Journal of the Korean Society of Mathematical Education Series D:
Research in Mathematical Education
Vol. 14, No. 2, June 2010, 123–141

韓國數學敎育學會誌 시리즈 D:
<數學敎育硏究>
제 14 권 제 2 호 2010 년 6 월, 123–141

A Coding Method for Mathematical Problems in the TIMSS 1999 Video Study and its Applications[1,2]

Yuan, Zhiqiang*
Department of Mathematics, East China Normal University, Minhang, Shanghai, 200241, China;
Email: zhqyuan@gmail.com

(Received March 20, 2010 Revised June 23, 2010 Accepted June 29, 2010)

This study introduced a coding method for mathematical problems in the *TIMSS 1999 Video Study*, which used sixteen indicators to analyze mathematical problems in a lesson. Based on this framework for coding, the researcher analyzed three lesson videos on Binomial Theorem taught respectively by three Chinese teachers, and got some features of mathematical problems in these three lessons.

Keywords: TIMSS, video study, mathematical problem, coding method, binomial theorem, classroom teaching, Chinese
MESC Classification: D20
MSC2010 Classification: 97D20

INTRODUCTION

The Trends in International Mathematics and Science Study (TIMSS) is an international comparative project on a large scale conducted by the International Association for the Evaluation of Educational Achievement (IEA). It carries out every four years since 1995. The main purpose of the study is to track changes in achievement over time in mathematics and science from an international perspective by test problems and questionnaires.

The TIMSS 1995 Video Study of mathematics teaching is an effort to obtain rich, contextual information about what goes on inside eighth-grade mathematics classes in

[1] A draft version of this article was presented at International Classroom Teaching Research Annual Group Meeting 2009, Beijing, China; May 22–25, 2009.
[2] This work is supported by the fund from Developing Fujian Secondary School Mathematics Subject Leading Teachers Project.
* Zhiqiang Yuan is currently a doctoral student of East China Normal University, Shanghai, China. He is also a faculty member of Fujian Normal University, Fuzhou, Fujian 350007, China.

addition to the information collected through the TIMSS assessments and questionnaires, and to compare actual mathematics teaching methods in the United States and the two other countries (Stigler, Gonzales, Kawanaka, Knoll & Serrano, 1999). The *TIMSS 1999 Video Study* is a follow-up and expansion of the *TIMSS 1995 Video Study* of mathematics teaching. Countries that participating in the *TIMSS 1999 Mathematics Video Study* expanded from three (Germany, Japan and United States) to seven (Australia, Czech Republic, Hong Kong, Japan, Netherlands, Switzerland, and United States). In March 2003, the main research finding "*Teaching Mathematics in Seven Countries: Results from the TIMSS 1999 Video Study*" was published by US Department of Education, National Center for Education Statistics (Hiebert *et al.*, 2003). It also published the related technical report on mathematics video study in September 2003 (Jacobs *et al.*, 2003).

Some studies (Leung & Park, 2005; Huang, 2006; Huang & Wang, 2007) paid attention to both *TIMSS 1999 Video Study* and *Learner's Perspective Study* (LPS). The researchers analyzed East Asian classrooms using different methods.

Just like what Halmos (1980, p. 519) has ever said, the heart of mathematics is its problems. The *TIMSS 1999 Video Study* regarded mathematical problems as a key factor that influences the mathematics classroom teaching. It analyzed mathematical problems in the videotaped lessons using a series of indicators. What are these indicators? What results can this study get by using this coding method?

THEORETICAL FRAMEWORK

Based on Hiebert *et al.* (2003) and Jacobs *et al.* (2003), this study refined the framework of coding method for mathematical problems in the *TIMSS 1999 Video Study*. The researcher demonstrated how to use this framework to analyze the videotaped lessons. The following is the detailed information for sixteen indicators. The whole framework refined by the researcher is shown in Table 1.

What is a Mathematical Problem?

Problems contain an explicit or implicit Problem Statement (PS) that includes an unknown aspect, something that must be determined by applying a mathematical operation, and they contain a *Target Result* (TR). The PS describes the task to be completed. The answer to the PS is the TR (Jacobs *et al.*, 2003, p. 409). The decision tree (see Figure 1) gives a method to judge how many problems to be coded in a lesson (Jacobs *et al.*, 2003, p. 411).

