mkandawire, 2013).

The importance attached to good questioning techniques in the teaching and learning of mathematics, demands for student teachers of mathematics to be effectively taught on how to formulate and ask very good and productive questions both in oral and written form. This is likely to reduce on teachers asking unproductive questions such as: are we together? Are you following? Isn't it? And many others that force learners to simply say yes even if they have no idea of what the teacher is talking about. According to Anderson (2001) cognitive domain of Bloom's Taxonomy has six levels where both oral and written tests can be formulated from as shown in the tables below that indicate changes in Bloom's Taxonomy.

Table 2.1: *Changes in Bloom's Taxonomy*

Bloom's Taxonomy 1956 (Old)	Bloom's Taxonomy 2001(Revised)
Evaluation	Creating
Synthesis	Evaluating
Analysis	Analysing
Application	Applying
Comprehension	Understanding
knowledge	Remembering

Noun → Verb form

(Adopted from Anderson, 2001)

The study by Mkandawire was important to this study more especially that he used the mixed methods approach which the researcher in the current study employed. Additionally, teacher education programme cannot be effective if student teachers have no knowledge on how to interact with learners in mathematics lessons through asking of very good and probing questions. However, Mkandawire's study did not state clearly whether the mathematics teacher education programme did contribute to the problems teachers encountered in terms of questioning techniques which the researcher through this study tried to establish. This study tried to find out whether questioning techniques during methodology courses were focused on as a way of preparing student teachers in the teaching and learning of classroom mathematics.

2.8. The Research Gap Identified

Nalube (2014) carried out a similar study where she focused on student teachers' preparedness to engage with the discourse of learner mathematical thinking. Her study was specific as it described LMT to be focused on: learner errors and misconceptions, developing in learners mathematical reasoning and creating an environment where teachers of mathematics can listen to learners. The study revealed that teacher educator's privileged selections of what entails LMT was weakly classified and framed, hence implicit messages relayed to student teachers. She argued that this came about as a result of lack of clear principles that guided discussions on topics/courses in mathematics education curriculum.

Based on the reviewed literature, it appears no study has been carried out in Zambia regarding the effectiveness of the mathematics teacher education curriculum in preparing secondary school teachers of mathematics. The current study was different from the studies that have been reviewed in this chapter in terms of research title, context and research methodology. Instead of only analysing what various scholars had written on teacher education curriculum at UNZA, this study went further to critically analyse studies done outside Zambia on mathematics teacher education curriculum. This was done in order for the researcher to have the broader understanding in the way teachers of mathematics were prepared to teach the subject to learners of different learning abilities.

Different scholars had pointed out what had led to poor learner performance in mathematics. Kajander (2010) stated that student teachers expressed weaknesses in conceptual understanding of basic mathematical concepts for teaching. Despite scholars having brought out vital issues in their studies, they never examined the mathematics teacher education curriculum in order to establish whether student teachers of mathematics were exposed to the appropriate MKT secondary school mathematics during their teacher education programme. This is one of the key areas this study addressed in order to contribute to the gap. Additionally, the researcher was able to make evidenced claims based on the attributes of effectiveness of the mathematics teacher education curriculum that have been cited in the reviewed literature.

2.9. Summary

In summary, the researcher attempted to carry out this study bearing in mind and having reviewed what other scholars had written both in Zambia and internationally on mathematics teacher education curriculum in different tertiary institutions of learning. Researchers in several studies had indicated that there was no relationship between what student teachers were taught during teacher education programme and the mathematics that they were expected to teach in secondary schools. The studies revealed that these serious gaps in MCK and PCK had repercussions in the way teachers taught learners classroom mathematics. Besides, the studies also revealed that student teachers were given very short period of time in which to do their school teaching experience as a result they were denied enough hands on practical experience during their teacher education programme. In the chapter that follows, an explanation of the methodology that was used has been done.

CHAPTER THREE: METHODOLOGY

3.1. Overview

The researcher in this chapter will describe the methodology that was used in the study. The chapter is organised under the following sections: research design and approach, study site, target population, sample size, sampling technique, data collection instruments, validity, reliability, trustworthiness, data collection procedure, data analysis and ethical considerations.

3.2. Research Design and Approach

A research design according to Kombo and Tromp (2006: 70) "is a glue that holds all of the elements in a research project together." While Rowley (2002: 18) defined it as "the logic that links the data to be collected and the conclusions to be drawn to the initial questions of a study in order to ensure coherence." The researcher in this study used a mixed methods design under the descriptive survey approach which took into consideration both the qualitative and the quantitative designs simultaneously. Descriptive survey approach enables the researcher to "gather data at a particular point in time with the intention of describing the nature of the existing conditions or identifying standards against which existing conditions can be compared or determining the relationship that exist between specific events" (Cohen et al., 2007: 205). The researcher in the following sub-section describes the mixed methods design where both qualitative and quantitative designs will be explained.

3.2.1. Mixed Methods Design

According to Creswell (2015: 2) a mixed method research is;

> *An approach to research in the social, behavioural and health sciences in which the investigator gathers both quantitative (closed-ended) and qualitative (open-ended) data, integrates the two, and then drawls interpretations based on the combined strengths of both sets of data to understand research problems.*

Bearing in mind the weaknesses and strengths of the two designs, the researcher used mixed methods design which tried to mitigate limitations and biases found in both the qualitative and quantitative designs. Kombo and Tromp (2006) explained that the mixed methods design maximises the strengths and minimises the limitations of both qualitative and quantitative design. This enabled the researcher to be confident that the design would yield good results for the study.

After scrutinising the six types of mixed methods design in Creswell (2009) which are: sequential explanatory design, sequential exploratory design, the sequential transformative design, the concurrent embedded design, concurrent triangulation design and the concurrent transformative design, the researcher considered the concurrent triangulation design which is also known as convergent parallel design to be the best in this study. Creswell (2002, 2003, 2009 and 2012) had consistently revealed that this design is one of the most popular and effective in educational research. The main reason of using this design in this study was because of its ability to enable the researcher to collect and analyse both qualitative and quantitative data concurrently and merge the results to interpret the findings on whether there is convergence, divergence or some combination (Creswell, 2009).

Using the concurrent triangulation design, the researcher was able to find out the extent to which the mathematics teacher education curriculum at UNZA had the appropriate content and teaching methods which were relevant for teaching mathematics in secondary schools and to establish the intentions of the curriculum designers for the mathematics teacher education curriculum. Despite having cited several causes of poor learner performance in mathematics, the researcher used the design to explore student teachers', teachers and teacher educators' opinion on whether the teacher education preparation could affect the teaching and ultimately learner performance in secondary school mathematics. The researcher further used the design as well to provide suggestions that would improve further the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics. The researcher used the collected data to address all research objectives and questions. Figure 3.1 illustrates how the concurrent triangulation design or convergent parallel design was applied.

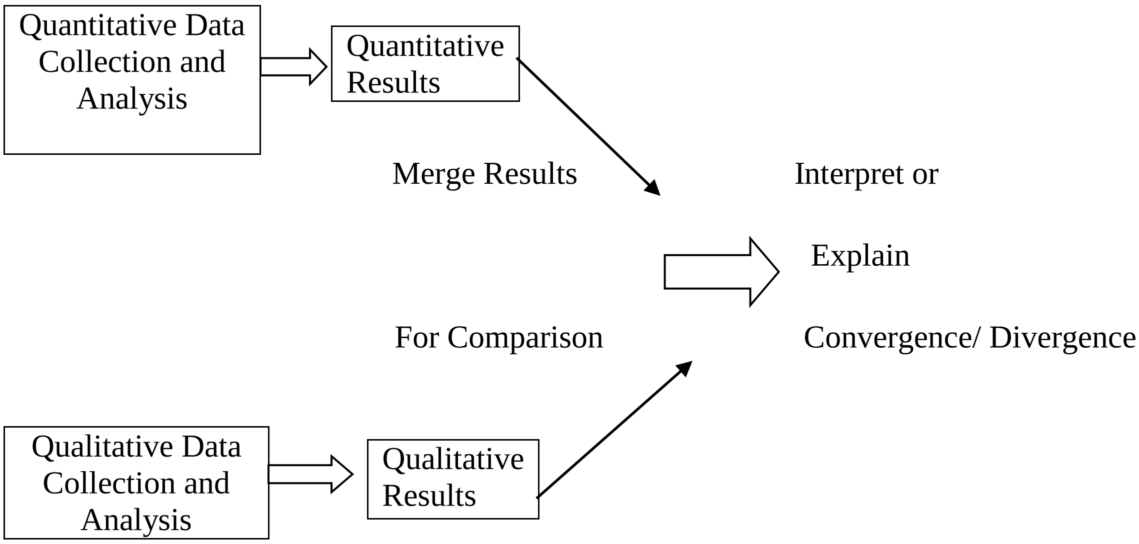

Figure 3.1: *Concurrent Triangulation Design (Convergent Parallel Design) illustrations*

Source: Adapted from Creswell (2013).

3.2.1.1. Qualitative Design

Qualitative design enables the researcher to carry out the study in the natural environment besides its reliance on research strategy that is flexible and interactive (Kombo and Tromp, 2006). This flexibility and interactivity allows for the discovery of the unexpected as well as in depth investigation of the topic. Similarly, Bryman (2001) explained that in qualitative research, the researcher focuses on the way people interpret and make sense of their experiences and the world in which they live which eventually enables them to explore the behaviour, perspectives, feelings and experiences of people and what lies at the core of their lives. This is generally done through: interviews, observations and focus group discussions. Despite this design having higher degree of validity because of its flexibility in data collection through the method of triangulation than quantitative design, its method of drawing conclusion is questionable by many researchers (Ghosh, 1992). This could be because the researcher is not completely detached from the study hence the aspect of subjectivity. In addition, qualitative researchers tend to encounter some difficulties when studying human beings where individuals' feelings, attitudes or judgment become too complex and need to be quantified (NECO, 1997, Verma and Mallick, 1999).

3.2.1.2. Quantitative Design

Quantitative design is "where an investigator primarily assesses positivists' claims for developing knowledge" (Creswell, 2003: 18). He further explained that the data collected from quantitative design is based on predetermined instruments that yield statistical data. According to Hebert (1990) this design imposes restrictions on the scope of the investigation. This is because of its requirements for rigidly adhering to certain procedures such as sampling procedures and data analysis techniques (Mulenga, 2015). One of the advantages of this design is that details of the study are easily measured which enables the results to be generalised. According to NECO (1997) most researchers consider quantitative research to be more precise and reliable regardless of its data which calls for careful evaluation for meaning. The quantitative data in this study was collected through the use of questionnaires which were answered by student teachers of mathematics and UNZA products who were teaching mathematics in the selected secondary schools in Lusaka district based on the five points likert scale. The researcher in the following section will explain and justify the reasons of selecting a site where this study was conducted.

3.3. Study Site

This study was conducted at the University of Zambia and selected secondary schools in Lusaka district. The reason for selecting UNZA was that the researcher was of the view that UNZA is the first highest institution of learning in Zambia which among the programmes offered at the institution was teacher education. Besides, most of the lecturers in Zambian universities and colleges of education which were affiliated to UNZA were influenced by the UNZA curricula. Besides, lecturers in most universities and colleges of education whether it was an affiliate to UNZA or not who were products of UNZA could be influenced by the curricula they had gone through at the University of Zambia. Schools within Lusaka were chosen because they had a good number of UNZA products teaching mathematics in secondary schools. This made the researcher to collect data from the rightful respondents. In the next section, the researcher describes the target population which will be followed by the sample size.

3.4. Target Population

Bryman (2001) defined a population as a group of elements or cases whether individuals, objects or events that conform to specific criteria and to which the research intends to generalise its results. In other words, a population is a total number of objects or people from which the sample for a particular study is selected from (Kombo and Tromp, 2006). The study targeted the Standards Officers for mathematics, lecturers of mathematics who taught content courses in the department of Mathematics and Statistics and lecturers of mathematics teaching methods in the department of Mathematics and Science Education (MSE). The population also consisted of all student teachers on the Bachelor of Arts with Education (BA. Ed), Bachelor of Education Mathematics and Sciences (Secondary) (BEDMAS) and Bachelor of Science with Education (BSC. Ed) studying mathematics as a teaching subject in their final year of 2016/2017 academic year. These cohorts were selected because the researcher was of the view that by the time a student teacher reaches fourth or final year of study, he or she will have learnt enough content and teaching methods in his or her teaching subject. The study also involved all the teachers from the University of Zambia teaching mathematics in the secondary schools in Lusaka district.

3.5. Sample Size

The Australian Bureau of Statistics (2004) indicated that the purpose of sampling in any research work is to overcome the problem associated with the vastness of the study population. Similarly, Best and Khan (2006) defined an ideal sample as a number that is large enough to serve as an adequate representation of the population which the researcher wishes to generalise and small enough to be selected economically in terms of subject availability and expense in both time and money. Best and Khan have argued that an ideal sample size may depend on the nature of the population and the type of data that needs to be collected and analysed. It is for this reason that every researcher needs to come up with a good and manageable sample representation of the population. Yamane (2015) devised a formula of determining a sample size of the population for a study. The formula below by Yamane was used to determine the sample size for this study.

$$n = \frac{N}{1 + N(e)} 2$$

N= population size, n= corrected sample, e = margin of error (MoE), e =0.05 based on research condition.

In this study, N= 259, at 5% of MoE, at 95% confidence level and p = 0.5

$$n = \frac{259}{1+259(0.05)^2}$$

$$n = \frac{259}{1+259(0.0025)}$$

$$n = \frac{259}{1+0.6475}$$

$$n = \frac{259}{1.6475}$$

$$n = 157.2078907$$

$$n \approx 157$$

∴Sample size was 157 respondents

From the calculations, the sample size for this study was one hundred fifty-seven (157) respondents which was broken down as follows: 10 lecturers that is seven (7) from those lecturing content courses of mathematics and three (3) from those lecturing mathematics teaching methods. It furthermore comprised 66 student teachers of mathematics both in-service and pre-service at the University of Zambia, one (1) National Standards Officer for mathematics and 80 teachers from the University of Zambia who were teaching mathematics in the selected ten (10) secondary schools in Lusaka district. Table 3.1 shows the status of questionnaires that were distributed as well as the number of questionnaires that the researcher received for analysis.

Table 3.1: *Status of Questionnaires Distributed and Returns*

Type of Respondents	Number of questionnaires distributed	Number of questionnaires received for analysis	%
Teachers of Mathematics	55	43	78.2
Student Teachers	42	39	92.9
Total	97	82	84.5

The researcher in table 3.1 presents the general status of the questionnaires that were distributed and later received after filling in by the respondents. It is clear from the table that 55 questionnaires were distributed to teachers of mathematics and 42 to student teachers. 43 teachers which represent 78.2% managed to return completed questionnaires, while 39 student teachers which represent 92.9% had also to fill in the questionnaires and returned them for analysis. This means that in total 97 questionnaires were distributed and 82 (84.5 %) were subjected for analysis. 12 teachers and 6 student teachers did not return the completed questionnaires. The description of how the respondents were selected is what is described in the following section.

3.6. Sampling Techniques

Both non-probability and probability sampling techniques were used when selecting respondents for the study.

3.6.1. Purposive Sampling

According to Bernard (2002) purposive sampling is a type of non- probability sampling that is most effective when one needs to study a certain cultural domain with knowledgeable experts within. In purposive sampling, the researcher decides on what needs to be known and targets people who can and are willing to provide the information by virtue of their knowledge or experience (Bernard, 2002; Cohen et al., 2007; Lewis & Sheppard, 2006). Thus, the study employed purposive sampling in the selection of lecturers and National Standards Officer for mathematics. Bearing in mind different types of purposive sampling, the researcher specifically used homogeneous purposive sampling. Kombo and Tromp (2006) referred to this type of purposive sampling as homogeneous because it aims at picking a small sample with similar characteristic in order to describe some particular subgroup in depth. This was one of the reasons lecturers of mathematics and National Standards Officer for mathematics were respondents in the study.

3.6.2. Simple Random Sampling

Simple random sampling is "a procedure in which all the individuals in the defined population have an equal and independent chance of being selected as a member of the sample" (Kombo and Tromp, 2006: 79). The scholars explained that the advantages of simple random sampling are that: the samples yield research data that can be generalised to a larger population; it also allows the researcher to apply inferential statistics to the data as well as providing an equal opportunity of selection for each respondent of the population.

Based on the merits of this sampling technique, in this study, secondary schools in Lusaka district, student teachers of mathematics as well as UNZA products teaching mathematics in secondary schools in Lusaka district were selected using simple random sampling. Since the respondents were from both sexes, a stratified random sampling was used to come up with two strata, male and female. Then the names of respondents were written on small pieces of papers and stored in two boxes according to their sex. The names were raffled and the selection was done at random in each of the boxes until the required number was attained. This ensured gender balance which to some extent minimised prejudice and biasness. This also provided a platform where certain subgroups in the population were represented in the sample in proportion to their population (Kombo and Tromp, 2006).

Besides, all the names of thirty-four public secondary schools in Lusaka district were also written on small pieces of papers before putting them in a small box. Selection of schools was done at random until the tenth school was picked. To select teachers in the selected secondary schools, the same stratified random sampling was used as described earlier to select male and female respondents. As stated before, the sample comprised: seven content lecturers of mathematics and 3 lecturers of mathematics teaching methods courses at the University of Zambia, 66 student teachers of mathematics both in-service and pre-service studying Bachelor of Arts with Education, Bachelor of Education Mathematics and Sciences (Secondary) and Bachelor of Science with Education all being prepared to teach mathematics, one National Standards Officer for mathematics including 80 teachers who were teaching mathematics in selected secondary schools in Lusaka district, all products of UNZA. The following section is where there is a description of the instruments that were used to collect data for this study.

3.7. Data Collection Instruments

According to Kombo and Tromp (2006) questionnaires, interview schedules, observation and focus group discussions are the most commonly used research instruments. The researcher in this study was guided by the semi-structured interview schedules to conduct face to face interviews, lesson observation schedule as well as structured questionnaires. It was prudent to triangulate using three different instruments of data collection as a way of ensuring validity and credibility of the research findings. What follows below is a brief description of each research instrument and the type of data that was collected.

3.7.1. Structured Questionnaires

Ghosh (1992: 241) defined a questionnaire as "a list of questions sent to a number of persons for them to answer." The scholar further explained that the instrument secures standardised results that can be tabulated and treated statistically. The scholars such as Kombo and Tromp (2006) argued that questionnaires are better research instruments because they save on time, uphold respondents' confidentiality and enables the researcher to collect data from a large sample and diverse regions.

The questionnaire that was used in this study had both open-ended questions and closed-ended questions. According to Ghosh (1992) open-ended questions help the researcher to gather new facts because respondents are free to express their views and ideas. Besides, closed-ended questions are meant to collect categorised data where the respondents have no freedom to express their own judgement. Some of the data that was collected by this instrument were as follows: the link between theory and practice in the mathematics teacher education curriculum at UNZA, students/graduate teachers' opinion about the relevance and appropriateness of content and teaching methods courses in the mathematics teacher education curriculum they were going through or they had gone through at UNZA in relation to what they taught in secondary schools, coverage and understanding of secondary school mathematics in the content and methods courses at UNZA, confidence of teachers to effectively teach secondary school mathematics based on their tertiary teacher education programme and the respondents' suggestions on how the mathematics teacher education curriculum at UNZA could be further improved. For more detailed information, refer to

Appendix 1 and 2.

3.7.2. Semi Structured Interviews

Borg (1963) asserted that no system of inquiry can be as revealing as an interview. This could be because an interview clearly shows the immediate feelings and emotions of the interviewee based on the topic of discussion. In addition, interviews are well suited for exploring and confirming ideas and provide in-depth information about particular cases of interest (Kombo and Tromp, 2006). Interviews were principally used in this study because of their flexibility which enabled the researcher to rephrase the questions and probe further to clearly get the actual views of the respondents. Permission was sought from the respondents in order to have the interviews recorded. Respondents who did not want the researcher to record the interview were also interviewed.

Semi-structured interview was used in this study to find out from ten (10) teacher educators the aim of the: Bachelor of Science with Education (mathematics), Bachelor of Arts with Education (mathematics) and Bachelor of Education Mathematics and Sciences (Secondary) at UNZA. Furthermore, the researcher wanted to find out from teacher educators and the National Standards Officer for Mathematics on: the work place where products of the programme would go and utilise the knowledge, values, skills and attitudes gained during their teacher education programme, the relevance and appropriateness of mathematics content and methods courses for teaching secondary school mathematics, factors that were considered when developing the mathematics teacher education curriculum as well as if the manner in which teachers were prepared to teach secondary school mathematics affected their teaching and eventually learner performance in the subject. For details on the semi structured interviews refer to Appendix 3 and 4.

3.7.3. Observations

Sidhu (2014) considered observations to be one of the most important research instruments. He noted that observation method is a more natural way of collecting data and data collected through observation is more real and true. This could be because it depicts what exactly transpires on the actual ground than data collected from other methods. An observation is a method in which the researcher takes field notes on the behaviour and activities of individuals at the research site (Creswell, 2003).

Structured observation was used in this study where the researcher was an onlooker focusing only on specific behaviour patterns reflecting on a pre-defined observation list. From the teachers of mathematics who answered the questionnaires, ten (10) of them were requested so that the researcher could observe one of their mathematics lessons according to their scheme of work and only five (5) agreed to have one of their lessons observed. Some of the information that this instrument enabled the researcher to collect were: subjectivity through problem solving of the teaching and learning process, quality of questions teachers of mathematics ask learners during mathematics lessons, use of the teaching and learning aids, appropriateness of content and teaching strategies according to the level of the learner and many other things reflected in the research instrument in Appendix 5.

3.8. Validity, Reliability and Trustworthiness

Validity, reliability and trustworthiness are very important features to consider for the credibility of research findings in any study. In the sub-sections below the researcher explains how this study ensured the aspects of validity, reliability and trustworthiness.

3.8.1. Validity

The aspect of validity examines the extent to which the results of the study could be generalised to the real world (Achola and Bless, 1988). Similarly, Mulenga (2015) explained that validity is the degree to which results obtained from the analysis of data represent the phenomenon under study. In other words, research findings are said to be valid if the research carried out depicts and brings out what it purported to bring out. One of the approaches of validating research findings is to use multiple methods of data collection. This is supported by Brewer and Patton (2002) who argued that the combination of methods complement each other by eliminating overlapping flaws. Besides, when methods are combined, which is known as triangulation, inconsistencies are taken care of, thus valid and reliable data emerges (Patton, 1990).

In order to validate the findings in this study, the researcher recorded some of the interviews where respondents permitted him to record during data collection so as to check for unclear information and then cross check with the respondents. During cross checking, the researcher had to make use of the responses for the verification of the findings and was able to make follow ups on issues that needed clarity. In addition, the researcher was able to compare the findings from the interviews, observation schedules and questionnaires in order to check whether the analysed data represented the phenomenon under study.

3.8.2. Reliability

The accuracy precision of a measurement procedure of research instruments is commonly known as reliability (Thorndike, 1997; Mugenda & Mugenda, 1999 and Creswell, 2012). Mugenda and Mugenda (1999) looked at reliability as the degree to which a research instrument yields consistent results or data after repeated trials. To ensure reliability, thirty (30) questionnaires for the final year student teachers of mathematics at the Copperbelt University as well as UNZA products who were teaching mathematics in Kitwe district were piloted.

In addition, Blair and Czaja (2014) asserted that if the questionnaire is not well developed, it tends to have a high probability of making the researcher collect inaccurate data. This would paralyse the whole essence of the research to be carried out. It was in this view that questionnaires were pre-tested in order to assess whether the instruments addressed the following key questions:

(i) Are the questions contained in the questionnaire measuring what they are supposed to measure?

(ii) Do the questions provoke a response?

(iii) Is there any researcher bias?

(iv) Is the wording clear and do different respondents interpret the questions in the similar way?

The questions that have been cited enabled the researcher to evaluate whether the questionnaires were clear and specific. Piloting this study enabled the researcher to make amendments on the research instruments which led him to collect appropriate data from the sampled respondents.

3.8.3. Trustworthiness

Ensuring trustworthiness in every qualitative study begins with the research findings which must be as truthful as possible. This is why it is important to evaluate the research in line with the procedure used to generalise its findings. In qualitative research, the concepts such as credibility, dependability and transferability have been used to describe various aspects of trustworthiness (Patton, 1987; Polit and Hungler, 1999 & Long and Johnson, 2000). Trustworthiness in this study was achieved through giving a clear and distinctive description of the: research context, selection and characteristics of respondents, data collection as well as the procedure for data analysis. The section below describes the procedure that was followed in order for the data to be collected which will be eventually followed by the description of how the collected data was analysed.

3.9. Data Collection Procedure

In order to have data collected, the researcher requested for permission from the two Deans that is the Deans of School of Education and School of Natural Sciences including the District Education Board Secretary for Lusaka district. This was done in order for the researcher to be given permission to freely interact with the selected respondents without any interference. The researcher also had to ask for consent from the respondents to enable them make an informed decision on whether they could participate in the study or not. Since respondents comprised male and female, the order of administering the research instruments was guided by the sampling techniques described in section 3.5 so that each respondent is given chance to be part of the study.

