ANALYSIS OF UNIVERSAL BASIC EDUCATION MATHEMATICS TEACHERS' CONTENT KNOWLEDGE IN NIGERIAN PUBLIC SCHOOLS

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Abstract
It is generally agreed that teachers' mathematics content knowledge is a necessary, though not a sufficient condition for the working, because one cannot teach what one does not know. In this paper, we analyse the responses of a group of 98 Universal Basic Education (UBE) teachers from one Nigerian state to a conceptually based mathematics content knowledge test. The findings, in a context of emerging attention to primary teacher knowledge in Nigeria, point to serious gaps in teachers' mathematical content knowledge. Furthermore, the findings also point to the need to disaggregate the levels at which in-service mathematics teacher professional development interventions could usefully start across lower, middle and upper basic teachers. We recommend the need for urgent and robust research and development projects with focus on developing teachers' mathematics content knowledge in ways that are useful for teaching. In this way, successful interventions can be scaled-up to more teachers.

Keywords: *9-year mathematics curriculum; Content Knowledge; Nigerian public schools; professional development interventions; teacher assessment; Universal Basic Education.*

Introduction
There is broad agreement that the performance of primary school pupils in Nigerian public schools is below curricular expectations, with most pupils leaving primary schools without the expected foundational numeracy knowledge and skills (Adeyemi, 2014). This is leading to more recent policy attention, at the state level, to asking questions about primary teachers' mathematical knowledge and classroom practice skills (NAN, 2017). Extensive rollout of professional development interventions were conducted by Universal Basic Education Commission (UBEC), State Universal Basic Education Board (SUBEB), and the Collaboration with Millennium Development Goals and National Teachers' Institute (NTI) followed the introduction of the revised 9-year Universal Basic Education (UBE) curriculum in Nigeria.

Several of these interventions were focused on developing teachers' content knowledge and content-specific pedagogy in core subject areas. However, recent quantitative studies across the country point to weak mastery of mathematical content knowledge among teachers (e.g. Adeyemi, 2014; Humphreys & Crawfurd, 2014; Odili & Asuru, 2010; Rabiu & Saidu, 2015). A common finding across these studies relates to the presence of large numbers of Nigerian UBE mathematics teachers with gaps in their fundamental understandings of Mathematics. The quantitative slant of these studies has tended to focus on performance without attention to the nature of UBE teachers' mathematical knowledge across curriculum strands and grade levels.

It is this gap that we focus on in this paper with an in-depth analysis of UBE teachers' mathematical content knowledge across different level bands and curriculum strands.

In doing this, we aimed to provide a more detailed and holistic picture of teachers' areas of strength and weaknesses that can guide the design of responsive interventions, as well as providing evidence for policy on the content for pre- and in-service Mathematics teacher professional development in Nigeria. Our empirical base in this paper rests on analysis of 98 UBE (1-9) teachers' responses on a conceptually mathematical content knowledge test. The test was adapted from one used in the Wits Maths Connect – Primary (WMC-P)[1] project in South Africa to assess primary school teachers' conceptual understanding of elementary Mathematics. While the test was not designed with reference to the Nigerian UBE Mathematics curriculum, we mapped the 66-items of the test to the Nigerian UBE curriculum. This mapping linked the majority of the items to curriculum specifications at middle basic (primary 4-6) level, with a small number at the upper basic (JSS 1-3). The teachers in this study were the opportune sample of willing participants drawn from eleven government schools in one Nigerian State.

The research objectives for this study focus on understanding what Nigeria's UBE Mathematics teachers across the three levels (Lower: primary 1-3; Middle: primary 4-6; and Upper: JSS 1-3) know relative to the Nigerian UBE Mathematics curriculum. This kind of curriculum-linked analysis has been conducted in the South African context (Venkat & Spaull, 2015), with those authors noting, as we have indicated, that an interest in understanding the topic areas and levels that should form starting points for pre- and in-service professional development, guided their analyses. Our interest in this study is guided by concerns for re-conceptualizing Mathematics teacher re-training and intervention programmes, as well as for policy implications that might guide this conceptualization, particularly in the context of implementation of the revised 9-year UBE mathematics curriculum in Nigeria. Specifically, this paper addressed the following questions:

1. What are the performance of UBE teachers of Mathematics relative to the Nigerian UBE curriculum in terms of grade-level bands and content themes?
2. What kind of professional development interventions in mathematics for the UBE teachers could usefully start?