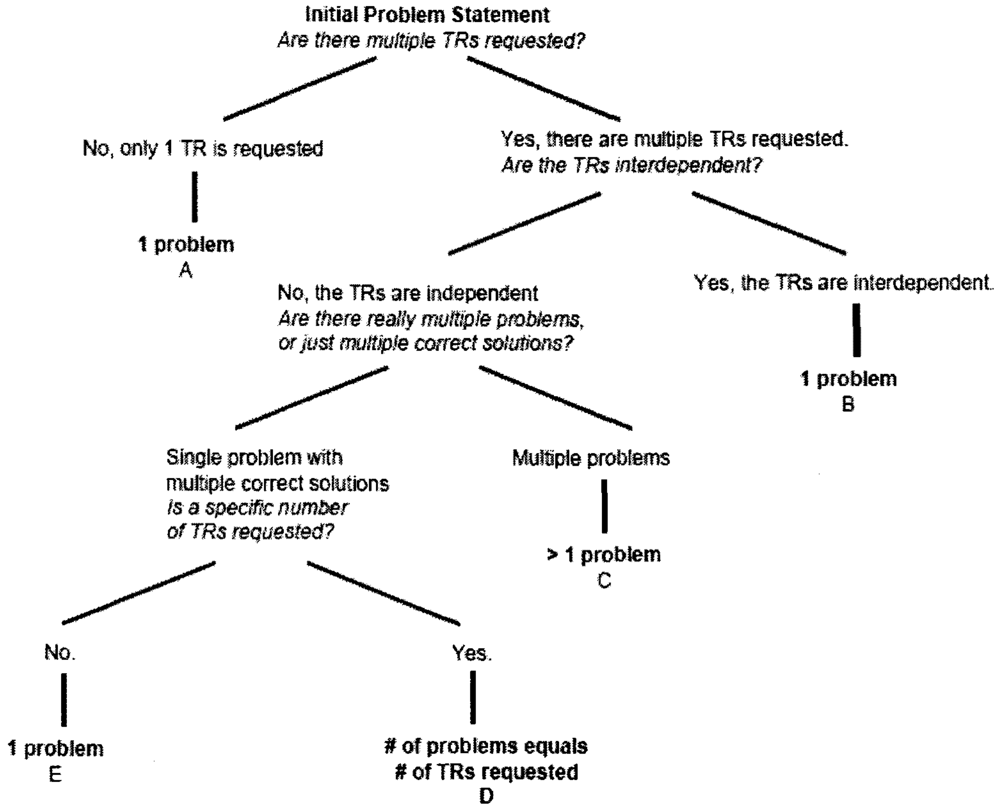

Figure 1. This diagram comes from the decision tree on judging how many problems to be coded in a lesson, by Jacobs *et al.* (2003, p. 411).

The Role of Mathematical Problems

Mathematical problems are categorized into three types according to their roles (RL) in a lesson. They are independent problems, concurrent problems and answered-only problems. Independent problems are presented as single problems and worked on for a clearly definable period of time. These problems might have been solved publicly-as a whole class-or they might have contained a private work phase when students worked on them individually or in small groups. Concurrent problems are presented as a set of problems. Because they were assigned as a group and worked on privately, it was not possible to determine how long students spent working on any individual problem of this kind. Answered-only problems are most often from homework or an earlier test, these problems had already been completed prior to the lesson, and only their answers were shared. They included no public discussion of a solution procedure and no time in which students worked on them privately (Hiebert *et al.*, 2003, p. 43). In the coding system,

$RL = 1$ denotes an independent problem, $RL = 2$ denotes a concurrent problem, $RL = 3$ denotes an answered-only problem.

Time Spent on Problems

Mathematical problems are categorized into two types according to the length of time (LT) spent on a problem in a lesson. They are problems that time spent on is more than or is equal to 45 seconds and problems that time spent on is less than 45 seconds (Hiebert *et al.*, 2003, p. 46). We can clearly calculate the time spent on independent problems and answered-only problems. For concurrent problems, we calculate the average time. In the coding system, $LT = 1$ denotes a problem that time spent on is more than or is equal to 45 seconds, and $LT = 0$ denotes a problem that time spent on is less than 45 seconds.

Procedural Complexity of the Problems

Mathematical problems are categorized into three types according to the procedural complexity (PC) in a lesson. They are low, moderate, or high complexity problems. Low complexity problem means it requires four or fewer decisions by the students using conventional procedures to solve it. The low complexity problem contains no sub-problems. Moderate complexity problem means it requires more than four decisions by the students using conventional procedures to solve it and can contain one sub-problem. High complexity problem means it requires more than four decisions by the students using conventional procedures to solve it and contains two or more sub-problems (Hiebert *et al.*, 2003, pp. 70–71). In the coding system, $PC = 1$ denotes a low complexity problem, $PC = 2$ denotes a moderate complexity problem, and $PC = 3$ denotes a high complexity problem.

The Degree of Relationship among the Mathematical Problems

Each problem, except the first problem in the lesson, was categorized into four types according to the degree of relationship (RD) among the mathematical problems in a lesson. They are repetition, mathematics related, thematically related and unrelated problems. Repetition problem is the same, or mostly the same, as a preceding problem in the lesson. Mathematically related problem is related to a preceding problem in the lesson in a mathematically significant way. This include using the solution to a previous problem for solving this problem, extending a previous problem by requiring additional operations, highlighting some operations of a previous problem by considering a simpler example, or elaborating a previous problem by solving a similar problem in a different way. Thematically related problem is related to a preceding problem only by virtue of it being a problem of a similar topic or a problem treated under a larger cover story or real-life scenario introduced by the teacher or the curriculum materials. Unrelated problem is none of the above (Hiebert *et al.*, 2003, p. 76). In the coding system, RD = 0 denotes the first problem, RD = 1 denotes a repetition problem, RD = 2 denotes a mathematically related problem, RD = 3 denotes a thematically related problem and RD = 4 denotes an unrelated problem.

