Mathematics Teacher Education Curriculum at a University in Zambia: Student Teachers' Acquisition of Appropriate Competencies for Teaching Mathematics in Secondary School

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Abstract

Learners' performance in mathematics in Zambian secondary schools has remained unsatisfactory for several years (ECZ, 2016). Studies by Mwape and Musonda (2014) as well as Kafata and Mbetwa (2016) revealed that lack of appropriate teaching and learning materials and learners' negative attitude towards mathematics were among the factors that had led to poor learner performance in mathematics. However, there seems to have been no study done regarding the appropriateness of the mathematics teacher education curriculum. This study therefore, sought to investigate whether the mathematics teacher education curriculum at one university in Zambia adequately prepared student teachers in mathematical content knowledge and mathematical pedagogical content knowledge.

The mixed method approach and in particular, the concurrent triangulation research design was used in

this study. Questionnaires were employed to collect data from university graduates 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 were also interviewed. Mathematics class lessons were also observed.

The main findings of the study indicated that the university mathematics teacher education curriculum did not adequately prepare student teachers to teach mathematics. Graduates lacked the relevant mathematical knowledge and the mathematical pedagogical knowledge upon graduation. Results also suggested that this had contributed to the poor mathematics learner performance in secondary schools.

Hence, it was recommended that the university mathematics teacher education curriculum should be reviewed after conducting a job analysis of the teacher 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.

Key words: Teacher Education, Mathematical Content Knowledge, Pedagogical Content Knowledge, Mathematical Knowledge for Teaching, Job Analysis.

Introduction

Mathematics is one of the most important subjects in every human society. 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.'

Similarly, the Examinations Council of Zambia (ECZ) (2012: 31) argued that 'one of the objectives of teaching mathematics is to build up an 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.

Despite mathematics being one of the most important subjects in the Zambian education system as well as one of the key subjects that is considered for admission of students for most post-secondary school educational programmes, learners' performance has remained unsatisfactory for several years (ECZ, 2016). The study conducted by the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) which aimed at testing learners' mathematical and reading skills in fifteen Southern and Eastern African counties, ranked Zambian learners as the worst in mathematics and reading skills. Mwape and Musonda (2014) as well as Kafata and Mbetwa (2016) revealed that lack of appropriate teaching and learning materials and learners' negative attitude towards mathematics were among the factors that contributed to the poor learner performance in mathematics. Figure 1.1 shows the mean score percentages for some selected subjects in the 2014 and 2015 national school certificate examinations results. This kind of performance did not change in the 2016 school certificate leaving examination.

As indicated in figure 1.1, it is evident that learners have not been performing very well in mathematics school certificate final examination countrywide. Could it be that the factors identified by Mwape and Musonda (2014) and Kafata and Mbetwa (2016)

were the only factors that had led to such a continuous poor learner performance? This question calls for the establishment of what could have led to such unsatisfactory performance in the subject. A study that was carried out in Pakistan by Khan (2012) also revealed that mathematics was one of the school subjects that had continued giving serious challenges to learners' abilities of understanding concepts and principles.

Despite studies that have been conducted by different scholars such as: Mbugua et al., (2012), Mutai (2010), Mwape and Musonda (2014) as well as Kafata and Mbetwa (2016) all having revealed that high teacher to pupil ratio due to overcrowded classes, negative attitudes and beliefs of learners towards mathematics as well as lack of appropriate teaching and learning materials being among the factors that had led to poor performance of learners in mathematics, The Examination Council of Zambia (ECZ, 2016: 3) documented that '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 (2016) further documented that the poor learner performance in mathematics at all levels of secondary school could partly be attributed to the way teachers mark classwork and provide feedback to the learners.

Studies have revealed that 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). Based on what has been revealed by various scholars, and researchers, in this study, the authors were of the view that the mathematics teacher education curriculum needed to be examined in order to ascertain whether in some way it did contribute to teachers' failure to effectively teach classroom mathematics resulting in learners' poor performance in school certificate examinations.