We begin this paper with a review of literature on conceptualizations of Mathematics subject matter knowledge that draws particularly from the work of Deborah Ball and her colleagues. We then provided a brief description of the Abubakar Tafawa Balewa University (ATBU) Maths Improvement Project as the analysis in this paper is drawn from the baseline data of the project. The history and structure of the revised Nigerian 9-Year Basic Education Mathematics Curriculum is also provided. Our analysis was based on the strands of the content of this curriculum. This is followed by details of the methodology of the study, before proceeding into our findings and discussion. We concluded with implications for professional development for UBE teachers based on our evidence.

Conceptualization of Teachers' Mathematics Content Knowledge

The focus of this paper was on one specific aspect of teachers' Mathematics knowledge: subject matter knowledge (SMK). SMK is a necessary (but not sufficient) prerequisite knowledge base that teachers need in order to teach Mathematics well at all levels. This is the case, since one cannot teach what one does not know. Shulman (1986) defined SMK as "the amount and

[1] WMC-P Project is a longitudinal research and development project located in Wits University, South Africa. The project targets improvement of primary mathematics teaching and learning in government primary schools in South Africa.

organization of knowledge *per se* in the mind of the teacher" (p. 9). He further elaborates that SMK has both

- Substantive structure – the variety of ways in which the basic concepts and principles of the discipline are organized to incorporate its fact[s], and
- Syntactic structure – the set of ways in which truth or falsehood, validity or invalidity are established (p. 9).

Thus, understanding SMK goes beyond the understanding of disciplinary facts. It also includes understanding of a discipline's structure and its processes of establishing ideas. Ball (1991) uses the concepts of substantive and syntactic structure of a discipline to make a distinction between knowledge of Mathematics and knowledge about Mathematics. Ball, Thames, and Phelps (2008) have produced a widely-cited model breaking down SMK on the basis of a practice-driven conceptualization. They sub-divide SMK into three subdomains: common content knowledge (CCK), specialized content knowledge (SCK) and horizon content knowledge (HCK).

Common content knowledge refers to the knowledge of Mathematics that might be expected of adult who uses Mathematics in their work and everyday life. Ball et al. (2008) highlighted the importance of this knowledge and pointed to how instruction suffers if teacher's CCK is weak.

> By 'common' however we do not mean to suggest everybody has this knowledge. Rather, we mean to indicate that this is knowledge of kind used in wide variety of settings … not unique to teaching … When a teacher mispronounced terms, made calculation errors or get stuck trying to solve a problemon the board, instruction suffered, and valuable time was lost (p.399).

In their instrument for measuring 'mathematical knowledge for teaching', items to tap CCK draw on what the authors described as everyday knowledge of Mathematics – e.g. "What is the number that lies between 1.1 and 1.11?"; "Can the number 8 be written as 08?" (Hill, Schillings, & Ball, 2004).

The second domain, specialized content knowledge (SCK) is knowledge which is unique to teaching and separates a mathematics teacher from a mathematician and other professions that use mathematics. Ball et al (2008) argued that teachers must do a kind of mathematics that people in other professions do not have to do. Teachers' specialized Mathematical knowledge includes the ability to look for "patterns in student errors or in sizing up whether a nonstandard approach would work in general, ... teachers have to do a kind of mathematical work that others do not" (Ball *et al* 2008, p.400).