Real-life Connection

Mathematical problems are categorized into two types according to whether or not connecting with real-life contexts (RLC) in which problems are presented and solved. They are problems that include real-life contexts and problems that use mathematical language and symbols only (Hiebert *et al.*, 2003, p. 84). In the coding system, RLC = 1 denotes a problem that includes real-life contexts, and RLC = 0 denotes a problem that uses mathematical language and symbols only.

Representation Way

Mathematical problems are categorized into four types according to representation way (RW). They are problems that use regular written symbols only, problems that include graphs, problems that include tables and problems that include diagrams (Hiebert *et al.*, 2003, p. 86). In the coding system, RW = 0 denotes a problem that uses regular written symbols only, RW = 1 denotes a problem that includes graphs, RW = 2 denotes a problem that includes tables, RW = 3 denotes a problem that includes diagrams. If a problem includes two or three types of graph, table or diagram, then RW = 4.

Physical Materials

Mathematical problems are categorized into two types according to whether or not using physical materials (PM) to demonstrate during the problem is presented and solved. They are problems that use physical materials and problems that do not use physical materials (Hiebert *et al.*, 2003, p. 87). In the coding system, PM = 1 denotes a problem that uses physical materials, and PM = 0 denotes a problem that does not use physical materials.

Applications

Mathematical problems are categorized into two types according to the levels of application (AP). They are applications and exercises. Students can be asked to apply procedures they have learned in one context in order to solve problems presented in a different context. These problems are called applications. Alternatively, students can be taught a particular procedure and then asked to practice that procedure on a series of similar problems. These problems are called exercises (Hiebert *et al.*, 2003, p.90). In the coding system, AP = 1 denotes an application problem, and AP = 0 denotes an exercise problem.

Proof, Verification and Derivation

Mathematical problems are categorized into two types according to whether or not including proof, verification and derivation (PVD) during the process of solving problems. They are problems that include PVD and problems that do not include PVD (Jacobs *et al.*, 2003, p. 455). In the coding system, PVD = 1 denotes a problem that includes PVD, and PVD = 0 denotes a problem that does not include PVD.

Solutions Presented Publicly

Mathematical problems are categorized into two types according to whether or not solutions presented publicly (SPP) by the teacher or the students. They are problems that at least a solution is presented publicly and problems that no solution is presented publicly (Hiebert *et al.*, 2003, p. 91). In the coding system, SPP = 1 denotes a problem that at least a solution is presented publicly, and SPP = 0 denotes a problem that no solution is presented publicly.

Alternative Solution Methods Presented Publicly

Mathematical problems are categorized into two types according to whether or not alternative solution methods presented publicly (ASP). They are problems that alternative solution methods are presented publicly and problems that alternative solution methods are not presented publicly (Hiebert *et al.*, 2003, p. 93). In the coding system, ASP = 1 denotes a problem that alternative solution methods are presented publicly, and ASP = 0 denotes a problem that alternative solution methods are not presented publicly.

The Opportunity for Students to choose their own Solution Method

Mathematical problems are categorized into two types according to whether or not students have opportunity to choose their own solution method (CS). They are problems that students have opportunity to choose their own solution method and problems that students have no opportunity to choose their own solution method (Hiebert *et al.*, 2003, p. 94). In the coding system, CS = 1 denotes a problem that students have opportunity to choose their own solution method, and CS = 0 denotes a problem that students have no opportunity to choose their own solution method.

Table 1. A coding method for mathematical problems in the *TIMSS 1999 Video Study*

Indicators \ Code	0	1	2	3	4
RL		independent	concurrent	answered-only	
LT	is less than 45 seconds	is more than or is equal to 45 seconds			
PC		low complexity	moderate complexity	high complexity	
RD	first	repetition	mathematically related	thematically related	unrelated
RLC	using mathematical language and symbols only	including real-life contexts			
RW	using regular written symbols only	including graph	including table	including diagrams	including two or three types of graph, table or diagram
PM	no	yes			
AP	exercise	application			
PVD	no	yes			
SPP	no	yes			
ASP	no	yes			
CS	no	yes			
EAS	no	yes			
SM	no	yes			
PPS		using procedures	stating concepts	making connections	
PSP	giving results only	using procedures	stating concepts	making connections	

Note. RL = role; LT = length of time; PC = procedure complexity; RD = degree of relationship; RLC = real-life context; RW = representation way; PM = physical material; AP = application; PVD = proof, verification and derivation; SPP = solutions presented publicly; ASP = alternative solution methods presented publicly; CS = opportunity to choose their own solutions method; EAS = examine alternative solutions; SM = summary; PPS = process suggested by problem statements; PSP = process used when solving problems. Students Participate in Presenting and Examining Alternative Solutions Methods

Students participate in presenting and examining alternative solutions methods

Mathematical problems are categorized into two types according to whether or not students participating in presenting and examining alternative solutions methods (EAS). They are problems that students participate in presenting and examining alternative solutions methods and problems that students don't participate in presenting and examining alternative solutions methods (Hiebert *et al.*, 2003, p. 95). In the coding system, $EAS = 1$ denotes a problem that students participate in presenting and examining alternative solutions methods, and $EAS = 0$ denotes a problem that students don't participate in presenting and examining alternative solutions methods.

Problems Summary

Mathematical problems are categorized into two types according to whether or not there is summary (SM) after a problem is solved. They are problems that have summary and problems that don't have summary (Hiebert *et al.*, 2003, p. 96). In the coding system, $SM = 1$ denotes a problem that has summary, and $SM = 0$ denotes a problem that doesn't have summary.

