東京未来大学研究紀要　2012年　第5号　pp.91-97

Linkage between Mathematics Syllabus and Textbooks in the Republic of Zambia

Nagisa Nakawa

ザンビア共和国における数学のシラバスと教科書の関連性

中和　渚

Abstract

The discussion and need to improve individual countries' quality of education has received increased attention since the international community agreed to the Education for all (EFA) movement. Zambia also agreed on the international consensus and is seeking for quality education, especially for the basic education. This paper reports a case of mathematics education in the country and examined the linkage between syllabus and textbooks.

The analysis of the syllabus and textbooks concluded that the ideal objectives in the syllabus were not always reflected at the textbook level. The results showed that while the objectives in mathematics education syllabus advocated for the ability of communication, pupils' activities desired in the textbooks were limited to mostly writing practices.

Considering the fact that developing countries have limited resources for teaching and learning in classroom, the actualization of the educational objectives set up in a nation into textbooks would be crucial in developing countries.

Keywords

quality education, educational development in developing countries, mathematics education, syllabus, textbooks

1. Background and Problem Statement

Achieving quality education is an everlasting challenge not only within nations but also in the international community. Quality education emphasizes every child's literacy and numeracy. Numeracy is strongly connected to mathematics education. This paper discusses mathematics education in Zambia as a developing country, with a focus on curriculum.

Zambia, one of Sub-Saharan African countries, has been struggling with poverty, and admitted that education would be one of the key issues to uplift the development of the country (Republic of Zambia, 2006). Therefore, it has been aiming at improving qualitative aspects in the educational sector since Education for All (EFA) of which international community made an agreement in 1990. The national development plan from 2006 to 2010 (Republic of Zambia, 2006) regarded education as a key factor, and held up educational goals and objectives.

However, pupils' academic achievement has been severely low according to both international and national assessment (SACMEQ, 2000; ECZ, 2008). Pupils' academic performance in mathematics has been problematic while it is one of the essential subjects for competency (e.g. numeracy) at the basic level in Zambia. Moreover, little research has been done on mathematics education in Zambia as well as Sub-Saharan African countries (Sawamura, 2007). It is a long way to go for improvement of mathematics education. There would be several approaches for the development, for instance, we could approach how students understand contents in class, how teachers teach, or how curriculum should be. The research would like to examine how the contents in syllabus are concretised into mathematics textbooks, as one of the investigative ways for curriculum development. Textbooks in Zambia seem to be most accessible and

valuable teaching and learning resources due to the difficulties of access to them. So it would be valuable to see how textbooks reflect the country's educational objectives and methodology mentioned in the syllabus. Thus, this paper will discuss the linkage between syllabus and textbooks, and shed light on some challenges.

2. Mathematics Syllabus in Zambia

After the independence in 1964, Zambia published three syllabi for the primary level[i] from Grade 1 to Grade 7 (MoE, 2003). The objective in mathematics was to enable students to acquire mathematical knowledge and develop skills necessary for application in their everyday life (MoE, 2003). It also stated that the skills to be imparted to students at this level should be focus on encouraging communication of mathematical ideas among learners, problem solving and application to real life situations as well as developing interest in mathematics (MoE, 2003). It pointed out that mathematical skills meant numeracy and communication. Numeracy meant the abilities to make use of mathematical knowledge and skills with ease and confidence in everyday life, and to understand and appreciate information, which was presented in different forms such as graphs, charts, tables and percentages. Communication included reading, writing, listening, speaking and use of written information (MoE, 2003)

Towards these objectives and skills for students, general learning outcomes were set up to develop mathematical knowledge and skills; to communicate mathematical ideas effectively; develop skills in problem solving; develop skills for use in social and commercial mathematics; develop and foster order, speed and accuracy in problem solving; apply mathematical concepts in their environment; develop interest in mathematical skills for everyday use; develop understanding of measurements and shapes; and apply mathematical operations in problem solving (MoE, 2003).

However, the syllabus did not clearly state how the above objective was connected to these skills mentioned, and how learning outcomes were related to the objectives. Therefore, the author picked up important keywords appearing in the part of objectives, outcomes and methodology in the syllabus: mathematical knowledge and skills, communications, problem-solving and application to real life situations for the coming analysis.