According to the Zambian education policy document, Educating our Future (MoE, 1996) it is explained that the

essential competencies expected in every teacher are to master the subject matter to be taught and a skill in communicating that subject matter to the learners. Besides, Soer (2009) contended that teachers of mathematics should be in a position to communicate the required knowledge in a clear, informative and precise manner to their learners. This would eventually help learners to learn mathematics with good conceptual understanding rather than by memorisation.

Several research works that have been done at the University of Zambia (UNZA) pertaining to teacher education, had all shown that the quality of teachers that have been produced at the institution under teacher education curricula lacked knowledge and skills necessary for effective classroom teaching (Banja, 2012a & b; Chabatama, 2012; Masaiti and Manchishi, 2011; Manchishi, 2013 and 2004 as well as Mulenga, 2015). Despite the above cited scholars not having carried out their studies in mathematics teacher education curriculum in particular, their studies to understanding the issues being analysed in this paper is critical.

In addition, research has shown that for any teacher education curricula to be effective in producing quality teachers, priority should be given to the in-depth grounding of the student teacher in the knowledge and skills they are expected to teach upon graduation (Darling-Hammond, 2000; Lampert, 2001, Ball and Forzani, 2009 & Mulenga, 2015). However, the researchers in this study sought to establish whether student teachers at one university in Zambia had acquired the appropriate competencies for teaching secondary school mathematics by investigating views of the lecturers at that institution, National Standards Officer for mathematics, student teachers of mathematics at the institution and graduates from the same institution who were teaching mathematics in secondary schools in Lusaka district of Zambia.

Theoretical Perspectives

This study was guided by the content-based and competence-based teacher education curriculum theoretical approaches. These approaches have also been used by different scholars such as Haberman and Stinnett (1973); Shulman (1987); Chishimba (2001); Bowles (2012) and Mulenga, (2015) who have all studied teacher education in different institutions. For instance, Mulenga and Luangala (2015) argued that if one is to judge the quality of any teacher education programme, one of the criterion that can be used is to examine the content that student-teachers are exposed to as well as the products of the programme. Other scholars who have taken time to scrutinise the quality of the product of teacher education programmes namely; Biggs (2001); Cochran-Smith (2005) and Roofe and Miller (2013) have all argued that if a particular curriculum was designed to achieve clearly defined outcomes, then it would increase the likelihood of student teachers to successfully perform well in their future responsibilities of teaching upon graduation.

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 to go and teach. It is as a result of the nature of the content-based practice that Mulenga (2015) associated such a programme to be an academic, scholarly, irrelevant and remote from classroom teaching. On the other hand, a Competency-based Teacher Education (CBTE) curriculum is slightly different from a 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 institutions of learning should arrive 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 graduates of the content-based teacher education curriculum are not adequately prepared for the job of classroom teaching while the graduates of the CBTE curriculum are likely to acquire the relevant knowledge and skills for classroom teaching. This clearly means that the absence of job analysis in the curriculum development process leads to the development of the general curriculum because it is the application of job analysis which creates a conducive environment for curricula developers to design the professional curriculum where student teachers are effectively prepared for the purpose before them.

An Overview of Literature

In the 1977 Zambian education policy document, teachers were considered as a key human resource in the entire educational system and programme of the country (MoE, 1977). In this document, teachers were viewed as having been 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 to realise their hidden potential and eventually make use of them. On teacher education curriculum, the Ministry of Education specifically explained 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).

The policy was supported by what was documented in the United States of America department on Education (2008: 36) where it was argued that 'teachers must know in detail the mathematical content they were responsible for teaching and its connections to other important mathematics, both prior and beyond the level they were assigned to teach.' In addition, Banner and Cannon (1997: 7) documented that 'in order to teach mathematics well, teachers must know what they teach and how to teach it; and in order to teach effectively, they must know it deeply and well enough.'

Despite the Ministry of Education having called upon every teacher education programme to equip student teachers with appropriate subject matter knowledge for teaching as early as 1977, studies that were done much later as indicated earlier on teacher education curriculum have indicated that student teachers in various institutions of learning were not effectively prepared for the job they were expected to assume upon graduation. Studies elsewhere have also shown that student teachers and graduates of mathematics education lacked 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). Additionally, Mansfield (1985), Ball and Wilson (1990), Monk (1994) and Bryan (1999) have all revealed that student teachers including graduates whose major teaching subject was

mathematics had gaps in their content knowledge in knowing how to apply and teach the secondary school mathematics. One of the questions that could be of interest would be to find out what could have led to student-teachers having those gaps and why they lack the confidence to teach mathematics in a classroom situation. The answer may be found in several studies conducted in different colleges and universities of the United States of America as well as Europe which revealed 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 for in school, or looking at these topics from an advanced point of view.'