Mathematical process suggested by problem statements

Mathematical problems are categorized into three types according to mathematical process suggested by problem statements (PPS). They are using procedures, stating concepts and making connections. Problem statements of using procedures suggested the problem is typically solved by applying a procedure or set of procedures. Problem statements of stating concepts suggested the problem calls for a mathematical convention or an example of a mathematical concept. Problem statements of making connections imply the problem would focus on constructing relationships among mathematical ideas, facts, or procedures (Hiebert *et al.*, 2003, p. 98). In the coding system, $PPS = 1$ denotes a problem that is using procedures, PPS = 2 denotes a problem that is stating concepts, and $PPS = 3$ denotes a problem that is making connections.

Mathematical processes used when solving problems

Mathematical problems are categorized into four types according to mathematical process used when solving problems (PSP). They are problems of giving results only, using procedures, stating concepts and making connections (Hiebert *et al.*, 2003, pp. 99–100). In the coding system, $PSP = 0$ denotes a problem that giving results only, $PSP = 1$ denotes a problem that is using procedures, $PSP = 2$ denotes a problem that is stating concepts, and $PSP = 3$ denotes a problem that is making connections.

METHODOLOGY

Subjects

Three Chinese senior high school classroom teachers (Mr. Q, Mr. J, and Mr. H) participated in this study. They are all from Fujian, which is one of the provinces on the southeast coast of China. Their demographic information is found in Table 2.

Table 2. Three Chinese teachers' Demographic Information

Teacher	Degree	Gender	Ethnicity	Grade level	Subject area	Teaching years	Title
Mr. Q	Bachelor	Male	Han	11	Mathematics	15	Senior
Mr. J	Bachelor	Male	Han	11	Mathematics	19	Senior
Mr. H	Bachelor	Male	Han	11	Mathematics	16	Senior

Procedure

Mr. Q, Mr. J, and Mr. H came from different cities. They were participating in a teacher professional development project when they took part in this study in 2007. This study was one part of that teacher professional development project. The teaching research model was borrowing students to have a class, which means that three teachers didn't teach in their own classrooms. Respectively, they had one class with the other teachers' students, who were from the school that hosted this research activity. They all taught the same mathematics content—Binomial Theorem in the different classes, which was taught in Grade 11 in China. This research activity is similar to *Japanese Lesson Study* (*cf.* Stigler, Gonzales, Kawanaka, Knoll & Serrano, 1999; Hiebert *et al.*, 2003) but it is not the same activity. It is a kind of special *Teaching Research Group Activity* (TRGA) in China.

Data collection and Analysis

This study videotaped all three classes taught by Mr. Q, Mr. J, and Mr. H. The length of each video is about 45 minutes. The analysis was based on these three videotapes.

This study used a quantitative method to analyze data. The researcher observed the real classes on site and watched the videotapes. According to the judging criterion for a mathematical problem described in Jacobs *et al.* (2003, p. 411), the researcher made three lists for all mathematical problems from three video lessons on *Binomial Theorem*, which were shown in Table 3, Table 6, and Table 9. Using the framework of coding method for mathematical problems in the *TIMSS 1999 Video Study*, this study got the coding results for mathematical problems in *Binomial Theorem* lessons taught by Mr. Q, Mr. J, and Mr. H, which were respectively shown in Table 4, Table 7, and Table 10.

RESULTS AND FINDINGS

Table 3. Mr. Q's mathematical problems presented in *Binomial Theorem* lesson

ID	Problems	Time
1	Expand $(a+b)^4$.	(01:22–05:10)
2	There are two glass balls in each container of four, one is red and the other is blue. How can we choose only one ball from each container at a time? How many kinds of methods for choosing?	(05:15–09:55)
3	What are the terms and their coefficients in the expansion of $(a+b)(a+b)(a+b)(a+b)$? (Using *Combinatorics* knowledge to inquire)	(09:56–14:05)
4	Expand $(a+b)^n$.	(14:15–20:05)
5	Expand $(2x-y)^8$. What is the fourth term, the coefficient of the fourth term and the binomial coefficient of the fourth term in the expansion of $(2x-y)^8$?	(23:15–30:50)
6	Find the term containing x^2 in the expansion of $(2x-\frac{1}{x})^8$.	(31:20–35:40)
7	Expand $(1+q)^7$.	(36:00–41:16)
8	Expand $(1+x)^n$.	
9	Expand $(a-b)^n$.	
10	What is the third term in the expansion of $(2x+3y)^6$?	(41:17–43:46)
11	What is the third term in the expansion of $(3y+2x)^6$?	
12	What is the binomial coefficient of the third term in the expansion of $(2a+3b)^6$?	

Mathematical problems in Mr. Q's, Mr. J's, and Mr. H's lessons were respectively shown in Table 3, Table 6, and Table 9. The coding results were respectively shown in Table 4, Table 7, and Table 10. The coding frequencies were respectively shown in Table 5, Table 8, and Table 11. The corresponding coding frequencies bar charts were respectively shown in Figures 2–4.