The researcher had begun by administering questionnaires to student teachers who were currently on the programme and had done their teaching experience. This was done in order to assess the mathematics that they were learning in relation to what was taught in secondary schools before interacting with any other respondent. Secondly, questionnaires were administered to teachers of mathematics education from 10 selected secondary schools in Lusaka district who had gone through the UNZA mathematics teacher education curriculum. This enabled the researcher to compare the responses of both student and teachers of mathematics on the appropriateness of the mathematics teacher education curriculum in preparing secondary school teachers of mathematics. As a way of getting first-hand information on how mathematics was taught by the University of Zambia products, the researcher asked for permission from the school administration in the selected schools in Lusaka district to observe some mathematics lessons and only 5 teachers were willing to have their lessons observed. This was done in order to compare their responses in the questionnaires to the actual classroom practices. Finally, the researcher had to interview the lecturers of mathematics content and methods courses and the National Standards Officer for mathematics. Since most teachers did not want to have their mathematics lessons observed, the researcher had to interview 10 teachers of mathematics after having observed 5 lessons of mathematics. Having interviewed lecturers and National Standards Officer for mathematics at the end, enabled the researcher to even probe them further on what was earlier observed in the mathematics lessons.

All in all, using the research instruments prepared, the researcher managed to interview and distribute questionnaires to the sampled respondents. He had to introduce the topic and got various respondents' views so as to discuss in more detail the effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics.

3.10. Data Analysis

Data analysis refers to "examining what has been collected in a survey or experiment and making deductions and inferences. It involves uncovering underlying structures; extracting important variables, detecting any anomalies and testing any assumptions" (Kombo and Tromp, 2006: 117).

3.10.1. Qualitative Data Analysis

Miles and Huberman (1994) documented that data analysis in the qualitative model comprises three levels of activities which are: data reduction, data display and conclusion drawing or verification. Slightly different from the views of Miles and Huberman, Sjostrom and Dahlgren (2002) in their study revealed that qualitative analysis involves seven key steps which are: familiarisation, compilation of answers from respondents, condensation or reduction, preliminary comparison or classification, naming of categories and contrastive comparison of categories.

The first step is familiarisation, this is where the researcher reads through all the collected data so that he or she understands and makes necessary corrections by getting back to the actual respondents or recorded data. After step one is done, the next step involves compilation of responses from participants where vital responses should be considered. In the third step the researcher tries to condense or reduce individual responses by finding the central parts of dialogue. Upon addressing step three, the researcher goes into preliminary grouping or classifying responses that sounds to be similar. What exactly follows after classification of similar answers is preliminary comparison of categories by the researcher. When the categories are clearly compared, the researcher goes to the sixth step which involves naming of categories which Creswell (2009) call coding. The seventh step is contrastive comparison of categories where the description of the character of each category and similarities between categories are done in order to come up with similar emerging themes (Sjostrom & Dahlgren, 2002). Thus qualitative data collected from interviews and lesson observations was analysed from the seven steps cited above and coded into emergent themes and grouped into categories (Creswell, 2009). This implies that the researcher used description and thematic analysis in analysing qualitative data to have the research questions answered.

3.10.2. Quantitative Data analysis

Awoniyi and Aderanti (2013: 109) stated that "when the performances of two independent samples need to be compared, the independent t-test form may be used to test for significance." In this study, some data that was collected from questionnaires was analysed through the use of the statistical package for social sciences version 20 where descriptive and inferential numeric analysis were used. The researcher specifically used frequencies, means and independent samples t-tests.

The quantitative results were compared with qualitative results before a conclusion was drawn. It was through this analysis of data; a rational and fairly well informed assessment of the effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics was addressed.

3.11. Ethical Considerations

An 'ethic' is a moral principle or a code of conduct which guides what people do (Wellington, 2000). Considering the significance of ethical issues in every research, responses from respondents in this study were treated with maximum confidentiality as the data was used purely for academic purposes. The respondents in this study were lecturers from the University Zambia, National Standards Officer for mathematics, student teachers both the in-service and the pre-service of mathematics as well as teachers of mathematics from UNZA. The following were among the cardinal things the researcher had to put into consideration.

3.11.1. Informed Consent

Informed consent is a communication between the researcher and the respondent. Informed consent had to be sought from respondents by informing them what the study was about and their benefits of participating in the study. This guided the respondents to decide on their own whether to participate in the study or not (Cohen et al., 2007). Permission was sought from the Deans of School of Education and School of Natural Sciences for the researcher to freely interact with lecturers of mathematics and student teachers of mathematics at UNZA. Besides, permission had also to be sought from Lusaka District Education Board Secretary (DEBS) for the researcher to freely visit the ten selected secondary schools and interact with teachers of mathematics in a friendly manner.

3.11.2. Research Description

The researcher had to introduce himself to the respondents and there after the respondents were told the purpose of the study for them to be clear about the study they were about to be involved in.

3.11.3. Risks

The respondents were assured that there was no any form of risks that they were going to encounter as a result of their participation in this study.

3.11.4. Benefits

Respondents were told that their constructive contributions to the study were going to bring out suggestions that could improve the mathematics teacher education curriculum at UNZA that was going to eventually benefit their children and the generations to come.

3.11.5. Anonymity and Confidentiality

All respondents were told not to write any name on the research instruments for no name of respondent or school was expected to be mentioned in this study and every response concerning the study had to be treated with high level of confidentiality besides being used only for the purpose of the study.

3.11.6. Voluntary Participation

In addition to what has been stated above, respondents were informed that participation in this study was voluntary and that they were expected to feel very free to withdraw from the study at any time. For details on the informed consent refer to Appendix 7.

3.12. Summary

What has been discussed in chapter three is the methodology that was used in the study. Mixed methods design was used particularly the concurrent triangulation design which is also known as the convergent parallel design. This design enabled the researcher to collect and analyse both the qualitative and quantitative data, merge the results for comparison and eventually interpret or explain if at all there was convergence, divergence or some combination. Besides, the researcher also discussed the: study site, target population, sample size which was 157 respondents, sampling techniques (i.e. both purposive and simple random sampling), data collection instruments, validity and reliability, data collection procedure, data analysis as well as ethical considerations which all falls in different sections of chapter three. What follows next is now the presentation of the research findings.

CHAPTER FOUR: RESULTS

4.1. Overview

In the previous chapter, the researcher described the research methodology, which was employed in the study to come up with the results which are presented in this chapter. The themes that are presented in this chapter emerged from the data collected from lesson observation, questionnaires and interviews. In this study, the researcher managed to collect a lot of data, however, the analysis of data was specifically guided by the information which addressed the research questions below:

1. To what extent did the UNZA mathematics teacher education curriculum have the appropriate content and teaching methods which were relevant for teaching mathematics in Zambian secondary schools?
2. What were the intentions of the UNZA curriculum designers for the mathematics teacher education curriculum?
3. How does teacher education preparation affect learner performance in secondary school mathematics?
4. What suggestions would be appropriate to improve further the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics?

4.2. Demographics of the Respondents

Respondents who had taken part in this study had to indicate their brief background information for the purpose of analysis regarding their gender, working experience and type of students whether in-service or pre-service. Tables 4.1, 4.2 and 4.3 indicate the background information of the respondents.

Table 4.1: *Frequency and percentage distributions of teachers according to gender and working experiences*

Variable	*f*	%	Total	
			Number	Cumulative %
Gender (n= 43)				
Male	31	72	43	72
Female	12	28		100
Working Experience				
Below 5 years	05	12	43	12
5-10 years	12	28		40
11-15 years	13	30		70
16 and above	13	30		100

Table 4.1 indicates that 72% of teachers who participated in the study were male while 28% were female. Meaning, there were more male teachers of mathematics than female teachers. Furthermore, it also shows that 12%, 28%, 30% and 30% represented the teachers' working experience in the ranges of: below 5 years, between 5-10 years, 11-15 years and above 16 years respectively. It is clear that the majority of the respondents comprising 88% had taught mathematics for more than 5 years. This meant that the respondents were conversant with most of the topics in the syllabus.

Table 4.2: *Frequency and percentage distributions of student teachers at UNZA according to gender and type of students*

Variable	*f*	%	Total	
			Number	Cumulative %
Gender (n = 39)				
Male	36	92	39	92
Female	03	08		100
Type of respondents (n = 39)				
In-service	05	13	39	13
Pre-service	34	87		100

Table 4.2 shows a total of 39 final year student teachers of mathematics at UNZA who were respondents in this study. Out of the total participants, 92% were male while the remaining

08% were female. The table also indicates that the majority of the respondents were pre-service comprising 87% while the rest representing 13% were in-service.

Table 4.3: *Frequency and percentage distributions according to gender for the combination of teachers and student teachers*

Gender	*f*	%
Male	67	82
Female	15	18

Table 4.3 shows the combination of teachers and student teachers representing 82% male respondents and 18% female respondents.

In addition to the student teachers and teachers of mathematics, part of the respondents included one (1) National Standards Officer for Mathematics, ten (10) lecturers, seven (7) of them taught mathematics content courses in the School of Natural Sciences from the department of Mathematics and Statistics and three (3) taught mathematics teaching methods in the School of Education from the department of Mathematics and Science Education.

4.3. Research Findings from the Pilot Study

Pilot study was done amongst ten (10) final year student teachers of mathematics at Copperbelt University and twenty (20) teachers of mathematics from UNZA who were teaching mathematics in Kitwe district. This was mainly done to assess the reliability of the research instruments. Pilot study enabled the researcher to find out whether the research instruments were measuring what they were expected to measure, whether the questions could provoke a response as well as to check for the clarity of the wording and if different respondents could interpret the questions in a similar way. The research results were not different from what was found in the actual field. The findings indicated that the mathematics teacher education curriculum did not adequately prepared teachers to teach secondary school mathematics. Although only questionnaires were used in the pilot study, it was revealed that student teachers were exposed to very advanced content which did not match with the secondary school mathematics they would teach upon graduation.

4.4. Actual Research Findings for the Targeted Sample

The research questions guided the researcher to formulate and organise the research instruments in this study. Research question one implored for quantitative data while research questions two, three and four implored for qualitative data. In addition to the data collected from open-ended questions in the questionnaires and lesson observation, data that was collected from lecturers and National Standards Officer for mathematics to answer question two, three and four through interviews were transcribed and reported word for word.

4.5. Research Question One

Research question one sought to find out the extent to which the mathematics teacher education curriculum had the appropriate content and teaching methods which were relevant for teaching mathematics in Zambian secondary schools. This prompted for quantitative data through question 2, 3, 4, 6, 7 and 8 from student teachers' questionnaire and question 4, 5, 7, 8 and 9 from teachers' questionnaire. All the questions that sought for quantitative data enabled respondents to indicate on a five points likert scale rated as: 1= not well, 2 = fairly well, 3 = well, 4 = very well and 5 = excellent. Below are the findings of research question one.

4.5.1. Student Teachers' Confidence to Teach Secondary School Mathematics

Using a five points likert scale, student teachers had to indicate the level of confidence to teach secondary school mathematics topics after having learnt the University mathematics up to their final year of study and what they had learnt during their teaching experience. Table 4.4 and table 4.5 shows the independent samples t-test results.

Table 4.4: *Independent t-test results showing student teachers' own rating to confidently teach various secondary school mathematics topics*

Mathematics Topics	*Type of Student*	*Mean*	*S.D*	*t*	*df*	*P*
Sets	pre-service	4.35	.812	1.478	37	.148
	in-service	3.80	.447			
Similarity and Congruency	pre-service	3.55	1.148	-.104	36	.918
	in-service	3.60	.548			
Variations	pre-service	3.79	1.225	1.353	37	.184
	in-service	3.00	1.225			
Sequences and Series	pre-service	3.94	.983	1.646	37	.108
	in-service	3.20	.447			
Coordinate Geometry	pre-service	4.18	.999	.369	37	.714
	in-service	4.00	1.000			
Quadratic Functions	pre-service	4.62	.817	2.963	37	.005
	in-service	3.40	1.140			
Relations and Functions	pre-service	4.15	.892	1.326	37	.193
	in-service	3.60	.548			
Circle Theorem	pre-service	3.36	1.617	1.530	36	.135
	in-service	2.20	1.304			
Constructions and Loci	pre-service	3.29	1.508	1.237	37	.224
	in-service	2.40	1.517			
Trigonometry	pre-service	4.45	.711	-.436	36	.665
	in-service	4.60	.548			
Mensuration	pre-service	3.26	1.563	2.309	37	.027
	in-service	1.60	.894			
Probability	pre-service	3.34	1.208	.901	8.256	.393
	in-service	3.00	.707			
Statistics	pre-service	3.56	1.211	.095	36	.925
	in-service	3.50	.577			
Graphs of Functions	pre-service	3.88	1.244	1.475	36	.149
	in-service	3.00	1.225			
Linear Programming	pre-service	2.74	1.504	3.754	15.477	.002
	in-service	1.40	.548			
Vectors in two Dimensions	pre-service	3.76	1.146	1.749	36	.089
	in-service	2.80	1.095			
Geometrical Transformation	pre-service	2.61	1.144	1.508	36	.140
	in-service	1.80	.837			
Earth Geometry	pre-service	2.79	1.495	1.134	36	.264
	in-service	2.00	1.000			
Introduction to Calculus	pre-service	4.18	.999	1.030	33.000	.311
	in-service	4.00	0.000			
	pre-service	68.8824	16.26441	1.693	37	.099
Total	in-service	56.2000	8.92749			

*Significance at $p < 0.05$ $n = 39$

From the two sets of respondents in table 4.4, the mean differences indicated that in 3 topics that is Quadratic Functions, Mensuration and Linear Programming; there was a significance difference at the confidence level of $p < 0.05$ while the other 16 topics the mean differences were not statistically significant.

Table 4.5: *Independent t-test results showing student teachers and teachers own rating of their confidence to teach various secondary school mathematics topics*

Mathematics Topics	Type of Respondent	Mean	SD	t	df	p
Sets	Student Teachers	4.28	.793	-.105	80	.917
	Teachers	4.30	.939			
Similarity and Congruency	Student Teachers	3.55	1.083	-1.310	78	.194
	Teachers	3.88	1.152			
Variations	Student Teachers	3.69	1.239	-1.365	79	.176
	Teachers	4.05	1.103			
Sequences and Series	Student Teachers	3.85	.961	-.539	80	.591
	Teachers	3.98	1.205			
Coordinate Geometry	Student Teachers	4.15	.988	-1.416	80	.161
	Teacher	4.44	.854			
Quadratic Functions	Student Teachers	4.46	.942	.555	80	.580
	Teachers	4.35	.897			
Relations and Functions	Student Teachers	4.08	.870	-.580	79	.564
	Teachers	4.19	.890			
Circle Theorem	Student Teachers	3.21	1.613	-1.949	67.526	.055
	Teachers	3.83	1.188			
Constructions and Loci	Student Teachers	3.18	1.520	-1.594	80	.115
	Teachers	3.70	1.423			
Trigonometry	Student teacher	4.47	.687	-.385	79	.701
	Teachers	4.53	.735			
Mensuration	Student Teachers	3.05	1.589	-2.541	79	.013
	Teachers	3.88	1.347			
Probability	Student Teachers	3.30	1.151	-4.365	62.650	.000
	Teachers	4.28	.797			
Statistics	Student Teachers	3.55	1.155	-4.334	59.542	.000
	Teachers	4.49	.703			
Graphs of Functions	Student Teachers	3.76	1.261	-1.506	67.865	.137
	Teachers	4.14	.941			
Linear Programming	Student Teacher	2.56	1.483	-3.905	71.900	.000
	Teachers	3.72	1.161			
Vectors in two Dimensions	Student Teachers	3.63	1.172	-2.091	79	.040
	Teachers	4.14	1.014			
Geometrical Transformation	Student Teachers	2.50	1.133	-4.009	79	.000
	Teachers	3.58	1.277			
Earth Geometry	Student Teachers	2.68	1.454	-2.362	78	.021
	Teachers	3.43	1.364			
Introduction to Calculus	Student Teachers	4.15	.933	-.880	79	.381
	Teachers	4.33	.902			
Total	Student Teachers	67.2564	16.01762	-2.741	80	.008
	Teachers	76.6047	14.86309			

* Significant at $p < 0.05$ n = 82

Table 4.5 shows that in 7 variables which included: Mensuration, Probability, Statistics, Linear Programming, Vectors in two Dimensions, Geometrical Transformation and Earth Geometry, there was a statistically significant difference at the confidence level of $p < 0.05$. The means for the two groups are between 4.53 and 2.50 which fall between slightly above very well and slightly below well on the five points likert scale. In addition, the mean for only teachers ranged from 4.53 to 3.43 which were slightly above very well to well, while the mean for student teachers ranged from 4.47 to 2.50, meaning student teachers rated themselves around very well to well or close to fairly well.

4.5.2. Rating the Coverage and Understanding of the Mathematics Topics in the Content Courses offered at UNZA

Question number 3 in the student teachers' questionnaire and question number 5 in the teachers' questionnaire requested the respondents to rate their coverage and understanding of secondary school mathematics topics based on what they had studied in their mathematics content courses in the department of Mathematics and Statistics in order for them to appropriately teach in secondary school. Table 4.6 and table 4.8 shows the independent t-test results where the researcher compared the mean of the pre-service and the in-service student teachers as well as the mean of student teachers and teachers (UNZA products) respectively.

Table 4.6: *Independent t-test results of student teachers rating of their coverage and understanding of various secondary school mathematics topics in the content courses*

Mathematics Topics	*Type of Student*	*Mean*	*SD*	*t*	*df*	*p*
Sets	pre-service	3.76	1.304	1.921	37	.063
	in-service	2.60	.894			
Similarity and Congruency	pre-service	2.52	1.326	1.144	36	.260
	in-service	1.80	1.095			
Variations	pre-service	2.41	1.341	1.613	35	.116
	in-service	1.40	.894			
Sequences and Series	pre-service	3.15	1.351	1.515	37	.138
	in-service	2.20	.837			
Coordinate Geometry	pre-service	4.00	1.031	1.264	36	.214
	in-service	3.40	.548			
Quadratic Functions	pre-service	4.21	.978	3.046	37	.004
	in-service	2.80	.837			
Relations and Functions	pre-service	4.18	.869	2.274	37	.029
	in-service	3.20	1.095			
Circle Theorem	pre-service	2.82	1.610	2.904	8.629	.018
	in-service	1.40	.894			
Constructions and Loci	pre-service	2.36	1.496	2.019	7.933	.079
	in-service	1.40	.894			
Trigonometry	pre-service	4.00	.953	.909	37	.369
	in-service	3.60	.548			
Mensuration	pre-service	2.59	1.478	1.744	35	.090
	in-service	1.40	.894			

Probability	pre-service	3.09	1.353	.468	35	.642
	in-service	2.80	.837			
Statistics	pre-service	3.68	1.194	1.923	34	.063
	in-service	2.60	.894			
Graphs of Functions	pre-service	3.25	1.503	1.741	35	.090
	in-service	2.00	1.414			
Linear Programming	pre-service	2.29	1.321	1.148	33	.259
	in-service	1.50	1.000			
Vectors in two Dimensions	pre-service	3.36	1.141	1.426	36	.163
	in-service	2.60	.894			
Geometrical Transformation	pre-service	2.30	1.425	2.590	14.503	.021
	in-service	1.40	.548			
Earth Geometry	pre-service	2.50	1.503	3.482	11.573	.005
	in-service	1.25	.500			
Introduction to Calculus	pre-service	4.33	.990	1.176	36	.247
	in-service	3.80	.447			
Total	pre-service	58.9706	18.79956	1.876	37	.069
	in-service	42.6000	12.48199			

* Significant at $p < 0.05$ n = 39

Based on the probability level of confidence at $p < 0.05$, table 4.6 indicates that there is a statistically significant difference between the in-service and the pre-service student teachers in: Quadratic Functions with p value of 0.004, Relations and Functions with p value of 0.029, Circle Theorem with p value of 0.018, Geometrical Transformation with p value of 0.021 and Earth Geometry with p value of 0.005. Table 4.6 has also shown that in 14 mathematics topics there was no statistically significant difference between in-service and pre-service student teachers regarding their coverage and understanding of secondary school mathematics in the content courses they did at UNZA. Despite in five mathematics topics having indicated a statistically significant difference, the means revealed that in most of the mathematics topics, the coverage and understanding were either just well, fairly well and not well with few scoring very well.

4.5.3. Content Lecturers' Emphasis on Secondary School Mathematics Topics during Content Courses in the Mathematics Teacher Education Curriculum

The researcher decided to ask a follow up question in the questionnaire for student teachers in order for them to show the emphasis lecturers of mathematics had made on the secondary school mathematics topics during content courses. Table 4.7 shows the independent t-test results of student teachers' responses.

Table 4.7: *Independent t-test results of student teachers' rating on the emphasis lecturers of mathematics had made on secondary school topics during content courses*

Mathematics Topics	Type of Student	Mean	SD	t	df	p
Sets	pre-service	3.26	1.524	.365	37	.717
	in-service	3.00	1.414			
Similarity and Congruency	pre-service	1.76	1.091	-.776	36	.443
	in-service	2.20	1.789			
Variations	pre-service	1.73	.977	.726	36	.472
	in-service	1.40	.548			
Sequences and Series	pre-service	2.79	1.553	1.526	7.229	.170
	in-service	2.00	1.000			
Coordinate Geometry	pre-service	3.47	1.187	.490	37	.627
	in-service	3.20	.837			
Quadratic Functions	pre-service	3.65	1.203	1.456	37	.154
	in-service	2.80	1.304			
Relations and Functions	pre-service	3.50	1.354	.296	13.134	.772
	in-service	3.40	.548			
Circle Theorem	pre-service	2.09	1.489	1.930	15.843	.072
	in-service	1.40	.548			
Constructions and Loci	pre-service	1.61	.998	.888	36	.380
	in-service	1.20	.447			
Trigonometry	pre-service	3.52	1.202	.205	36	.839
	in-service	3.40	.894			
Mensuration	pre-service	2.19	1.330	1.294	35	.204
	in-service	1.40	.548			
Probability	pre-service	3.06	1.390	1.587	35	.122
	in-service	2.00	1.414			
Statistics	pre-service	3.19	1.447	2.179	8.374	.059
	in-service	2.20	.837			
Graphs of Functions	pre-service	3.00	1.518	1.695	37	.098
	in-service	1.80	1.095			
Linear Programming	pre-service	1.85	1.158	2.316	14.117	.036
	in-service	1.20	.447			
Vectors in two Dimensions	pre-service	3.06	1.435	2.632	10.058	.025
	in-service	2.00	.707			
Geometrical Transformation	pre-service	2.12	1.453	2.049	14.945	.058
	in-service	1.40	.548			
Earth Geometry	pre-service	1.70	1.045	1.039	36	.306
	in-service	1.20	.447			
Introduction to Calculus	pre-service	4.12	.913	.751	33.000	.458
	in-service	4.00	0.000			
Total	pre-service	54.0588	18.24570	1.148	37	.258
	in-service	44.4000	10.26158			

* Significant at $p < 0.05$ n = 39

The results in table 4.7 shows that there was no statistically significant difference in 17 secondary school mathematics topics concerning the emphasis lecturers of mathematics had made on them as they taught content courses. However, the results indicated a statistically significant difference between in-service and pre-service students in Linear Programming with p value of 0.036 and Vectors in two Dimensions with p value of 0.025. Although two of the variables revealed a statistically significant difference between in-service and pre-service student teachers on the emphasis made on them by lecturers during content courses, the mean for pre-service ranged from 4.12 to 1.61 while the mean for in-service ranged from 4.00 to 1.20. This meant that student teachers rated lecturers' emphasis on secondary school mathematics around well, fairly well and not well. The results seemed to have suggested that secondary school mathematics was not very much emphasised by lecturers of mathematics during content courses.

As earlier stated, table 4.8 below shows the comparison of the means of student teachers and teachers of mathematics based on their coverage and understanding of the secondary school mathematics topics during content courses in the department of Mathematics and Statistics.