The third domain of SMK is horizon content knowledge (HCK), which is described as "an awareness of how mathematical topics are related over the span of mathematics included in the curriculum" (p. 403). For example, widespread evidence points to early primary school teachers making the generalization that the result of multiplying two numbers is always bigger than either of the two numbers. However, this is not true in the case of multiplication of fraction numbers (e.g. 10 multiply by ½ gives a result that is less than 10). Having good HCK on the part of the teacher involves among other things, knowing that generalizations that hold in current experiences may break down at a later stage. Therefore, taking care to structure classroom communication in ways that acknowledge this temporality is important.

The majority of the test items we used in this study could be classified as relating to common content knowledge (CCK). Our focus on CCK was based on the acknowledgement that fundamental mathematical knowledge is necessary for one to effectively manifest the SCK and

HCK dimensions. This choice was also driven by the evidence of gaps in content knowledge that we noted in our introduction. It is in our effort to better understand gaps in teacher content knowledge and possible solutions to address this gap at the UBE level that we launched a research and development project entitled: ATBU Maths Improvement Project. A brief overview of the project is provided in the next section.

ATBU Maths Improvement Project: A Brief Overview

The ATBU Maths Improvement (ATBU-MI) project is a research and development project working with eleven primary and junior secondary schools in one state in northern Nigeria. The project emanates from concerns that, though, the problem of primary Mathematics teaching and learning in Nigeria is well known, but it is grossly under-researched. This lack of research evidence has hindered the development of robust and effective interventions for enhancing Mathematics teaching and learning. The project is currently at phase I, with the following two interrelated objectives:

1. To gather and analyze baseline data on teachers' knowledge for/in teaching; and students' achievement in Mathematics; as well as students' connected understanding of number facts and relationships at the foundational level.
2. To use findings from this study in re-conceptualizing Mathematics teachers' professional development intervention programmes and for policy implications that might guide this re-conceptualization.

The choice of initial teacher assessment is drawn from two bases. Firstly, there is growing body of international literature in mathematics education (Ball *et al* 2008; Borko, 2004; Huang & Bao, 2006; Turner & Rowland, 2011) that testifies to the importance of understanding and developing teachers' mathematical knowledge for/in teaching as a tool for improving the quality of mathematics teaching. Secondly, studies relating to teacher assessment in Nigeria has tended to focus on performance without attention to the nature of UBE teachers' mathematical knowledge across curriculum strands and grade-band levels.

As a result, we adapted assessment that have been developed and used at the international level (Ball & Bass, 2003; Hart, Brown, Kuchemann, Kerslake, Ruddock & McCartney, 1981; Ryan & McCrae, 2006; Venkat, 2011; Wright, Martland, & Stafford, 2006). Using these measures, our aim is to categorise the current status of our teachers' mathematical knowledge in relation to curriculum strands and grade-band levels, as well as students' achievement and the sophistication of the strategies students' use in solving mathematical tasks. These combined findings are intended to provide strong grounds to guide efforts in addressing the constellation of problems related to the teaching and learning of mathematics in Nigeria. This paper drew specifically from data on assessment of teacher's Mathematics content knowledge relative to the 9-year UBE Mathematics curriculum. A brief history and structure of the curriculum is presented in the next section.

History and Structure of the Nigerian 9-Year Basic Education Mathematics Curriculum

As a means of attaining the Goal number 2 of the Millennium Development Goals (MDGs) which centres on achieving Universal Primary Education by the year 2015, the Federal Government of Nigeria approved the introduction of the 9-year basic education and directed the National Education Research and Development Council (NERDC) through National Council on Education (NCE) to review, re-structure, and re-align the then curricula for primary and junior secondary school to fit into the 9-year basic education programme. The new curriculum has the following structure for basic education: Lower Basic Education Curriculum (primary 1-3), Middle Basic Education Curriculum (primary 4-6) and Upper Basic Education Curriculum (JSS 1-3), listing relevant contents for each level.

A thematic approach across Basic1-9 Mathematics curriculum was adopted in selecting the content and learning experiences. Again, a spirality of themes is used in structuring the curriculum, with themes remaining the same at each grade level, but with increasing cognitive demand as pupils' move to the higher grade. In the 9-year UBE Mathematics Curriculum, there are five recurring themes namely: (1) Number and Numeration; (2) Basic Operations; (3) Algebraic Process; (4) Mensuration and Geometry; and (5) Everyday Statistics. The themes and sub-themes in the 9-year Mathematics curriculum (Nigerian Educational Research and Development Council (NERDC), 2012) are presented in Table 1.