From Table 4, Table 5, Table 7, Table 8, Table 10, Table 11, and Figures 2–4, this study got the following findings.

The number of mathematical problems is almost equal in *Binomial Theorem* lessons taught by Mr. Q, Mr. J, and Mr. H. They are respectively 12, 13, and 12. Mr. Q gave 6 independent problems and 6 concurrent problems. The other two teachers gave independent problems only. There are no answered-only problems in all three video lessons.

Time spent on most of mathematical problems is more than 45 seconds. In all 12 problems given by Mr. Q, time spent on each problem is more than 45 seconds. However, Mr. J has 3 problems and Mr. H has 4 problems that time spent on is less than 45 seconds.

Most of mathematical problems belong to low complexity and moderate complexity problems, high complexity problems are few.

The degree of relationship among mathematical problems is typically strong. There is no unrelated problem. Especially, all mathematical problems given by Mr. Q are mathematics related problems.

Table 4. Mr. Q's coding table for mathematical problems presented in *Binomial Theorem* lesson

ID	1	2	3	4	5	6	7	8	9	10	11	12
RL	1	1	1	1	1	1	2	2	2	2	2	2
LT	1	1	1	1	1	1	1	1	1	1	1	1
PC	1	2	2	2	3	2	1	1	1	1	1	1
RD	0	2	2	2	2	2	2	2	2	2	2	2
RLC	0	1	0	0	0	0	0	0	0	0	0	0
RW	0	3	3	0	0	0	0	0	0	0	0	0
PM	0	0	0	0	0	0	0	0	0	0	0	0
AP	1	1	1	1	1	1	0	0	0	0	0	0
PVD	0	0	0	0	0	0	0	0	0	0	0	0
SPP	1	1	1	1	1	1	1	1	1	1	1	1
ASP	0	0	0	0	0	0	0	0	0	0	0	0
CS	1	0	0	0	0	0	0	0	0	0	0	0
EAS	0	0	0	0	0	0	0	0	0	0	0	0
SM	1	1	1	1	1	1	0	1	1	0	0	0
PPS	0	1	1	1	2	3	1	1	1	1	1	2
PSP	1	1	1	1	2	3	1	1	1	1	1	2

Note. RL = role; LT = length of time; PC = procedure complexity; RD = degree of relationship; RLC = real-life context; RW = representation way; PM = physical material; AP = application; PVD = proof, verification and derivation; SPP = solutions presented publicly; ASP = alternative solution methods presented publicly; CS = opportunity to choose their own solutions method; EAS = examine alternative solutions; SM = summary; PPS = process suggested by problem statements; PSP = process used when solving problems.

Table 5. Mr. Q's coding frequencies table for mathematical problems presented in *Binomial Theorem* lesson

Code	0	1	2	3
RL	0	6	6	0
LT	0	12	0	0
PC	0	7	4	1
RD	1	0	11	0
RLC	11	1	0	0
RW	10	0	0	2
PM	12	0	0	0
AP	6	6	0	0
PVD	12	0	0	0
SPP	0	12	0	0
ASP	12	0	0	0
CS	11	1	0	0
EAS	12	0	0	0
SM	4	8	0	0
PPS	0	9	2	1
PSP	0	9	2	1

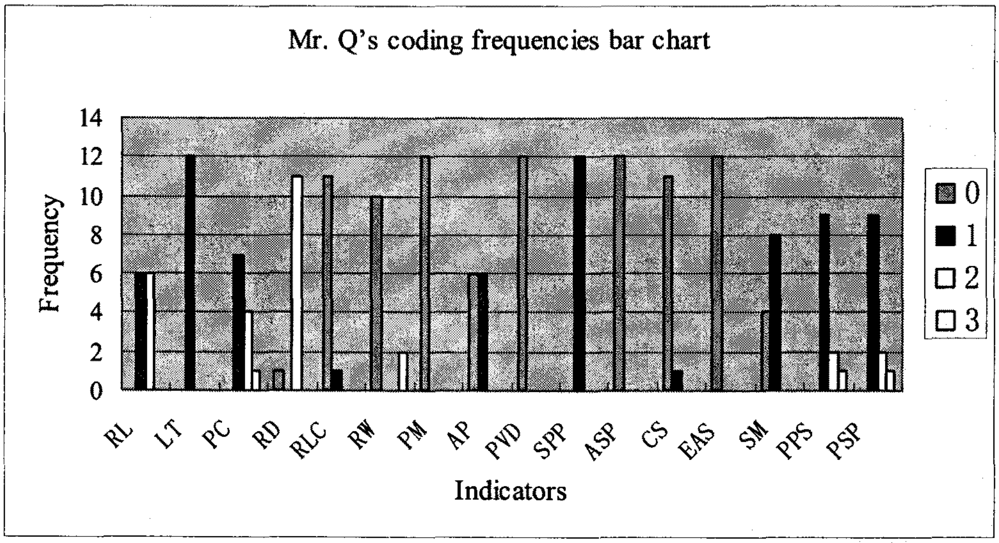

Figure 2. Mr. Q's coding frequencies bar chart for mathematical problems presented in *Binomial Theorem* lesson