Table 4.8: *Independent t-test results of student teachers' and teachers' rating of their coverage and understanding of various secondary school mathematics in content courses*

Mathematics Topics						
	Type of Respondent	*Mean*	*SD*	*t*	*df*	*p*
Sets	Student Teachers	3.62	1.310	-1.069	80	.288
	Teachers	3.93	1.352			
Similarity and Congruency	Student Teachers	2.42	1.308	-2.940	77	.004
	Teachers	3.37	1.529			
Variations	Student Teachers	2.27	1.326	-3.573	75	.001
	Teachers	3.45	1.552			
Sequences and Series	Student Teachers	3.03	1.328	-1.567	79	.121
	Teachers	3.52	1.518			
Coordinate Geometry	Student Teachers	3.92	.997	-.119	75.104	.905
	Teachers	3.95	1.430			
Quadratic Functions	Student Teachers	4.03	1.063	.356	80	.723
	Teachers	3.93	1.334			
Relations and Functions	Student Teachers	4.05	.944	.753	73.467	.454
	Teachers	3.86	1.354			
Circle Theorem	Student Teachers	2.63	1.601	-2.002	76	.049
	Teachers	3.38	1.675			
Constructions and Loci	Student Teachers	2.24	1.460	-2.031	76.027	.046
	Teachers	2.98	1.768			
Trigonometry	Student Teachers	3.95	.916	-.689	71.810	.493
	Teachers	4.12	1.308			
Mensuration	Student Teachers	2.43	1.463	-2.843	77	.006
	Teachers	3.40	1.563			
Probability	Student Teachers	3.05	1.290	-2.701	78	.008
	Teachers	3.88	1.434			
Statistics	Student Teachers	3.53	1.207	-2.244	77	.028
	Teachers	4.14	1.207			
Graphs of Functions	Student Teachers	3.08	1.534	-2.021	78	.047
	Teachers	3.74	1.399			
Linear Programming	Student Teachers	2.20	1.302	-3.640	74	.001
	Teachers	3.41	1.565			
Vectors in two Dimensions	Student Teachers	3.26	1.131	-1.866	76.938	.066
	Teachers	3.81	1.516			

Geometrical Transformation	Student Teachers	2.18	1.373	-3.322	77	.001
	Teachers	3.32	1.635			
Earth Geometry	Student Teachers	2.37	1.478	-1.763	77	.082
	Teachers	3.00	1.688			
Introduction to Calculus	Student Teachers	4.26	.950	.497	79	.620
	Teachers	4.14	1.246			
Total	Student Teachers	56.8718	18.81654	-2.296	80	.024
	Teachers	67.6744	23.28163			

* Significant at $p < 0.05$ $n = 82$

Table 4.8 shows that in 9 mathematics topics there was no statistically significant difference in terms of student teachers' and teachers' rating of their coverage and understanding of: Sets, Sequences and Series, Coordinate Geometry, Quadratic Functions, Relations and Functions, Trigonometry, Vectors in two Dimensions, Earth Geometry and Introduction to Calculus. Despite 9 items having no statistically significant difference, the remaining 10 mathematics topics showed that there were statistically significant difference between teachers and student teachers in the coverage and understanding of secondary school mathematics. Teachers' ratings ranged around very well and slightly below well while student teachers rated themselves around very well to well or fairly well.

4.5.4. Relevance and Appropriateness of University Mathematics Courses to the Teaching of Secondary School Mathematics

The questionnaires for both student teachers and teachers had an open-ended question which requested student teachers and teachers to state and justify whether the courses they were doing at UNZA in the department of Mathematics and Statistics were relevant and appropriate for teaching classroom mathematics in secondary schools.

When asked to explain on how teachers (UNZA products) and student teachers felt about the relevance of the content courses and methodology courses offered at UNZA, different views and perceptions were revealed. Figure 4.1 shows the responses of teachers.

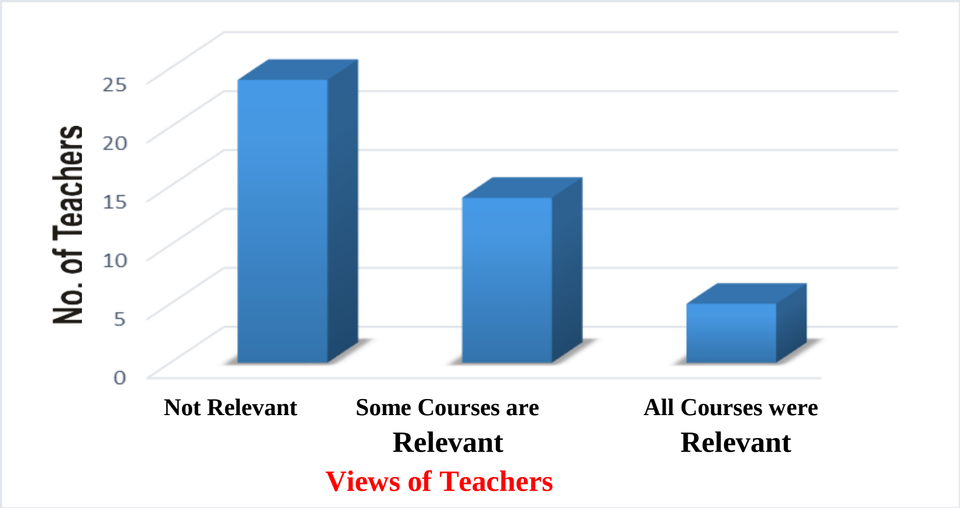

Figure 4.1: *Teachers' Views of the Relevance of Mathematics Courses Offered at UNZA*

The responses from teachers indicated 24 representing 55.8% of teachers who said the courses were not relevant, 14 representing 32.6% stated that some of the courses were relevant and 5 respondents representing 11.6% argued that all the courses were relevant to the teaching of secondary school mathematics. Figure 4.2 shows the responses from student teachers.

Out of 39 student teachers, 9 representing 23.1% said the courses were relevant and appropriate to what they taught and 30 representing 76.9% of the respondents argued that the courses were not relevant and appropriate to the mathematics they found in secondary schools. Figure 4.2 shows different percentages representing different reasons student teachers had given.

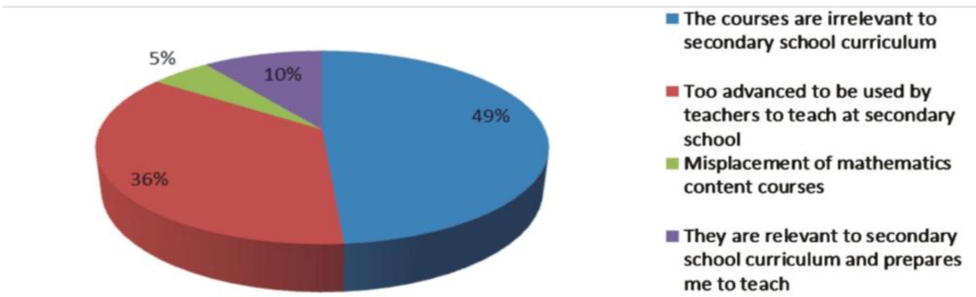

Figure 4.2: *Reasons of Student Teachers on the Relevance of the Mathematics Courses Offered at UNZA to what they Taught During their Teaching Experience*

As indicated in figure 4.1 and figure 4.2, respondents had expressed their views in various ways. For instance, some of the views of teachers were;

(i) *Most of the courses are relevant though some materials are not applicable to secondary school pupils.*

(ii) *Some few first year courses are relevant like introduction to calculus, coordinate geometry, quadratic functions and relations and functions.*

(iii) *Not related or relevant to the mathematics taught in secondary school.*

(iv) *What I was taught at UNZA was very advanced and irrelevant to what is taught in classroom.*

(v) *Not very relevant as it was advanced thereby neglecting what was to be taught in schools. Nevertheless, it broadens the teachers' content knowledge.*

(vi) *Not relevant at all. The gap is very wide between what I did and what is on the ground.*

(vii) *The courses are making a lot of sense to the latest curriculum but had no connection to the old curriculum.*

(viii) *They have been very relevant although improvement must be made to emphasise on the content taught in secondary schools.*

(ix) *Not much of the content courses have been directly applicable to what I teach. However, the courses I did at UNZA have helped me to adapt to different environment.*

(x) *Three quarters of the courses were irrelevant, most of the concepts I have been using to teach are the ones I learnt in secondary school as a pupil.*

Student teachers had similar views although they had to put them in their own context. Some of their views were;

(i) *Some courses do not apply to secondary school curriculum and we only come to hear about them here at UNZA.*

(ii) *Courses like real analysis have no impact because we just memorise the stuff and reproduce on the paper without a clear understanding.*

(iii) *The department of Mathematics and Statistics exposed us to advanced mathematics hence secondary school mathematics became simple to explain and solve for the pupils.*

(iv) *Mathematics at UNZA is too advanced and lecturers do not consider whether students are able to understand what he/she is teaching or not.*

(v) *The mathematics taught at UNZA is not relevant for teaching secondary school mathematics because it is taught in the School of Natural Sciences where they don't train teachers. Hence the mathematics taught at UNZA is industrial in nature.*

(vi) *Most of the UNZA mathematics courses apart from some methodology courses has no meaning to the teaching of secondary school mathematics.*

4.5.5. Relevance of University Methodology Courses to the actual Coverage and Understanding of Secondary School Classroom Mathematics

The questionnaires for both student teachers and teachers had each a survey question which requested the respondents to rate their coverage and understanding of secondary school mathematics as a result of having learned methodology courses in the department of Mathematics and Science Education. To assess on how methods courses prepared student teachers in the coverage and understanding of secondary school mathematics, an independent t-test was employed to compare the means of in-service and pre-service student teachers as well as the means of student teachers and teachers. Table 4.9 and table 4.10 shows the results.

Table 4.9: *Independent t-test results of student teachers' rating of their coverage and understanding of secondary school mathematics in methods courses*

Mathematics Topics						
	Type of Student	*Mean*	*SD*	*t*	*df*	*p*
Sets	pre-service	3.32	1.646	.365	37	.717
	in-service	2.40	1.517			
Similarity and Congruency	pre-service	2.79	1.298	-.776	36	.443
	in-service	2.00	1.414			
Variations	pre-service	2.68	1.471	.726	36	.472
	in-service	1.80	1.304			

Sequences and Series	pre-service	3.09	1.564	1.526	7.229	.170
	in-service	1.80	1.304			
Coordinate Geometry	pre-service	3.06	1.575	.490	37	.627
	in-service	2.20	.837			
Quadratic Functions	pre-service	3.53	1.482	1.456	37	.154
	in-service	1.80	1.095			
Relations and Functions	pre-service	3.03	1.446	.296	13.134	.772
	in-service	2.00	1.414			
Circle Theorem	pre-service	2.88	1.533	1.930	15.843	.072
	in-service	1.60	.894			
Constructions and Loci	pre-service	2.62	1.538	.888	36	.380
	in-service	1.60	1.342			
Trigonometry	pre-service	3.18	1.566	.205	36	.839
	in-service	2.00	1.225			
Mensuration	pre-service	2.71	1.315	1.294	35	.204
	in-service	1.60	.894			
Probability	pre-service	2.88	1.343	1.587	35	.122
	in-service	2.40	1.673			
Statistics	pre-service	3.00	1.651	2.179	8.374	.059
	in-service	2.00	1.414			
Graphs of Functions	pre-service	3.24	1.577	1.695	37	.098
	in-service	2.00	1.225			
Linear Programming	pre-service	2.82	1.424	2.316	14.117	.036
	in-service	1.40	.894			
Vectors in two Dimensions	pre-service	2.97	1.492	2.632	10.058	.025
	in-service	2.20	.837			
Geometrical Transformation	pre-service	2.32	1.273	2.049	14.945	.058
	in-service	2.00	1.414			
Earth Geometry	pre-service	2.61	1.435	1.039	36	.306
	in-service	1.60	.894			
Introduction to Calculus	pre-service	3.50	1.780	.751	33.000	.458
	in-service	2.80	1.789			
Total	pre-service	55.9706	24.85776	1.148	37	.258
	in-service	37.2000	20.24105			

* Significant at $p < 0.05$ n = 39

Table 4.9 shows that there was no statistically significant difference in almost all the secondary school mathematics topics between the pre-service and the in-service student teachers except in two mathematics topics where there was statistically significant difference between in-service and pre-service student teachers. Apart from the mean for Quadratic Functions and Introduction to Calculus, the rest of the mathematics topics had the means scoring in the range 3.32 and 1.40.

Table 4.10: *Independent t-test results of student teachers' and teachers' rating of their coverage and understanding of secondary school mathematics in methods courses*

Mathematics Topics	*Type of Respondent*	*Mean*	*SD*	*t*	*df*	*p*
Sets	Student Teachers	3.21	1.641	-.405	80	.687
	Teachers	3.35	1.572			
Similarity and Congruency	Student Teachers	2.69	1.321	-1.003	77.426	.319
	Teachers	3.02	1.645			

Variations	Student Teachers	2.56	1.465	-1.543	79	.127
	Teachers	3.10	1.620			
Sequences and Series	Student Teachers	2.92	1.579	-.815	80	.418
	Teachers	3.21	1.597			
Coordinate Geometry	Student Teachers	2.95	1.521	-1.955	80	.054
	Teachers	3.60	1.514			
Quadratic Functions	Student Teachers	3.31	1.542	-.741	80	.461
	Teachers	3.56	1.517			
Relations and Functions	Student Teachers	2.90	1.465	-1.266	80	.209
	Teachers	3.33	1.584			
Circle Theorem	Student Teachers	2.72	1.521	-.801	79	.425
	Teachers	3.00	1.638			
Constructions and Loci	Student Teachers	2.49	1.537	-.834	79	.407
	Teachers	2.79	1.675			
Trigonometry	Student Teachers	3.03	1.564	-1.161	80	.249
	Teachers	3.42	1.500			
Mensuration	Student Teachers	2.56	1.314	-.824	77.608	.413
	Teachers	2.83	1.622			
Probability	Student Teachers	2.82	1.374	-1.651	80	.103
	Teachers	3.35	1.510			
Statistics	Student Teachers	2.87	1.641	-1.445	79	.152
	Teachers	3.38	1.529			
Graphs of Functions	Student Teachers	3.08	1.579	-.573	80	.568
	Teachers	3.28	1.608			
Linear Programming	Student Teachers	2.64	1.442	-.784	79	.435
	Teachers	2.90	1.574			
Vectors in two Dimensions	Student Teachers	2.86	1.437	-1.445	78	.153
	Teachers	3.35	1.541			
Geometrical Transformation	Student Teachers	2.28	1.276	-1.607	79	.112
	Teachers	2.79	1.523			
Earth Geometry	Student Teachers	2.47	1.409	-.778	78	.439
	Teachers	2.74	1.609			
Introduction to Calculus	Student Teachers	3.41	1.773	-.210	80	.834
	Teachers	3.49	1.594			
Total	Student Teachers	53.5641	24.90275	-1.108	80	.271
	Teachers	59.8605	26.39858			

* Significant at $p < 0.05$ n = 82

The results from table 4.10 show that there was no statistically significant difference in all secondary school mathematics topics including the totals between student teachers and the teachers. The means in all items for both groups were indicating well to fairly well apart from two topics Coordinate Geometry where student teachers had a mean of 2.95, SD = 1.521, while teachers had a mean of 3.60, SD = 1.514 both at p value of 0.054 and Quadratic Functions where student teachers had a mean of 3.31, SD = 1.542, while teachers had a mean of 3.56, SD = 1.517 both at p value of 0.461.

4.5.6. Rating the Teachers' and Student Teachers' Preparedness in the preparation of Documents for Quality Teaching of Mathematics

Teaching and learning can be effectively done where the teacher is capable of preparing and using professional documents such as: schemes of work, records of work, lesson plan, assessment instruments and many more others. These are some of the things student teachers are expected to be taught during methodology courses. Using the five points likert scale, both student teachers and teachers were requested to rate themselves on the extent to which courses they had learnt in the teaching methods had prepared them in the preparation of professional documents. Table 4.11 shows the results.

Table 4.11: *Independent t-test results of student teachers and teachers rating of their preparation of professional documents in methods courses*

	Type of Respondent	*Mean*	*SD*	*t*	*df*	*p*
How to use a syllabus.	Student Teacher	3.49	1.254	.072	80	.943
	Teachers	3.47	1.502			
Preparation of schemes of work.	Student Teacher	3.54	.996	-.074	75.793	.941
	Teacher	3.56	1.402			
Preparation of lesson plans.	Student Teacher	3.97	1.013	1.447	73.098	.152
	Teacher	3.57	1.467			
Preparation of appropriate learning outcome (objectives).	Student Teacher	3.67	1.199	.383	80	.703
	Teacher	3.56	1.351			
Making, selection and using of teaching /learning aids.	Student Teacher	3.26	1.697	.131	80	.896
	Teacher	3.21	1.552			
Preparation of records of work.	Student Teacher	3.21	1.151	-.731	78.186	.467
	Teacher	3.42	1.484			
Construction of appropriate assessment instruments such: tests, class exercise and assignments.	Student Teacher	2.82	1.554	-1.754	80	.083
	Teacher	3.42	1.531			
Marking of pupils' exercise books, tests and examinations.	Student Teacher	2.75	1.422	-1.814	77	.074
	Teacher	3.35	1.494			
Making of self-evaluation after teaching.	Student Teacher	2.68	1.469	-1.851	71	.068
	Teacher	3.31	1.423			
Peer teaching	Student Teacher	3.50	1.202	.240	78	.811
	Teacher	3.43	1.434			
Remedial teaching	Student Teacher	3.35	1.317	1.006	78	.317
	Teacher	3.05	1.379			
Teaching experience	Student Teacher	3.21	1.094	-1.795	79	.076
	Teacher	3.70	1.319			
Total	Student Teacher	38.3333	11.54017	-.837	78.068	.405
	Teacher	40.7907	14.95160			

* Significant at $p < 0.05$ n = 82

Table 4.11 indicates that the means for student teachers ranged from 3.97 to 2.68, meaning student teachers rated themselves close to very well to slightly below well, while the means for teachers ranged from 3.70 to 3.05, meaning teachers rated themselves slightly above well to well.

4.5.7. Preparedness of Teachers and Student Teachers in Teaching Methodology and Techniques of Teaching

In order for teaching and learning to take place, two things are crucial that is, what to teach (content) and how to teach (teaching strategies). During the teacher education programme, student teachers are expected to be exposed to various teaching strategies through methodology courses. In this study, both teachers and student teachers were asked in the questionnaire to rate themselves on the extent to which the department of Mathematics and Science Education in the School of Education had prepared them in various teaching methods or strategies. Table 4.12 shows the independent t-test results on how the respondents had rated themselves on a five points likert scale.

Table 4.12: *Independent t-test results of student teachers' and teachers' own rating of their understanding of teaching strategies in methods courses*

Teaching Strategies	*Type of Respondent*	*Mean*	*SD*	*t*	*df*	*p*
Demonstration	Student Teacher	3.28	1.317	-.339	79	.735
	Teacher	3.38	1.306			
Question and Answer	Student Teacher	3.72	1.099	.602	76.309	.549
	Teacher	3.55	1.435			
Subjective Learning through problem solving	Student Teacher	3.00	1.487	-.749	79	.456
	Teacher	3.24	1.376			
Group work/pair work	Student Teacher	3.41	1.352	.498	79	.620
	Teacher	3.26	1.326			
Discussion/Brain Storming	Student Teacher	3.24	1.283	-.742	78	.460
	Teacher	3.45	1.310			
Team Teaching/ Team Planning	Student Teacher	2.56	1.429	-1.642	79	.105
	Teacher	3.10	1.478			
Total	Student Teacher	19.1282	6.92128	-.544	79	.588
	Teacher	19.9762	7.08653			

* Significant at $p < 0.05$ n = 82

Table 4.12 indicates that the means of the rating on the six teaching strategies ranged from 3.72 to 2.56 for student teachers and from 3.55 to 3.10 for teachers. This means that student teachers had rated themselves slightly above well to slightly below well, while teachers rated themselves neither on excellent nor very well but slightly above well to well.

4.6. Summary

Research question one investigated the extent to which the mathematics teacher education curriculum had the appropriate content and teaching methods which were relevant for teaching mathematics in Zambian secondary schools. Both student teachers and UNZA products indicated having acquired PCK and lacked MKT. Respondents expressed lack of good coverage and understanding of secondary school mathematics such as: Earth Geometry, Circle Theorem, Mensuration, Variations, Linear Programming, Geometrical Transformation and Constructions and Loci.

4.7. Research Question Two

In order for the researcher to have a clear understanding of the problem under investigation, he found it to be very helpful to establish the intentions of the curriculum developers (lecturers) for the mathematics teacher education curriculum and where they would expect their products to work from upon graduation.

4.7.1. Designer's Intensions of the Mathematics Teacher Education Curriculum

Based on the aim of the programme, the response of some lecturers from the School of Education and School of Natural Sciences to some extent differs in a way they viewed the aim of the programme. For example, lecturer 3 from the School of Education explained that;

> *I will not necessarily coin the aim for you but I will speak in generic terms. The general aim is to prepare secondary school teachers of mathematics at degree level.*

In a separate interview, when the same question was asked to lecturer 2, he said;

> *Generally, the aim is to equip students with effective skills in mathematics so that they would be comfortable to go and teach in secondary schools.*

The same general understanding of the aim was shared by lecturer: 5, 6, 9, 10 and the National Standards Officer for Mathematics. All were coming to the answer that the aim of the mathematics teacher education curriculum was to produce good teachers of mathematics and science who were expected to add value to the society by teaching learners in secondary schools who would later contribute to the development of the country.

When the researcher asked the same question to the sampled lecturers of mathematics from the School of Natural Sciences, it was discovered that some gave the similar responses that lecturers from the School of Education had given while others seemed not to be sure about the aim of the mathematics teacher education curriculum. For instance, lecturer 4 said that;

> *It is difficult for us to say what the aim is because we are only doing a service, the people with the aim is the department in the School of Education who would know the aim because we did not design the programme. Here in the School of Natural Sciences we have students studying Bachelor of Arts with Education, Bachelor of Science with Education, Bachelor of Engineering and many more other programmes who are subjected to the same mathematics courses.*

Although some lecturers in the School of Natural Sciences seemed to have given different views about the aim of the mathematics teacher education programme, they were pointing to the views echoed by lecturer 4. This was attested by the views of lecturer 7 who said;

> *The aim is to prepare students to fit well in the world of technology and various areas of engineering. Not only to train teachers but students with a wide knowledge and skill.*

The same understanding was held by lecturer 8 who argued that the aim of the programme was to produce an effective mathematician who could work anywhere without any serious challenge.

4.7.2. Type of Product Expected to be Produced and the Institution where they would work

In order for the researcher to be certain about the responses that teacher educators had given on the aim of the programme, he further asked them to state the type of product they would like to produce and where he/she would be likely to practice the knowledge and skills acquired through the programme. Lecturer 2 explained that;

> *We expect to produce a teacher who should not have any problem in teaching secondary school mathematics and also to produce a teacher who is able to take up postgraduate studies with no problems.*

This response was supported by the response from lecturer 5 who stated that;

> *Just some effective, someone who can teach effectively, of course they can do many more things but our interest is teaching in secondary schools.*

Lecturer 3 commented that;

> *Certainly we expect as a department to produce a teacher who will appropriately and confidently teach the secondary school mathematics*

syllabus. We expect them to teach in schools of course others could teach in colleges of education but primarily the idea is that once they complete their University studies they should be able to teach secondary school mathematics.

Some lecturers for example lecturer 7 from the school of Natural Sciences stated that;

We expect to produce all round mathematicians who are capable of working in any field such as: engineering, banks, mining, statisticians and many other fields because they are expected to be logical thinkers.

This view seemed to have the support of lecturer 4 and lecturer 6 from the same department who also felt that their mandate was not only to produce a teacher of mathematics. In supporting this view lecturer 6 asserted that;

The programme of mathematics at UNZA is quite diverse in the sense that not only do we expect them to go and teach because government may not employ all our students at once, therefore given the skills in mathematics, we know that they will understand better anything to do with arithmetic and our students can work in any insurance company, Central Statistical Offices and banks because in such institutions they need people who understands better calculations.

4.7.3. Appropriateness and Relevance of Content and Teaching Methods Courses Offered to Student Teachers

As earlier indicated, research question two sought to investigate the intentions of the curriculum designers of the programme. This prompted the researcher to find out the views of teacher educators on the appropriateness and relevance of mathematics content and methodology courses that were taught at UNZA to student teachers of mathematics. He further wanted to find out the factors that they considered in the process of developing such a curriculum and whether the department of Mathematics and Statistics and the department of Mathematics and Science Education planned together to ensure coordination between the content courses in the School of Natural Sciences and methodology courses offered in the School of Education. Interviewees gave different views, for instance, lecturer 5 from the School of Education commented that;

Not quite appropriate and relevant, I think there is a lot of content we really don't need for the purpose of teaching. A lot of mathematics up to fourth year level in terms of effective teaching at secondary school there is a lot of it we don't need. In terms of methods there are a lot that we can do which we don't do; we can do a lot in terms of methods. This concept of mathematical knowledge for teaching, I think we need a *better blend between methodology and content. I don't think we are doing that well enough. We have high powered mathematics and theories but on blending we have not gotten it right between methodology and content.*

This view was supported by another lecturer from the School of Natural Sciences who strongly stated that;

The level at which we teach mathematics is a little bit at a higher level than what someone would need just to teach secondary school mathematics. That is why you find that even someone who has a diploma can teach secondary school mathematics but for a degree level, we appreciate that it must be a little bit higher, this is because we don't have a designed programme to say this is the mathematics for secondary school teachers.

