Mathematics Teacher Education Curriculum in Zambia: Lecturers', Students' and In-service Teachers' Perspective

Robert Changwe

The University of Zambia, School of Education, Department of Language and Social Sciences Education. P.O Box 32379 Lusaka, Zambia

***Abstract*: Quality teaching of classroom mathematics in schools begin with exposing student teachers to a quality teacher education curriculum during their teacher education programme. The rationale for this study was to analyse the mathematics teacher education curriculum by reflecting on lecturers', students and in-service teachers' perceptions. Mixed methods design particularly the convergent parallel design was used. Questionnaires were distributed to former university students who were teaching mathematics in Lusaka and Kitwe district of Zambia as well as final year student teachers who were on the programme and had done their school teaching experience. In addition, some teachers, lecturers of mathematics content and mathematics teaching methods were interviewed. The researcher used description and thematic analysis in analysing qualitative data and quantitative data was analysed through the use of the statistical package for social sciences version 20 where means and independent samples t-tests were used. The study key findings reviewed that the way teachers of mathematics were prepared for their professional classroom job was inappropriate as the curriculum they were exposed to during their teacher education programme was loosely linked to what the student teachers were expected to teach upon graduation in Zambian schools. This affected the way mathematics was taught in secondary schools. Besides, the mismatch in the two curricula led to teachers of mathematics with diplomas to divert to other teaching subjects when upgrading their studies to a degree level. Hence, it was recommended that the higher institutions of learning needed to consider the ministerial directive by reviewing the mathematics teacher education curriculum after thoroughly conducting a job analysis. It was also recommended that the Ministry of Education needed to reinforce the already existing continuous professional development to bridge the gap between the two curricula.**

***Keywords*: Teacher education, mathematical knowledge for teaching, quality teaching, job analysis.**

I. INTRODUCTION

The sustainable development goal number four addresses the aspect of quality provision of education. If any country is to experience quality teaching and learning in the classroom, there is need to begin with quality provision of education to student teachers in various institutions of higher learning. Mulenga (2015) considered teachers to be the most critical resources of any formal education this is because of their key role in facilitating learners' acquisition of desirable knowledge, skills, values and attitudes. Based on the expected quality of teachers graduating from colleges and universities, the MoE (1992) documented that the qualities and competencies displayed by teachers in their respective schools clearly reflects the effectiveness of the institutions from where they did their teacher education. Similarly, Bishop (1985) also argued that the quality of the teacher education curriculum is as good as the quality of its teachers. This means that the development of the teacher education curriculum need to be done with care bearing in mind all the competencies that the products of such a curriculum are expected to practice upon graduation.

The study by Changwe and Mulenga (2018) revealed that the teacher education curriculum at one of the Zambian Universities was developed without conducting job analysis which led to student teachers to acquire some competences that were at variance with the secondary school mathematics curriculum. The question that demands a response is, could this mismatch have led to poor classroom teaching of mathematics and consequently poor learner performance in national assessments? This question has been partly answered by the study done by Changwe and Mulenga (2018) where it was revealed that the inappropriate acquisition of mathematical content knowledge by student teachers contributed to inappropriate teaching of classroom mathematics. Besides, ECZ (2016: 3) report noted 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." The report further revealed 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. This means that the way teachers of mathematics conducted the whole teaching and learning of classroom mathematics had affected the performance of learners in the subject.

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. Based on this assertion, the researcher in this study analysed various perceptions of student teachers, teachers and lecturers in order to have the general overview of the mathematics teacher education curriculum in

Zambian institutions of higher learning. The theory which guided the study is explained in the following section.

1.1. Theoretical Framework

This study was underpinned by content-based and competency-based teacher education curriculum theoretical approaches. Despite this theoretical orientation being coined by Haberman and Stinnett (1973), many other scholars such as Shulman (1987), Chishimba (2001), Bowles (2012), Mulenga (2015) and Changwe (2017) have used this theory when justifying various issues regarding curriculum development.