Table 1: Themes and Sub-themes as contained in the 9-Year UBE Mathematics Curriculum

Themes	**Sub-themes**
Number and Numeration	Whole number Fractions
Basic Operations	Basic Operations Derived Functions Derived Operations
Algebraic Process	Algebraic Operations Open sentences
Mensuration and Geometry	Primary Measures Secondary Measures Shapes
Everyday Statistics	Data collection and Presentation Chance and Events

Source: 9-Year Basic Education Curriculum (FME, 2012)

It is important to note that the themes were reduced to four in Basic 8 and 9 with 'Basic Operations' taken off. However, all the other themes remain the same throughout the grades.

Methodology

This paper is drawn from ATBU-MI project's baseline data that assess Nigerian mathematics teachers' content knowledge. Teachers were drawn from 11 UBE schools in one state in northeastern Nigeria. One hundred and ten teachers (10 from each of the 11 schools) were selected across Basic 1-9. These teachers were invited to write the test, and 98 teachers participated. Of the 98 teachers, 35 were from lower basic (primary 1-3); 30 from middle basic (primary 4-6); and 33 from upper basic (JSS 1-3). All teachers are currently teaching Mathematics in their schools, and each holds a minimum of the Nigeria Certificate in Education (NCE) qualification. However, majority of the teachers have qualifications not in Mathematics or Mathematics related disciplines. This category of teachers could participate because in reality they were the ones teaching Mathematics in their schools.

A 66-item test was adapted from the WMC-P project located in Wits University, Johannesburg in South Africa. Items in this test were conceptually-oriented and drawn from a range of prior studies including Hart et al.'s (1981) Concepts in Secondary Mathematics and Science studies, and Ryan and McCrae's (2006) Teacher Education Mathematics Test studies. A permission to use the test was granted from the WMC-P project Chair. The content focus and difficulty level of the test remained the same as original. Changes were made to suit the Nigerian context. For example, decimal commas were changed with points (e.g. in South Africa, 2.5 is written as 2, 5), in money context, rand were changed with naira, names were changed to common Nigerian names, and some wordings were adapted to be meaningful to Nigerian teachers.

In order to provide an analytical tool to assess the levels and distribution of Mathematics content knowledge of the Nigerian teachers, it was first necessary to classify items into broad content domains in line with the Nigerian UBE mathematics curriculum. We classified each item in the test by grade level and broad content-related themes. Given that the test items were not originally designed with the Nigerian curriculum in mind, we therefore based our content related strands on the following five recurring themes as stipulated in the UBE mathematics curriculum: (1) Number and numeration, (2) Basic operations, (3) Algebraic process, (4) Mensuration and geometry, and (5) Every day statistics.

Veteran primary Mathematics teacher with three decades of teaching experience at primary school level joined our team in placing the items appropriately. We are also challenged with items that have multiple embedded ideas that cut across two or more themes. As a team, we decided on the bases of predominant idea, and place the item in that theme. Table 2 gives the summary of the number of items in the test matched to the content themes of the Nigerian curriculum. Of the 66-items, 37 were directly on number related work (whole number, fractions, decimal and percentages, and four basic operations). The theme that has least number of items is everyday statistics.

Table 2: Test-items matched to the themes of the Nigerian UBE curriculum

S/N	Themes	No. of items	Percentage
1.	Number and Numeration	22	33%
2.	Basic Operations	15	23%
3.	Algebraic reasoning	12	18%
4.	Measurement and Geometry	14	21%
5.	Everyday Statistics	3	5%
	Total	66	100%

For further level of analysis in relation to grade levels, we classified each item into the grade as specify in the Nigerian curriculum. In a situation where an item contained an idea that is at lower level, but has higher number range, we placed that item at higher grade. Out of the 66 items in the test, 24 items could be matched to primary 4 curriculum, 8 items could be matched to primary 5 curriculum, 16 items could be matched to primary 6 curriculum, 16 items could be matched to JSS 1 curriculum, and 2 items could be matched to JSS 2 curriculum. At the broader level classification by the Nigerian curriculum (lower, middle, and upper) levels band, yielded the following distribution of the 66-items in the test as presented in Table 3.