In response to the same question, another teacher educator lecturer 3 from the School of Education argued that;

Of course you have asked the question that would require the attention of those that are teaching our students content mathematics especially in the School of Natural Sciences. As a lecturer I would say yes and no. Yes in the sense that learners are given the chance to experience that which they will be able to do when they go to teach secondary school mathematics. No in the sense that some of the subject matter that we subject our students to may not be necessarily the subject matter that they will teach upon graduation. Let me say at this point that there are different schools of thoughts. There are those that believe that when training a secondary school teacher, it is best that you allow them to study the so called advanced mathematics, such people believe that such kind of mathematics would make it easier for student teachers to comprehend or teach well lower mathematics. For me I will say yes but there is a room for improvement.

The views of lecturer 5 seemed to have been supported by other interviewees. For example, lecturer 4 commented that;

The level is too much, I will say the knowledge they use in secondary schools from the mathematics they learn is very minimal, because even the mathematics they learn in first year is enough to make them teach in secondary schools. From second year going upwards the knowledge they learn is too much. For lack of a better term I can say it is the wastage of knowledge, yes I would call that. For the betterment of our county, it is better our students who go through the mathematics we teach them here they do other things rather than just teaching in secondary schools. The mathematics curriculum is not effective because it is beyond for the teacher education.

Concerning the curriculum development process of the mathematics teacher education, teacher educators gave different views. Lecturer 6 explained that;

> *We look at how the mathematics that will teach our students will help them not only as teachers because some of them may choose to be academicians. We tend to go beyond what is taught in secondary schools so that when one applies for masters anywhere he/she will be accepted because the content that one has already is worth to allow one to be admitted for master's programme. Personally I would say we have never had chance to sit down with lecturers teaching mathematics methods when designing the mathematics curriculum.*

Similarly, lecturer 2 commented that;

> *We do not consider the mathematics taught in secondary schools. When we come to A levels we assume that the mathematics that they are learning they should have done it at secondary schools. It is our assumption but sometimes we find that our assumption doesn't work. Usually we have gotten the secondary school syllabus and looked at it so that we determine at what level we can start teaching our students. The pre-requisite we expect students to have they don't have them, so the secondary school syllabus is misleading us. We don't know the kind of teaching that take place in secondary schools. It's like it is specialised in making pupils pass the examinations. Students come to the University without simple mathematical concepts such as laws of exponents.*

The researcher asked a follow up question on whether the department of Mathematics and Science Education and the department of Mathematics and Statistics did plan together when designing the curriculum. In response lecturer 2 stated that;

> *It is one of the problems that we encounter; here when we are designing our programme, we design them as standard mathematics programmes. We do not really care so much that there will be students of education who will need to do a different mathematics. We would like the School of Education to tell us the specific things they would want us to teach students from the School of Education or them to say, teachers of mathematics need this and this and this, can you design a programme that will cover this. They can tell us so that we design a course for secondary school teachers the way we have designed a mathematics course for the School of Humanities and Social Sciences. They don't do the same mathematics that our students do here, their mathematics is slightly different.*

When lecturer 3 was asked on the issue of the two departments working together when developing the mathematics teacher education curriculum, he stated that;

> *Not to my knowledge and for me that is a gap. That can be helpful what you have alluded to if that was the case so that even the mathematics that our students are studying need to be tailored according to their needs.*

In addition, lecturer 5 contended that;

> *The present basis for determining the mathematics that we teach was more from the point of view of what mathematics does a University graduate need rather than what mathematics does one require for teaching. So we are trying to review our curriculum focusing more on what mathematics do students require for teaching. What is taught in secondary schools was not sufficiently considered because our students take the same mathematics that everyone else does in the School of Natural Sciences. So the meaning is that the curriculum does not focus on the teaching needs. If everyone else is doing the same mathematics, then the curriculum is not tailored for teaching purposes it is only a University course. There is need for us to scrutinise the current curriculum and focus more on what is relevant for secondary school teaching.*

When commenting on whether the two departments worked together when designing the curriculum for teachers, he stated that;

> *We have been talking to each other even the things we are talking about they fully understand. So it doesn't matter if they can continue teaching content but we need to agree on what we need. It is quite tricky; if we are to teach content here it has implications on the increase of the load. We would need more man power. But there are some agreements that there are certain things that our students do that they should not do for the purpose of teaching. What we have not done is to come up with the revised course outline for the content we need for our students. But they do understand that we have different needs.*

Based on the responses given by different interviewees, the researcher asked the teacher educators to comment on the effectiveness of the mathematics teacher education curriculum at UNZA. Lecturer 2 explained that;

> *It may not be effective but we can improve. The major weakness is dealing with school mathematics. We have a lot of University mathematics and methodology but in between we are not actually dealing sufficiently with the mathematics that students are actually going to teach. I think that is the big gap that we have to address more meaningfully. It is not good enough just to know differential equations*

meanwhile you cannot deal with simultaneous equations taught at secondary school, it doesn't make sense. A lot of our students they can't solve grade 12 questions but can solve all sort of sophisticated mathematical problems, it doesn't make sense. I think there is need to get to the ground to the very mathematics that they are going to teach it would make a lot of sense.

In trying to collect more information on the appropriateness and relevance of the mathematics content and methods courses offered to student teachers at UNZA, the questionnaires for teachers had an open-ended question where they were expected to state with reasons whether the mathematics teacher education curriculum at UNZA prepared them well to teach secondary school mathematics. While the questionnaire for student teachers had also an open-ended question where they were requested to state with some reasons on whether the mathematics teacher education curriculum at UNZA was effective in preparing competent teacher for teaching secondary school mathematics. Their responses are shown below.

Table 4.13: *Frequency and Percentage Distributions of Teachers on Whether the Mathematics Teacher Education Curriculum at UNZA Prepared them well to Teach Secondary School Mathematics*

		f	%	Valid %	Cumulative %
Valid	yes	19	44.2	45.2	45.2
	no	23	53.5	54.8	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

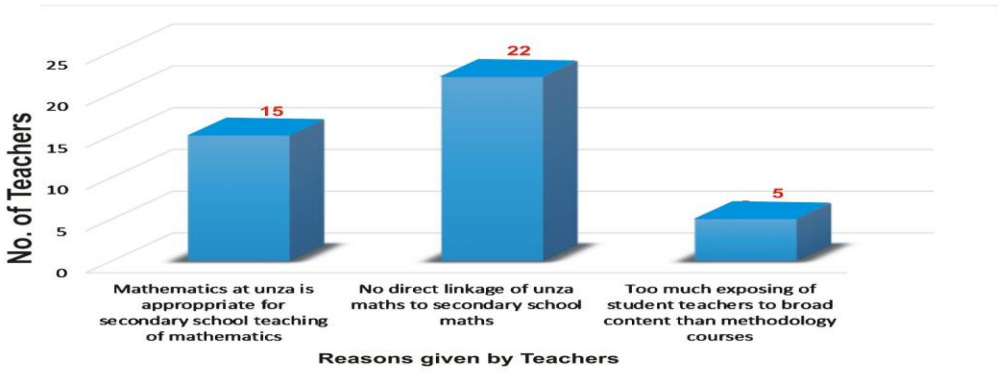

Figure 4.3: *Reasons of Teachers on Whether the Mathematics Teacher Education Curriculum at UNZA Prepared them well to Teach Secondary School Mathematics*

Table 4.13 shows that 19 teachers representing 44.2% said that the mathematics teacher education curriculum at UNZA prepared them well to teach secondary school mathematics while 23 teachers representing 53.5% said that the mathematics teacher education curriculum at UNZA did not prepare them well to teach secondary school mathematics. One teacher representing 2.3% did not answer the question.

Figure 4.3 indicates that 15 respondents which represented 36% stated that the mathematics teacher education curriculum at UNZA was appropriate for secondary school teachers of mathematics, 22 respondents representing 52% argued that there was no direct linkage between the mathematics teacher education curriculum at UNZA and the mathematics that was taught in secondary schools. 5 respondents which represented 12% stated that the mathematics teacher education curriculum at UNZA exposed student teachers to broad content than methodology courses.

Table 4.14: *Frequency and Percentage Distributions of Student Teachers on Whether the Mathematics Teacher Education Curriculum at UNZA was Effective in Preparing Secondary School Teachers of Mathematics*

		f	%	Valid %	Cumulative %
Valid	yes	11	28.2	28.2	28.2
	no	28	71.8	71.8	100.0
	Total	39	100.0	100.0	

Table 4.14 shows that 11 student teachers representing 28.2% agreed that the mathematics teacher education curriculum was effective in preparing secondary school teachers while 28 student teachers representing 71.8% argued that the mathematics teacher education curriculum at UNZA was not effective to prepare secondary school teachers of mathematics. Figure 4.4 shows the reasons that student teachers had cited.

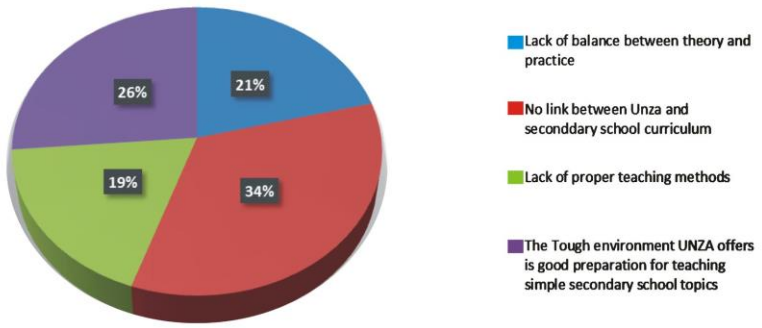

Figure 4.4: *Reasons of Student Teachers on Whether the Mathematics Teacher Education Curriculum at UNZA was Effective in Preparing Secondary School Teachers of Mathematics*

From figure 4.4, 21% of the respondents stated that the mathematics teacher education curriculum at UNZA lacked the balance between theory and practice, 26% of the respondents commented that the tough mathematics they were studying at UNZA was a good preparation for teaching simple secondary school mathematics topics, 19% of the respondents stated that there was lack of proper teaching methods at UNZA while 34% of the respondents argued that there was no link between the mathematics teacher education curriculum at UNZA and the secondary school mathematics curriculum.

4.8. Research Question Three

Research question number three tried to find out the respondents' opinion on whether teacher education preparation could affect the teaching and eventually learner performance in secondary school mathematics. This question was answered by question 10 and 11 through interviews by lecturers of mathematics. The researcher also used open-ended questions from two questionnaires which sought for the same information from student teachers and teachers of mathematics. Question 9, 10, 11, 12, 13 and 14 from the questionnaire for student teachers and question 10, 11, 12, 13 and 14 from questionnaire for teachers addressed research question number three. This was supplemented by the findings from the mathematics lessons which were observed by the researcher. The researcher in the sub-sections below will present different perceptions of respondents. Below are the responses from the respondents.

4.8.1. Questioning Techniques amongst Teachers of Mathematics

The quality of questions that teachers ask learners during the teaching and learning process is important for the enhancement of mathematical conceptual understanding. The question below was asked to the teachers:

Do you think the way teachers of mathematics ask questions in their lessons and assessment instruments do affect learners' performance in mathematics?

The responses are shown in table 4.15 and the justifications for their responses are shown in figure 4.5.

Table 4.15: *Frequency and Percentage Distributions of Teachers on Whether Questions Teachers of Mathematics ask Affect Learners' Performance*

		f	%	Valid %	Cumulative %
Valid	yes	33	76.7	78.6	78.6
	no	9	20.9	21.4	100.0
	Total	42	97.6	100.0	
Missing	System	1	2.3		
Total		43	100.0		

Table 4.15 shows that 33 respondents representing 76.7% agreed that the way teachers of mathematics ask questions affected learners' performance while 9 respondents representing 20.9% stated that questions that teachers ask learners did not affect learners' performance in mathematics. Only one respondent representing 2.3% did not answer the question.

When asked to give reasons for their responses, those who said the way teachers ask learners questions does affect learners' performance both positively and negatively because well phrased questions help learners to think deeply in mathematics lessons and tests but low cognitive level questions does not provoke learners' critical thinking. One respondent stated that;

> *This is because good questioning techniques can result in pupils thinking deeper and make them be alert.*

From the total of 40 respondents who answered this question, 15 respondents representing 37.5% said *good questioning techniques promote critical and creative thinking amongst the learners* while 20 respondents representing 50% argued that *poor questioning techniques by teachers have a negative effect on learners*. The total of 5 respondents representing 12.5% stated that *questions that teachers ask do not affect learners' performance but what leads to* *poor performance in mathematics is the lack of understanding of mathematics topics by the learners themselves.* Three respondents did not comment.

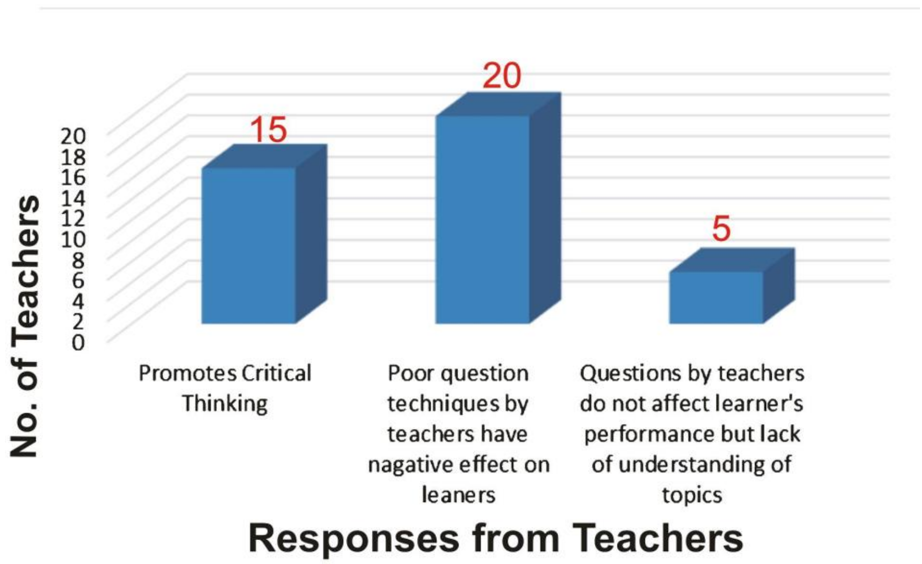

Figure 4.5: *Teachers' Responses on how Questions by Teachers of Mathematics Affect Learners' Performance*

When the same question was asked to student teachers, they also gave similar views which are presented in table 4.16. From the total number of 39 student teachers, two of the respondents never answered the question. The remaining 37 student teachers indicated that teachers' questions do affect learners' performance. 25 representing 68% stated that good questioning techniques promotes critical thinking amongst the learners while 12 respondents representing 32% argued that poor questioning techniques affect learners' performance negatively.

Table 4.16: *Frequency and Percentage Distributions of Student Teachers on How Questions that Teachers of Mathematics ask affect Learners' Performance*

Views of Respondents	*f*	%
Promotes critical thinking	25	68
Poor questioning techniques by teachers have negative effect	12	32
	37	100

4.8.2. Challenges of Student Teachers in Adjusting to Teaching Secondary School Mathematics upon Graduation

When lecturers were asked to comment on whether the way teachers were prepared to teach secondary school mathematics at UNZA in a way affected their classroom teaching as well as the performance of learners in schools, lecturer 3 stated that;

> *Without doubts, without doubts because you see there is an inclination to go and teach as you were taught. Remember along the way I had said, you cannot teach that you don't know. and so if you as a teacher you are not confident, you lack the necessary competences, chances are high that when you go to teach those subject areas where you had deficiency you may not teach them well. For me there is a relationship but we cannot just simply swiftly say that is what causes poor performance no but I want to make this submission that indeed it can affect the performance. For me it starts here where teachers are trained, we must give them an opportunity to experience all that would make them begin a good teacher of mathematics at the level we expect them to go and teach.*

This view of teachers of mathematics translating the mathematics they learnt during their teacher education directly to learners seemed to have the support of lecturer 1, 4, 6 and 7. For instance, lecturer 6 asserted that;

> *It may affect learner performance positively because the mathematics that we teach students makes them to be equipped to overcome challenges that they may encounter when they go to teach. Learners may be affected negatively if a teacher thinks he/ she has done advanced mathematics and fails to humble himself or herself and adjust their teaching to suit secondary school mathematics.*

In response to the same question, lecturer 5 commented that;

> *That is a big jump; there is no way we can get to that connection. Factors that lead to poor performance are so numerous. Yes there is a link but very remote link. There is the issue of teacher pupil ratios, pre-requisites within schools and learners who get zeroes at grade 9 and giving them calculus at senior level such things like that, lack of teaching and learning materials such as books. There are so many factors. Of course the issue of teacher education is relevant to look at but it is difficult to associate poor performance to teacher education it is like jumping too many bridges in between because there are so many factors that leads to poor learner performance. It is difficult to place a finger on the causes of poor performance but to try to improve in all parts. To address this challenge each one need to play a role. As teacher educators we need also to play a role so that our programmes are more relevant to a student teacher.*

When the same question was asked to teachers, different views were revealed as shown in table 4.17 and table 4.18 which reveals the reasons that the respondents had given for their yes and no answer.

Table 4.17: *Frequency and Percentage Distributions of Teachers on Whether the way Teachers are Prepared to Teach Affect Learner Performance in Mathematics*

Teachers of Mathematics may Affect Learner Performance		*f*	%	Valid %	Cumulative %
Valid	yes	30	69.8	85.7	85.7
	no	5	11.6	14.3	100.0
	Total	35	81.4	100.0	
Missing	System	8	18.6		
Total		43	100.0		

Table 4.18: *Frequency and Percentage Distributions of Reasons Teachers had given for their yes or no Responses in table 4.17*

Views of Respondents	*f*	%
Mathematics Teacher Education Curriculum at UNZA is appropriate in preparing secondary school teachers of mathematics	9	26
No linkage of UNZA Mathematics Teacher Education Curriculum to secondary school mathematics curriculum	21	62
Direct translation of the complex university mathematics to the teaching of secondary school mathematics by teachers.	3	9
Lack of adequate time for teaching experience	1	3
	34	100

From the two tables, 69.8% of the sampled teachers agreed that the mathematics teacher education programme affected in the way teachers taught mathematics, 11.6% said that the teacher education programme did not affect the way teachers taught classroom mathematics and 18.6% of the sampled teachers did not answer the question. In trying to find out what the respondents meant by stating that teachers were affected as well as not affected, the researcher asked the respondents to give reasons for their responses. It was found that 9 of the respondents stated that the mathematics teacher education curriculum at UNZA was appropriate for teaching secondary school mathematics. This meant that teachers' teaching was affected in a positive way. 21 respondents said that there was no linkage between the mathematics teacher education curriculum at UNZA and the secondary school mathematics curriculum which affected the teaching and eventually the learners. 3 respondents said that due to lack of linkage between the two curricula, teachers failed or took a lot of time to easily adjust to the mathematics they found in schools hence teaching the way they were taught during their teacher education programme. One respondent stated that there was inadequate time for teaching experience during the teacher education programme. This meant that teachers' teaching was affected negatively. One respondent who answered on yes and no part did not give a reason.

The views of teachers regarding teacher preparation was shared with the responses from the student teachers whose responses are summarised in figure 4.6.

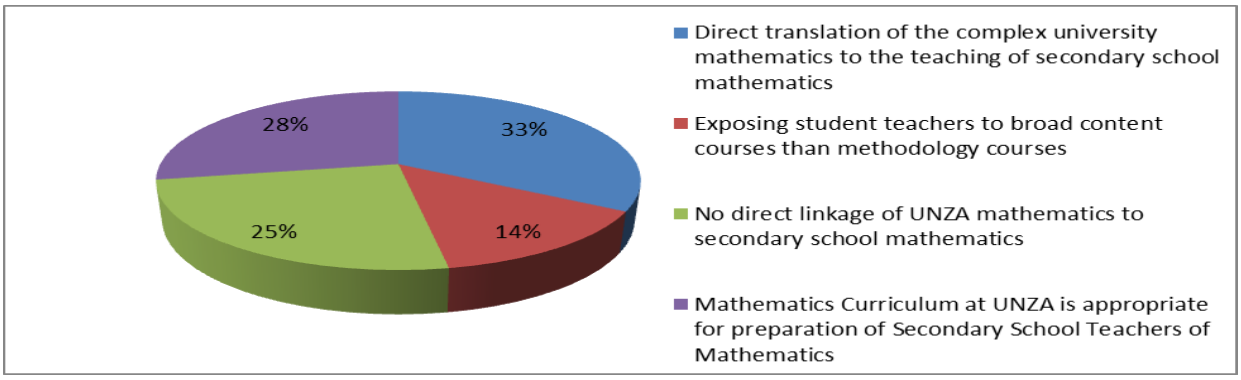

Figure 4.6: *Responses of Student Teachers on Whether the way Teachers are Prepared to Teach Mathematics may Affect Learner Performance*

4.8.3. Other views of Lecturers and Standards Officers on what leads to Unsatisfactory Performance of Learners in Mathematics

When lecturers were asked to state what they felt were the causes of poor performance of learners in mathematics, lecturer 3 said that;

> *I have not carried out a research so I cannot authoritatively speak on that one but I can speculate, one of them is what you have already alluded to. Teachers play a vital role and I have already made an argument that if teachers are ill qualified which is not what I am saying that our products are ill prepared but I am trying to mention that if teachers are ill qualified it means that they will not teach mathematics effectively, they will not assess their learners effectively and all these goes to compound affecting learners' performance. But also the learners themselves they have a take in this aspect. You know as they argue, you can train a footballer but at the end of the day it's the player who plays the game. The economies where learners themselves come*

from, the environment where mathematics is taught and sometimes just the belief about mathematics itself, there are people who just fear mathematics. There are people who would say, me I don't have the ability to do mathematics.

The response by lecturer 3 seemed to have been supported by lecturer 2, 4, 6, 1, 8, 10 and the National Standards Officer for Mathematics who argued that poor results of mathematics was as a result of bad teaching of mathematical concepts by teachers. The National Standards Officer for Mathematics argued that; *teachers who are ill prepared fail to put themselves in the position of the learners who already have the misconceptions of mathematics on how best they would understand that which he/she would like to teach them*. In addition, lecturer 2 said that;

I think it could be the way our pupils are taught mathematics at secondary school, they are just directed that this question do like this and the answer will come out like that. There is no point of teachers asking and explaining on why learners are doing what they are doing.

Just like the views of the National Standards Officer for Mathematics, lecturer 6 commented that;

Most teachers aim at finishing the syllabus not learners comprehending mathematical concepts. Teachers want to cover the syllabus instead of uncovering the syllabus so that learners are able to see the beauty of mathematics.

Apart from the views of lecturers on what had led to poor performance of learners in mathematics, student teachers and teachers had also given their views although some views were similar to what the lecturers had given. Table 4.19 summarises the views of teachers and student teachers.

Table 4.19: *Frequency and Percentage Distributions of Teachers and Student Teachers' Views on the Causes of Poor Learner Performance in Mathematics*

	Views of Respondents	Teachers		Student Teachers	
		f	%	*f*	%
1	Poor attitude of learners towards mathematics and lack of teaching and learning resources.	16	38	2	5
2	Methods teachers use and learners' perception towards mathematics.	5	12	19	50
3	Lack of good mathematics background amongst learners.	8	19	2	5
4	Lack of mathematical knowledge for teaching by teachers.	7	17	1	3
5	Lack of self-practice by the learners.	5	12	5	13
6	Lack of well-qualified teachers of mathematics in secondary schools.	1	2	7	18
7	Lack of direct relationship between the mathematics taught in schools and learners daily life experiences.			1	3
8	Shortage of teachers of mathematics			1	3
		42	100	38	100

Table 4.19 shows that one teacher did not provide the response. 16 respondents representing 38% cited poor attitude of learners towards mathematics and lack of teaching and learning resources, 5 respondents representing 12% cited teaching methods that were used by teachers and learners' perception towards mathematics, 8 respondents representing 19% cited lack of good mathematics background amongst learners, 7 respondents representing 17% cited lack of mathematical knowledge for teaching by teachers, 5 respondents representing 12% cited lack of practice through problem solving by learners and 1 respondent who represented 2% cited lack of qualified teachers of mathematics. Besides, the same table also shows student teachers' views on what they thought could have led to unsatisfactory learner performance in mathematics. One student teacher did not answer the question. 1 respondent representing 3% cited lack of direct relationship between the mathematics taught in schools and the learners' daily life experiences, 19 respondents representing 50% cited the methods that were used by teachers and learners' perception towards mathematics, 7 respondents representing 18% cited lack of well qualified teachers of mathematics, 1 respondent representing 3% cited shortage of teachers of mathematics, 2 respondents representing 5% cited lack of appropriate teaching and learning resources, 5 respondents representing 13% cited lack of self-practice by the learners, 2 respondents representing 5% cited lack of good mathematics background for learners at primary school and 1 respondent representing 3% cited lack of mathematical knowledge for teaching by teachers.

4.8.4. Teaching Methods used by Teachers of Mathematics

In order for the researcher to be certain concerning the responses that respondents had given on various matters of the mathematics teacher education curriculum at UNZA, he had to observe some mathematics lessons for some teachers who had answered the questionnaires. The researcher used a teachers' lesson observation checklist in order to check on how UNZA products were teaching secondary school mathematics. The instrument included indicators that were expected in a normal classroom environment. The instrument had columns for yes, no and comments to show the type of methods or technique the teacher used and the level of appropriateness of the content taught.

