A COMPARATIVE STUDY OF GEOMETRY PROBLEMS IN JUNIOR SECONDARY MATHEMATICS TEXTBOOKS FROM US, SINGAPORE, AND INDONESIA

[1]SARI MUTHIA SILALAHI, [2]CHENG CHIEH CHANG

[1,2]Institute of Education, National Taiwan Ocean University
E-mail: [1]sarimuthiasilalahi@gmail.com

Abstract - The primary aim of the study is to explore the similarities and differences problems (mathematics question) in geometry though analyzing the contents of the junior Secondary school (grade 7-9) mathematics textbooks of California, Singapore and Indonesia. A content analysis has been taken in this study, by comparing the distribution patterns of the quantities of problems representing various kinds of applications in the selected textbooks. In this study, it was found that the totally of all the problems until 23.107 in geometry subjects. Class practice was the most analyzed in function of problems which have been given in the end of sub topics in geometry textbooks in California and Singapore but different in Indonesia. In the other hand, the similarities from California, Singapore and Indonesia have used non-application become the most than application problems in textbooks. Non-application problems were more used to convey the knowledge to student before using application related to student's life. Suggestion to various sectors of education and ways to improve the mathematics are given. Finally, for the future research, the deep analysis can be produce in every part includes teacher and student activity how they wil use mathematics textbooks in classroom

Keywords - Comparison of study, geometry problems, junior high school.

I.INTRODUCTION

Mathematics is one of the important academic disciplines which play a critical role in most of the scientific inquiry. This is a subject of study that involves frequent usage of calculations and multiplications written out on paper, including the use of the numbers, figures, theories, and proofs; it thus requires patience and perseverance in thinking critically and logically when students solve the problems in mathematics Kilpatrick & Swafford, 2002; Verschaffel & De Corte, 1996). Geometry is one of the subjects that play an important role in mathematics. Love (1995) identified geometry was one of subject in mathematics education which explained and described the problems with real context in human's life. Therefore, school has challenged to design and form the geometry curriculum with appropriate and valid for the student's need. For some previous research found that it was because school lacked the methodology and tool for support geometry's lesson. Many researches have conducted research about geometry's lesson, showing that the most commonly problem in geometry was students achievement and skill still far from standard education in geometry result. It was because students were not able to analyze and describe the numbers that was written on mathematics textbook with theoretical explanation. However, there is little research that indicated problems in geometry subject especially in Indonesia. There have been a number of international studies in mathematics education such as PISA where the mathematics (curricula and student achievements) in various countries were compared and can be seen from year to year in this table below.

The Program for International Student Assessment (PISA' Result)					
No.	2003	2006	2009	2012	2015
1	H. K.-China 547(3/45)	Taipei 549(1/57)	Shanghai-China 600(1/74)	Shanghai-China 613(1/65)	Singapore 564(1/72)
2	Finland 544 (2/45)	Finland 548(2/57)	Singapore 562(2/74)	Singapore 573(2/65)	Japan 532(2/72)
3	Korea 542 (3/45)	H. K.-China 547(3/57)	H. K.-China 555(3/74)	H. K.-China 561(3/65)	Estonia 520(3/72)
4	Singapore -	Singapore -	Taipei 543(5/74)	Taipei 560(4/65)	Taipei 542(4/72)
5	United States 483 (33/45)	United States 474 (18/57)	United States 487(31/74)	United States 481(37/65)	United States 470 (25/72)
6	Indonesia 360(43/45)	Indonesia 391 (50/57)	Indonesia 371 (68/74)	Indonesia 371 (64/65)	Indonesia 386(64/72)
7	Tunisia 359(44/45)	Qatar 318 (56/57)	Himachal, India 338(73/74)	Qatar 376 (63/65)	Algeria 360(71/72)
8	Brazil 356(45/45)	Kyrgyzstan 311(57/57)	Kyrgyzstan 331(74/74)	Peru 368 (65/65)	Dominican Republic 328(72/72)