In each grade, general outcome and learning units are stated in the syllabus. General outcomes are written in two or three sentences, which emphasized some of the four keywords that the author mentioned above. In each teaching and learning unit, learning contents are shown by a run of items, for instance, 'Count, read and write numbers from 1 to 100' (MoE, 2003).

Looking at the arrangement of teaching and learning units, units of number concepts and calculations, measurement, arithmetic and sets were mentioned throughout all grades. It seemed that the area of number and calculations was regarded as more important than other areas in the syllabus.

3. Methodology of Textbook Analysis

In Zambia, book publishers recently took over the responsibility to publish textbooks, which in turn are procured by schools for use. This research used seven textbooks published by one company (Liyungu et al., 2004; Liyungu et al., 2005; Monde et al., 2006; Monde 2007) based on the author's experience of usability in Zambian schools. The purpose of the analysis is to examine how several important points in the syllabus are actualized in these textbooks.

Two methods were employed in order to grasp the comprehensive tendency of all textbooks and to see the extent of the relations of objectives in the syllabus and contents in textbooks. Firstly, the author confirmed which sentences, expressions and questions on each page of textbooks were related to mathematical knowledge and skills, daily life, communication including reading, writing, speaking and listening, and problem-solving activities. For instance, the criteria shows that questions on calculations such as '5 + 2=' were not classified in problem-solving activities (See Table 1).

Secondly, the author particularly concentrated on the expressions of learning contents because degrees of abstractions and concreteness would be related to the extent to the visualization of above objectives. The author classified them into three levels of Bruner's EIS (Enactive-Iconic-Symbolic) principles (Bruner, 1972). Enactive representation meant usage of concrete materials or by hand or body, iconic representation meant expressions by figures and pictures, and symbolic representation meant expressions by symbols and languages (Cf: Matsunaga, 2009). Table 1 shows the criteria for analysis in each item.

The author counted the pages out of 807 in total with any descriptions for each item in seven textbooks, and calculated the percentages for each classification. More than two items were often counted in the same page, so the sums of all the percentages did not reach 100%.

Table 1　Criteria for judgments on each page of textbooks

Items	Criteria for judgement
Mathematical knowledge and skills	・There is a description related to reviews or new learning on mathematical konwledge and skills including introductions of calculations and mathemarical sentences, methods for calculations and practices
Application to real life situations	・There is a setting for real life situations.
	・There is a picture related to real life situations.
Communication	・There is an instructive verb for example, `write', `read', `speak', `say' and `listen'が
	・There is an explanation or instructions asking pupils to listen to or to speak out
Problem-solving	・Not just a simple calculation with a single answer for instance: 2 + 5 =
	・There is a sentenece problem.
	・There is a task or activities to obtain solutions.
Enactive representations	・There is an expression using hands, body and other learning materials (e.g. circle, paper sticks and blocks)
	・There is a operative table or materials (e.g. 1-100 table and number line)
Iconic representations	・There is a picture or figure.
Symbolic representations	・There is an expression or table using languages and symbols.

4. Result of analysis

The aim of the analysis is to grasp the overall tendency of the structure of textbooks. Its intention is to examine whether the structure of textbooks is directly reflected to the contents and objectives of the syllabus. Tables 2 through 4 showed the overall tendencies of correspondences between textbooks and syllabus.

Mathematical knowledge and skills

Table 2 showed the following two findings toward the four main objectives the author summed up. Firstly, 790 pages out of 807 pages were allocated for the descriptions of mathematical knowledge and skills. The percentage was 97.9%, suggesting that the objective was actualized enough in textbooks. The major

Table 2　Percentages of the correspondence between descriptions of textbooks and objectives shown in the syllabus

Grades	Pages	Mathematical knowledge and skills		Application to real life situations		Communication		Problem-solving	
		Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted
1	91	91.2%	83	31.9%	29	93.4%	85	0.0%	0
2	101	95.0%	96	22.8%	23	87.1%	88	1.0%	1
3	92	98.9%	91	33.7%	31	79.3%	73	5.4%	5
4	92	97.8%	90	44.6%	41	84.8%	78	10.9%	10
5	130	100%	130	16.2%	21	93.8%	122	0.8%	1
6	145	100%	145	24.1%	35	96.6%	140	2.1%	3
7	156	99.4%	155	43.6%	68	94.2%	147	4.5%	7
Total	807	97.9%	790	30.7%	248	90.8%	733	3.3%	27