Table 4.20: *Frequency Distribution of Activities Teachers used to Teach Classroom Mathematics*.

Category	Number of Teachers Involved in the Activity	
1. Teaching Approaches	Teacher Centred 4	Learner Centred 1
2. Ability to Integrate Various Teaching Methods	Able to Integrate Various Teaching Methods 1	Unable to Integrate Various Teaching Methods 4
3. Quality of Questions Teachers' asked	Questions that Promote Critical Thinking 0	Questions that does not Promote Critical Thinking 5
4. Availability and usage of Teaching/Learning aids	Teaching/Learning aids Available and used 1	Teaching/Learning aids Unavailable 4
5. Appropriateness of Content to Learners	Content Appropriate to Learners 5	Content Inappropriate to Learners 0
6. Teachers' Knowledge of the Subject Matter	Good Knowledge of the Subject Matter 5	Inappropriate Knowledge of the Subject Matter 0
7. Involvement of learners in the lesson conclusion	0	0

Table 4.20 shows that four (4) teachers used teacher centred approach and one (1) teacher used learner centred approach. It also indicates that in all the five lessons observed, the quality of questions teachers asked learners could not promote critical and creative thinking amongst the learners and all teachers demonstrated good knowledge of the subject matter and the content was appropriate to the level of the learners. One (1) teacher was able to integrate different methods of teaching and only one (1) teacher had a teaching/learning aid which was

adequately used. In addition, no teacher had involved learners in the lesson conclusion. Below is a description of the lessons observed.

The researcher visited school z and teacher one (1) was observed for 80 minutes. The teacher was teaching grade ten (10) learners on Processes of Algebra and the lesson was on changing the subject of the formula. The teacher had to introduce the lesson by telling the learners the topic of the day. The teacher proceeded to lesson development where he wrote three examples and found the answers by himself writing the answers on the board. The method he used was lecture method although at some points he was able to use question and answer method. The teacher did not ask specific questions where learners could think and give reasons for their answers. The level of content and class activities were very appropriate for the learners but the teacher used pupils' textbook instead of the lesson plan and no teaching/ learning aid was used apart from the usual chalk board. The teacher's subject matter was good, learners were not involved in the lesson conclusion. The teacher left five questions as a class exercise and asked the class monitor to take the learners' exercise books in the staffroom for marking.

At the same school, teacher two (2) was observed teaching factorising of quadratic expressions by difference of two squares which is a sub topic under Processes of Algebra. The teacher had to begin the lesson by question and answer. She asked learners to expand (a-b) (a+b). Learners were given chance to explain the stages involved. She summarised by a brief explanation and eventually explained to the learners what difference of two squares meant. In the lesson development, she wrote four examples on the board and explained by answering all the four examples on the board. Learners were just observing and listening to the teacher. The explanation was good but she had neither a lesson plan nor teaching and learning aids. She only had a paper where there were examples and class exercise for the learners. After giving learners a class exercise the teacher rushed for another class.

The researcher also went to school M, where he observed teacher three (3) teaching a grade eleven (11) class on the topic: matrices with the sub topic; multiplication of matrices. The teacher asked learners some questions from what they had learnt previously on multiplication of matrices by a scalar before telling them the lesson of the day. Meaning, the teacher used question and answer method. In the lesson development the teacher gave examples and continued with question and answer method. No probing question was used in the lesson and learners were allowed to give chorus answers. At some points the teacher could point at the learners including those who were not willing to participate in the lesson and no teaching and learning aids were used. The lesson was concluded with a class exercise which was not marked during the lesson time.

Another teacher four (4) at school P was observed teaching grade eleven (11) class the topic: Coordinate Geometry and the lesson was on equation of a straight line. The teacher introduced the lesson by asking revision questions on gradients of straight lines. Learners were actively involved. In the lesson development, the teacher gave five examples of which he found the solution of the first example with the involvement of learners in class. The second and the third example, he pointed at two learners one girl and one boy to find the solutions on the board and there after the solutions were discussed by the entire class with the guidance of the teacher. The teacher asked the learners to be in groups of six to answer the last two examples and he started checking what was going on in each group of learners. After the learners had found the answers, the teacher asked each group to present their solutions on the board and the teacher corrected some of the mistakes he noted in the learners' solutions. The group which performed well was motivated by clapping for them. The lesson was concluded with a class exercise which was not marked within the lesson.

At school Y the researcher observed teacher five (5) who was teaching a grade twelve (12) class vectors in two dimensions whose sub-topic was addition and subtraction of vectors. The teacher introduced the lesson by demonstrating the normal human movements from one point to the other without making short cuts. The teacher went into lesson development by displaying a chart in trying to explain how positive and negative signs in terms of movements come about in vectors. She gave examples which she explained to the learner which was followed by a class exercise. The teacher had good subject matter knowledge and the class activities were appropriate to the level of the learners.

4.8.5. Teachers' Refusal to be Observed whilst Teaching Classroom Mathematics

The researcher in this study did not initially plan to interview teachers of mathematics. In the process of the study, a good number of teachers were not willing to be observed whilst teaching even after informing them that the observation was only meant for the study and not for any other form of assessment. This made the researcher to conduct interviews with ten (10) teachers of mathematics on the following questions: why do teachers fear to be observed whilst teaching classroom mathematics? Is the level at which mathematics content is taught at UNZA appropriate for secondary school teaching? What makes teachers of mathematics to skip topics such as Geometrical Transformation, Linear Programming, Earth Geometry and Mensuration when teaching secondary school mathematics? Why do teachers of mathematics divert from mathematics to other teaching subjects when they want to upgrade their studies to a degree level? What leads to poor performance of learners in secondary school mathematics?

In trying to find out the reasons why teachers of mathematics were not willing to be observed as they taught secondary school mathematics, one head of mathematics department stated that;

> *It is lack of confidence to teach secondary school mathematics. The presence of the observer in the lesson prevents the lesson from flowing the way the teacher had planned it. Also some teachers are just too suspicious because they may not be sure of what the observer is looking for as well as his/her intention.*

Similar views were raised by six (6) teachers who were interviewed. The lack of confidence to teach classroom mathematics as well as the fear of teachers of mathematics to be observed whilst teaching was worrisome to the researcher. It was not clear whether this had to do with the level of competence in their subject matter.

4.8.6. Appropriateness and Relevance of Mathematics Content Courses Offered at UNZA for Secondary School Teaching

Eight (8) of the respondents representing 80% stated that UNZA mathematics was too broad, complex and abstract with no direct link to what was taught in secondary schools and two (2) representing 20% of the respondents argued that UNZA mathematics was appropriate for secondary school teaching of mathematics. One of the teachers, who was the head of mathematics department at one of the schools in Lusaka district, narrated that:

> *I have been teaching mathematics for twenty-six (26) years and my learners have been passing secondary school mathematics. When I went to UNZA to upgrade my studies to a degree level, the mathematics I found there was not in line with the mathematics I have been teaching. I thought the mathematics that I would find at UNZA would help me understand further the mathematics I teach. It was unfortunate for me that I was excluded from UNZA and I have not gone back for further studies.*

The other respondent explained that;

Despite UNZA mathematics not being in line with what we teach in secondary schools, mathematics content is not well presented to students by the lecturers. Most lecturers do not appropriately respond to students' questions during lectures. This is one of the reasons some students tend to withdraw from studying mathematics while others end up leaving UNZA without being adequately prepared to teach secondary school mathematics. This is why we have few teachers of mathematics.

This view had the support of 6 of the interviewed teachers.

4.8.7. Skipping of Some Mathematics Topics in the Teaching of Secondary School Mathematics

Some of the reasons cited by respondents on why some teachers of mathematics skipped topics such as Geometrical Transformations, Linear Programming and Earth Geometry were: the topics were not taught to student teachers during their teacher education programme, hence teachers had problems when teaching the topics to the learners. One respondent stated that;

Topics like Geometrical Transformation may take at least a month for it to be well taught to a learner and for a learner to answer one Geometrical Transformation question in the examination takes a lot of time. The marks for a transformation question are the same as for statistics and any other question in section B of mathematics paper two. So learners in most cases decide not to attempt a transformation question at the expense of time.

Concerning Linear Programming, one of the respondents stated that;

Teachers of mathematics generally have problems with the language and Linear Programming demands a better understanding and application of terms such as: at least, utmost and many more.

4.8.8. Teachers of Mathematics Diverting to other Teaching Subjects when Upgrading their Studies to a Degree Programme.

When asked to explain why teachers of mathematics had a tendency of diverting to other teaching subjects when upgrading their studies, one of the respondents said that;

The University of Zambia mathematics does not help the already serving teachers to have a comprehensive understanding of what they already know but tend to go beyond what is relevant for a secondary school teacher. It makes in-service teachers to begin from zero as if they are coming direct from secondary school. I have teachers in the department who have diverted to Civic Education and English and

Religious Education and History. They say UNZA mathematics is hard and it doesn't match with what they teach at secondary school.

This view was supported by five (5) teachers of mathematics and one HoD.

4.9. Research Question Four

Research question number four sought to bring out suggestions that would be appropriate to improve further the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics. What is presented below were the views of respondents on what they thought could be done for the mathematics teacher education curriculum to be appropriate and relevant to the student teachers and learners who are the final beneficiaries. This is because the quality of the curriculum determines the quality of what comes out of such a curriculum.

4.9.1. Suggestions from Respondents on How to Improve the Mathematics Teacher Education Programme

Several suggestions were given by respondents based on what they thought could improve the mathematics teacher education curriculum at UNZA. The researcher in this subsection has highlighted two of the suggestions which are part of the suggestions which are summarised in table 4.21.

4.9.1.1. Linking of UNZA Mathematics Teacher Education Curriculum to Secondary School Mathematics Curriculum

When asked to suggest what lecturers thought could improve further the mathematics teacher education curriculum at UNZA, lecturer 3 said that;

For me for instance in the department of Mathematics and Science Education, I would love a situation where student teachers are given the opportunity to experience the secondary school mathematics whilst on training because I am of the view that much as the umbrella term is mathematics, secondary school mathematics and university mathematics may not mean one and the same thing. They have got different demands. I would love while students are on training at UNZA in the department of Mathematics and Science Education student teachers are exposed to the subject matter of secondary school mathematics. Of course it does happen but not in a manner that I think would ground these student teachers in the subject matter because I consider issues of for instance, not only reproducing the knowledge but issues of justifying why certain things are the way they are in *mathematics. That is one of the things I would expect besides equipping them with pedagogical skills because my view is that you cannot teach that you don't know and if they are to competently go and teach they need to understand the subject matter. I would like to see the School of Natural Sciences through the department of Mathematics and Statistics and our department of Mathematics and Science Education to work together to comprehensively review the mathematics teacher education curriculum where we can look at topics in mathematics offered in the School of Natural Sciences which are relevant to a teacher of mathematics.*

This view was shared by almost all the lecturers interviewed in the School of Education and some lecturers from the School of Natural Sciences, for instance, lecturer 5 argued that;

In terms of curriculum, we need a stronger focus on the mathematical knowledge for teaching. This is different from having strong mathematics content. It is an important concept that we would need to build a strong course. That is one way we can improve. We would want our students to do more of hands on activities that teachers may need in their normal school environment but this has become extremely difficult. Even the normal routine thing like peer teaching is now challenging. We are forced to put them in groups meaning not everyone can have a chance to teach. We still need to find out the resourceful means of improving our teacher education programme. Our teaching experience is not long enough it is more of dry routine than normal. Teaching experience is supposed to be a more meaningful learning experience. It must be done at least twice in four years of study. There are a lot of things we would like to do which are beyond our control.

Lecturer 2 from the School of Natural Sciences stated that;

The best way was to design courses that are specialised to teach teachers who are going to teach secondary school mathematics, because apart from first year foundation mathematics, moving on to second year up to fourth year the mathematics tends to become a little bit more abstract and we don't use that abstract mathematics to teach at the secondary schools. Most students even if they try to learn this mathematics most of them struggle, it would actually be better to teach them a lot of more fundamental but basic mathematics because you will find that at fourth year they do complex analysis which is too much beyond the level of secondary school mathematics. It would be better to do more basic algebra than teaching them complex analysis.

4.9.1.2. Employing Experienced Teachers as Lecturers and Teaching Experience to be Done Twice During the Teacher Education Programme.

The National Standards Officer as earlier indicated was not excepted from bringing out his views on how the mathematics teacher education curriculum could be improved. When asked to bring out his suggestions he said;

> *I would advise UNZA to get qualified experienced teachers as lecturers because teaching is about experience and talking about experience, but a student direct from secondary school performs better at UNZA and is retained as a lecturer, may have no experiences to talk about. The period for teaching experience should be increased 6 weeks is not good enough. I would advocate for teaching experience to be done both in third year and fourth year. The first one should be an experience and the second one is to do the actual teaching. I would also advocate for team teaching during the teaching experience where 5 student teachers are given a class, they plan together and one teaches whilst others are observing in the presence of the mentor. In the next lesson the other student teaches whilst others are observing and later share their experiences.*

In trying to inquire from teachers and student teachers of mathematics on what they thought could improve further the mode of mathematics teacher preparation at UNZA, the researcher managed to collect the views of the respondents which are summarised in table 4.20 apart from four teachers who did not suggest anything.

Table 4.21: *Frequency and Percentage Distributions of Teachers and Student Teachers' Suggestions on how to Improve Further the Mathematics Teacher Education Curriculum at UNZA*

	Views of Respondents	Teachers		*Student Teachers*	
		f	%	*f*	%
1	Mathematics content courses to be taught in the school of education.	1	3	2	5.1
2	Linkage of UNZA mathematics teacher education curriculum to secondary school mathematics curriculum.	20	51	17	43.6
3	Improving the way teaching methods are offered by starting teaching methods courses from second year to fourth year.	7	18	3	17.7
4	Exposing student teachers for a long period of time to school teaching experience at least twice during their entire programme.	9	23	3	7.7
5	Include projects in mathematics so that mathematics become functional to real life issues.	2	5	6	15.4
6	Lectures to be centred on students' clear understanding of mathematical concepts rather than rushing through the courses by lecturers.	_	_	7	17.9
7	Ensuring that all student teachers training to become teachers of mathematics must have good knowledge base of the subject.	_	_	1	2.6
		39	100	39	100

From the suggestions in table 4.21, teachers and student teachers seemed to have given similar views of how to improve the mathematics teacher education curriculum at UNZA. For instance, 3% of teachers and 5.1% of student teachers stated that mathematics content courses needed to be taught in the School of Education, 51% of teachers and 43.6% of student teachers indicated the need to link the UNZA mathematics teacher education curriculum to secondary school mathematics curriculum, 18% of teachers and 17.7% of student teachers stated that there was need to introduce teaching methods courses starting from second year up to fourth year, 23% of teachers and 7.7% of student teachers indicated the need to expose student teachers for a long period of time to school teaching experience at least twice during their teacher education programme, 5% of teachers and 15.4% of student teachers stated that projects in mathematics would help mathematics to become functional to real life issues, 17.9% of student teachers stated that lecturers of mathematics need to take time when explaining mathematical concepts to the students and 2.6% of student teachers stated that all student teachers training to become teachers of mathematics needed to have good knowledge base of the subject.

4.10. Summary

The research findings based on four research questions had indicated that both student teachers and teachers had no confidence to teach some secondary school mathematics topics which was as a result of student teachers' having a weak coverage and understanding of secondary school mathematics during content courses. Besides, the curriculum designers did not consider MKT when designing the programme. This could have affected the way teachers taught secondary school mathematics. From the research findings, suggestions were made on how to improve further the programme. The researcher in the next chapter will discuss the research findings that have been presented in this chapter.

CHAPTER FIVE: DISCUSSION

5.1. Overview

The researcher in the previous chapter presented the findings of the study which investigated the appropriateness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics. According to Hofstee (2006) discussion of the findings is an important part of the dissertation which brings the findings to reality by giving reference to the existing knowledge. Through the use of related literature presented in chapter two, research objectives and the theoretical framework or conceptual framework, the researcher in this chapter will venture into discussing the research findings. As earlier indicated in chapter one, this study adopted the content-based and competency-based teacher education curriculum theoretical approaches.

5.2. Students' Acquisition of Appropriate Competencies for Teaching Secondary School Mathematics

The teaching profession demands that teachers should acquire the appropriate competencies which are relevant for teaching a specified discipline in the school curricula during their teacher education programme. The competencies acquired must in turn give good coverage and understanding of appropriate content knowledge which would eventually give confidence to trainee teachers to effectively teach learners of different abilities upon the completion of the programme.

In this study, the researcher had asked both student teachers and teachers of mathematics to rate themselves on their confidence to teach secondary school mathematics after going through the UNZA mathematics teacher education curriculum. Based on the results on table 4.4 it can be argued that having no statistically significant difference between the two groups did not mean that both groups were very confident to teach all the 16 mathematics topics. This can be attested from the range of the means for each group of respondents. For instance, the range of the means for in-service were from 4.60 to 1.40 which meant that rating was around slightly above very well to not well. While the mean for pre-service ranged from 4.62 to 2.61 which also meant that the rating on some topics was slightly above very well as well as slightly below well on the five points likert scale.

Out of the three items where there was a significance difference, results showed that pre-service student teachers were better in teaching Quadratic Functions than the in-service while in the other two the results did not suggest that any one of the two groups was better than the other. The findings indicated in table 4.4 and 4.5 suggested that although the total mean score had gone above half, the differences noted in terms of confidence to teach secondary school mathematics showed that the mathematics teacher education curriculum at UNZA prepared teachers well to teach Introduction to Calculus, Relations and Functions, Coordinate Geometry, Trigonometry and Sets. Besides, the same curriculum never prepared teachers to teach very well topics such as: Circle Theorem, Constructions and Loci, Mensuration, Linear Programming, Geometrical Transformation as well as Earth Geometry. The reason was that these were among the topics that had no link to any of the content courses offered in the teacher education curriculum.

The part which was quite interesting in the findings was that pre-service student teachers expressed confidence to teach some secondary school mathematics topics than the in-service student teachers. This finding was similar to what was revealed in the research findings done by Mulenga (2015) who examined the English language teacher education curriculum at UNZA. However, pre-service student teachers had not yet taught most of the topics in the Zambian mathematics syllabus and some of their scoring seemed to have been based on their perceptions and not experience. While the in-service student teachers had taught most of the topics in the syllabus and they scored according to what they had experienced in a normal classroom environment. Could it be that the initial programme that the in-service student teachers had gone through before enrolling in the programme they were currently pursuing never gave them a better understanding of secondary school mathematics? This question can be better answered by conducting a research on how teachers holding diplomas were prepared in the acquisition of appropriate competencies for teaching secondary school mathematics.

Besides respondents' confidence to teach secondary school mathematics, the researcher also wanted to find out the student teachers' and teachers' own ratings on the coverage and understanding of secondary school mathematics topics in the content courses at UNZA. The independent samples t-test results in table 4.6 and table 4.8 indicated that teachers rated their coverage and understanding of secondary school mathematics on the five points likert scale in the content courses from very well and close to well. On the other hand, student teachers rated themselves around very well, well or fairly well. The results suggested that both student teachers and teachers had a weak coverage and understanding of some secondary school mathematics topics namely; Earth Geometry, Geometrical Transformation, Linear

Programming, Mensuration, Constructions and Loci, Circle Theorem, Variations as well as Similarity and Congruency. When student teachers where asked to rate the emphasis made by lecturers on secondary school mathematics topics during content courses in the teacher education programme, the results indicated in table 4.7 suggested that the same topics where student and teachers expressed no confidence and had weak coverage and understanding, were the same topics that lecturers never emphasised on during content courses. This was in line with the findings of Andreas et al., (2014) who had a view just like other scholars that the mathematics that student teachers were exposed to in teacher education was neither necessary nor sufficient for secondary school teaching.

Since in the content courses both student teachers and teachers had a weak coverage and understanding of secondary school mathematics, the researcher had also to find out if at all student teachers at UNZA were given chance to have a good coverage and understanding of secondary school mathematics during methods courses. The pre-service student teachers rated themselves on the five points likert scale around well and not fairly well while in-service student teachers rated themselves slightly above fairly well and not well. Besides, teachers rated themselves slightly above well to slightly above fairly well while student teachers rated themselves around well and fairly well. The results presented in table 4.9 and table 4.10 just like other independent t-tests results suggested that methods courses at UNZA did not help student teachers during the teacher education programme to have a very good coverage and understanding of the mathematics that was taught in Zambian secondary schools. It could be argued that the MKT in the programme could have been a missing link. This confirms the research findings in the studies done by Kajander (2010) as well as Masaiti and Manchishi (2011) who had indicated that during teacher education programme more time was spent on content courses than on methodological courses. This being the case, this then left no doubt to question the relevance and appropriateness of both the content and methods courses student teachers were exposed to during their teacher education programme.

5.3. Relevance of Mathematics Content and Methods Courses to Secondary School Mathematics

Effective teaching of mathematics requires subject teachers to have a better understanding of the mathematical knowledge for teaching. Although teachers are expected to be more knowledgeable in terms of knowledge and skills than the learners, the mathematics content and methods courses that is taught to them during their teacher education programme need to be relevant and appropriate to the job ahead of them upon graduation. Teachers are expected to be critical and analytical on asking and answering questions on why certain concepts in mathematics are the way they are. They need to be in a position to justify mathematical concepts and expressions so that they can eventually teach the subject with full conceptual understanding rather than memorisation of various concepts.

In order to have research question one wholly addressed, one open-ended question in the questionnaire requested both the student teachers and teachers to give their opinion on the relevance and appropriateness of the mathematics content and methods courses they had gone through at UNZA. The findings indicated in figure 4.1 and figure 4.2 showed that the total number of 54 respondents representing 66% of the student teachers and teachers stated that the courses were irrelevant and inappropriate for the teaching of secondary school mathematics, 14 respondents representing 17% argued that some courses were relevant and appropriate for secondary school mathematics and 14 representing 17% stated that the courses were relevant for the teaching of secondary school mathematics. The aspect of irrelevance and inappropriateness of the mathematics content and methods courses was worrisome to the researcher knowing very well that the sustainable development goal number four (4) emphasised much on quality provision of education.

The research findings in table 4.11 and table 4.12 also showed student teachers' and teachers' ratings based on their perceptions in the preparation of some professional documents as well as in the use of some appropriate teaching strategies. Although student teachers rated self-evaluation as the least and preparation of lesson plans as the highest, the independent t-test results revealed that there were no mean differences between student teachers and teachers which were statistically significant at $p < 0.05$. The results had indicated that most of the respondents had rated themselves around well prepared on the five points likert scale. This rating did not suggest that the curriculum was very effective as there were areas to work on so that the rating could move to very well even excellent in the way teachers of mathematics were prepared to teach. The results from table 4.12 show that in all teaching strategies, there were no statistically significant differences at $p < 0.05$ between the mean of the two sets of respondents as rating was around well prepared. The results suggested that student teachers and teachers had understood well the question and answer teaching strategy and they did not understand very well team teaching/team planning as a teaching strategy. Although teachers rated themselves slightly above well on question and answer, from the lessons observed it was clear that teachers had challenges in their questioning techniques. The inappropriate questioning techniques by teachers could have led them not to be in a position to conduct appropriate subjective learning through problem solving in a mathematics lesson.

The following were the common reasons that were cited by the respondents on the relevance and appropriateness of content and methods courses: lack of linkage between the University mathematics and the mathematics taught in secondary schools, misplacement of mathematics content courses in the School of Natural Sciences which did not aim at producing a competent teacher of mathematics, only methods courses made some sense, too much time was spent on complex and very abstract mathematics courses which had no link to secondary school mathematics, tough mathematics learnt at UNZA made the teaching of secondary school mathematics not to be challenging and many more reasons. The findings suggested that the mathematics teacher education curriculum at UNZA did not enable student teachers to acquire the appropriate competencies for teaching secondary school mathematics. This finding raised some question marks on where and how student teachers could acquire these mathematical competencies for teaching if the teacher education programme could not provide them with relevant and appropriate mathematical knowledge for teaching. These findings are supported by several studies that have been done where researchers have argued that everything student teachers are taught in terms of knowledge and skills during their teacher education programme must be in line with the work they are going to do in their respective classrooms (Darling-Hammond, 2000; Chishimba, 2001 and Mulenga, 2015).

The findings from teachers suggested that the lack of mathematics knowledge for teaching in the mathematics teacher education curriculum led to most teachers to avoid teaching some topics where they had no adequate knowledge and skills such as: Geometrical Transformation, Linear Programming, Constructions and Loci, Earth Geometry and many more others. Besides, the complex and abstract mathematics in the teacher education programme which had very little or nothing to do with the mathematics that was taught in secondary schools led to many teachers who had the intention of upgrading to a degree level to divert to other teaching subjects. This was worrisome because if this problem remained unchecked, Zambia was going to have a very small fraction of teachers of mathematics.