It is important from the onset to clearly note the distinction between content-based and competency-based theoretical approaches to curriculum development. Content-based theoretical approach according to Chishimba (2001) enables curriculum developers to go into curriculum development by simply following a common curriculum which is grounded on traditionally accepted subject divisions at the expense of conducting job analysis prior to curriculum development. On the other hand, competency-based theoretical approach to curriculum development enables curriculum developers to conduct job analysis which enables the competencies to be learnt and demonstrated by student teachers to be specified in advance (Mulenga, 2015 and Chishimba 2001).

II. AN OVERVIEW OF LITERATURE

Literature has revealed that 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 and Forzani, 2009; Mulenga, 2015). The cited 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 and not for acquiring of relevant and desirable knowledge, values, attitudes and skills by the learners as demanded by the national school curriculum.

It must be acknowledged that teacher education is a process that involves a lot of key stakeholders, namely; teacher educators, student teachers and practicing trained teachers who act as mentors for both student teachers and the newly deployed teachers. This means that school teaching experience is one of the areas that develops and improves the teaching skills of the student teachers. The Canadian Report (2008) on teacher education and development studies in mathematics, indicated 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. 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.

Although Artique et al., (2001) argued that due time constraints, teacher preparation in institutions of higher learning may not focus on everything that a teacher may require but some aspects can be learnt during the actual practice of teaching, it is important also to note that teachers cannot teach that which they do not know (Changwe & Mwanza, 2019). Learning to teach mathematics is something that must be done during the mathematics teacher education programme. 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."

Other studies done in different countries have indicated that student teachers and graduates of mathematics education lack appropriate 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 curriculum for student teachers in higher institutions of learning, then there could be a likelihood of effective learning of mathematics which may lead to reinforce confidence in student teachers who would eventually teach classroom mathematics with full understanding.

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 pedagogical content knowledge (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 (Stohlmann, Moore and Cramer, 2013). Besides, the study by Ball, Hill and Bass (2003) as well as Chapman (2005) indicated that there is a strong relationship between teachers' MCK and their ability to teach well in classrooms.

Most of the studies that have been done so far had 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). Ball and Bass (2000) and Graham, Portnoy and Groundmeier (2002) also noted that the mathematics content and pedagogical knowledge which teachers learnt during their teacher education programme was normally not the knowledge most useful for teaching secondary school mathematics. 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.

Mathematics is perceived by several people to be a difficult subject at both tertiary level 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 of mathematics were prepared during teacher education to enable the translation of the mathematical abstractions. This and many other assertions made the researcher in this study to look at the mathematics teacher education curriculum in Zambia by reflecting on students', lecturers' and in-service teachers' viewpoints.

In line with linking theory to practice, it may suffice to state that mathematics 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 where 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 one of the highest institutions 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.

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 linkage 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 institutions and what they are supposed to go and teach in the actual classrooms. 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.

Based on the reviewed literature, it is clear that much needed to be done to improve quality teaching and learning of classroom mathematics by rethinking the mathematics teacher education curriculum in Zambia. One of the ways of rethinking the mathematics teacher education in Zambia was to gather different views of teacher educators, student teachers as well as in-service teachers on how student teachers of mathematics were prepared for classroom teaching as well as views on what was lacking in the teacher education curriculum.

2.1. Aim

The main objective was to analyse the mathematics teacher education curriculum in Zambia by reflecting on perceptions of students, lecturers and in-service teachers.

III. METHODOLOGY

Mixed methods design under descriptive survey approach was used. The researcher particularly used the concurrent triangulation design which enabled him to collect and analyse both quantitative and qualitative data concurrently and then have the two data bases merged for comparison in order to determine if there was convergence, divergence or some combination (Creswell, 2009). This design was used to cross validate and corroborate the findings as well as to overcome the flaws of one approach by the strength of the other. Ten lecturers, one standards officer for mathematics and ten teachers of mathematics were interviewed, 39 student teachers and 43 teachers of mathematics who were once students at one of the Zambian universities were subjected to answer the questionnaire and five lessons of mathematics were observed.