Table 3　Percentages of each item on communications

Grades	Pages	Reading		Listening		Speaking		Writing		Communication	
		Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted
1	91	6.6%	6	9.9%	9	23.1%	21	78.0%	71	93.4%	85
2	101	0.0%	0	16.8%	17	16.8%	17	85.10%	86	87.1%	88
3	92	3.3%	3	14.1%	13	6.5%	6	75.0%	69	79.3%	73
4	92	0.0%	0	9.8%	9	5.4%	5	84.8%	78	84.8%	78
5	130	0.0%	0	18.5%	24	6.9%	9	93.8%	122	93.8%	122
6	145	0.0%	0	7.6%	11	0.0%	0	96.6%	140	96.6%	140
7	156	0.0%	0	7.1%	11	3.8%	6	91.7%	143	94.2%	147
Total	807	1.1%	9	11.6%	94	7.9%	64	87.9%	709	90.8%	733

Table 4　Percentage of each expression based on EIS principle

Grades	Pages	Enactive representation		Iconic representation		Symbolic representation	
		Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted	Percentage of the pages toward the whole pages (%)	Pages counted
1	91	40.7%	37	50.5%	46	92.3%	84
2	101	27.7%	28	36.6%	37	93.1%	94
3	92	10.9%	10	59.8%	55	83.7%	77
4	92	5.4%	5	58.7%	54	95.7%	88
5	130	25.4%	33	29.2%	38	94.6%	123
6	145	9.0%	13	52.4%	76	96.6%	140
7	156	7.1%	11	66.0%	103	100%	156
Total	807	17.0%	137	50.7%	409	94.4%	762

sequences of the contents in textbooks were definitions or mathematical knowledge, examples, exercises and practices.

Communication

The average percentages for communication in all grades were 90.8%, relatively higher than the other percentages shown in Table 2. Table 3 showed the result of the more detailed classifications. The percentage of 'writing' was 87.9 %[ii], relatively higher than the other three. In writing, most of the sentences shown in textbooks were 'Complete and Calculate'[iii], confirming students' knowledge and skills and offering technical practices. In the other three categories, the percentage for 'speaking' and 'listening' were 7.9% and 11.6%, respectively, lower than the one for 'writing'. Moreover, there was none of teaching and learning activities that teacher asked students to express their mathematical idea and to discuss verbally in class.

Application to daily life

Table 2 showed 30.7% for application to daily life. The descriptions related to daily life were selected in the beginning of new learning topics or contents, and in the units of arithmetic, measurement, length, weight, volume and capacity, ratio and proportion, time and temperature. For instance, a learning activity where pupils were supposed to measure things in/around classroom and to share their results in class was shown. Thus, textbooks offered teaching and learning settings using concrete materials in order to let pupils make sense of the relations between mathematics and daily life.

Problem solving

The percentage of problem solving was only 3.3% according to Table 2. Problem solving activities were relatively complicated sentence problems with two thinking steps. There was no problem solving activity with different or various thinking strategies. The major tendency of textbooks required students to solve a sentence problem expressed in a mathematical sentence, which was not counted as problem-solving activities, but mathematical knowledge and skills. As exceptions, there were only two instructions encouraging appropriate problem-solving: 'Explain why "ten" is written "two zero" and why "fifteen" is written "three zero" in base five' (Monde et al., 2007) and 'What do you notice about the number of sides and the number of lines of symmetry?' (Monde et al., 2007). Therefore, problem-solving activities requiring deeper mathematical thinking were not often observed in textbooks.

Result of EIS principle

Table 4 showed the percentages toward three expressions based on EIS principle. The percentages of enactive representations including semi-concrete materials such as sticks or circles in earlier grades were relatively higher than the one in latter grades. In grade 1, it was 40.7% while 7.1% in grade 7. From the result of the overall averages on three representations, the percentage of symbolic representations was 94.4%, the highest among three representations. Enactive and iconic were 17.0% and 50.7%, respectively[iv]. This frequent usage of symbolic representation would be connected to the emphasis of mathematical knowledge and skills.

5. Discussions and conclusion

The author would like to mention the following three points regarding linkage between syllabus and textbooks and finally to conclude the comprehensive view. First, textbooks emphasises mathematical knowledge and skills. The structures of textbooks supports this as they offer simple learning sequences such as showing mathematical skills or definitions that students are supposed to learn in the beginning of new contents, confirmations through some examples and exercises in the end.

