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FEATURES OF EXEMPLARY LESSONS UNDER THE CURRICULUM REFORM IN CHINA: A CASE STUDY ON THIRTEEN ELEMENTARY MATHEMATICS LESSONS

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Dramatic changes in mathematics education in China have taken place since the new mathematics curriculum standard was implemented in 2001. What do new features of exemplary lessons appear under the context of the curriculum reform? This paper will answer this question by presenting a case study on 13 elementary mathematics lessons that were evaluated as excellent exemplary lessons by mathematics educators in China. This study found that, consistent with the ideas advocated by the new curriculum, the selected lessons demonstrated the features of emphasizing on student's overall development, connecting mathematics to real-life, providing students the opportunities for inquiring and collaborating, and teachers' exploiting various resources for teaching. Meanwhile, the selected lessons also shared other common features in the lesson structure, interaction between the teacher and students, classroom discourse. The results reveal that the exemplary lessons have practiced the advocated ideas of the current reform, while they also embodied some elements that might be the stable characteristics of Chinese mathematics education.

Key words: Chinese mathematics classroom, teaching practice reform, exemplary lesson, elementary mathematics

1 INTRODUCTION

In the past decades, investigating and understanding Chinese mathematics education, especially the mathematics classroom in China, has been of interest to many educators and researchers (e.g., Gu, Huang, & Marton, 2004; Huang, Mok, & Leung, 2006; Huang & Leung, 2004; Leung, 1995; Ma, Zhao, & Tuo, 2004; Stevenson & Stigler, 1992). Recently, efforts to improve the quality of classroom instruction have led to ever-increased interests in research on excellent lessons (e.g., Li & Shimizu, 2009; Huang, Pang, & Li, 2009; Li & Yang, 2003; Zhao & Ma, in press). From different perspectives, the existent studies have deepened the understanding of Chinese mathematics classroom. Yet, the picture of Chinese mathematics classroom is not clear enough. More investigations and studies on Chinese mathematics classroom are needed.

In pursuit of knowing and understanding the characteristics of Chinese mathematics classroom, it should be aware of that changes might be taking place in Chinese mathematics

classroom with the global change and the development of Chinese society. At the turn of the 21st century, with the aim of preparing younger generations for an age in which the economy is globalized, and the society is information-rich and "knowledge-based", mathematics curriculum in many education systems around the world have undergone dramatic changes (Wong, Han, & Lee, 2004). In such a situation, mathematics curriculum in China is no exception. In September, 2001, China initiated and implemented the new round of curriculum reform of compulsory education (Ministry of Education of China, 2001). According to some reports, changes have taken place in the classroom as a result of the current curriculum reform (Song, 2003; Li, 2002). If the reform could be implemented deeply and continuously, we may expect that the practice of China's mathematics classroom will demonstrate many differences from that of the classroom in past decades. While as a cultural activity, teaching has its relative stability. In some comparative studies, both differences and similarities were found in the exemplary mathematics lessons in different decades (Huang, Pang, & Li, 2009; Li & Yang, 2003; Zhao & Ma, in press).

What characteristics do the "excellent" lessons have in the current curriculum reform? Or, how mathematics is taught and learned in the exemplary lessons in the context of reform? How are the ideas advocated by the new curriculum embodied in these exemplary lessons? Are there any other common features shown in these lessons? Much remains unknown about these questions. This paper will attemptito answer these questions by presenting a study,in which 13 elementary mathematics lessons valued as the excellent exemplary lessons under the new curriculum reform,were analysed.

The paper is structured with four parts: firstly, the background and main changes of the mathematics curriculum will be briefly introduced; secondly, the background of the lessons analysed in this study and the analysis method will be described; thirdly, we will present the results of this study in two aspects: one is the lessons' features that were consistent with the ideas advocated by the curriculum reform; the other one is other common features embodied in the lessons; and at last, we will give a short summary and discussion on the results. Based on the discussion, we will share our implications drawn from this study with you.

2 BACKGROUND: CURRENT CURRICULUM REFORM IN CHINA

Mathematics curriculum in China has experienced several waves of changes since the founding of People's Republic of China in 1949 (Su & Xie, 2007). The current new round of mathematics curriculum reform of compulsory education[1] was initiated and implemented under the guidance of *Mathematics Curriculum Standard for Full-time Compulsory Education (Manuscript for consultation)* (hereafter *Standards*) in September, 2001 (Ministry of Education of China, 2001). Since September, 2005, all the students in the first academic year of primary school and junior high school have used the new curriculum. Now, the new curriculum has spread out nationwide.