3.1. Data Analysis

Qualitative data was analysed using descriptive thematic analysis while quantitative data was analysed through the use of statistical package for social sciences version 20 where means, frequencies and independent samples t-tests were employed. The justification for employing independent samples t-tests is supported by Awoniyi and Aderanti (2013: 109) who argued that 'when the performances of two independent samples need to be compared, the independent t-test form may be used to test for significance.' Thus the researcher in this study used independent samples t-test to rate in-service and pre-service student teachers' confidence to teach various secondary school mathematics topics as well as using the responses of both the pre-service and in-service student teachers to rate the emphasis lecturers of mathematics had made on secondary school mathematics topics.

IV. RESULTS

The two forms of questionnaires that were used requested for the same information from both the students and teachers of mathematics. Respondents were expected to indicate: the level of confidence they had to teach secondary school mathematics having gone through the mathematics teacher education curriculum at the university, the extent of coverage and understanding of secondary school mathematics topics in the content and methodology courses and the emphasis lecturers of mathematics had made on secondary school mathematics topics during the teaching of content courses. All the questions that sought for quantitative data enabled respondents to indicate on a five point likert scale rated as: 1= not well, 2 = fairly well, 3 = well, 4 = very well and 5 = excellent.

Table 1: Independent t-test results showing respondents' 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			
Total	pre-service	68.8824	16.26441	1.693	37	.099
	in-service	56.2000	8.92749			

*Significance at $p < 0.05$ n = 39

From the two sets of respondents in table 1, 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. Having no statistically significant difference between the two groups did not mean that both groups were very confident to teach all the 16 topics in mathematics. 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. For example, in Quadratic Functions, the mean for pre-service was 4.62, SD = 0.817 and p = 0.005 while the mean for in-service was 3.40, SD = 1.140 and p =0.05. Following the likert scale description indicated in the questionnaire, this means that the pre-service had rated themselves slightly above very well in terms of confidence to teach the topic while the in-service were well confident. Besides, for Mensuration pre-service were well confident while the in-service were slightly above not well confident. When it came to Linear Programming, pre-service rated themselves slightly above fairly well confident but not well while the in-service student teachers rated themselves on not well confident. Besides, the mean for teachers and student teachers of mathematics ranged between 4.53 and 2.50.

The results suggested that student teachers expressed confidence to teach topics such as: Introduction to Calculus, Relations and Functions, Coordinate Geometry, Trigonometry as well as Sets. They also indicated that they were not very confident to teach topics such as: Circle Theorem, Constructions and Loci, Mensuration, Linear Programming, Geometrical Transformation as well as Earth Geometry.

In another instance, the researcher wanted to find out the rate of coverage and understanding of various secondary school mathematics topics during content and teaching methodology courses. Based on the probability level of confidence at $p < 0.05$, the results indicated 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. The results had further 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 the 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. The means for teachers and student teachers of mathematics ranged between 4.26 and 2.18. In teaching methods courses, the means ranged between 3.32 and 1.40. This shows that although student teachers had a good coverage and understanding of some secondary school mathematics topics like: Trigonometry, Quadratic Functions and Introduction to Calculus in the content courses, there was also a weak coverage and understanding of secondary school mathematics topics namely; Linear Programming, Construction and Loci, Variations Geometrical Transformation and many more others.

Table 2: Independent t-test results of respondents' rating on the emphasis lecturers of mathematics had made on secondary school mathematics topics

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 2 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 means had shown that in most of the variables including where there was no statistically significant difference, the emphasis was either well, fairly well or not well.

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 respondents mostly rated lecturers' emphasis on secondary school mathematics around well, fairly well and not well. The results suggested that secondary school mathematics was not very much emphasised by lecturers of mathematics during content courses.

According to the results, the topics that seemed not to be mostly emphasised were: Similarity and Congruency, Variations, Sequences and Series, Circle Theorem, Constructions and loci, Mensuration, Linear Programming, Geometrical Transformation and Earth Geometry. This can in some way confirm the results in table 1 where respondents had expressed no confidence to teach some of the stated topics as well as the results on the coverage and understanding of various secondary school mathematics topics where respondents had shown that content courses had not provided them with very good coverage and understanding of secondary school mathematics.