It was not clear how such teacher education curricula were designed if the programmes never coincided with what teachers were expected to teach. The findings which are stated in the mentioned studies were also reflected in the studies done by: Ball and Bass (2000), Hill, Lewis and Ball (2000), Graham, Portnoy and Groundmeier (2002) who contended 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.

Besides, despite studies that have been conducted in Zambia not having looked at the mathematics teacher education curriculum in particular as earlier indicated in the introduction, the researchers in this study wanted to establish if the mathematics teacher education curriculum at one university in Zambia enabled student teachers to acquire the appropriate competencies for teaching secondary school mathematics.

Could the way teachers are prepared to teach in institutions of higher learning affect the way they later teach their lessons in classrooms? Bull (1987) had indicated that it is impossible to disassociate what goes on in classroom from the way teachers are prepared because schooling and teacher preparation were naturally connected. Besides, the National Council for Teacher Quality (2007) revealed that teachers cannot teach what they do not understand and what they do not know. Ball, Hill and Bass (2003) and Chapman (2005) argued that there is a strong relationship between teachers' mathematical content knowledge and their ability to teach well in classroom. Similarly, Manchishi (2007) in his study on 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 wondered as to why the University of Zambia 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:

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

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 mathematics content knowledge (MCK) and pedagogical content knowledge (PCK). In addition, Hurrel (2013) argued that if society required effective learning, then effective teaching is necessary and inevitable. It is worth stating that if there is an effective teaching in teacher education programmes, then there could be a likelyhood 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. It is, therefore, vital at this point to state that what the scholars that have been cited were referring to, was the need to equip student teachers with the appropriate mathematical knowledge for teaching.

One of the most cardinal components in every teacher education programme is teaching experience which in most cases is 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. Peressini *et al.,* (2004) supported this finding 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. The importance of teaching experience is also 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 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.

Having in mind what scholars both in Zambia and elsewhere have analysed on the mathematics teacher education curriculum in various institutions of learning, the researchers wanted to investigate the extent to which the mathematics teacher education

curriculum at a university in Zambia had the appropriate content and teaching methods relevant for teaching mathematics in Zambian secondary schools. The researchers further wanted to find out if the way teachers were prepared to teach secondary school mathematics affected the way they taught classroom mathematics.

Methodology

The researchers used a mixed method approach. According to Creswell (2015: 2) mixed method research is;

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

Bearing in mind the six types of mixed method designs in Creswell (2009), the researchers particularly used the concurrent triangulation design which enabled them to collect and analyse both quantitative and qualitative data concurrently and then had two data bases merged for comparison in order to determine if there was convergence, divergence or a combination.

In order to come up with the participants for the study, both probability (simple random sampling) and non-probability (homogenous purposive sampling) sampling were used. Fifty-five questionnaires were administered to graduate teachers (former university students), 42

questionnaires to final year student teachers cohort who had done their teaching experience and were on the Bachelor of Arts with Education, Bachelor of Science with Education and Bachelor of Education Mathematics and Science (secondary) all studying mathematics as their teaching subject. The two questionnaires had the same information where respondents were requested to rate their coverage and understanding of secondary school mathematics during content and methods courses on a likert scale of very well, well, fairly well, not well and poor. They were also requested to rate the emphasis lecturers made on secondary school mathematics topics during content courses. Additionally, respondents were asked to express their opinion on the relevance of the mathematics content and methods courses they went through during their teacher education programme. Furthermore, the researchers interviewed 10 lecturers of mathematics, 6 who taught content courses and 4 who taught teaching methods courses including the National Standards officer for mathematics and 10 graduate teachers were interviewed and number of courses on the programme analysed.