Before the implementation of the new curriculum, the latest mathematics curriculum was developed under the guidance of Mathematics syllabus for elementary school of nine-year compulsory education and Mathematics syllabus for junior high school of nine-year

compulsory education issued in 1992. The mathematics curriculum guided by the above-mentioned two syllabi was suitable for social development at that time, but there are still some problems left to be solved. For example, the syllabi issued in 1992 over-emphasizes "two basics" (basic knowledge and basic skill) and did not take into account students' development of affection and attitude, and this resulted in student's unbalanced development. Some contents of the curriculum were too difficult and narrow, and was not related to the students' real life (Zhang, 2002; Ma, 2001). Furthermore, the teaching method was monotonous; teachers useed textbooks as the only reference for their teaching, and perceived teaching as transferring knowledge from textbook to students (Ma, 2001). In order to solve these problems and make the mathematics curriculum more responsive to the need of the development of both students and society, the Ministry of Education (MOE) of China initiated the mathematics curriculum reform.

The new mathematics curriculum at the stage of compulsory education aims at providing a solid foundation for students' full, sustainable and harmonious development, and to provide mathematics education for all students (MOE of China, 2001, p.1). Students' over-all development has been the most important goal of China's education especially because quality-oriented education was advocated by Chinese government since the 1990s (CCCPC & the State Council, 1999). The *Standards* takes student's affection and attitude as one important dimension of their over-all development, and takes students' learning "process" as important as "outcome". For example, the *Standards* emphasizes students' full development by focusing curriculum objectives on four aspects: knowledge and skill, mathematical thinking, problem solving, as well as affection and attitude. The curriculum contents consist of four dimensions: Number & Algebra, Space & Graph, Statistics & Probability, and Integration & Practice. Nine-year Compulsory education is divided into three phases: the first is for Grade 1 to 3; the second is for Grade 4 to 6; and the third is for Grade 7 to 9. For each phase, objectives for knowledge and skills, mathematical thinking, problem solving, and affect & attitude are elaborated in the *Standards*. Some contents in the former mathematics curriculum was trimmed down, meanwhile, some new contents was added to the new curriculum. Calculating and solving problem in multiple ways and strategies are encouraged.

The new curriculum also proposes some new ideas for improving mathematics classroom practice. It suggests that teaching should be closely related to students' daily life so that students can connect mathematics with real world (MOE, 2001, p. 51). It emphasizes that mathematics teaching and learning should "begin from student's primary experience of real life, and encourage student to experience the process of abstracting mathematics model from real-life problem, and the process of interpreting and applying." (MOE of China, 2001, p.1) "Contents of mathematics learning for school children ought to be realistic, meaningful and challenging. These contents should facilitate school children to engage actively in mathematical activities, such as observation, experimentation, guessing, hypothesis testing, inference making, and communication." (MOE of China, 2001, p. 2) It is also claimed that "effective mathematics learning activities cannot simply rely on imitation and memorization. Instead, hands-on practical work, autonomous investigation and cooperative exchanges are important modes of mathematics learning." (MOE of China, 2001, p. 2) Besides, the

Standards also encourages teachers to design and enact their lessons creatively rather than to perceive teaching as transferring knowledge from textbook to students mechanically (MOE, 2001, p.51).

In a word, dramatic changes have taken place in the mathematics curriculum in China since 2001. The ideas advocated by the new curriculum bring both opportunities and challenges for mathematics teachers. How to implement the new ideas in mathematics classroom? And what should an excellent mathematics lesson be like? Mathematics educators have been thinking about these questions and putting their understanding into their classroom practice. It is also of interest to researchers to identify and examine the features of the excellent lessons in this reform context.

3 METHODOLOGY

3.1 Research questions

The analysed lessons in this study were the prized exemplary lessons at the national level in the current context of curriculum reform. This study aims at answering two questions as following: (1) how the ideas advocated by the *Standards* are implemented in the exemplary lessons? And (2) what other common features could be found in the exemplary lessons?

3.2 The selected lessons

In China, the institutions responsible for administrating educational research at the national or provincial levels often organize teaching contests and teaching exhibitions (see Li & Li, 2009). In 2008, the NCCT (National Centre for School Curriculum and Textbook Development) of the Ministry of Education organized the 1st National Contest in Exemplary Lessons of Elementary Mathematics in the new curriculum reform context. Elementary mathematics teachers were encouraged to design and implement mathematics lessons to show how the new curriculum was taught and learned in their classrooms. The teachers had many choices in the teaching topic, grades, mathematics content fields, and lesson types. They had their lessons video-taped and submitted the lessons to the NCCT. At last, about 820 video-taped lessons were called up from each province (municipality and autonomous region) in China. These lessons were evaluated by an Expert Evaluating Group which was constituted of Mathematics educators and researchers. Finally, 55 lessons were selected and honoured as the First Prize. These 55 lessons covered grade 1-6, four fields of content (*Number & Algebra*, *Space & Graph*, *Statistics & Probability*, and *Integration & Practice*), and 3 types of lesson (*XinShou Ke*--Teaching and learning new content, *FuXi Ke*--Reviewing the previously learned content, and *ZongHe ShiJian Ke*--Integrated using knowledge to solve problems).