Having seen in the analysis of data student teachers lacking confidence and good coverage and understanding of relevant and appropriate mathematical knowledge for teaching, it became necessary to question the intention of the mathematics teacher education curriculum designers. This was because, if the programme was meant to prepare effective teachers of mathematics, then it was irrelevant to spend much of the time during the teacher education programme on teaching student teachers mathematics which had no linkage to the job they were supposed to assume upon graduation.

Since mathematics is a science which enables people to have a comprehensive understanding of other academic disciplines, the findings of this study of not adequately preparing teachers for effective teaching of classroom mathematics had implications on several areas of human life. For the country to have effective engineers, economist and skilled human resource in various fields, it begins with learners' clear understanding of basic mathematics that they are taught in secondary schools. In addition, mathematics is one of the most important subjects that is considered when enrolling/admitting students for various post-secondary school educational programmes in the School of Business, Engineering, Natural Sciences and many more other areas. Now if teachers who must teach learners mathematical concepts are not exposed to the appropriate MKT during their teacher education programme, they may not competently teach classroom mathematics. This may result in poor performance of learners in the subject which may eventually lead to have few or no students in programmes that only accords chance to students who have passed the secondary school mathematics.

The research findings are in agreement with several research findings by different scholars who argued that student teachers including teachers whose major teaching subject is mathematics had gaps in their content knowledge in knowing how to apply and teach the secondary school mathematics (Mansfield, 1985; Ball and Wilson, 1990; Monk, 1994 and Bryan, 1999). In addition, MoE (1996) had documented that the essential competencies expected in every teacher is to master the material to be taught and a skill in communicating that material to the learners. In a similar way, Mulenga (2015) wrote that in every teacher education programme, what is important is to make a rightful judgement about the content knowledge and skills that teachers should possess in order for them to be well equipped for secondary school teaching. Based on the relevance and appropriateness of content and methods courses, the study by Major and Tiro (2012) indicated that the teacher education programme did not address the quality and the relevance that was expected to reflect in a trainee teacher as one joins the teaching profession. In addition, the scholars strongly argued that the teacher education programme contributed very little in as far as the development of an effective teacher was concerned. These coincided with the current findings in the mathematics teacher education curriculum at UNZA.

Similarly, the findings are in harmony with Mansfield (1985) and Ball and Wilson (1990) who wrote that teacher educators must know how to apply and teach student teachers mathematics that has a direct link to a classroom situation. If there is lack of acquisition of mathematical competencies on how teachers of mathematics are supposed to develop mathematical concepts in the mind of a learner as well as the failure to bridge the gap between theory and practice during teacher education programme, the result might be having trained teachers without competence in teaching what they were trained to teach (Idowu, 2015).

Besides, the National Commission on Teaching and America's Future (NCTAF) (1996, 2003) revealed that a good teacher is judged by the possession of a deep knowledge base of the subjects he or she is prepared to teach in order to effectively work with the learners. Also Mulenga (2015) just like Shulman (1987) argued that when teachers possess inaccurate information or lack deep knowledge in their subject matter, they are likely to pass on the same incorrect information to their pupils and the generation to come. This means that lack of adequate mathematical knowledge for teaching in teacher education may produce teachers who may fail to justify certain mathematical concepts before a learner as well as failing to challenge and correct learners' negative attitude and misconceptions in the subject. Besides, Hodgson (2001: 509) asserted that within teacher education programmes, student teachers of mathematics "have no explicit occasion for making connections with the mathematical topics for which they will be responsible in school, or looking at these topics from an advanced point of view." Mewborn (2001) argued that although some pre-service teachers were able to successfully solve mathematical problems, many were unable to explain the concepts and procedures they performed. The question that could demand a response is that what could have led pre-service student teachers to fail to explain the concepts and the procedures they had performed? Could it be that they learnt much of the mathematics by memorisation?

The research findings in this study are supported by studies that have been done in United States, Europe, India, Zambia to mention but a few which clearly revealed that teacher education preparation programmes in tertiary institutions of learning were not effectively done as they were based on courses that were unrelated to what was taught in classrooms

(Shulman, 1986; UNESCO, 1990; Ball and Forzani, 2009; Ball, Sleep, Boerst and Bass, 2009; Grossmann, Hammerness and McDonald, 2008; Hodgson, 2001; Lampert, Beasley, Ghousseini, Kazemi and Franke, 2010; Pandey, 2009; Banja, 2012a and b, Chabatama, 2012; Masaiti and Manchishi, 2011; Manchishi, 2013; Hine, 2015 and Mulenga, 2015). From the discussion, it was clear that the UNZA mathematics teacher education curriculum could have been designed following the content-based instead of competence-based teacher education curriculum theoretical approach. This led to the development of a general curriculum which lacked the most desirable competencies for the secondary school teachers of mathematics.

If quality teachers are to come out of the mathematics teacher education curriculum, the curriculum need not to be loosely linked to the mathematics that student teachers are expected to teach upon graduation. Goma (1984) instructed the University of Zambia not to be in the hurry to graduate students who lack quality in order for its contribution to the society not to be inferior and counter-productive.

5.4. Mathematics Teacher Education Curriculum Designers' Intentions

When asked to state their intention for designing the mathematics teacher education curriculum at UNZA, diverse views were recorded from different teacher educators. The findings indicated that the aim of the programme was to prepare secondary school teachers at degree level who could be comfortable to teach secondary school mathematics. At the same time other lecturers aimed at producing a mathematician who could work anywhere besides teaching. Some lecturers stated that it was the school of education who knew the aim because the School of Natural Sciences was only doing a favour to the students who were coming from the School of Education. The diverse views of teacher educators regarding the aim of the programme was worrisome to the researcher more especially that student teachers expressed lack of confidence and a better coverage and understanding of some secondary school mathematics topics. Curriculum designers admitted that the mathematics teacher education curriculum had flaws as it contained much of the content which was not relevant to someone who was being prepared to teach secondary school mathematics. Besides, teaching experience was not an exception as some respondents argued that the period for teaching experience was too short for student teachers to have enough hands on practical experience. One of the problems that was noted was the failure of the Mathematics and Statistics department in the School of Natural Sciences and the department of Mathematics and Science

Education in the School of Education to plan together and come up with appropriate courses to be offered specifically to secondary school student teachers of mathematics.

Regarding teaching experience, the finding tallies with the Canadian Report (2008) which is documented that over 60 per cent of the respondents were of the view that the knowledge they gained from their mentors during their teaching experience helped them to improve their teaching methods and they were able to understand the abilities of their learners than what they had learnt during their teacher education programme. Similarly, Goos (2006: 6) disclosed that the survey carried out by the Australian Secondary Principal found out that "many beginning teachers felt their university pre-service programme had not prepared them adequately for the challenges of the classroom, and that their in-school training was far more effective than anything they learned in university classes." In line with the research findings, this clearly confirms that teaching experience is an important part in the teacher education programme which deserves a reasonable period of time for student teachers to practice and experience among other things that which they had learnt during content and methods courses. This is also supported by Artique et al., (2001) who argued that due to limited time during the teacher education programme, it is difficult to look at all the vital knowledge and skills that a teacher may require but some aspects can be learnt during the actual practice of teaching. This could be the reason Ball and Forzani (2009: 509) pointed out that "there is need for the general public to acknowledge that teaching is hard work that many people need to learn to do well, and build a system of reliable professional preparation."

Based on the research findings, the quality of teachers produced from UNZA mathematics teacher education curriculum risked lacking quality mathematical knowledge and skills for effective teaching of classroom mathematics. This was in line with the argument made by Mulenga (2015) in his doctoral study that the quality of teacher education curriculum designing, determines the quality of the teacher who graduates from such a programme. It must be made clear that such a curriculum that Mulenga talked about is better developed through the use of competency-based teacher education approach to curriculum development which unveils the appropriate and the most relevant skills, knowledge and responsibilities that future teachers would need for their effective classroom teaching. This comes about through critical analysis of the school syllabi so that there is a good linkage of worthwhile skills, values, attitudes and knowledge between what student teachers are expected to be taught in tertiary institutions of learning and what they are supposed to go and teach in the actual classroom.

5.5. Learner Performance in Mathematics

The unsatisfactory performance of learners in mathematics in Zambian secondary education is something that deserves the attention of teacher educators, researchers as well as the actual implementers of the secondary school mathematics curriculum. Despite the findings of some scholars such as: Mbugua et al., (2012), Mutai (2010), Mwape and Musonda (2014) as well as Kafata and Mbetwa (2016) having associated the poor performance of learners in mathematics to negative attitude of learners towards the subject and lack of teaching and learning materials in schools which also reflected amongst the findings of this study, the findings in this study indicated that student teachers and teachers of mathematics felt not to be confident to teach some mathematics topics such as: Geometrical Transformation, Linear Programming, Constructions and Loci and many more others. It is very difficult for teachers to teach what they do not know and understand. This could have led to lack of some mathematical concepts amongst the learners in secondary schools which could have contributed to unsatisfactory performance in the subject. In line with such findings, Manchishi (2007) questioned the possibility of teachers to effectively implement the school curriculum which is not in harmony with what they went through during their teacher education programme.

Besides, ECZ (2016) affirmed the finding as it was argued that the poor performance of learners in mathematics was as a result of lack of mathematical conceptual understanding by the learners. This meant that teachers to some extent never taught some appropriate mathematical concepts very well to the learners. This is in agreement with what has been reported already from the independent t-test results where student teachers and teachers expressed no confidence and lack of adequate coverage and understanding of some secondary school mathematics. This led to some teachers skipping some topics which eventually disadvantaged the innocent learner. This could be the reason why Mulenga (2015) and many other scholars have argued in line with the assertion of Manchishi (2007) that it is very difficult for the teacher to effectively implement the curriculum which is at variance with what they had gone through during their teacher education programme.

Mulenga and Luangala (2011) argued that teaching is only said to be done when learning has taken place. Similarly, learning can also be said to have taken place if learners are able to change the behaviour in doing things that they were unable to do before. This could be through solving mathematical problems as well as performing better in any form of assessment. After all, assessment measures the degree of acquisition of desirable values, skills, attitudes and knowledge which can come about as a result of effective classroom teaching and learning.

Additionally, it can be argued that if learners have a negative attitude towards mathematics, does it mean that various educational courses student teachers were exposed to during their teacher education programme made no impact on their ability to change learners' way of thinking and doing things in mathematics and any other subjects? Could it be that schools/government had been failing to procure appropriate teaching and learning resources for teachers and learners for all these years? These could be interesting areas for further research. Based on the theory used in the current study, it can be argued that if teachers who are fit for the purpose are to be produced, CBTE curriculum theoretical approach could be the solution. This theory promotes the need to conduct job analysis of the teacher of mathematics prior to the designing of the curriculum.

The findings were in line with the findings of many other researchers of teacher education. For instance, Baumert et al., (2010) as well as Hill, Rowan and Ball, (2005) explained that teachers' mathematical knowledge influences the mathematical achievement of their learners and the knowledge that student teachers gain may be a key indicator of the success of the teacher education programme. Ball et al., (2003) argued that there is a strong relationship between teachers' mathematical content knowledge and their ability to teach well in classroom. Similarly, Avong (2013) and Okafor and Anaduaka (2013) explained that ill-prepared teachers, teachers' attitudes and their lack of readiness to teach appropriately might affect learner's performance in mathematics.

In addition to other factors, the perceptions of respondents in this study seemed to suggest that the poor performance of secondary school learners in mathematics was as a result of the way teachers of mathematics were prepared and in turn the way teachers presented mathematical concepts to the learners. Lessons of mathematics observed by the researcher indicated that despite teachers of mathematics having demonstrated good knowledge of the subject matter, they still had problems in communicating mathematical concepts to learners. Teacher centred approach seemed to have been used by four teachers and only one teacher employed learner centred approach. Besides, the type of questions that were asked by teachers during mathematics lessons/assessments, lack of adequate time for teaching experience, lack of linkage between the mathematics teacher education curriculum to the secondary school mathematics curriculum and inability of teachers to adjust the university mathematics acquired from the teacher education programme to the secondary school mathematics were cited to be amongst the major causes of poor performance of learners in mathematics.

The findings of this study were similar to the findings of Mkandawire (2013) who indicated that the majority of the questions that teachers asked leaners in mathematics lessons did not help them to think critically because they were in the low cognitive level category of Bloom's Taxonomy. Similarly, Mulenga (2015) argued that a teacher with PCK would know how to effectively sequence the teaching and learning materials and formulate very good questions that probe for alternative views. This means that a well prepared teacher of mathematics must be in position to ask useful questions that are capable of provoking learners to be critical as well as creative thinkers so that mathematics can be learnt with full conceptual understanding rather than memorising of concepts. Khan (2012) revealed in his findings that the mathematics courses in teacher education programme were not preparing student teachers for conceptual teaching as a result most students ended up joining the teaching career with poor content knowledge and pedagogical skills. Khan further argued that such a situation led to teachers ending up teaching learners based on their academic qualifications at the expense of professional qualifications. If this was the case as it was revealed in this study with the mathematics teacher education curriculum at UNZA, then the teacher education programme could have played a limited role in preparing secondary school teachers who were taught content courses which were loosely linked to the secondary school mathematics curriculum.

Besides, the findings of this study are supported by the findings of researchers of the second International Mathematics and Science Study who attributed the poor performance of United States learners to uneven exposure of student teachers to the mathematics topics that were taught in secondary school classrooms. Just like other scholars, Beisiegel et al., (2013) asserted that mathematics and statistics departments have the responsibility to ensure that future teachers of mathematics have a deep and connected understandings of the mathematics they will teach. As already discussed, lack of acquisition of appropriate mathematical knowledge for teaching by students at UNZA led them to have some challenges in teaching some secondary school classroom mathematics. This was in agreement with what other scholars of teacher education who revealed that most teachers lacked either adequate background knowledge in the subjects they were supposed to teach or enough skills that was needed for them to teach effectively which eventually affected the teaching and the learning process (Shulman, 1987; National Research Council, 1996 and 1997; Darling-Hammond, 2000; Roofe and Miller, 2013).

Slightly contrary to the findings of this study and many other studies that are in harmony with this study, Cavannah and Prescott (2007) argued that even after exposing student teachers to progressive pedagogical approaches during their teacher education programme, they still resort to use teacher centred approach of teaching when they begin their teaching career. This means that despite having received good quality teacher education programme, the actual school environment has its own influence on the way teachers implement secondary school curriculum. However, it can still be argued that newly graduated teachers should be confident enough to educate already serving teachers on the new practices of teaching attained in their teacher education programme and not them being converted to practices that may not yield effective teaching and learning.

In line with the research findings, it was clear as earlier indicated that the designers of the mathematics teacher education curriculum at UNZA followed content-based teacher education curriculum theoretical approach as opposed to competency-based. It could be lack of conducting job analysis by curriculum designers that could have led to loosely link the mathematics teacher education curriculum at UNZA to the mathematics that student teachers were supposed to teach upon graduation. Having discussed the appropriateness and relevance of mathematics content and methods courses in the mathematics teacher education curriculum at UNZA for teaching secondary school mathematics, intentions of curriculum designers as well as factors that could have led to unsatisfactory performance of learners in mathematics, the researcher in the section that follows will discuss the suggestions that may improve further the mathematics teacher education curriculum at UNZA.

5.6. Reconsidering the Mathematics Teacher Education Programme at UNZA

The importance attached to mathematics in every human society, the performance of learners in mathematics and above all the curriculum that is expected to produce quality teachers of mathematics were serious areas of concern in this study. As earlier indicated, learner performance in mathematics is as a result of several factors. If teacher education is to play a role that may assist in the appropriate teaching and learning of classroom mathematics, it requires rethinking the mathematics teacher education curriculum so that the aspect of MKT is adequately put into consideration. Such a curriculum can only be designed after carrying out a well thought out job analysis using competence-based theoretical approach to curriculum development.

The research findings had clearly shown that the mathematics teacher education curriculum at UNZA was not effective enough to equip teachers with good coverage and understanding of secondary school mathematics which led them to lack confidence in teaching some mathematics topics in the secondary school curriculum. This was as a result of the UNZA mathematics teacher education curriculum being at variance with the secondary school mathematics curriculum. This problem led to the products of the programme among other things to have difficulties in the use of some teaching strategies and asking of productive questions that could bring about subjective learning in mathematics.

Every teacher of mathematics is expected to teach both syllabus D ordinary level mathematics as well as additional mathematics, at the same time some teachers of mathematics might have an opportunity to undertake postgraduate studies in mathematics for them to later on assume some other responsibilities such as lecturing in some colleges and universities. The open-ended questions in both the questionnaires and interview guide enabled the respondents to strongly suggest what they thought could improve the mathematics teacher education curriculum at UNZA. The suggestions were based on two categories and these were; attaching relevance to the mathematics teacher education curriculum and increasing the duration in which to teach and learn methods courses as well as critically analysing the role of teaching experience during the teacher education programme.

Based on the category that attaches relevance to the mathematics teacher education curriculum, the researcher established that the department of Mathematics and Statistics in the School of Natural Sciences and the department of Mathematics and Science Education in the School of Education should work together in order to review the mathematics teacher education programme. This should be done so that the mathematics knowledge for teaching is included where student teachers need to analyse and justify why certain secondary school mathematical concepts are the way they are as well as maintaining some advanced mathematics courses to create a good foundation for teachers who would want to continue in the field of mathematics.

Teacher educators' experience in the teaching and learning of classroom mathematics is key. From the research findings, it was established that secondary school mathematics content and methods courses needed to be taught by lecturers who have taught before in secondary schools so that various experiences regarding secondary mathematics could be shared to the trainee teachers. It would also help if projects in mathematics teacher education curriculum can be introduced so that mathematics may become functional to real life issues. Besides, the researcher was also informed by the research findings that all student teachers aspiring to be prepared for teaching secondary school mathematics needed to have a good knowledge base of the subject before enrolling them into the programme.

It was also established that the duration for teaching and learning methods courses as well as for teaching experience was not adequate enough for student teachers to have enough hands on practical experiences. Thus it was suggested that methods courses needed to be given enough time by introducing the courses starting from second year up to fourth year. This would create a conducive and productive peer teaching during methods courses.

Additionally, for teaching experience to contribute to the appropriate preparation of teachers, it was indicated that teaching experience be conducted at least twice in the entire teacher education programme for one full term and not for six weeks. The first teaching experience in third year to be a mere experience where students should be sent to various secondary schools just for teacher educators to conduct formative assessment on students. It might be helpful if student teachers with the guidance of their mentors or Head of Departments (HoD) to be organising team planning/team teaching so that student teachers can learn from one another as well as from the mentor during their teaching experience. The first teaching experience would give chance for teacher educators and students to share and discuss their experiences, challenges and lessons learnt. The second teaching experience to be done in fourth year and be graded according to the performance of the student rather than just indicating satisfactory on the students' transcript. The findings were in agreement with several studies where researchers had argued that teaching experience needed adequate time for student teachers to have appropriate hands on experience pertaining to what makes up their career (Canadian Report, 2008; Goos, 2006 & Bull, 1987).

Based on the respondents' suggestions, it was clear that the mathematics teacher education curriculum at UNZA had gaps which needed to be looked into for the institution to be capable of producing competent secondary school teachers of mathematics.

5.7. Summary of the Theoretical Framework with Implications to the Study

Competence-based teacher education curriculum theoretical approach to curriculum development provides the need to conduct job analysis before the curriculum is developed unlike content-based theoretical approach. This provides curriculum developers with the appropriate guidance of linking the curriculum to the job that the products of such a curriculum would assume upon graduation. When adequately used in the designing of the mathematics teacher education curriculum could enable student teachers of mathematics to acquire the relevant knowledge and skills for classroom teaching. Having used this theory in the context of the current investigation, the researcher is of the view that this could work towards addressing the issue of MKT in mathematics teacher education programme. The researcher in the section below will give a summary of the discussion of the research findings.

5.8. Summary

Student teachers', teachers' as well as teacher educators' perceptions had indicated that the mathematics teacher education curriculum at UNZA had no relevant and appropriate mathematics content courses which could effectively prepare someone to competently teach secondary school mathematics. It was also clear that methods courses did not adequately help student teachers to have a comprehensive coverage and understanding of how to teach secondary school mathematics. This was because student teachers were exposed to very complex and abstract mathematics which had very little or nothing to do with the secondary school classroom mathematics. This could be one of the reasons Manchishi (2007) questioned the possibility of teachers to effectively implement the school curriculum which is not in harmony with what they had gone through during their teacher education programme. Additionally, the findings had suggested that teacher educators in the department of Mathematics and Science Education aimed at producing a teacher who could teach secondary school mathematics while teacher educators in the department of Mathematics and Statistics aimed at not only producing a teacher but a mathematician who could work in banks, insurance companies, Central Statistical Offices and many others. This seemed to have justified why student teachers at UNZA were exposed to broad, complex and abstract mathematics during their teacher education programme which was loosely linked to the actual secondary school mathematics. The consequences were student teachers joining the teaching profession with no confidence and good coverage and understanding of secondary school mathematics topics such as: Earth Geometry, Geometrical Transformation, Linear Programming, Mensuration, Constructions and Loci, Circle Theorem, Variations, Similarity and Congruency and many more others.

From the findings, it was clear that the mathematics teacher education curriculum at UNZA was designed using content-based and not competence-based teacher education curriculum theoretical approach. Based on the findings, suggestions have been made on how the mathematics teacher education curriculum could be improved to enhance quality in the products of the programme. The researcher in the following chapter will now give the conclusions and recommendations based on this study.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1. Overview

The researcher in chapter four presented the research findings which were later discussed in chapter five to ensure that the four research questions raised in chapter one are addressed. In this chapter, the researcher presents the summary of the main research findings which answered the research questions and finally recommendations are given. Since teacher education is one of the areas that requires the attention of every scholar who aspires for quality teacher education for quality teaching and learning in schools, the researcher has suggested some of the areas that may require further research to enhance quality in teacher education.

6.2. The Main Research Findings and Conclusion

Being the final chapter of this study, it is important to note that the study looked at the effectiveness of the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics. The researcher wanted to establish if teachers of mathematics produced from the mathematics teacher education curriculum at UNZA had acquired the appropriate and relevant competencies for teaching secondary school mathematics. The researcher in the sub-sections below presents the main findings as mirrored by the research questions.

6.2.1. Appropriateness of Content and Methods Courses Relevant for Teaching

The study established that the mathematics teacher education curriculum at UNZA did not focus on equipping student teachers with the appropriate mathematical knowledge for teaching secondary school mathematics. Respondents expressed lack of better understanding and confidence to teach topics such as: Earth Geometry, Circle Theorem, Mensuration, Variations, Linear Programming, Geometrical Transformation and Constructions and Loci.

6.2.2. Divergence Intentions of Curriculum Designers

The study established that the two departments that is the department of Mathematics and Statistics and the department of Mathematics and Science Education who were directly involved in the mathematics teacher education programme never planned together to come up with what was to constitute the curriculum for student teachers. This was seen in the different views that some lecturers had expressed regarding the aim of the mathematics teacher education programme. It was further established in this study that no job analysis was done when designing the mathematics teacher education curriculum, hence curriculum designers developed and used a general curriculum (content-based curriculum) at the expense of the professional curriculum which is centred on the competencies that future teachers would need for them to teach secondary school classroom mathematics.

6.2.3. Learner the victim of Teacher Education Curriculum

The lack of MKT amongst teachers led to skipping of some mathematics topics in schools by some teachers. This affected learners in secondary schools in terms of acquisition of worthwhile mathematical knowledge, values and skills. The study further revealed that teachers of mathematics lacked good questioning techniques that could bring about subjective learning in mathematics lessons and mostly teacher centred approach was prominently used. The researcher was informed by the research findings that all these could have contributed to unsatisfactory learner performance in mathematics.

6.2.4. Rethinking the Mathematics Teacher Education Curriculum

Based on the responses from research question one, two and three, research question four further sought to suggest some strategies of improving the mathematics teacher education curriculum at UNZA so that competent secondary school teachers of mathematics could be produced. In the light of the respondents' responses, the researcher in this study has the following as suggestions: the department of mathematics and statistics and the department of Mathematics and Science Education to redesign the mathematics teacher education curriculum which would include: the MKT secondary school mathematics, teaching experience to be done twice in the entire programme by student teachers so that they can have enough hands on practical experience and the teaching methods courses to be part of the teacher education programme unlike introducing mathematics methods courses in third year or fourth year of the programme.

6.3. Recommendations

The following recommendations arose from the research findings, discussions and conclusions drawn in this study.

i. Teacher educators should take kin interest in conducting job analysis when designing the mathematics teacher education curriculum that would provide appropriate and relevant knowledge and skills to future teachers of mathematics.

ii. Teacher educators once in a while should invite head teachers and heads of departments (HoD) for mathematics from different secondary schools in order for them to hear and share various views on how the mathematics teacher education curriculum is influencing students/teachers of mathematics in the acquisition and implementing of MKT in secondary schools.

iii. The department of Mathematics and Science Education should design a full course which would address all secondary school mathematics topics. This would give student teachers confidence to teach secondary school classroom mathematics.

iv. The university administration should ensure that lecturers who have taught secondary school mathematics before are given the responsibility of preparing student teachers for teaching secondary school mathematics. This may enhance good sharing of real life experiences about secondary school mathematics.

v. The Ministry of General Education (MoGE) should ensure that there is efficient Continuing Professional Development (CPD) in secondary schools so that teachers should continue sharing and acquiring new knowledge and skills based on best practices of teaching and learning secondary school mathematics.