Results

Respondents were asked to rate themselves on a likert scale on how much they had covered and understood different topics that they were expected to teach in secondary school. Their responses where then analysed using an independent t-test. The results were as indicated in table 5.1.

Table 5.1: Independent t-test results of respondents' rating of their coverage and understanding of various secondary school mathematics topics.

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 $p < 0.05$

Based on the probability level of confidence at $p < 0.05$, the results in Table 1 revealed that there was 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 1 has also shown that in 14 mathematics topics, there was no statistically significant difference between in-service and student teachers regarding their understanding and coverage of secondary school mathematics in the content courses that they did at university. 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.

In addition, the total mean for pre-service scored slightly above average that is 58.97, SD = 18.8 and the total mean for in-service scoring below average which is 42.60, SD = 12.48 both at p = 0.069. Additionally, pre-service rated themselves higher than the in-service in all secondary school mathematics topics. The range of the mean for pre-service is from 4.33 to 2.29. This meant that the rating of their coverage and understanding was around very well to fairly well, while the mean for in-service ranged from 3.80 to 1.25. This meant that their rating was close to very well in some topics and not well in some other topics.

The results indicated that despite student teachers having a good understanding and coverage of some secondary school mathematics topics such as: Quadratic Functions, Trigonometry and Introduction to Calculus in the content courses, there was also a very weak coverage and understanding of secondary school topics such as; Earth Geometry, Geometrical Transformation, Linear Programming, Mensuration, Variations, Circle Theorem as well as in Constructions and Loci.

When respondents were asked to rate their confidence to teach secondary school mathematics, the mean for both in-service and pre-service ranged between 4.62 and 1.40, while the mean for both graduate and student teachers ranged between 4.53 and 2.50. Respondents were also asked to rate their coverage and understanding of secondary school mathematics during methods courses and the means ranged between 3.32 and 1.40 for student teachers and 3.60 and 2.28 for graduate teachers.

The researchers were also interested in finding out how

student teachers would rate the emphasis lecturers made on secondary school mathematics during content courses. The results showed the means ranging between 4.12 and 1.61. Having looked at the independent samples t-test results, the general results suggested that student teachers did not acquire the appropriate mathematical competencies for teaching secondary school mathematics in both content and methods courses. Student teachers rated themselves on very well and well on topics such as: Trigonometry, Introduction to Calculus and Quadratic Functions which they did in their content courses. Both student teachers and graduate teachers showed that they had weak coverage and understanding of secondary school mathematics on topics which were loosely linked to secondary school mathematics curriculum such as: Earth Geometry, Geometrical Transformation, Linear Programming, Mensuration, Variations, Circle Theorem as well as in Constructions and Loci. This may have led to both student and graduate teachers to have no confidence in teaching such topics.

When student teachers and graduate teachers were asked through the questionnaire to give their opinions on the nature of mathematics content and teaching methods they had gone through, various perceptions were revealed as indicated in Figure 5.1.

Figure 5.1. *Views of Student Teachers on the relevance of the Mathematics courses that they did at university.*

As indicated in Figure 5.1 respondents had expressed their views in various ways. For instance, some other views

of graduate teachers were that;

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

(ii) *What I was taught at the university was very advanced and irrelevant to what is taught in classroom at secondary school.*

(iii) Not relevant at all. The gap is very wide between what I did and what is on the ground in secondary school.

(iv) *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 that;

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

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

(iii) *The mathematics taught at university is not relevant for teaching secondary school mathematics because it is taught in another school where they don't train teachers.*

(iv) *Most of the university mathematics courses apart from*

some methodology courses had no meaning to the teaching of secondary school mathematics.

When lecturers were asked about the relevance and appropriateness of content and methods courses offered by the university in relation to what was taught in secondary schools, one lecturer from the methods section said that;

> *Not quite appropriate and relevant, I think there is a lot of content we really don't need for the purpose of teaching in secondary school. A lot of mathematics up to fourth year level in terms of effective teaching at secondary school we don't need. In terms of methods, there is 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 a content lecturer who strongly stated that;

> *The level at which we teach mathematics is higher 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.