Second, problem-solving activities are less observed and limited to sentence problems and simple calculations. There are far less learning activities shown in textbooks regarding a variety of communications regarding mathematical ideas and problem-solving.

Thirdly, textbooks only offer confirmations of skills, knowledge and exercises that students are supposed to learn. The highest frequency of teacher's possible instructions observed in textbooks is 'Copy and complete…' and students are required to write. Writing seemed mostly desired activities in communication activities. It indicates that, in most mathematics classrooms, there should be passive learning that would encourage students neither to express nor to discuss their mathematical ideas in class.

Consequently, the structures and contents of textbooks are inclined to mathematical knowledge and skills. On the other hand, communication and problem-solving which would enhance their mathematical thinking were much less treated. In intended curriculum, therefore, ideal objectives stated in syllabus are partially actualized in textbooks. However, there are some gaps between syllabus and contents in textbooks. The author suggests that the objectives in syllabus successfully considered both international trends and social and cultural contexts that Zambia had, therefore improvement of qualitative aspects of textbooks should be conducted in the way of expressing various mathematical activities, questions and expressions as the next step for the further mathematics curriculum development. Finally, the paper does not have a clear answer of what pages should be allocated to each category considering students' abilities. Instead, the analysis suggests that contents related to communication and problem-solving activities should be more encouraged in the textbooks in order to achieve the final goal stated in syllabus.

Notes:i Zambia's school system has two tiers; basic level from grade 1 to 9 and high school level from grade 10 to 12. The basic level has three levels; primary from grade 1 to 3, middle basic from grade 4 to 6, and upper basic from grade 8 and grade 9.

ii The amount of writing was the biggest among the other three items in the result of Chi-Square Discrimination (χ^2=1032.8743, p=1.2844E-226 in between writing and speaking, χ^2=937.38362, p=7.3325E-206 in between writing and listening, χ^2=1229.3263, p=2.582E-269 in between writing and reading, and all the degrees of freedom were 1).

iii 'Calculate' was included in 'writing' as an instruction and it asked pupils to write and calculate.

iv As a result of Chi-Square Discrimination toward the counted pages in three representations, there were

differences. χ^2=980.84, p=2.6252E-215 in between enactive and symbolic representations, χ^2=387.70, p=2.62585E-86 in iconic and symbolic representations, χ^2=204.78, p=1.89595E-46 in enactive and iconic representations, and all the degrees of freedom were 1).

Reference

Bruner, R. (1972). *Relevance of Education*, Meiji Tosho. (In Japanese)

Liyungu, R., Monde, M., and Robert, B. (2004). *Basic Mathematics Pupil's Book 1 and 2*, Macmillan Zambia, Lusaka, Zambia.

Liyungu, R., Monde, M., and Robert, B. (2005). *Basic Mathematics Pupil's Book 5*, Macmillan Zambia, Lusaka, Zambia.

Matsunaga, A. (2009). Examination of Learning Activities in Kenyan Primary Mathematics Textbooks –Focusing on Expressions-, *Journal of International Cooperation in Education*, 12(2), 189-201.

Ministry of Education (MoE). (2003). *Basic Education Mathematics Syllabi Grade 1-7*, Ministry of Education, Lusaka, Zambia.

Monde, M., Mutale, L., Rowlands, G., and Sakala, C. (2006). *Basic Mathematics Pupil's Book 3 and 6,* Macmillan Zambia, Lusaka, Zambia.

Monde, M., Mutale, L., Rowlands, G., and Sakala, C. (2007). *Basic Mathematics Pupil's Book 4 and 7*, Macmillan Zambia, Lusaka, Zambia.

Republic of Zambia. (2006). *Fifth National Development Plan*, Republic of Zambia, Lusaka, Zambia.

SACMEQ, (2000). http://www.sacmeq.org/education-zambia.htm

Sawamura, N. (2007). Chapter 2 Qualitative Fieldwork in Research for Educational Development -Understanding the Reality from Fieldwork-. In Sawamura, N.(Ed.), *Development of Research for International Educational Development –Practices and Challenges in the Achievement of EFA(Education for All)-*, Akashi Shoten, 27-47. (In Japanese)

The Examination Council of Zambia (ECZ). (2008). *Learning Achievement at the Middle Basic Level-Zambia's National Assessment Survey Report 2006-*, Ministry of Education, Lusaka, Zambia.