6.4. Proposed areas for Future Research

In view of the findings of this study which looked at the effectiveness of the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics, it is therefore necessary to propose the following as areas for further research.

i. An investigation of student teachers' acquisition of appropriate and relevant competencies in the mushrooming Colleges of Education and Universities for teaching secondary school mathematics.

ii. Preparing secondary school teachers of mathematics to teach in a democratic classroom environment.

iii. It would also be better to conduct a comparative study on the mathematics teacher education curriculum and student teachers' acquisition of mathematical knowledge for teaching.

References

Ambrose, R. (2004). Initiating Change in Prospective Elementary School Teachers' Orientations to Mathematics Teaching by Building on Beliefs. *Journal of Mathematics Teacher Education, 7 (2), 91-119.*

Anderson, L. W. et al., (2001). *Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Boston: Pearson Education Group.

Andreas, J. S. & Gabriel, J. S. (2014). *Viewing "Mathematics for Teaching" as a Form of Applied Mathematics: Implications for the Mathematical Preparation of Teachers, NOTICES of the AMS, 61, 266-276.*

Artigue, M., Assude, T., Grugeon, B., & Lenfant, A. (2001). *Teaching and learning algebra: Approaching complexity through complementary perspectives.* Paper presented at the Proceedings of the 12th ICMI study conference: The future of the teaching and learning of algebra, Melbourne.

Avong, H. N. (2013). Poor Performance in Mathematics among Senior Secondary School Students in Kaduna State: What to blame? *Journal of Research in National Development, 11(2), 319-324.*

Awoniyi, S. A. & Aderanti, R. A. (2013). *Understanding Test and Measurement in Education*. Kwara: Fatyusuf Printing Productions.

Ball, D. L. & Mc Diarmid, G.W. (2010). *The Subject Matter Preparation of Teachers. Handbook for Research on Teacher Education*. New York: Macmillan.

Ball, D. L, & Forzani, F. (2009). The Work of Teaching and the Challenge for Teacher Education. *Journal of Teacher Education, 60 (5), 497-511.*

Ball, D. L., Sleep, L., Boerst, T. & Bass, H. (2009). Combining the Development of Practice and the Practice of Development in Teacher Education. *Elementary School Journal, 109, 458-476.*

Ball, D. L., Thames, M. & Phelps, G. (2008). Content Knowledge for Teaching: What makes it special? *Journal of Teacher Education 59 (5), 389-407.*

Ball, D. L. & Forzani, F. M. (2007). What makes education research "educational"? *Educational Researcher, 36(9), 529-540.*

Ball, D. L., Hill, H. C., & Bass, H. (2005). *Knowing Mathematics for Teaching: Who knows mathematics well enough to teach third grade and how can we decide? American Educator 29 (1), 14-17.*

Ball, D. L. & Bass, H. (2003). *Towards a Practice–Based Theory of Mathematics Knowledge for Teaching.* In Davis & Simmit, E. (Eds), *Proceedings of the 2002 Annual Meeting of the Canadian Mathematics Education, EB: CMESG/ GCEDM.*

Ball, D. L. & Bass, H. (2000). *Interweaving Content and Pedagogy in Teaching and Learning to Teach: Knowing and Using Mathematics. In* Boaler, J. *(Ed.), Multiple Perspectives on the Teaching and Learning of Mathematics* (83–104). Westport CT: Ablex.

Ball, D. L. (1990). Prospective Elementary and Secondary Teachers' Understanding of Division. *Journal for Research in Mathematics Education, 21 (2), 132-144.*

Ball, D. L. (1990). *Breaking with Experience in Learning to Teach Mathematics: The Role of a Pre-service Methods Course. For the Learning of Mathematics, 10(2), 10-16.*

Ball, D. L. & Wilson, S. (1990). *Knowing the Subject and Learning to Teach it: Examining Assumptions about Becoming a Mathematics Teacher. East Lansing,* MI: Michigan State University, NCRTE. http://ncrtl.msu.edu/http/reports/html/pdf/rr907.pdf.

Banja, K. M. (2012 a). The Teaching Profession in Zambia: Myth or Reality? The University of Zambia. *Zambia Journal of Education. 3 (2) 1-11.*

Banja, K. M. (2012 b). The relevance and adequacy of University education to occupational demands*:* The case of Zambia. *Journal of Contemporary Issues. 29.*

Banner, J. & Cannon, H. (1997). *The Elements of Teaching*. New Haven: Yale University Press.

Baumert, J. et al., (2010). Teachers' Mathematical Knowledge, Cognitive Activation in the Classroom, and Student Progress. *American Educational Research Journal, 47(1), 133–180*.

Beisiegel, M. et al., (2013). *Reconsidering the Mathematics Preparation of Pre- service Secondary Mathematics Teachers, 60 (8), 1056-1058*.

Bernard, H. R. (2002). *Research Methods in Anthropology: Qualitative and Quantitative Methods. (3rd edition).* Walnut Greek: Altamira Press.

Best, J. W. & Khan, J. V. (2006). *Research in Education.* Tenth edition. New Jersey: Prentice-Hall.

Biggs, J. (2001). The *Reflective Institution: Assuring and Enhancing the Quality of Teaching and Learning*. Chicago: Prentice-Hall.

Blair, J. & Czaja, R. (2014). *Designing surveys: A guide to decision and procedures*. Los Angeles: Sage Publications.

Bless, C. & Achola, P. (1988). *Fundamentals of Social Research Methods: An African Perspective*. Lusaka: Government Printer.

Borg, W. R. (1963). *Educational Research: An Introduction*. New York: David McKay and Company.

Bowles, F. D. (2012). *Handbook for the Development of Instructional Modules in Competency-Based Teacher Education Programmes*. New York: Syracuse.

Brewer & Patton, D. F. (2002). *Qualitative Research and evaluation Methods (3rd ed).* London: Sage publication.

Brown, C. & Borko, H. (1992). *Becoming a Mathematics Teacher in: D. A. Grouwns (Ed) Handbook of Research on Mathematics Teaching and Learning.* New York: Macmillan Publishing.

Bryan, T. J. (1999). The Conceptual Knowledge of Pre-service Secondary Mathematics Teachers: How well do they know the subject matter they will teach? Issues in the undergraduate mathematics of school teachers: *The Journal, I.*

Bryman, A. (2001). *Social Research Methods*. New York: Oxford University Press.

Bull, L. B. (1987). *Confronting Reform in Teacher Preparation: One State's Experience. Educational Evaluation and Policy Analysis. 9 (1), 25-40.*

Canadian Report (2008). *Teacher Education and Development Study in Mathematics*. Toronto: Council of Ministers of Education.

Cavanagh, M. & Prescott, A. (2007). *Professional Experience in Learning to Teach Secondary Mathematics: Incorporating pre-service teachers into a community of practice. Mathematics: Essential Research, Essential Practice, (1), 182-191.*

Chabatama, M. C. (2012). Contradictions and weaknesses in the teaching an examination of History in Zambian secondary schools. *Zambia Journal of Education*. *(3)2, 12-18.*

Chamberlain, M. T. (2007). *Teachers Considering Implications for Mathematics Learning and Teaching in the Context of their own Learning during Professional Development. In Lamberg, T. & Wiest, L. R. (Eds.), Proceedings of the 29th Annual Meeting of the North American Chapter of the International Group of the Psychology of Mathematics Education,* (893-895). Stateline (Lake Tahoe), NV: University of Nevada, Reno.

Chapman, O. (2005). Constructing *Pedagogical Knowledge of Problem Solving: Pre-Service Mathematics Teachers.* In Chick, H. L. & Vincent, J. L. *(Eds), Processing of the 29th Conference of the International Group for the Psychology of Mathematics Education, (2), 225-232*.

Chick, H. L. (2012). *Pedagogical Content Knowledge. Paper Presented at Cement Conference*. Launceston: The University of Tasmania.

Chishimba, C.P. (2001). Content-Based Teacher Education Approach versus Competence-Based Teacher Education Approach. Prospects. *Quarterly review of comparative education, XXXI (2), 229-238.*

Cochran-Smith, M. (2005). *The new Teacher Education: For better or Worse. Educational Research 34, 3-17.*

Cockcroft, W. H. (1982). *Mathematics Counts*. London: H. M. Stationery Office.

Cohen, D. K. (2009). *Teaching: Practice and its Predicaments. Cambridge, PhD Thesis*: Harvard University Press.

Cohen, L. Manion, L. & Morrison, K. (2007). *Research Methods in Education* (6th ed). New York: Madison Avenue.

Creswell, J. W. (2015). *A Concise Introduction to Mixed Methods Research.* London: Sage Publishers.

Creswell, J. W. (2013). "*Steps in Conducting a Scholarly Mixed Methods Study". DBER Speaker Series Pages* 48. http:// digitalcommons.unl.edu/dberspeakers/48.

Creswell, J. W. (2012). *Education Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research. (4th Ed.).* New York: Pearson.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* California: Sage Publications.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches (3rd Edition*). London: Sage Publications.

Creswell, J. W. (2002). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Approaches to Research.* Upper Saddle River, NJ: Merrill/Pearson Education.

Darling-Hammond, L. (2006). Constructing 21st Century Teacher Education. *Journal of Teacher Education, 57, 300-314.*

Darling-Hammond, L. (2000). How Teacher Education Matters. *Journal of Teacher Education. 51 (3), 166-173.*

Davis, B. & Simmit, E. (2006). *Mathematics for Teaching:* An *on going Investigation of the Mathematics that Teachers Need to Know*. *Educational Studies in Mathematics, 61(3), 293-319.*

Delaney, S., Ball, D. L., Hill, H. C., Schilling, S. G., & Zopf, D. (2008). Mathematical Knowledge for Teaching: Adopting U.S Measures for use in Ireland. *Journal of Mathematics Teacher Education, 11(3), 171-197.*

Depaepe, F., Verschaffel, L. & Kelchtermans, G. (2013). *Pedagogical Content Knowledge: A Systematic Review of the way in which the concept has pervaded Mathematics Education Research. Teaching and Teacher Education, 34,12-25.*

Doerr, H. M. (2004). *Teachers' knowledge and the teaching of algebra. In K. Stacey, H. Chick & M. Kendal (Eds.), The Future of the Teaching and Learning of algebra: 12th ICMI Study,* 8. Boston: Kluwer Academic Publishers.

Examinations Council of Zambia (2012). *School Certificate and General Certificate Examiners' Reports October/ November 2006 Examinations*. *Chief Examiners Report.*

Examinations Council of Zambia (2015). *Highlights of the 2015 Grade 12 Examination Results Statistics*. Lusaka: The Research and Test Development Department.

Examinations Council of Zambia (2016). *2015 Examination Performance Review Report for Natural Sciences.* Lusaka: Examination Council of Zambia typesetting Section.

Fatima, R. (2005). *Role of Mathematics in the Development of Society*. New Delhi: NCERT Publications.

Fatima, R. (2012). *Role of Mathematics in the Development of Society. Current Research in Elementary School Mathematics*. https://www.semantic scholar.org/…/Role-of-Mathematics…Fatima/bae6bf15245ble56.

Fennema, E. & Franke, M. (1992). *Teachers' Knowledge and its Impact:* In Grouws, D.A. *(Ed) Handbook of Research on Mathematics Teaching and Learning*. New York: Macmillan Publishing.

Gadanidis, G. & Namukasa, I. C. (2007). Mathematics-for-Teachers and Students. *Journal of Teaching and Learning, 5(1), 13-22*. Retrieved March 29, 2010, from h ttp://www.phaenex.uwindsor.ca/ojs/leddy/ index.php/JTL/article/view/ 277/330.

Ghani, Z. (1990). *Pre-service Teacher Education in Developing Countries.* In V. D. Rust, *D.A.* & Dalin P., *(Eds.), Teachers and teaching in the developing world* (23-50). New York: Garland Publishing.

Ghosh, B. N. (1992). *Scientific Method and Social Research*. New Delhi: Sterling Publishers Private Limited.

Goma, L. H. K. (1984). "*Miscellaneous Addresses", In* Tembo, L. *(ed). The African University: Issues and Perspective*. Lusaka: NEDCOZ, 43-90.

Goos, M. (2006). *License to thrill or live and let die? Principal Matters, Spring 1, 6-8*.

Graham, K. J., Portnoy, N., & Grundmeier, T. (2002). *Making Mathematical Connections in Programs for Prospective Teachers.* In Mewborn, D. S., White, D. Y., Wiegel, H. G., Bryant, R. L. & Nooney, K. *(Eds.), Proceedings of the twenty-fourth annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, 4, 1930–1932. Columbus, OH: ERIC Clearing house for Science* Mathematics *and International Education.*

Grossman, P. & McDonald, M. (2008). Back to the Future: Directions for Research in Teaching and Teacher education. *American Educational Research Journal, 45, 184–205*.

Grossman, P. L. (1990). *The Making of a Teacher: Teacher Knowledge and Teacher Education*. New York: Teachers College Press.

Grouws, D. & Schultz, K. (1996). *Mathematics Teacher Education:* In Sikula, J. *(Ed) Handbook of Research on Teacher Education*, 2nd edition (USA: Macmillan).

Haberman, M. & Stinnett, T. M. (1973). *Teacher Education and the new Profession of Teaching.* Berkeley, CA: McCutchan.

Herbert, M. (1990). Planning a research project. London: Casella Education Limited.

Hiebert, J., Morris, A. K. & Glass, B. (2003). Learning to Learn to Teach: An "Experiment" Model for Teaching and Teacher Preparations in Mathematics. *Journal of Mathematics Teacher Education, 6(3), 201-222*.

Hill, H. C., Ball, D. L. & Schilling, S. G. (2008). Unpacking Pedagogical Content Knowledge: Conceptualising and Measuring Teachers' Topic Specific Knowledge of Students. *Journal for Research in Mathematics Education, 39 (4), 372-400.*

Hill, C. H., Rowan, B. & Ball, D. L. (2005*).* Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement. *American Educational Research Journal, 42 (2) 371-406.*

Hill, H. C. & Ball, D. L. (2004). Learning Mathematics for Teaching: Results from California's Mathematics Professional Development Institutes. *Journal of Research in Mathematics Education, 35, 330–351*.

Hine, G. S. C. (2015). *Self-perceptions of Pre-service Mathematics Teachers Completing a Graduate Diploma of Secondary Education. Issues in Educational Research, 25(4), 480-500. http://www.iier.org.au/iier25/hine.pdf*

Hodgson, B. (2001). *The Mathematical of Education of School Teachers: Role and Responsibilities of University Mathematicians.* In Holton, D. A. *(ed). The Teaching and Learning of Mathematics at the University Level*. Boston: Kluwer Academic Publishers. (Massachusetts, 2001), 501-518.

Hofstee, E. (2006). *Constructing a Good Dissertation*. Johannesburg: Interpak Books (Pty) L.t.d.

Hungerford, T.W. (1994). *Future Elementary Teachers: The Neglected Constituency. The American Mathematical Monthly, 101(1), 15-21*. http://www.jstor.org/stable/2325117.

Hurrel, D. P. (2013). What Teachers Need to Know to Teach Mathematics: An argument for a reconceptualised model. *Australian Journal of Teacher Education*, 38 (11): http://dx.doi.org/10.14221/ajte.2013v38n 11.3.

Hutchinson, L. (1997). *Learning for Teaching: A Case of Constructing the Bridge Between Subject Matter Knowledge and Pedagogical Content Knowledge (Research Report).* Wyoming: The University of Wyoming. http://files.eric.ed.gov/fulltext/ED413332.pdf.

Idowu, O. O. (2015*). Pre-service Teacher Perceptions on Poor Performance of Elementary School Students in Mathematics*. Unpublished Manuscript, College of Education, University of Wyoming.

Kafata, F. & Mbetwa, K. S. (2016). An Investigation into the Failure Rate in Mathematics and Science at Grade Twelve (12) Examinations and its Impact to the School of Engineering: A case Study of Kitwe District of Zambia. *International Journal of Scientific & Technology Research, 5 (8) .*

Kajander, A. (2010). Elementary Mathematics Teacher Preparation in an Era of Reform: The Development and Assessment of Mathematics for Teaching. *Canadian Journal of Education, 33, (1), 228-255.*

Kajander, A. (2005). *Moving towards Conceptual Understanding in the Pre-service Classroom: A study of Learning Fractions. Towards Conceptual*

Understanding in the Pre-service classroom: A Study of Evolving Knowledge and Values. 27th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Roanoke University of Virginia.

Khan, S. B. (2012). Preparation of Effective Teachers of Mathematics for Effective Teaching of Mathematics. *Journal of Educational and Instructional Studies in the World, 2 (4)* Article 09. ISSN: 2146-7463.

Khan, S. B. & Jumani, N. B. (2008). Teaching of Basic Concepts at Secondary School Level. *Pakistan Journal of Education, 25 (1), 109-121.*

Khan, M. S. (1983). '*Teacher Education in India and Abroad'*. New Delhi: Hilamaya Publishing House.

Kohli, V. K. (1992). '*Teacher Education in India'*. Ambala: Vivek Publishers.

Kombo, D. K. & Tromp, D. L. A. (2006). *Proposal and Thesis Writing: An Introduction.* Nairobi: Paulines Publication Africa.

Korthagen, E., Loughran, J. and Russell, T. (2006). *Developing Fundamental Principles for Teacher Education Programmes and practices. Teaching and Teacher Education. 22 (3) 20 – 41.*

Lewis, J. L. & Sheppard, S. R. J. (2006). *Culture and Communities: Can Landscape Visualisation Improve Forest Management Consultation with Indigenous Communities?* Landscape and Urban Planning 77, 291-313.

Long, T. & Johnson, M. (2000). *Rigour, Reliability and Validity Research. Clinical Effectiveness in Nursing, 4 (1), 30-37.*

Luangala, J. R. and Mulenga, I. M. (2011). *Cultivation of Thinking Skills through Instructional Procedures in Zambian Basic Schools*. London: Lambert Academic Publishing.

Ma, L. (1999). *Knowing and Teaching Elementary School Mathematics.* Mahwah, NJ: Lawrence Erlbaum Associates.

Ma, X. & Xu (2004). Assessing the Relationship between Attitudes towards Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal for Research in Mathematics Education, 28(1), 26-47*.

Major, T. E. & Tiro, L. (2012). Theory versus Practice: The Case of Primary Teacher Education in Botswana. *International Journal of Scientific Research in Education*, *5 (1), 63-70*.

Manchishi, P. C. (2013). *Reforming Zambian Pre-Service Teacher Education for Quality Learning.* Lusaka: The University of Zambia Press.

Manchishi, P. C. (2004). 'The Growth of Teacher Education in Zambia since Independence', *in Educational Research Journal* (online publication of African Educational Research Network), *4(4).*

Masaiti, G. & Manchishi, P. C. (2011). The University of Zambia Pre-service Teacher Education Programme: Is it Responsive to Schools and Communities' Aspirations? *European Journal of Educational Studies, 3 (2), 311-324.*

Masters, G. N. (2009). *A Shared Challenge: Improving Literacy, Numeracy and Science Learning in Queensland Primary Schools*. Camberwell, Victoria: Australian Council for Educational Research. http://education.qld.gov.au/mastersreview/pdfs/final-report-masters.pdf

Matthews, M., Rech, J. & Grandgenett, N. (2010). The Impact of Content Courses on Pre-Service Elementary Teachers' Mathematical Content Knowledge. IUMPST: *The Journal, 1, 1-11*. http:// files.eric.ed.gov/fulltext/EJ914253.pdf.

Mansfield, H. (1985). *Points, Lines and their Representations for Learning of Mathematics,* 5 (3), 2-6. http://www.jstor.org/stable/40247786.

Mbugua, K. Z., Kibet, K., Muthaa, M, G. & Nkonke, R. G. (2012). *Factors Contributing to Students' Poor Performance in Mathematics at Kenya Certificate of Secondary Education in Kenya: A case of Baringo Country*, Kenya. Chuka University College.

Mc Lead, D. B. (1994). Research on affect and Mathematics Learning in the JRME: 1970 to the Present. *Journal for Research in Mathematics Education, 25(6), 637-647.*

Mewborn, D. (2001). Teachers Content Knowledge, Teacher Education and their Effects on the Preparation of Elementary Teachers. *United States Mathematics Education Research Journal, 3, 28-36.*

Miles, M. B. & Huberman, A. M. (1994). *Qualitative Analysis: An Expanded Sourcebook.* Thousand Oaks: Sage.

Ministerial Council on Education, Employment, Teaching and Youth Affairs (MCEETYA) (2008). *National Assessment Programme, Literacy and Numeracy*. Victoria: Curriculum Corporation.

Ministry of Education, (1996). *Educating Our Future: National Policy on Education*. Lusaka: Zambia Educational Publishing House.

Ministry of Education, (1992). *Focus on Learning*. Lusaka: Government Printer.

Ministry of Education, (1977). *Educational Reform: Proposals and Recommendations.* Lusaka: Government Printers.

Ministry of General Education, (2015). *Educational Statistical Bulletin*. Lusaka: Directorate of Planning and Information.

Mkandawire, C. (2013). *Teachers' Questioning Techniques in Mathematics at Grade 11 Level: A Case of four Selected Secondary Schools in Petauke District. M.Ed Dissertation.* The University of Zambia.

Monk, D. (1994). Subject *Area Preparation of Secondary Mathematics and Science Teachers and Student Achievements. Economics of Education Review, 13 (2), 125-145.*

Morris, A. K., Hiebert, J. & Spitzer, S. M. (2009). Mathematical Knowledge for Teaching in Planning and Evaluating Instruction: What can Pre-service teachers learn*? Journal for Research in Mathematics Education, 40 (5), 491-529.*

Mugenda, O. M. and Mugenda, A. G. (1999). *Research methods: Quantitative and Qualitative approaches*. Nairobi: Acts Press.

Mulenga, I. M. (2015). *English Language Teacher Education Curriculum Designing: A Mixed Methods Analysis of the Programme at the University of Zambia*. PhD Thesis. The University of Zambia.

Mutai, J. K. (2010). *Attitudes Towards Learning and Performance in Mathematics Among Students in selected Secondary Schools in Bureti District*, Kenya. M. Ed.

Mwape, J. & Musonda, A. (2014). An Investigation in the Teaching and Learning of Mathematics at Senior Secondary level in Solwezi District. *Research journali's Journal of Mathematics, 1 (6) November ISSSN23495375.*

Nalube, P. P. (2014). *Student-Teachers Learning Mathematics for Teaching: Learner Thinking and Sense Making in Algebra*. PhD Thesis. University of the Witwatersrand.

National Commission on Teaching and America's Future. (1996). *What matters most: Teaching for America's future*. New York: National Council of Teachers of Mathematics.

National Commission of Teacher Education (NCTE), (1998). *Competency Based and Commitment Oriented, Teacher Education for Quality College Education*. New Delhi: NCTE.

National Mathematics Advisory Panel. (2008). *Foundations for Success: The final Report of the National Mathematics Advisory Pane*l. Washington, DC: U. S. Department of Education. Retrieved March 30, 2010, from http://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

National Council on Teacher Quality. (2007). *State teacher policy yearbook: Progress on teacher quality, Ohio 2007*. Washington, DC: National Council on Teacher Quality.

National Research Council. (1997). *Improving Schooling for Language-Minority Children: A research agenda.* Washington, DC: National Academy Press.

National Research Council. (1996). *National Education Standards*. Washington, DC: National Academic Press.

NECO, (1997). *Techniques of Investigation: An Introduction to Research Methods*. Cambridge: National Extension College Trust Limited.

Norton, S. (2010). *How Deeply and How Well? How Ready to Teach Mathematics after a one-year Programme? Mathematics Teacher Education and Development, 12 (1), 65-84.*

Ogula, P. A. (2002). *Monitoring and Evaluation of Educational Projects and Programmes*. Nairobi: New Kemit Publishers.

Ogula, P. A. (1998). *A Handbook on Curriculum Development.* Nairobi: New Kemit Publishers.

Okafor, C. F. & Anaduaka, U. S. (2013). Nigerian School Children and Mathematics Phobia: How the Mathematics Teacher can help. *American Journal of Educational Research*, *1(7), 247-251*.

Ornstein, A. C. (1995). *Strategies for Effective Teaching.* (2nd ed). Madison: Brown and Benchmark.

Park, S. & Oliver, J. S. (2008). *Revisiting the Conceptualisation of Pedagogical Content Knowledge PCK: PCK as a conceptual tool to understand teachers as professionals. Research in Science Education, 38, 261-284*.

Patton, M. (1987). *How to use Qualitative Methods in Evaluation*. London: Sage Publication Inc.