Table 1 Student's Achievements in PISA' result
Source: (PISA;OECD, 2003 - 2015)

Table 1 shows the students' performance in mathematics from each country didn't have good distribution, significant scores indicated that the mathematical skills of students on the world still far from expected especially for Indonesia which became almost the last position Anand and Ross (1987) described that the most difficulty situation when the student did the question and the result did not appropriate with the question's purpose was made in textbooks. In addition, to decrease the difficulty situation, there were some efforts to examine mathematics textbooks was going to present for students and teachers, the International Association for the Evaluation of Educational Achievement (IEA) began with the textbook analyses by the Third International Mathematics and Science Studies (TIMSS) in curriculum studies (e.g., Schmidt, McKnight, Valverde, Houang, & Wiley, 1997).So, the analysis of textbooks assists educational researchers in understanding the effectiveness of specific schemes and approaches, which can turn the aid of understanding what is required in terms of teaching and curriculum development.

	Mathematical problems	Category		Code
1.	Functions of Problems Li (1999) as cited in Yau (2011)	Worked example		WE
		To-be-solved problems	Introductory problems	IP
			Class practice	CP
			Text problems	TP
			Exercises	E
			Review questions	RQ
			Challenging questions	CQ
			Project	P
2.	Context Of Problems (Fan & Zhu, 2006)	Application Problems		AP
		Non - application Problems		NAP
3.	Problem solving procedures (Polya, 1957) (Yeap,Ferruci, and Carter 2002) (Cheung, 2000)	Understand the problem		UP
		Devise a plan		DP
		Carry out the plan		CP
		Look back		LB

The aim of the study is to investigate and describe the commonalities and differences of problems as the question presented in mathematics textbooks specifically in geometry subject though analyzing the content in junior secondary school (grade 7-9) from three countries (US, Singapore, and Indonesia). The research question was what are the commonalities and differences of the problems in mathematics textbooks based on three countries from US, Singapore, and Indonesia?

II. METHODOLOGY

In this study, junior secondary textbooks were selected for investigation. Thiswas because many international comparative studies of curriculums (e.g. Li, 1999& TIMSS) include Secondary-2 (i.e. grade 7-9) students as target group. This study has chosen three sets of textbooks, which are widely used based on data ingovernment that could be accessed from three countries website with different grades (7-9) in United State (California), Singapore and Indonesia.

The problems would be appeared in geometry's topics of junior secondary textbooks from three counties would be compared and investigated.

Research Method and Conceptual Framework

The objects of this study are textbooks. Qualitative method has chosen in this study.The textbooks would be analysis by using a framework. The conceptual framework used by several studies(Li, 1999 as cited in Yau, 2011; Fan & Zhu, 2006; Polya, 1957; Yau, 2011; Yeap, Ferrucci, and Carter, 2002)that had been conducted about problems in a mathematic textbook.All of problems were divided and coded into three parts: Function, context problem, andproblem solving.

III. RESULTS

In this chapter, results of the analysis of problems presented in the textbooks will bereported. Emphasis is placed on comparison of textbooks based on three countries from California, Singapore and Indonesia.

Distribution Function of problems under Different Categories

	Grade 7			Grade 8			Grade 9		
Functions of Problems	Singapore	Indonesia	California	Singapore	Indonesia	California	Singapore	Indonesia	California
WE	75	113	104	44	47	76	95	35	84
IP	2	19	63	2	5	46	4	3	56
CP	290	58	1273	211	51	917	717	52	1042
TP	34	165	342	145	143	387	396	27	384
E	20	161	156	20	120	149	10	130	149
RQ	49	75	82	41	54	53	89	0	72
CQ	4	53	24	6	33	16	33	7	19
P	2	11	80	12	7	88	19	21	69

Table 2Comparison of the selected textbooks from three countries in number of functions of problems

Table 2 shows that, the average of the number class practice problems were the highest score of the overall problems in two countries. But, Indonesia textbook was the mainly covered by text problems. On the contrary in grade 9 (Indonesia), Example problems got more high number than text problems. The lower part was mainly covered by project problems. The following part will show the result of distribution context of problems under different categories.