Despite other lecturers expressing their views differently, 80 per cent of their views were all pointing to the fact that the mathematics that was being taught at university to student teachers was not in line with what they needed to teach in secondary school. When asked to comment on whether the way teachers were prepared could in any way affect the teaching of classroom mathematics and eventually learner performance, interviewees gave different views. For instance, a lecturer from the methods section said;

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 what you don't know. And so, if you as a teacher you are not confident, you lack the necessary competencies, chances are high that when you go to teach those subject areas where you had deficiency you may not teach them well.

These views were also supported by what the other lecturers had said. For instance, another lecturer in the methods section explained that;

It may affect learner performance both

> *positively and negatively because the mathematics that we teach students makes them to be equipped to overcome challenges that they may encounter when they go to teach in schools. While on the other hand, learners in secondary school 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.*

From the mathematics lesson observation, it was found that 80 per cent of the teachers observed used the teacher-centred approach of teaching and had problems in terms of questioning techniques. Most of the questions they asked the learners were of low cognitive level which could not provoke critical and creative thinking in the mind of a learner. Another aspect that the researchers explored with in-service teachers was that some teachers of mathematics who already had diplomas in mathematics would change their subject when doing their in-service programmes at the university. When asked to comment on the reasons teachers of mathematics were diverting to other teaching subjects when upgrading their studies to a degree level, one head of department said that;

> *University 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 university mathematics for teacher education is hard and it doesn't match with what they teach at secondary school.*

Researchers also took some time to compare the number of courses that students did in mathematics methods and mathematics content. It was discovered that they had more of the content than methods courses. 86 per cent of their total course load was content while only 14 per cent was in methods and education courses.

The researchers also had an interview with the National Standards Officer for mathematics. The National Standards Officer for mathematics argued that poor learner performance in mathematics was as a result of bad teaching of classroom mathematical concepts by teachers. He further 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*.

This was in line with what one lecture from the content section of the University understudy mentioned when he 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 at which teachers ask and explain why learners are doing what they are doing.*

Just like the views of the National Standards Officer for Mathematics one method lecturer commented that;

> *Most teachers aim at finishing the syllabus and 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.*

From the data that has been presented in this section, it is very clear that there was a mismatch between the university teacher education mathematics content knowledge and that which was relevant for teaching in secondary school.

Discussions and Implications

The teaching profession demands that teachers 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.

Darling-Hammond (2000) contended that one of the

most critical resources in the provision of formal education is a teacher. Based on the responses from both student and graduate teachers, the study established that the mathematics teacher education curriculum at a named university was weak in terms of enabling student teachers acquiring the appropriate competencies for teaching secondary school mathematics. Lecturers supplemented by acknowledging that the mathematics that was taught to secondary school teachers was not the knowledge worthwhile for the students who were prepared to go and teach in secondary schools. According to their views, this was as a result of not having a specified curriculum for student teachers who were to be specifically prepared for teaching secondary school mathematics. The implication of not having such a content course outline in the curriculum, resulted in student teachers being taught the same mathematics that was meant for students who were to become engineers, physicians and many other professions. This explained why content courses at a named university were loosely linked to the secondary school mathematics curriculum. This is not to mean that student teachers should be taught secondary school mathematics while in university but should do a type of mathematics which is for university level but at the same time that which will help them teach secondary school effectively. After all they were being prepared to teach mathematics at secondary school.

The study findings coincided with several studies which revealed that student teachers and graduates of mathematics education lacked mathematical content knowledge which also led to a lack of confidence when teaching mathematics (Ambrose, 2004; Kajander, 2005; Tsao, 2005; Tumuklu and

Yesildere, 2007; Norton, 2010 and Hine, 2015). Additionally, Mansfield (1985), Ball and Wilson (1990), Monk (1994) and Bryan (1999) had all shown that student teachers including graduates whose major teaching subject was mathematics had gaps in their content knowledge in knowing how to apply and teach the secondary school mathematics. Besides, 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, they must know deeply and well.'