4.1. Respondents' views on the Relevance of the Mathematics Courses Offered at the University to what was Taught in Secondary Schools

Respondents had expressed their views in various ways. For instance, some of the views of about 64% of former university students who were teaching mathematics in secondary schools were;

(i) *Most of the courses are relevant but as for mathematics content more needed to be done in order to link university mathematics to secondary school mathematics.*
(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. I would therefore suggest that the curriculum be revisited.*
(iv) *Not relevant at all. The gap is very wide between what I did and what is on the ground.*
(v) *They have been very relevant although improvement must be made to emphasise on the content taught in secondary schools.*
(vi) *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.*

66 out of 82 student teachers (both in-service and pre-service student teacher) 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 the University.*
(ii) *Courses like real analysis have no impact because we just memorise the stuff and reproduce on the paper without a clear understanding.*
(iii) *Most of the University mathematics courses apart from some methodology courses have no meaning to the teaching of secondary school mathematics.*

In addition to the views of students and teachers of mathematics, some lecturers felt that the mathematical knowledge for teaching was not adequately addressed in the mathematics teacher education curriculum at the institutions of higher learning. For instance, one lecturer said;

> *The curriculum is not quite appropriate and relevant; I think there is a lot of content we really don't need for the purpose of teaching. Most of the mathematics content that we teach our students start and end here. There is need to align our mathematics content and methods curriculum to what is prevailing in our schools otherwise we are training teachers in a vacuum. There must be a better way of blending teaching methodology and content.*

Five other lecturers shared the same view. For instance, one lecturer stated that;

> *We have lost a lot of students who wanted to study mathematics at this university but the level at which we teach mathematics is a little bit at a higher level than the mathematical knowledge for teaching someone would need to teach secondary school mathematics. I am of the view that we need to reconsider our mathematics curriculum so that the products of our programme would be fit for the purpose.*

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

Based on the aim of the programme, the response of some lecturers who taught teaching methodology and mathematics content courses to some extent differs in a way they viewed the aim of the programme. For example, when some lecturers had the aim of preparing competent teachers of mathematics, other lecturers had the aim of producing all round mathematicians who could work in any field such as: banks, mining, statisticians, insurance companies and many other fields. For instance, one lecturer said that;

> *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.*

When the researcher asked the same question to the sampled lecturers of mathematics who were teaching mathematics content courses, it was discovered that others gave the similar responses that lecturers who taught methods courses had given while others seemed not to be sure about the aim of the mathematics teacher education curriculum. For instance, one lecturer 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.*

4.3. 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 the University in a way affected their classroom teaching as well as the performance of learners in schools, one lecturer 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 what 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.*

The 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*. Additionally, when another lecturer was asked to comment on what led to poor learner performance in mathematics, 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 of teachers asking and explaining on why learners are doing what they are doing.*

As indicated earlier on, apart from using interviews and questionnaires, the researcher had to visit secondary schools in order to observe some lessons of mathematics taught by teachers who had gone through the same mathematics teacher education curriculum.

The conclusion drawn from the observation of mathematics lessons showed that teachers of mathematics seemed to have a good understanding of the subject matter but there were weak in terms of teaching methodology. It was also clear that time management was a problem to most teachers because there was no marking of class exercise during the normal period of teaching. This made it very difficult for teachers to effectively assess learners' acquisition of mathematical concepts because the absence of the teacher during the writing of the class exercise provided a conducive environment for copying/cheating amongst the learners. Besides, teachers' questioning techniques was not good because most of the questions they asked the learners were of low cognitive level which never prompted learners to be creative and critical thinkers.

V. DISCUSSION

It is a common phenomenon that every human being irrespective of his/her profession has to pass through the hands of teachers at one point in life. This could be one of the reasons Darling-Hammond (2000) and Mulenga (2015) considered teachers to be the most critical resource in the provision of any formal education. One would then wonder the attention and the level of seriousness teacher education curriculum designers need to attach to the actual process of curriculum development in tertiary institutions of learning.

5.1 Mathematical Knowledge for Teaching

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 (Andreas et al., 2014; Banner and Cannon, 1997). Every teacher educator need to acknowledge that getting a distinction in secondary school mathematics and becoming a teacher of mathematics are two different things. Teachers of mathematics 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. When one becomes a teacher of mathematics, he/she is expected to teach all the topics in the curriculum including the topics he/she did not understand when he/she was a pupil in secondary school. The role of a competent teacher of mathematics is not only to teach but also to help a learner to easily learn mathematics.