	Grade 7			Grade 8			Grade 9		
Context Of Problems	Singapore	Indonesia	California	Singapore	Indonesia	California	Singapore	Indonesia	California
AP	78	152	288	34	78	220	192	71	371
NAP	254	280	1269	316	233	1025	777	139	1169

Table 3 Comparison of the selected textbooks from three countries in number of Context of problems

Table 3 presents, non-application problems occupy the largest part of the overall problems. The rest part is mainly covered by application problems.The following part will show the result of Distribution of Context of problems under different categories.

	Grade 7			Grade 8			Grade 9		
Problem solving procedures	Singapore	Indonesia	California	Singapore	Indonesia	California	Singapore	Indonesia	California
UP	61	65	72	93	13	47	205	9	54
DP	61	65	72	93	13	47	205	9	54
CP	61	65	72	93	13	47	205	9	54
LB	10	56	39	21	11	36	37	9	45

Table 4 Comparison of the selected textbooks from three countries in number of problem solving procedures

As shown in the table 4, in grade 7 California textbook has slightly higher numberof problem solving procedures than Indonesia textbook and Singapore textbook. However In grade 8 and 9, Singapore textbook significantly higher number of problem solving procedures than Indonesia textbook and California textbook. On the other hand, in terms of problem solving procedures, all of the textbooks contain much fewer looking back step problems than the other steps.

DISCUSSION

In this study, problems presented in text books from three countries were compared. In summary, total number of problems in geometry chapters from the highest was California's textbooks (10712), the second was Singapore's textbooks (5116) and the last was Indonesia's textbooks (2680).

Number of functions of problems

The majority of the function of problems is under the category "class practice" in the selected textbook.In this study, it found that class practice became the majority in California and Singapore textbooks. More class practice is one of way to give challenge to students (Cheung, 2000). But different for Indonesia textbooks, text problems were the high number for described the problems to the students. For California and Singapore, textbooks use "class practice" as drilling question for students to do at home. More class practice is one of way to give challenge to students. However, for Indonesia tends to have different idea on student' abilities of class practice. All the development of students' abilities of class practice is concentrated on text problems. Most of the questions are firstly introducing students to recognize the geometry contents by reading the text. Text problems for teaching can enhance student' understanding.

Number of context of problems

This session analyzed the textbook based for the application problem and non-application problem. It described for the total of context of problem in three countries textbook which are California's textbook had 4342 (40.66%), Singapore's textbook had 1651(32.27%) and Indonesia's textbook had 953(35.56%). The three countries put more emphasize on non-application of mathematics. Three countries textbooks should have more problems with application. It is recommended that the percentage of application problems in text book problems should be largely increased, especially the authentic application problems becausein the process of struggling with the application problem, children can often obtain a fairly deep understanding of the mathematics surrounding the problem. Be line with NCTM (2000) recommendation for reforming in mathematics education purpose, that the inclusion in instruction of activities in which students can generate their own problems in additions to solving pre formulated

problems. This is one of the way, students can become active in the class for the exercises produced from their lives can attract their attention.

Number of problem solving problems

The problem solving problems only prepared steps 1 until 4. However there are a number of surprised to find just a little step 4 in each textbook selected. Almost the same result from three countries provided the problem solving procedures only 3 steps without looking back. The textbook should give the complete step of the problem solving, so that students can have a more complete idea on the strategies of solving problem. The author believes that students' problem solving skills can be enhanced. It's also support from similar outcomes were also obtained by other researchers on other US and Chinese textbooks (e.g., Fan & Zhu, 2006). Their study found that US and Chinese textbook series did not provide many non-traditional and innovative problems of various types, particularly the Chinese ones. Lots of researchers had explained that innovative problems might contribute more to students' understanding than rule-based and traditional problems (Siemon, Virgona, & Cornielle, 2001), therefore textbook could add more of problems with completely steps in problem solving.