In line with various research findings that have been cited, the question could be, what really led to those deficiencies in the teaching and learning of mathematics? This question is answered by the findings of this study which are in harmony with several studies conducted in different colleges and universities of the United States of America as well as Europe which revealed 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). This is also supported by the studies done by: Ball and Bass (2000), Hill, Lewis and Ball (2000), Graham, Portnoy and Groundmeier (2002) who contended that the mathematics content and pedagogical knowledge which teachers learn during teacher education programme is normally not the knowledge most useful for teaching secondary school mathematics. Students teachers in this study scored the same as the graduate teachers in the t-test.

This finding is interesting and may be surprising too. But it actually confirms that what was taught to these students at university was not related to what those who were already teaching mathematics in schools knew, otherwise they would have performed better than those straight from school or who had not taught mathematics in secondary school; student teachers, if what was being learnt was a buildup of secondary school mathematics.

Besides, methods courses also never helped student teachers to effectively have a good coverage and understanding of the mathematics which they were to teach upon graduation. It is important in mathematics methods courses to give an opportunity to student teachers to be able to analyse and justify why certain mathematical concepts are the way they are so that they eventually teach learners with full conceptual understanding rather than through memorisation. The study tallies with the study conducted by Masaiti and Manchishi (2011) who had indicated that during teacher education more time was spent on content courses than on methodological courses. This could be one of the reasons there was weak coverage and understanding of secondary school mathematics amongst student teachers during their teacher education programme. Similarly, Mwanza (2016) established that student teachers were exposed to very little practical work during training and that in the case of peer teaching, student teachers were given between 10 to 15 minutes to practice teaching while school teaching experience was also regrettably short. According to Mwanza (*ibid*), this explained why most students teachers from the University of Zambia had mastered too much

content but less practical knowledge of teaching which made teaching difficulty when these student teachers were deployed in schools upon completion of their studies.

The research findings suggested that there was the absence of job analysis when designing the mathematics teacher education curriculum which resulted in developing a general curriculum which could not prepare student teachers to be fit for the purpose as indicated by Mulenga (2015). The lack of acquisition of appropriate mathematical competencies during the teacher education programme had led to teachers' lack of confidence to teach some mathematics topics namely; Earth Geometry, Geometrical Transformation, Linear Programming, Mensuration, Variations, Circle Theorem as well as Constructions and Loci. Some teachers ended up not teaching them because they lacked good coverage and understanding of the named topics. Besides, teachers of mathematics who wanted to upgrade to a degree level had to divert to other teaching subjects which was likely to reduce the number of graduates teaching mathematics in Zambian secondary schools. In this study, we can conclude that all these may have contributed to the poor learner performance in the subject. The study findings were in agreement with several studies with regard to the teaching and learning of classroom mathematics. For instance, Bull (1987) had indicated that it is impossible to disassociate what goes on in classroom from the way teachers are prepared because schooling and teacher preparation were naturally connected. Similarly, Ball, Hill and Bass (2003), and Chapman (2005) argued that there is a strong relationship between teachers' mathematical content knowledge and their ability to teach

well in classroom. All these can be summarised by the study done in Zambia by Manchishi (2007) who argued 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).

From the discussion, it can be stated that teacher education curriculum need to equip student teachers with appropriate mathematical knowledge for teaching in order to enhance effective teaching and learning of classroom mathematics.

Conclusion

Since teachers are considered to be key human resource in terms of the development of the country, it is important that teachers are effectively prepared by equipping them with appropriate competencies for teaching during their teacher education programme as well as during School Based Continuing Professional Development (SBCPD). The study findings revealed that student teachers of mathematics at a named university did not acquire the appropriate mathematical competencies for teaching secondary school mathematics. This was because the mathematics teacher education curriculum was loosely linked to the secondary school mathematics curriculum. This is a clear sign that the teacher education curriculum was developed using the content-based teacher education curriculum approach where job analysis was ignored prior to the development of the curriculum. This resulted in teachers failing to

effectively teach secondary school mathematics which may had eventually led to poor learner performance. It was recommended that the mathematics teacher education curriculum should be reviewed so that mathematics knowledge for teaching could be included. Besides, 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. Since quality in teacher education is of great importance, the researchers proposed that further research needed to be conducted on student teachers' acquisition of appropriate and relevant competencies in the mushrooming Colleges of Education and Universities for teaching secondary school mathematics.

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