Table 3: Test-items matched to the UBE level

S/N	Level	No. of items	Percentage
1.	Lower basic (primary 1, 2, 3)	0	0%
2.	Middle basic (primary 4, 5, 6)	48	73%
3.	Upper basic (JSS 1, 2, 3)	18	27%
	Total	66	100%

This categorization indicated that clear majority of the test items (73%) could be matched to middle basic curriculum, with no item at the lower level curriculum. In their re-analysis of SACMEQ 2007 teacher test in South Africa, Venkat and Spaull (2015) considered score above 60% as an indication of mastery of the Mathematics content knowledge. However, due to the peculiarities of our current terrain in the study (northern Nigeria), and the nature of our dataset, we do not argue on the mastery level rather we considered score of 50% and above as a benchmark of performance to quantify the extent of gaps in teacher content knowledge in this area of study. We acknowledged that 50% is far low to be considered as level of attainment for teaching. This simply reveals the extent of differences in content knowledge of the teachers in our dataset in comparison to what is obtainable in the international literature base from developed countries context.

Findings

In this section, we present findings according to the research questions presented in the opening section of this paper that guided our analysis. These are: performance based on grade-level bands, and performance based on curriculum content themes. To further describe the extent of performance and to argue more on what findings meant for professional development interventions, we present findings based on benchmark of 50% and above performance. These findings are discussed in the section that follows. Throughout the analysis, we grouped teachers into the three levels: lower basic teachers (primary 1-3); middle basic teachers (primary 4-6) and upper basic teachers (JSS 1-3).

Performance based on grade levels band

As already mentioned in the methodology section, the test was segregated according to the content levels as contained in the UBE curriculum. Figure 1 reports the percentage average of the teachers' performance across grade levels band content classification.

The result shows that the highest mean score is 57% achieved by upper basic teachers on middle basic tasks. The lowest score is 12% achieved by lower basic teachers on upper basic task. Lower basic teachers achieved average of 26% on the middle basic task and 12% on upper basic task. Middle basic teachers achieved average score of 40% and 21% on middle and upper basic task respectively. While the Upper basic teachers have the average of 57% and 34% on middle and upper basic task respectively. It is worrisome to note that middle basic teachers (40%) and Upper basic teachers (34%) have average score below 50% on the items meant to be at the level they teach.