LIMITATION AND RECOMMENDATION

Analysis of the different grades, entire textbooks or more textbooks from different publishers may show a different picture. But, it still cannot view the full picture in the data presented. The more comprehensive analysis of textbooks can be conducted in this way. Follow the coding mechanism and framework of this study (with suitable refinement as suggested) to have preliminary analysis of textbooks. Another limitation is that we did not analyze how teachers interpret the content in the textbooks. So, for the future research, interview (or by other means) with teachers are required to understand how they use the textbooks. We hope that this study can give some insights for further analysis in textbooks.

REFERENCES

[1] Anand, P. D., & Ross, S. M. (1987). Using computer-assisted instruction to personalize arithmetic materials for elementary school students. Journal of Educational Psychology, 79 (1),72–78.

[2] Cheung, C.,Y. (2000). A comparative study of problems in algebra chapters in Hongkong secondary two zmathematics textbooks. Unpublished Master thesis, the University of Hong Kong.

[3] Fan, L., & Zhu, Y. (2006). Focus on the representation of problem types in intended curriculum: A comparison of selected mathematics textbooks from Mainland China and the United States. International Journal of Science and Mathematics Education, 4(4), 609-626.

[4] Kilpatric,J.,& Swafford,J.(2002). Helping children learn mathematics.Washington, DC: National Academy Press.

[5] Li, Y. (1999). An analysis of algebra content, content organization and presentation, and to-be-solved problems in eighth-grade mathematics textbooks from Hong Kong, Mainland China, Singapore and the united states. In Yau, K.C. (2011). An analysis of Hong Kong textbooks: A focus on problem types and ICT in geometry strand. Unpublished M.Ed. Thesis, University of Hong Kong

[6] Love, E. 1995. The functions of generalisation in learning geometry. In R. Sutherland and J. Mason (Eds), Exploiting mental imagery with computers in mathematics education. (pp. 142–157). Berlin: Springer

[7] NCTM (2000). Principles and Standards for School Mathematics. Reston, VA, NCTM.

[8] OCDE (2004). Learning for Tomorrow's World: First results from PISA 2003. Paris: OCDE.

[9] Polya, G. (1957). How to solve it (2nd ed.). Garden City, NY: Doubleday.

[10] Siemon, D., Vitgona, J., & Cornielle, K. (2001). The middle year numeracy research projects: 5-9. Bundoora, VA: RMIT University.

[11] TIMSS (International Results in Mathematics) Retrieved from Boston College, TIMSS & PIRLS International Study Center Retrieved September 19, 2016, from http://timssandpirls.bc.edu

[12] Valverde, G. A., Bianchi, L. J., Wolfe, R. G., Schmidt, W. H., & Houang, R. T. (2002). According to the book: Using TIMSS to investigate the translation of policy into practice through the world of textbooks. Boston: Kluwer Academic Publisher.

[13] Verschaffel, L., & De Corte, E. (1996). Number and arithmetic. In A. Bishop, K. Clements, C. Keitel, J. Kilpatrick, & C. Laborde (Eds.), International handbook of mathematics education (pp. 99-137). Dordrecht, The Netherlands: Kluwer Academic Publishers.

[14] Yau, K.C. 2011. An analysis of Hong Kong textbooks: A focus on problem types and ICT in geometry strand. Unpublished Master thesis, the University of Hong Kong.

[15] Yeap, B. H, Ferrucci, B. J, & Carter, J. A. (2006). Comparative study of arithmetic problems in Singaporean and American mathematics textbooks.Mathematics Education in Different Cultural Traditions-A Comparative Study of East Asia and the West, 9, 213-22

★★★