5.2 In-service and Pre-service Teachers' Confidence to Teach Secondary School Mathematics

The research findings in this study revealed that student teachers and teachers of mathematics who had gone through the mathematics teacher education curriculum had expressed little confidence in teaching some secondary school mathematics topics such as: linear programming, geometrical transformation, earth geometry, constructions and loci, mensuration, circle theorem, graphs of functions and many more others. The results indicated that the same topics were not well covered and understood by student teachers in both content and methods courses during their teacher education programme. According to the respondents' ratings on the five point likert scale, it was discovered that secondary school mathematics topics were hardly emphasised by lecturers. These findings were in harmony with other studies done in different countries which indicated that student teachers and graduates of mathematics education lacked mathematical content knowledge which also led to lack of confidence when teaching mathematics (Ambrose, 2004; Kajander, 2005; Tsao, 2005; Tumuklu and Yesildere, 2007; Norton, 2010 and Hine, 2015).

The quantitative findings were supplemented by the qualitative findings where respondents clearly indicated that the mathematics courses that student teachers were exposed to were loosely linked to the teaching of classroom mathematics. This affected the teaching and learning of classroom mathematics which eventually resulted in poor learner performance. This was in line with the findings of scholars who asserted that knowledge is cardinal to teachers and the mathematical content knowledge (MCK) that teachers are expected to possess 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). Besides, the study by Ball, Hill and Bass (2003) as well as Chapman (2005) indicated that there is a strong relationship between teachers' MCK and their ability to teach well in classrooms. This shows that teachers cannot teach that which they do not know. In line with this argument, Manchishi (2007) questioned the possibility of teachers to implement the school curriculum which is different from the programme they had gone through during their teacher education programme. Similarly, Hurrel (2013) argued that if society requires effective learning of mathematics, then effective teaching is necessary and inevitable. This is very crucial more especially when teachers themselves cannot fully comprehend classroom mathematics.

5.3 In-service and Pre-service Teachers' Competencies in Teaching Methods

In the mathematics lessons that were observed, teachers of mathematics expressed weaknesses in terms of teaching methodology. Only 20% of the teachers were able to integrate different teaching strategies in their teaching and 80% mostly used teacher centred approach. Besides, most teachers had flaws in questioning techniques as most of the questions they asked the learners were of low cognitive level. This was in agreement with the study done by Mkandawire (2013) who revealed that most of the teachers of mathematics were asking knowledge level questions which could not provoke learners' critical and analytical thinking. This definitely cannot help the country to have learners who are critical and analytical thinkers who may play key roles in providing solutions to societal problems.

Mwape and Musonda (2014), Kafata and Mbetwa (2016) as well as many other scholars have acknowledged that learners go to school to learn mathematics with misconceptions as a result of different stories they have heard about the subject. Now if teachers are not well prepared for their immediate job of classroom teaching, the result is poor teaching which may result in self-fulfilling prophesy amongst the learners.

5.4 Mathematics Teacher Education Curriculum Designers' Intentions

The divergence views of teacher educators pertaining to the aim of the programme, indicated that the lecturers who taught content and methods courses did not plan together on what to include in the curriculum. The findings further showed that curriculum designers did not conduct job analysis when designing the programme. This led to student teachers to be exposed to content-based curriculum at the expense of competence-based curriculum. This led to curriculum designers not to link the real experiences in teacher education curriculum to the actual classroom experiences as suggested by Darling-Hammond (2000), Chishimba (2001) & Mulenga (2015). The researcher in this study argued that teaching is a special professional which requires a professional curriculum and not a general curriculum. It is only during the designing of a professional curriculum where curriculum designers may use a special lens which can reflect on appropriate ingredients and vital knowledge, values, skills and attitudes that is expected in a competent teacher of mathematics.