Patton, M. (1990). *Qualitative evaluation and research methods (2nd ed.*). Newbury Park: Longman.

Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A conceptual framework for learning to teach secondary mathematics: A situative perspective. *Educational Studies in Mathematics, 56, 67-96.*

Polit, D. F., & Hungler, B. P. (1999). *Nursing Research. Principles and Methods (6th ed).* New York: J.B. Lippincott Company, Philadelphia.

Richardson, V. (1996). *The R ole of Attitudes and Beliefs in Learning to Teach. In J. Sikula Ed. Hand book of Research of Teacher Education*. 102-119. New York: Macmillan.

Roofe, C. G. and Miller, (2013). "Miss, I am not being fully prepared": Student – Teachers' Concerns about their Preparation at a Teacher Training Institution in Jamaica. *Australian Journal of Teacher Education. (38)5, 1-19.*

Rowley, J. (2002). "*Using Case Studies in Research," Management Research News, 25 (1) ,16-27.* http://dx.doi,org/10.1108/01409170210782990.

Schneider, R. M. & Plasman, K. (2011). *Science Teacher Learning Progressions: A Review of Science Teachers on Pedagogical Content Knowledge Development. Review of Educational Research 81 (4), 530-565.*

Shulman, L. S. (1987). *Knowledge and Teaching: Foundations of the New Reform.* Harvard Educational Review, *57 (1), 1-22.*

Shulman, L . S. (1986). *Those w h o Understand Knowledge Growth in Teaching. Educational Researcher, 15 (2), 4-14.* http://dx.doi.org/10.3102/0013189x015002004.

Sidhu, K . S. (2014). *Methodology of R e s e a r c h i n Education.* New D e l h i : Sterling Publishers.

Silverman, J. & Thompson, P. W. (2008). Towards a Framework for the Development of Mathematical Knowledge for Teachers. *Journal of Mathematics Teacher Education, 11, 499*-5*11.* http://dx.doi.org/10.1007/s10857-008-9089-5.

Sjostrom, B . & Dahlgren, L . O. (2002). 'Applying Phenomenography i n N u r s i n g Research'. *Journal of Advanced Nursing, 4 (1), 339-345.*

Soer, W. A. (2009). *Distribution of Professional Educators in Transvaal*. Durban: Butterworths.

Southwell, B. & Penglase, M. (2005). *Mathematical Knowledge of Pre-service Primary Teachers.* In Chick, H. L, & Vincent, J. L. (Eds), *Proceedings of the Psychology of Mathematics Education*, 4, 209-216. Melbourne, PME.

Stohlmann, M. S., Moore, T. J. & Cramer, K. (2013). Pre-service Elementary Teachers' Mathematical Content Knowledge from an Integrated STEM Modelling Activity. *Journal of Mathematical Modelling and Application*, *1(8),18-31*.http://proxy.furb.br/ojs/index.php/modelling/article/download/3299/2476.

Statement by the Minister on the results of the 2015 School Certificate (Grade 12) Examination (2016). Lusaka: Ministry Conference Room 2nd February, 2016. www.parliament.gov.zm/.../ministerial%20statement%20by20...

Teacher Education Ministerial Advisory Group (2014). *Action now: Classroom Ready Teachers*. http://dx.doi.org/10.1016/0272.7757 (94) 90003-5.

Thorndike, R. M. (1997). Measurement and Evaluation in Psychology and Education (6th ed.). Upper Saddle River, NJ: Prentice-Hall.

Tsao, Y. L. (2005). The Number Sense of Pre-service Elementary School Teachers. *College Student Journal 39 (4), 647-679*.

Tumuklu, E. B. & Yesildere, S. (2007). The Pedagogical Content Knowledge in Mathematics: Pre-service Primary Mathematics Teachers' Perspectives in Turkey. IUMPST: *The Journal*, *1* (Content Knowledge), (www.k-12 prep.maths.ttu.edu).

Turney, C. (1977). *Innovation in Teacher Education*. Australia: Sydney University Press.

UNESCO (1990). *Innovations and Initiatives in Teacher Education in Asia and the Pacific Region*. Vol. 1; Overview. Bangkok: UNESCO Principal Regional Office for Asia and the Pacific.

Verma, K. G. & Mallick, K. (1999). *Researching Education: Perspectives and Techniques*. London: Falmer press.

Wellington, J. (2000). *Educational research: Contemporary issues and practical approaches*. London: Continuum.

Yamane, T. (2015). Elementary Sampling Theory. Retrieved March 25, 2015 from http:// www.quora.com/what-is-yamane-sample-calculation.

Zapata, M. S. (2005). *Sequencing of Contents and Learning Objects-part* II. http://www.um.es/ead/red/14.

Appendix 1

QUESTIONNAIRE FOR STUDENT TEACHERS

I am a post graduate student carrying out an academic research study where your participation is very much important for the success of this study. The study is entitled 'Effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics'. Therefore, you are requested to respond honestly to the items below by a tick [ ] or an explanation in the spaces provided. Be assured that the information that you will provide shall be treated with high level of confidentiality and will only be used for the purpose of this study.

INSTRUCTIONS

(i) You are **not** expected to indicate your name or the name of any other person on any part of the questionnaire.

(ii) Before answering any of the items on the questionnaire, try by all means to read the items carefully.

Section A: General Information about the Respondent

1. (a) Sex

Male [ ] Female [ ]

(b) Type of students

Pre-service [ ] in- service [ ]

Section B: Appropriateness and Relevance of Content.

2. Indicate by ticking [ ] in the appropriate space to your right hand side the extent to which you can confidently teach the following topics of mathematics having gone through the Mathematics Teacher Education programme at UNZA.

TOPICS	EXCELLENT 5	VERY WELL 4	WELL 3	FAIRLY WELL 2	NOT WELL 1
Sets					
Similarity and Congruency					
Variations					
Sequences and Series					
Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					
Linear Programming					
Vectors in two dimensions					
Geometrical Transformation					
Earth Geometry					
Introduction to Calculus					

3. How do you rate your understanding and coverage of the topics below in the content courses you did/still doing at UNZA in the department of Mathematics and Statistics? Tick [ ] in the appropriate box to your right hand side.

TOPICS	**EXCELLET 5**	**VERYWELL 4**	**WELL 3**	**FAIRLYWELL 2**	**NOT WELL 1**
Sets					
Similarity and Congruency					
Variations					
Sequences and Series					
Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					
Linear Programming					
Vectors in two dimensions					
Geometrical Transformation					
Earth Geometry					
Introduction to Calculus					

4. How much emphasis was made on the following mathematics topics that are taught in secondary schools during content courses by your mathematics lecturers? Tick [ ] in the appropriate box to your right hand side.

TOPICS	**EXCELLENT** **5**	**VERY WELL** **4**	**WELL** **3**	**FAIRLY WELL** **2**	**NOT WELL** **1**
Sets					
Similarity and Congruency					
Variations					
Sequences and Series					
Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					
Linear Programming					
Vectors in two dimensions					

Geometrical Transformation					
Earth Geometry					
Introduction to Calculus					

5. (a) Were all the courses that you did/ still doing at UNZA in the department of Mathematics and Statistics relevant to what you taught during your teaching experience or to what you saw teachers teaching? Yes [ ] No [ ].

(b) Give reasons for your response in 5 (a).

....
....
....

SECTION C: Appropriateness and Relevance of Teaching Methods (Mathematics and Science Education).

6. How do you rate your understanding and coverage of the following mathematics topics (check in the table below) in preparation for your teaching career after doing your teaching methodology courses (MSE 3030 and MSE 9030) at UNZA in the department of Mathematics and Science Education. Tick [ ] in the appropriate box on your right hand side.

TOPICS	**EXCELLENT 5**	**VERY WELL 4**	**WELL 3**	**FAIRLY WELL 2**	**NOT WELL 1**
Sets					
Similarity and Congruency					
Variations					
Sequences and Series					

Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					
Linear Programming					
Vectors in two dimensions					
Geometrical Transformation					
Earth Geometry					
Introduction to Calculus.					

7. Rate by ticking [ ] in the appropriate space to your right hand side the extent to which mathematics teaching methodology courses prepared you in the following areas:

AREAS	EXCELLENT 5	VERY WELL 4	WELL 3	FAIRLY WELL 2	NOT WELL 1
How to use a syllabus.					
Preparation of schemes of work.					
Preparation of lesson plans.					
Preparation of appropriate learning outcome (objectives).					
Making, selection and using of teaching /learning aids.					
Preparation of records of work.					
Construction Of appropriate assessment instruments such as: tests, class exercise and assignments.					

Marking of Pupils' exercise books, tests and examinations.					
Making of Self-evaluation after teaching.					
Peer teaching					
Remedial teaching					
Teaching experience					

8. Tick [ ] in the appropriate box to your right hand side to show the extent to which you were prepared in mathematics teaching methods (MSE 3030 and MSE 9030) to use the following methods/ techniques of teaching.

TYPES OF TEACHING METHODS/TECHNIQUES	**EXCELLENT 5**	**VERY WELL 4**	**WELL 3**	**FAIRLY WELL 2**	**NOT WELL 1**
Demonstration					
Question and Answer					
Subjective learning through problem solving					
Group work / pair work					
Discussion / Brain storming					
Team teaching /team planning					

Section D: Extent to which Teachers of Mathematics affect the Performance of Learners.

9. Give your personal opinion about the mathematics teacher education programme you have gone through/ still going through at UNZA in relation to what you experienced during your school teaching experience.

…………………………………………………………………………………………

………………………………………………………………………………….............................

....

10. (a) Do you think if mathematics topics are not well sequenced or organised in the way they are supposed to be taught can affect learners' performance?

Yes [ ] No [ ]

(b) Give a reason for your answer ……………………………….........................

…………………………………………………………………………………………

…………………………………………………………………………………………

11. (a) Teachers ask learners different types of questions during lessons as well as during tests. Do you think the way teachers of mathematics ask questions in their lessons and assessment instruments do affect learners' performance in their school certificate examinations?

Yes [ ] No [ ]

(b) Justify your answer in part (a)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

12. (a) Would you say that the mathematics teacher education programme at UNZA is effective in preparing competent teachers for teaching secondary school mathematics?

Yes [ ] No [ ].

(b) Justify your response in 12 (a).

....

....

....

13. (a) Do you think the way teachers of mathematics are prepared at UNZA may in a way affect the way teachers teach classroom mathematics and eventually the performance of learners in Zambian secondary schools?

Yes [ ]   No [ ].

(b) Explain your response in 13(a).

....
....
....

14. Explain what could have been the major causes of poor performance of learners in mathematics.

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

Section E: Suggestions that would Improve Further the Mathematics Teacher Education Curriculum.

15. What suggestions would you give to improve further the mathematics teacher education curriculum/programme that you have gone/still going through at UNZA?

....
....
....
....
....

Thank you for your responses, time and your willingness to participate in this study.

Appendix 2

QUESTIONNAIRE FOR TEACHERS (UNZA PRODUCT)

I am a post graduate student carrying out an academic study where your participation is very important. The study is entitled 'Effectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics'. You are requested to respond truthfully to all the items in this instrument by a tick [ ] or a brief explanation in the spaces provided. You need to be assured that the information that you will provide shall be treated with high level of confidentiality and shall not interfere in any way with your work but will be used purely for the purpose of this study.

INSTRUCTIONS

(i) You are not allowed to write your name or the name of any other person anywhere.

(ii) Read the questionnaire items very carefully before writing your answers.

Section A: General Information about the Respondent

1. Gender:

Male [ ] Female [ ].

2. Indicate the year you graduated from UNZA...................................

3. For how long have you been teaching secondary school mathematics? Please tick.

Below 5 years [ ], 5-10 years [ ], 11-15 years [ ], 16 years and above [ ].

Section B: Appropriateness and Relevance of Content.

4. Indicate the extent to which you were confident enough to teach the following mathematics topics when you started teaching after graduating from UNZA.

TOPICS	EXCELLENT 5	VERY WELL 4	WELL 3	FAIRLY WELL 2	NOT WELL 1
Sets					
Similarity and Congruency					
Variations					
Sequences and Series					
Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					
Linear Programming					
Vectors in two dimensions					
Geometrical Transformation					
Earth Geometry					
Introduction to Calculus					

5. At the time of your graduation, how did you rate your understanding and coverage of the following mathematics topics when you did content courses at UNZA in the department of Mathematics and Statistics?

TOPICS	EXCELLENT 5	VERY WELL 4	WELL 3	FAIRLY WELL 2	NOT WELL 1
Sets.					
Similarity and Congruency					
Variations					
Sequences and Series					
Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					
Linear Programming					
Vectors in two dimensions					
Geometrical Transformation					
Earth Geometry					
Introduction to Calculus					

6. Explain how relevant were the courses that you did in the department of Mathematics and Statistics to what you have been teaching.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

SECTION C: Appropriateness and Relevance of Teaching Methods (Mathematics and Science Education).

7. How do you rate your understanding and coverage of the following mathematics topics (check the table below) in preparation for your mathematics teaching career after doing teaching methodology courses (MSE 331 now MSE 3030 and MSE 431 now MSE 9030) at UNZA in the department of Mathematics and Science Education. Tick [ ] in the appropriate box to your right hand side.

TOPICS	EXCELLENT 5	VERY WELL 4	WELL 3	FAIRLY WELL 2	NOT WELL 1
Sets					
Similarity and Congruency					
Variations					
Sequences and Series					
Coordinate Geometry					
Quadratic Functions					
Relations and Functions					
Circle Theorem					
Constructions and Loci					
Trigonometry					
Mensuration					
Probability					
Statistics					
Graphs of Functions					

Linear Programming					
Vectors in two dimensions					
Geometrical Transformation					
Earth Geometry					
Introduction to Calculus					

8. Rate by ticking [ ] in the appropriate space to your right hand side the extent to which mathematics teaching methodology courses (MSE 331 now MSE 3030 and MSE 431 now MSE 9030) prepared you in the following areas:

AREAS	**EXCELLENT 5**	**VERY WELL 4**	**WELL 3**	**FAIRLY WELL 2**	**NOT WELL 1**
How to use a syllabus.					
Preparation of schemes of work.					
Preparation of lesson plans.					
Preparation of appropriate lesson outcome (lesson objectives).					
Making, selection and using of teaching / learning aids.					
Preparation of records of work.					
Setting of appropriate assessment instruments such as: tests, class exercise, and assignments.					
Marking of pupils' exercise books, tests and examinations.					
Making of self-evaluation after teaching.					

Peer teaching					
Remedial teaching					
Teaching experience					

9. Tick [ ] in the appropriate box to your right hand side to show the extent to which you were prepared in mathematics teaching methods (MSE 331 now MSE 3030 and MSE 431 now MSE 9030) to use the following methods / techniques of teaching:

METHODS/ TECHNIQUES OF TEACHING	**EXCELLENT 5**	**VERY WELL 4**	**WELL 3**	**FAIRLY WELL 2**	**NOT WELL 1**
Demonstration					
Question and Answer					
Subjective learning through problem solving					
Group work/Pair work					
Discussion/ Brain storming					
Team Teaching/Team planning					

Section D: Extent to which Teachers of Mathematics affect the Performance of Learners.

10. Give your personal opinion about the mathematics teacher education curriculum/ programme you had gone through at UNZA in relation to what you have been experiencing from the time you graduated.

....

....
....
....

11. (a) Teachers ask learners different types of questions during mathematics lessons as well as during tests. Do you think the way teachers of mathematics ask questions in their lessons and assessment instruments do affect learners' performance in their school certificate examinations?

Yes [ ] No [ ]

(b) Justify your answer in part (a)

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

12.(a) According to your experience, considering the number of years or months that you have been teaching secondary school mathematics, were you adequately prepared by the mathematics teacher education curriculum at UNZA to effectively teach secondary school mathematics?

Yes [ ] No [ ].

(b) Give reasons for the response you have given in 12(a)
....
....
....

13. (a) Do you think the way teachers of mathematics are prepared at UNZA may in a way affect the way teachers teach classroom mathematics and eventually the performance of learners in Zambian secondary schools?

Yes [ ] No [ ].

(b) Justify the response you have given in 13 (a)

....
....

....

14. Explain what could have been the major causes of poor performance of learners in mathematics.

…………………………………………………………………………………………………
…………………………………………………………………………………………………
……………………

Section E: Suggestions that would Improve Further the Mathematics Teacher Education Curriculum.

15. Now, from your mathematics teaching experience, what suggestions would you give/suggest to improve further the mathematics teacher education curriculum/programme at UNZA?

....
....
....

Thank you for your responses, time and your willingness to participate in this study.

Appendix 3

INTERVIEW SCHEDULE FOR LECTURERS.

Intentions of the Curriculum Designers for the Mathematics Teacher Education Curriculum

1. What is the aim of the Bachelor of Science with Education (mathematics) / Bachelor of Arts with Education (mathematics) at UNZA?
2. What kind of a product do you expect to produce from the Bachelor of Arts with Education (mathematics) /Bachelor of Science with Education (mathematics)?
3. After students have graduated, where do you expect them to go and utilise the knowledge, skills, values and attitudes that they have acquired from the university education?
4. What are some of the mathematical skills and knowledge that the programme focuses on when preparing student teachers?

Appropriateness and Relevance of Content and Teaching methods.

5. is the level at which mathematics content and teaching methods are taught at UNZA appropriate for secondary school mathematics teaching?
6. How effective is the mathematics teacher education curriculum at UNZA in preparing secondary school teachers of mathematics?
7. How do you determine the mathematics content that constitutes the courses that you offer to your students?
8. Do you consider the content that is taught in Zambian secondary schools when designing the mathematics teacher education curriculum at UNZA?
9. Do you work together with the Mathematics and Science Education department in the School of Education to ensure coordination between the content courses offered by your department and the methodology courses offered in the School of Education?

Extent to which Teachers of Mathematics affect the Performance of Learners.

10. Do you think the way teachers are prepared to teach secondary school mathematics here at UNZA can in some way affect the teaching of classroom mathematics and eventually the performance of learners in Zambian secondary schools?
11. As a mathematics specialist, what really leads to poor performance in mathematics in

most Zambian secondary schools where learners are being taught by university products?

Suggestions that would Improve Further the Mathematics Teacher Education Curriculum.

12. Suppose you were given chance to suggest some appropriate strategies of improving further the mathematics teacher education curriculum at UNZA, what are some of the key strategies you would suggest that would improve further the preparation of secondary school teachers of mathematics?

Thank you for your time and willingness to participate in this study.

Appendix 4

INTERVIEW SCHEDULE FOR STANDARDS OFFICERS FOR MATHEMATICS

1. For how long have you been in this office as a Standards Officer for mathematics?
2. As a specialist in mathematics, what do you think are the intensions of the curriculum designers of the mathematics teacher education curriculum at UNZA?
3. Is the level at which mathematics content and teaching methods are taught to student teachers at UNZA appropriate for secondary school teaching?
4. What is your view about the link between content that student teachers are exposed to during their teacher education curriculum and the mathematics content that is taught in a secondary school classroom?
5. From your working experience as a standards officer, how do you rate the performance of UNZA products?
6. How do you rate the performance of learners in mathematics? (The researcher will probe on the reasons for the answer given).
7. Do you think the way teachers of mathematics are prepared to teach secondary school mathematics in a way affect the way teachers teach classroom mathematics and eventually the performance of learners in Zambian secondary schools?
8. Suppose you are given chance to suggest some appropriate strategies of improving further the mathematics teacher education curriculum at UNZA, what are some of the key strategies that you would suggest to improve the preparation of secondary school teachers of mathematics?

Thank you for your time and willingness to participate in this study.

Appendix 5

LESSON OBSERVATION SCHEDULE FOR TEACHERS IN SELECTED SECONDARY SCHOOLS

OBSERVER: ……………………………………

SCHOOL: ……………………………………….

DATE: …………………………………………..

DURATION; ……………………………………

TOPIC: ………………………………………….

LESSON: ……………………………………….

S/N	INDICATOR	YES	NO	COMMENT
01	Lesson introduced in a traditional way.			
02	Subjective learning through problem solving employed in the lesson.			
03	Methods of teaching in the lesson development: question and answer, group or pair work, demonstration, class discussion, lecture, etc.			
04	Good questioning techniques that promote creativity and analytical thinking.			
05	Availability and effective use of teaching/learning aids.			
06	Learner centred employed fully.			
07	Appropriateness of the content to the learners.			

08	Appropriateness of class activities to the lesson and level of the learners.			
09	Teacher's knowledge of the subject matter.			
10	Did the learners show that they had learnt something from the lesson?			
11	Time/ class management.			
12	Were the learners involved in the lesson conclusion?			

Appendix 6:

THE RAW MEAN SCORES FOR ALL SUBJECTS FROM 2011-2015 FINAL GRADE 12 EXAMINATIONS

Code	**Subjects**	**Raw mean scores**				
		2015	2014	2013	2012	2011
1121	English Language	35.16	34.72	34.24	29.48	41.8
2011	Literature in English	30.27	34.66	27.57	27.81	34.43
2030	Civic Education	25.42	43.20	53.94	62.58	61.05
2044	Christian Religious Education	34.83	28.06	31.07	32.53	29.62
2046	Christian Religious Education	31.63	26.74	27.29	33.8	31.28
2167	History	26.29	25.14	24.04	24.34	25.13
2218	Geograghy	39.17	37.14	46.76	41.18	43.84
3016	French	53.00	46.69	44.56	45.8	37.96
3147	Lunda	78.97	102.44	93.1	101.27	82.4
3148	Luvale	114.31	129.73	117.87	115.8	131.99
3149	Kiikaonde	98.05	102.87	107.69	96.52	100.22
3153	Icibemba	85.80	97.16	101.75	96.98	89.42
3154	Chitonga	96.17	91.35	85.11	72.4	80.69
3156	Chinyanja	79.56	88.39	79.52	89.51	79.73
3160	Silozi	97.67	108.23	95.65	94.37	77.44
4024	Mathematics	31.35	31.31	47.64	33.31	45.67
4030	Additional Mathematics	85.41	78.52	83.08	83.52	86.68
5037	Agriculture Science	30.64	31.32	26.73	26.78	33.58

5054	Physics	80.57	79.75	79.66	80.59	72.63
5070	Chemistry	87.18	85.96	83.98	84.3	77.59
5090	Biology	34.55	34.19	39.79	36.22	42.19
5124	Science	30.02	30.20	57.69	49.93	39.2
6010	Art	95.52	93.15	91.29	92.15	93.91
6020	Music	151.03	130.03	110.76	124.8	125.2
6030	Woodwork	92.37	84.58	85.96	89.48	88.5
6040	Metalwork	78.08	75.91	68.3	78.86	75.56
6050	Fashion & Fabric	87.90	96.31	107.45	114.28	112.74
6065	Food & Nutrition	101.67	101.04	95.79	102.72	100.96
6075	Home Management	96.91	90.49	92.99	105.99	97.09
7010	Computer Studies	51.19	56.69	16.28	47.16	52.59
7040	G & M Drawing	91.09	98.59	74.69	82.06	82.22
7100	Commerce	17.47	15.66	20.46	17.9	20.09
7110	Principles of Accounts	39.98	43.17	41.34	47.11	44.73

Highlights/ 2015/Grade 12 Examinations/ Results Statistics by the ECZ.

Appendix 7

INDIVIDUAL PARTICIPANT'S INFORMED CONSENT FORM

Dear respondent,

This serves to inform you about the purpose of this study and what will be followed in the process of conducting it. You will be requested to sign this form to indicate that you have willingly volunteered to participate in this exercise.

1. Description of the study: This is purely an academic education research where all respondents will not be identified in person for their participation. The researcher is a University of Zambia student pursuing a Master of Education degree in Curriculum Studies.

2. Purpose: It is the wish of the researcher to investigate the infectiveness of the mathematics teacher education curriculum at the University of Zambia in preparing secondary school teachers of mathematics.

3. Consent: Participation in this study is voluntary.

4. Confidentiality: Every information that will be collected in this study shall be treated with high level of confidentiality. Names or identity of respondents in this study shall not be revealed to anyone. In the case where the conversation is recorded, information will be kept under key and lock and shall be destroyed after data has been analysed.

5. Rights of respondents: The rights of every respondent shall be respected and protected and the researcher will ensure that no respondent shall suffer any harm as a result of their participation in this study.

6. Declaration of consent by the respondent

I have clearly read and understood every detail of this document and I therefore willingly and freely agree to participate in this study.

Signature: ………………………………. Date: ……………………………

Appendix 8

Papers Presented

1. Presented a paper at the 11th University of Zambia (UNZA)-Hiroshima University (HU), Research Dissemination Seminar held at the University of Zambia, School of Education on 21st August, 2017. The paper was titled Rethinking the Teacher Education Curriculum at the University of Zambia in the preparation of Teachers of Mathematics for Secondary Schools.

2. Co-presented a paper with my Supervisor based on this study at the Distance Education and Teacher Training in Africa (DETA) International Conference in Rwanda, Kigali from 22nd -25th August 2017. The paper was titled; Mathematics Teacher Education Curriculum at the University of Zambia: Students' Acquisition of Appropriate Competencies for Teaching Mathematics.