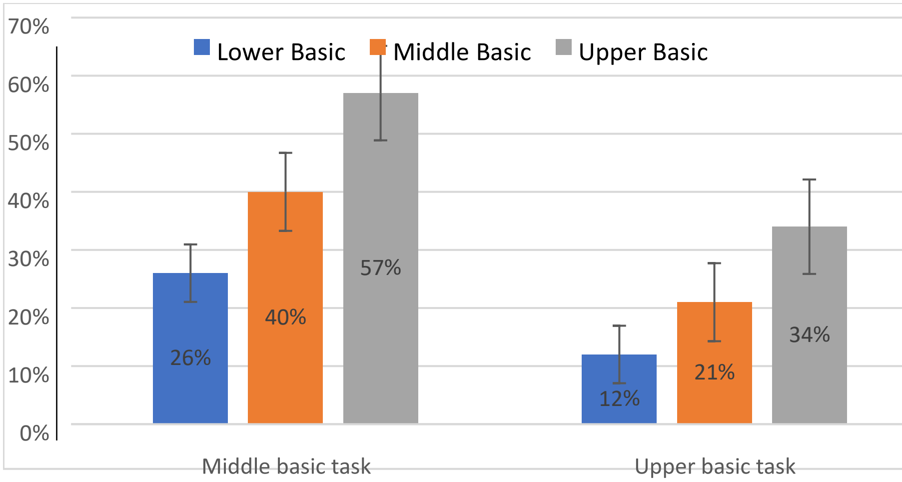

Figure 1: Mean performance across levels by test item classification

Performance based on curriculum themes

Figure 2 presents performance on the test based on UBE curriculum themes across different teacher levels (low, middle, and upper). It showed that the upper basic teachers performed higher in all curriculum themes. This is followed by the middle basic, and the least performing are the lower basic teachers. Only in number and numeration, basic operations, and everyday statistics that the upper basic teachers attained 50% and above. None of the middle basic or lower basic teachers attained 50% on any of the five themes of the curriculum. The least performance was recorded in algebraic reasoning and mensuration and geometry.

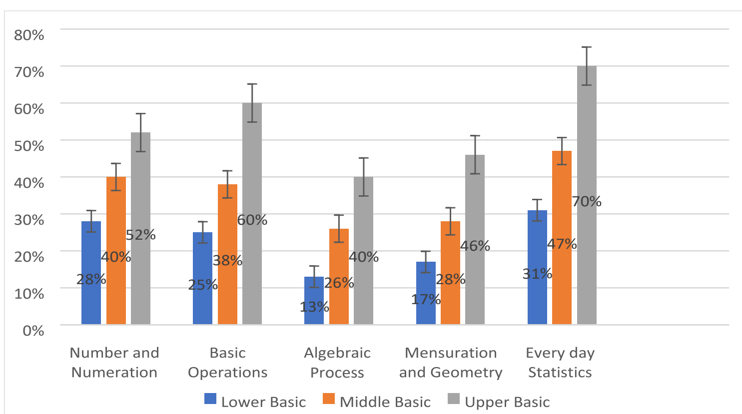

Figure 2: Mean % of performance by teacher levels across curriculum themes

Benchmark of 50% and above performance

Figure 3 reports the proportions of Nigerian Mathematics teachers in each category that scored 50% correct or higher on the test. The results can be presented as follows:

- Lower basic teachers – 11% of teachers score 50% and above on middle basic test items, and 0% on upper basic test items.
- Middle basic teachers – 23% of teachers score 50% and above on middle basic test items, and 0% on upper basic test items.
- Upper basic teachers – 67% of teachers score 50% and above on middle basic test items, and 12% on upper basic test items.

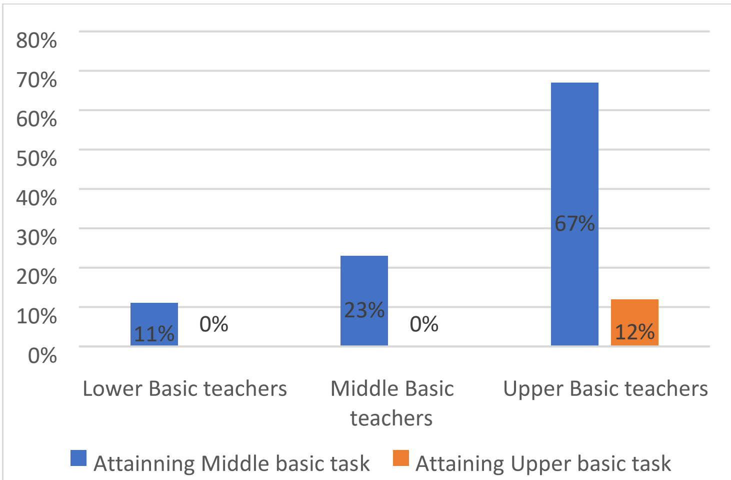

Figure 3: Proportion of teachers who scored 50% and higher in middle and upper basic tasks

Results show that all lower and middle basic teachers do not have content knowledge at upper basic level. That they could not achieve 50% correct or higher on the upper basic items in the test. The result also shows that 77% of middle basic teachers, and 88% of upper basic teachers did not score 50% and above on content knowledge at the level they are currently teaching.