Table 6. Mr. J's mathematical problems presented in *Binomial Theorem* lesson

ID	Problems	Time
1	If today is Friday, what day comes after 7 days?	00:00–00:10
2	If today is Friday, what day comes after 15 days?	00:11–00:20
3	If today is Friday, what day comes after 24 days?	00:21–00:31
4	Expand $(a+b)^4$.	03:01–12:55
5	Expand $(a+b)^n$	12:56–14:30
6	Expand $(1+\frac{1}{x})^4$.	18:06–19:36
7	Expand $(2\sqrt{x}-\frac{1}{\sqrt{x}})^6$.	19:37–21:34
8	In the expansion of $(x-\frac{1}{x})^{12}$, find: (1) the last but three term; (2) the coefficient and the binomial coefficient of the last but three term; (3) the coefficient of the term containing x^6.	21:35–28:50
9	What is the rank of the constant term in the expansion of $(x-\frac{1}{x})^{12}$.	28:51–31:04
10	What are the third term and its binomial coefficient in the expansion of $(1-2x)^5$.	31:09–33:49
11	Which one is equal to $P=(x-1)^4+4(x-1)^3+6(x-1)^2+4(x-1)+1$ in the following ? A. $(x-2)^4$ B. $(x-1)^4$ C. x^4 D. $(x+1)^4$	33:50–36:52
12	Which one is equal to $P=1+5(x+1)+10(x+1)^2+10(x+1)^3+5(x+1)^4+(x+1)^5$ in the following ? A. x^5 B. $(x+2)^5$ C. $(x-1)^5$ D. $(x+1)^5$	36:53–37:39
13	If today is Friday, what day comes after 8^{100} days?	37:40–39:35

Table 7. Mr. J's coding table for mathematical problems presented in *Binomial Theorem* lesson

ID	1	2	3	4	5	6	7	8	9	10	11	12	13
RL	1	1	1	1	1	1	1	1	1	1	1	1	1
LT	0	0	0	1	1	1	1	1	1	1	1	1	1
PC	1	1	1	2	2	1	1	3	2	2	1	1	2
RD	0	1	1	3	2	2	2	2	2	2	1	1	2
RLC	1	1	1	0	0	0	0	0	0	0	0	0	1
RW	0	0	0	0	0	0	0	0	0	0	0	0	0
PM	0	0	0	0	0	0	0	0	0	0	0	0	0
AP	0	0	0	1	1	0	0	0	0	0	1	1	1
PVD	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	1	1	1	0	1	1	1	1	1	1
ASP	0	0	0	0	0	0	0	0	0	0	0	0	0
CS	0	0	0	0	0	0	0	0	0	0	0	0	0
EAS	0	0	0	0	0	0	0	0	0	0	0	0	0
SM	0	0	0	1	1	0	0	0	0	1	0	0	0
PPS	1	1	1	1	1	1	1	2	2	2	1	1	1
PSP	0	0	0	3	3	1	1	2	2	2	2	2	1

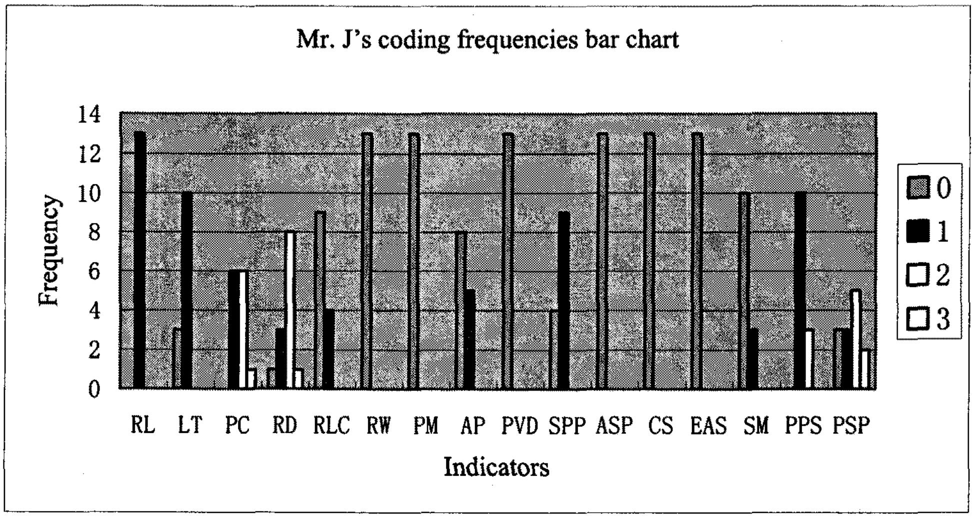

Figure 3. Mr. J's coding frequencies bar chart for mathematical problems presented in *Binomial Theorem* lesson

Table 8. Mr. J's coding frequencies table for mathematical problems presented in *Binomial Theorem* lesson

Code	0	1	2	3
RL	0	13	0	0
LT	3	10	0	0
PC	0	6	6	1
RD	1	3	8	1
RLC	9	4	0	0
RW	13	0	0	0
PM	13	0	0	0
AP	8	5	0	0
PVD	13	0	0	0
SPP	4	9	0	0
ASP	13	0	0	0
CS	13	0	0	0
EAS	13	0	0	0
SM	10	3	0	0
PPS	0	10	3	0
PSP	3	3	5	2