The study established that if student teachers are exposed to: appropriate MCK, PCK, MKT, history of education, educational psychology, sociology of education, philosophy of education, curriculum studies and educational administration and planning, most of the factors that various scholars have reported to be among the factors that had been affecting the teaching and learning of classroom mathematics and eventually learner performance would be overpowered by the degree of competence that student teachers would go out with in secondary schools. The researcher had considered effective teacher education curriculum which can be arrived at through competency-based curriculum theoretical approach to be a master key to several doors of academic breakthrough in the provision of quality teaching and learning processes.

VI. CONCLUSIONS

Based on the findings of this study, the author of this paper concluded that the mathematics teacher education curriculum at a University level was designed without taking into consideration job analysis of a teacher of mathematics. This resulted in the products of the programme to express weaknesses in terms of MKT secondary school mathematics. The author further established that student teachers were exposed to the same mathematics content courses that were taken by student teachers who had nothing to do with the teaching professional. This led to inappropriate teaching of secondary school mathematics and eventually poor learner performance. The author further suggested that there was need to reconsider the mathematics teacher education curriculum in most colleges and universities if quality teachers of mathematics were to be produced. Curriculum designers needed to: design a full course that would address the aspect of MKT secondary school mathematics, improve the way teaching methods courses were offered by introducing methods courses starting from second year up to fourth year, exposing student teachers for one full term of teaching experience at least twice during their entire programme as well as ensuring that all student teachers training to become teachers of mathematics have a good knowledge base of the subject. The Ministry of Education needed also to reinforce the continuous professional development amongst the teaching staff.

ABOUT THE AUTHOR

Robert Changwe is a Curriculum and Teacher Education Scholar at the University of Zambia in the School of Education. He holds a Master of Education degree in Curriculum Studies and a Bachelor of Arts with Education degree from the University of Zambia. He also holds a Secondary School Teachers' diploma from the Copperbelt Secondary Teachers' College, in Zambia. Mr. Changwe has been researching, publishing and teaching on issues such as; Curriculum Development and Implementation, Educational Assessment, Teacher Education and pedagogy. He also has vast experience in the teaching of Mathematics in secondary schools.

REFERENCES

[1] 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.

[2] 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.

[3] 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.

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

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

[6] 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.

[7] 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.

[8] 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.

[9] 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.

[10] 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.

[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.

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

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

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

[15] Bishop, G. (1985). Curriculum Development: A Textbook for Students. Hong Kong: Macmillan Education Ltd.

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

[17] 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.

[18] Chabatama, M. C. (2012). Contradictions and weaknesses in the teaching an examination of History in Zambian secondary schools. Zambia Journal of Education, 3 (20, 12-18.

[19] 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.

[20] Changwe, R. (2017). Effectiveness of the Mathematics Teacher Education Curriculum at the University of Zambia in Preparing Secondary School Teachers of Mathematics. Masters Dissertation. The University of Zambia.

[21] Changwe, R. & Mulenga, I. M. (2018). Mathematics Teacher Education Curriculum at a University in Zambia: Student Teachers' Acquisition of Appropriate Competencies for Teaching Mathematics in Secondary School. Multidisciplinary Journal of Language and Social Sciences Education, 1(1), 207-242.

[22] 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.

[23] 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.

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

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

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

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

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

[29] 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.

[30] 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.

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

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

[33] 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.

[34] 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.

[35] 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.

[36] 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.

[37] 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.

[38] 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.

[39] 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) .

[40] 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.

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

[42] 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).

[43] 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.

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

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

[46] Ministry of Education, (1992). Focus on Learning. Lusaka: Government Printer.

[47] 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.

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

[49] 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.

[50] 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.

[51] National Council on Teacher Quality. (2007). State teacher policy yearbook: Progress on teacher quality, Ohio 2007. Washington, D C : National Council on Teacher Quality.

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

[53] National Research Council. (1996). National Education Standards. Washington, DC: National Academic Press.

[54] 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.

[55] 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.

[56] 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.

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

[58] Shulman, L . S. (1986). Those who Understand Knowledge Growth in Teaching. Educational Researcher, 15 (2), 4-14. http://dx.doi.org/10.3102/0013189x015002004.

[59] 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.

[60] 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/3299/247.

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

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

[63] 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).

[64] 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.