Discussion of Findings

Several features of interest arose in relation to this analysis of assessment of teachers' mathematics content knowledge in Nigerian public schools. As outlined in the introductory part of this paper, our analysis is driven by interests in re-conceptualizing Mathematics teacher professional development intervention programmes and for policy implications that might guide this conceptualization. Firstly, despite the huge investment by Nigerian government through Universal Basic Education Commission (UBEC), State Universal Basic Education Board (SUBEB), and the Collaboration with Millennium Development Goals and National Teachers' Institute (NTI) in providing different kinds of workshops and re-training programmes, with focus on content and pedagogy, there is still confirmation of the earlier findings of significant gaps in mastery of content knowledge by teachers related to topics for the class they are teaching. It is of serious concern that our analysis revealed that 77% of middle basic teachers and 88% of upper basic teachers do not attend 50% and above performance on mathematics content knowledge at the class level they are teaching.

From Figure 3, only 11% of lower basic teachers had attend 50% and above on the middle basic task. This raised a serious concern, even though none of the test-item is matched to the lower basic curriculum, it is expected that lower basic teachers should be able to at least have mastery of the content knowledge at the level of middle basic as their horizon knowledge (Ball et al., 2008). The question one can asked is: How could these teachers imagine well what their pupils should expect in middle basic levels if only 11% of these teachers can score 50% and above? This indicated a weak horizon content knowledge by the lower basic teachers. However, we do not know how these teachers can perform if they are giving test that cover content of the lower basic curriculum.

In terms of content themes of the curriculum, lower basic teachers performed below 30% in all the five curricular themes. This suggests that professional development for these teachers need to focus more on number and numeration; and basic operations before moving to algebraic process, and mensuration and geometry. And the focus should be on developing teachers' common content knowledge sufficiently enough before moving into developing their specialized content knowledge for teaching.

Figure 3 also showed that only 23% of middle basic teachers had a score of 50% and above on middle basic content. This finding indicates that 77% of the middle basic teachers do not attend 50% and above of the content knowledge at the level they teach. One can imagine how well these teachers are teaching mathematics at this grade band level, because teachers cannot teach what they do not have. It is not surprise, however, that none of the middle basic teachers had scored 50% and above on upper basic task. This also suggest weak horizon content knowledge.

On the content themes, Figure 1 showed very low mastery in algebraic process (26%) and mensuration and geometry (28%). On the other themes, still low mastery is noted with all mean performance less than 50%: Basic operations (38%); number and number system (40%) and every day statistics (47%). More attention in terms of professional development need to focus on algebraic process, mensuration and geometry, basic operation and number and numerations. As argued in the case of the lower basic teachers, professional development at the middle basic should also focus more on developing common content knowledge before moving into developing their specialize content knowledge for teaching.

Similar pattern of performance is also noted in the case of upper basic teachers, as indicated in Figure 3, even though 67% of upper basic teachers scored 50% and higher on the middle basic content, but only 12% attend 50% and higher at the level they teach. In relation to content themes, performance on algebraic process (40%), and mensuration and geometry (46%) were below 50%. However, they had mean performance of 70% in everyday statistics; 60% in basic operations, and 52% in number and numeration. This finding suggests the need for different professional development focus on common content knowledge for these group of teachers. Attention on developing CCK in algebraic process and mensuration and geometry, with first focus on middle basic content, before moving to the upper basic content. When CCK is sufficiently developed then professional development should include developing their specialized content knowledge for teaching.

Conclusion

The analyses in this paper resonate3 prior evidence about serious gaps in primary and junior secondary school teachers' mathematical content knowledge in Nigeria. The finding also points to levels at which in-service Mathematics teacher professional development interventions could usefully start and confirm the need for emphasis on different starting point for lower, middle and upper basic teachers. National interventions currently run in 'one size fits all' standardization of content with combined sessions of all the three groups of teachers. With the wide range of gaps in the pattern of performance across the broad grade level band, there is need to separate the three groups of teachers as starting with different focus on content by each group is useful. Nevertheless, our analysis indicates the need for broad attention to common content knowledge across the three levels of teachers before attending to developing their specialized content knowledge for teaching.