Table 9. Mr. H's mathematical problems presented in *Binomial Theorem* lesson

ID	Problems	Time
1	If today is Friday, what day comes after 7 days?	00:00–00:22
2	If today is Friday, what day comes after 15 days?	00:23–00:33
3	If today is Friday, what day comes after 24 days?	00:34–01:00
4	Expand $(a+b)^4$.	10:10-15:05
5	Expand $(a+b)^n$.	15:15–17:00
6	How many subsets are there for a set containing N elements?	17:30–21:20
7	Expand $(1+2x)^5$.	23:35–28:35
8	Expand $(1-2x)^5$.	28:36–30:50
9	In the expansion of $(1-2x)^5$, find: (1) the third term; (2) the binomial coefficient of the third term; (3) the coefficient of the third term.	30:55–34:50
10	If today is Friday, what day comes after 8^{100} days?	35:00–40:55
11	Someone invests 100 thousands dollars in a project. If the annual compound interest is 9 percent, what are the seed capital and interest after ten years?	40:56–44:55
12	What is the remainder when 8^{100} is divided by 9?	45:10–45:37

Table 10. Mr. H's coding table for mathematical problems presented in *Binomial Theorem* lesson

ID	1	2	3	4	5	6	7	8	9	10	11	12
RL	1	1	1	1	1	1	1	1	1	1	1	1
LT	0	0	0	1	1	1	1	1	1	1	1	0
PC	1	1	1	2	2	3	1	1	3	2	2	2
RD	0	1	1	3	2	3	3	2	2	3	2	2
RLC	1	1	1	0	0	0	0	0	0	1	1	0
RW	0	0	0	3	0	0	0	0	0	0	0	0
PM	0	0	0	0	0	0	0	0	0	0	0	0
AP	0	0	0	1	1	1	0	0	0	1	1	1
PVD	0	0	0	0	0	1	0	0	0	0	0	0
SPP	0	0	1	1	1	1	1	1	1	1	0	1
ASP	0	0	0	0	0	0	0	0	0	0	0	0
CS	0	0	0	0	0	0	0	0	0	0	0	0
EAS	0	0	0	0	0	0	0	0	0	0	0	0
SM	0	0	0	1	1	1	0	0	0	0	0	0
PPS	1	1	1	1	1	2	1	1	2	1	3	1
PSP	0	0	1	3	3	3	3	3	2	1	1	1

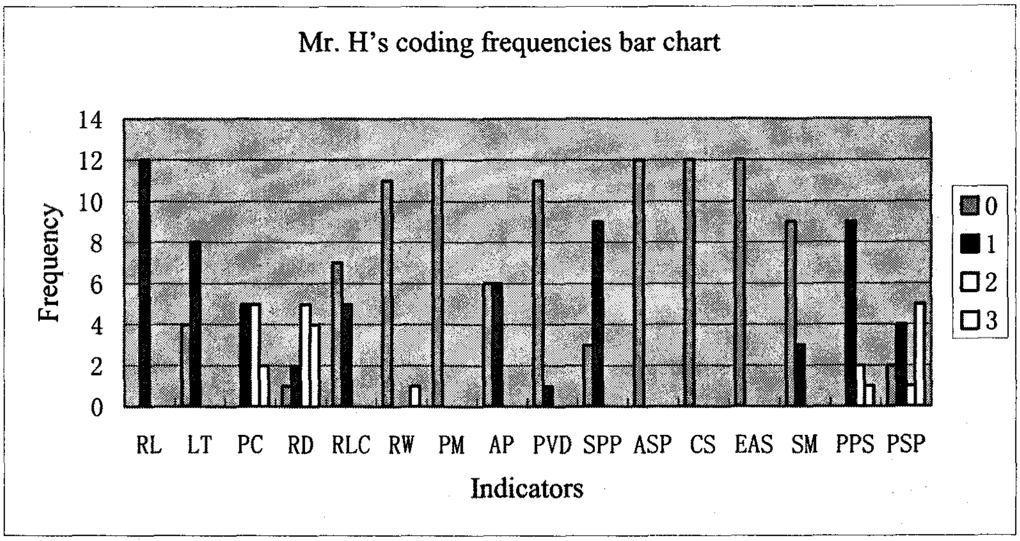

Figure 4. Mr. H's coding frequencies bar chart for mathematical problems presented in *Binomial Theorem* lesson

Table 11. Mr. H's coding frequencies table for mathematical problems presented in *Binomial Theorem* lesson

Code	0	1	2	3
RL	0	12	0	0
LT	4	8	0	0
PC	0	5	5	2
RD	1	2	5	4
RLC	7	5	0	0
RW	11	0	0	1
PM	12	0	0	0
AP	6	6	0	0
PVD	11	1	0	0
SPP	3	9	0	0
ASP	12	0	0	0
CS	12	0	0	0
EAS	12	0	0	0
SM	9	3	0	0
PPS	0	9	2	1
PSP	2	4	1	5

Most of mathematical problems are presented and solved using mathematics language and symbols only. Although Mr. J, and Mr. H respectively have four problems which are connected with real-life situations, three of four problems are spent less than 45 seconds. Most of mathematical problems are represented using regular written symbols. None of mathematical problems is demonstrated using physical materials. The number of applications and exercises is almost equal.

Proof, verification and derivation can hardly be seen during the process of problem solving. There is no alternative solution method presented publicly for all mathematical problems. The opportunity for students to choose their own solution method is quite few. No students participate in presenting and examining alternative solutions methods. However, the solutions to most of mathematical problems are presented publicly. Over one thirds of mathematical problems have summaries. Especially, each problem given by Mr. Q has solutions presented publicly and 2/3 problems are summarized.

Most of mathematical problems are solved by using procedures. Especially, almost half of mathematical problems given by Mr. H are solved by using the process of making connections.

DISCUSSION

According to this study, it seems that some features on Chinese classroom teaching align with the other researcher's findings. For example, the degree of relationship among mathematical problems is typically strong; most of mathematical problems are presented and solved using mathematics language and symbols only. These two findings are supported by Huang (2006). Most of mathematical problems belong to low complexity and moderate complexity problems, high complexity problems are few. This is also supported by Huang & Wang (2007).

CONCLUSIONS

According Hiebert *et al.* (2003) and Jacobs *et al.* (2003), the researcher refined a coding method for mathematical problems in *TIMSS 1999 Video Study*. It may contribute an additional cognitive tool to analyze K–12 classroom teaching. By analyzing three video lessons on Binomial Theorem taught by three Chinese teachers, the researcher demonstrated how to use this framework and got some features of mathematical problems in these three lessons. Namely,

(1) Most of mathematical problems belong to low complexity and moderate complexity problems;
(2) Most of mathematical problems are presented and solved using mathematics language and symbols only, which have nothing to do with real-life situation;
(3) Most of mathematical problems are presented using regular written symbols only, which are not related to graphs, tables and diagrams;
(4) Most of mathematical problems are solved by using procedures;
(5) Few mathematical problems are demonstrated using physical materials;
(6) Proof, verification and derivation can hardly be seen during the process of problem solving; and
(7) It is hard to find alternative solution methods discussed in the classes.

However;

(8) The degree of relationship among mathematical problems is typically strong;
(9) The solutions to most of mathematical problems are presented publicly;
(10) Over one thirds of mathematical problems have summaries; and
(11) Almost half of mathematical problems are applications.

ACKNOWLEDGEMENTS

I would like to thank Professor Shiqi Li, Professor Jiansheng Bao, Dr. Shuhua An, Dr. Zhonghe Wu, Dr. Thomas E. Ricks, and several anonymous reviewers for their thought provoking comments on this article. I also want to express my appreciation for getting the fund support from Developing Fujian Secondary School Mathematics Subject Leading Teachers Project, especially for the support from Dr. Zheyan Zhou. Finally I want to thank for three Chinese teachers who gave the lessons in this study.

REFERENCES

Halmos, P. (1980). The heart of mathematics. *Am. Math. Mon.* **87(7)**, 519–524. ME **1981f.** 01220 ERIC EJ232891

Hiebert, J.; Gallimore, R.; Garnier, H.; Givvin, K.; Hollingsworth, H.; Jacobs, J.; Chui, A.; Wearne, D.; Smith, M.; Kersting, N.; Manaster, A.; Tseng, E.; Etterbeek, W.; Manaster, C.; Gonzales, P. & Stigler, J. (2003). *Teaching Mathematics in Seven Countries: Results from the TIMSS 1999 Video Study (NCES 2003–013).* Washington, DC: National Center for Education Statistics. ME **2003c.**02114 ERIC ED476808 Available from: http://nces.ed.gov/pubs2003/2003013pdf

Huang, R. (2006). Looking into Chinese mathematics classroom—An analysis based on the international comparative studies (in Chinese). *J. Math. Educ.* **15(2)**, 67–70. ME **2006e.**02834

Huang, R. & Wang Z. (2007). Looking into mathematics classroom teaching in Hong Kong, Macau and Shanghai (in Chinese). *J. Math. Educ.* **16(2)**, 77–81. ME **2008c.**00228

Jacobs, J.; Garnier, H.; Gallimore, R.; Hollingsworth, H.; Givvin, K.; Rust, K.; Kawanaka, T.; Smith, M.; Wearne, D.; Manaster, A.; Etterbeek, W.; Hiebert, J. & Stigler, J. (2003). *Third International Mathematics and Science Study 1999 Video Study Technical Report Volume I: Mathematics (NCES 2003–012).* Washington, DC: National Center for Education Statistics. Available from: http://nces.ed.gov/pubs2003/2003012.pdf

Leung, Frederick K. S.; Park, Kyungmee (2005). Is mathematics teaching in East Asia conducive to creativity development? Results from the TIMSS 1999 Video Study and the learners' perspective study. *J. Korea Soc. Math. Educ. Ser. D* **9(3)**, 203–231. ME **2006a.**00125

Stigler, J.; Gonzales, P.; Kawanaka, T.; Knoll, S. & Serrano, A. (1999). *The TIMSS Videotape Classroom Study: Methods and Findings from an Exploratory Research Project on Eighth-Grade Mathematics Instruction in Germany, Japan, and the United States (NCES 1999–074).* Washington, DC: National Center for Education Statistics. ME **2000a.**00229 ERIC EJ431621 Available from: http://nces.ed.gov/pubs99/1999074.pdf