A useful initial point to address the problem of weak content knowledge by primary and junior secondary school teachers may be to bring key stakeholders (SUBEB, University teacher educators, and teachers' representatives) together to share evidence and build consensus on way forward. In our view, there is an urgent need to conduct small scale research and development projects with focus on developing teachers' common content knowledge from pedagogical perspectives. Hence interventions that have shown positive impact can be scale up to larger population of teachers.

References

Adeyemi, S. B. (2014). Comparative Study of Pupils' Academic Performance between Private and Public Primary Schools. *World Journal of Education, 4*(4), 55-60.

Ball, D. L. (1991). Research on teaching mathematics: Making subject matter knowledge part of the equation. In J. Brophy (Ed.), *Advances in research on teaching: Teachers' subject matter knowledge and classroom instruction* (Vol. 2, pp. 1-48). Greenwich: CT JAI Press.

Ball, D. L., & Bass, H. (2003). *Toward a practice-based theory of mathematical knowledge for teaching.* Paper presented at the 2002 annual meeting of Canadian mathematics education study Group, Edmonton, AB.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content Knowledge for Teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407. doi:10.1177/0022487108324554

Borko, H. (2004). Professional Development and Teacher Learning: Mapping the Terrain. *Educational Researcher, 33*(8), 3-15. doi:10.3102/0013189x033008003

Hart, K. M., Brown, M., Kuchemann, D., Kerslake, D., Ruddock, G., & McCartney, M. (1981). *Children's understanding of mathematics: 11-16*: John Murray London.

Hill, H. C., Schillings, S. G., & Ball, D. L. (2004). Deloping measures for teachers' mathematics knowledge for teaching. *The Elementary School Journal, 105*(1), 11-30.

Huang, R., & Bao, J. (2006). Towards a Model for Teacher Professional Development in China: Introducing Keli. *Journal of Mathematics Teacher Education, 9*(3), 279-298. doi:10.1007/s10857-006-9002-z

Humphreys, S., & Crawfurd, L. (2014). *Review of the literature on basic education in Nigeria: Issues of access, quality, equity and impact*. Abuja: EDOREN.

NAN. (2017, 10th October 2017). Two thirds kaduna primary school teachers couldn't conveniently pass primary four exams. *Premium Times*.

Nigerian Educational Research and Development Council (NERDC). (2012). *9-year Basic Education Curriculum, Mathematics for Lower, Middle and Upper Basic Education*. Lagos: NERDC Press.

Odili, G. A., & Asuru, A. V. (2010). Primary school teacher's mastery of primary school mathematics content. *International Journal of Science and Technology Education Research, 1*(3), 55-61.

Rabiu, A. T., & Saidu, S. (2015). A study on quality of mathematics teachers in content mastery in primary schools of Kaduna State. *ATBU Journal of Science, Technology and Education, 3*(2), 102-108.

Ryan, J., & McCrae, B. (2006). Assessing Pre-Service Teachers' Mathematics Subject Knowledge. *Mathematics Teacher Education and Development, 7*, 72-89.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*, 4-14.

Turner, F., & Rowland, T. (2011). The Knowledge Quartet as an Organising Framework for Developing and Deepening Teachers' Mathematics Knowledge. In T. Rowland & K. Ruthven (Eds.), (Vol. 50, pp. 195-212): Springer Netherlands.

Venkat, H. (2011). *SA Numeracy Chair, Wits - Discussion document for Community of Practice Forum*. Retrieved from Johannesburg, August 22-23:

Venkat, H., & Spaull, N. (2015). What do we know about primary teachers' mathematical content knowledge in South Africa? An analysis of SACMEQ 2007. *International Journal of Educational Development* (41), 121-130.

Wright, R. J., Martland, J., & Stafford, A. K. (2006). *Early numeracy: Assessment for teaching and intervention*: Sage.