We focused on the lessons in type of "*Number & Algebra*" and "*XinShou Ke*", and selected lessons only from those in grade 3 or 4. Finally, thirteen lessons in total were selected for analysis. Their topics of teaching and learning, grades of students', and their codes in this study are shown in table 1.

Table 1: General background information about the selected lessons

Lessons taught in grade 3		Lessons taught in grade 4	
Code	Topic of teaching and learning	Code	Topic of teaching and learning
A	Knowing and understanding second (time unit)	H	Countermeasure
B	Knowing and understanding fractions	I	Multiplication: 3-digit by 2-digit
C	Division with remainder	J	Using letters to present numbers
D	Year, month, and day	K	Multiples and factors
E	Year, month, and day	L	Solving the problems of planting trees
F	Year, month, and day	M	Solving the problems of planting trees
		N	Solving the problems of planting trees

Note: Lesson D, E, and F focused on the same topic, and lesson L, M, and N focused on another same topic. This is coincidental.

In addition, the textbooks used or referred by these lessons and the lesson plans of eleven lessons were also collected for analysis.

3.3 Method of analysing

The framework and the method of analysing are decided according to the research questions. For the first research question, we firstly extracted the advocated ideas relevant to mathematics teaching and learning from the *Standards* and then examined where these ideas could be found in the lesson videos or lesson plans and how they were implemented.

As introduced in the part of "Background" in this paper, many ideas relevant to mathematics teaching and learning were proposed in the *Standards*. However, some of them are difficult to be examined and identified in a lesson by video analysis. For example, in the "Suggestion for teaching" in the *Standards*, it is suggested that teachers should create contexts and guide students learning in the contexts (MOE of China, 2001, p. 51, p. 64). What is context? The *Standards* does not give a definition. Instead, it gives some suggestions for creating contexts for the phase one (Grade 1-3) and phase two (Grade 4-6) as following.

> Design the lively, interesting, and visual mathematical activities, such as the use of storytelling, games, visual demonstration, and scenario performance, to stimulate students' interest in learning, so that it can help the students know and understand the mathematics knowledge in a vivid and specific context (p.51). (Suggestions for the phase one)
>
> Create the contexts relevant to students' living situation and knowledge background in which the students are interested (p.64). (Suggestions for the phase one)

From these suggestions we can infer that the purpose of creating contexts is to make the mathematics lively, interesting, and relevant to real-life, so that it can provide a motivation and an experience fundation for students' learning. Even so, only from researcher's perspective without consulting the concerning students' opinions, is it difficult to judge whether teaching and learning are lively and interesting. By contrast, it is practicable to judge whether the teaching and learning are related to real-life.

Due to the limitation of the method used in this study, finally, only four ideas about teaching were identified for examining the selected lessons. They are: (1) taking students' over-all development into consideration; (3) connecting mathematics to real-life; (3) providing opportunity for student to inquire and collaborate; and (4) exploiting resources for teaching rather than just obeying to the textbook. The first idea was examined by analysing the objectives listed in the lesson plans. The second and the third were examined by analysing the lesson videos. And the fourth was examined by contrasting the actual taught content and the content in the textbook.

For the second research question, we adopted an open method for analysing rather than determined any analytical framework. The "constant comparison method" (Glaser & Strauss, 1967) was used for analysing the selected lessons. We watched the lesson videos and read the transcripts of the lessons several times until some themes came to our attention. Then these themes were further examined until they were found to represent the common features of all the 11 selected lessons. In other words, common features were gradually summarized. Finally, six common features were found in the lessons. More details will be reported in the next section.

All the selected lessons were analysed by two researchers. The results of their analysises were tested and discussed to get them be consistent between the two researchers.

4 RESULTS: FEATURES OF EXEMPLARY LESSONS

4.1 The features that were consistent with the ideas advocated by curriculum reform

4.1.1 Students' over-all development was concerned

By analysing the instructional objectives in the lesson plans, it was found that students' over-all development was concerned by all of the lessons. Both objectives about the results of learning and the process of learning were all shown in the lesson plans. Students' mathematical development and the non-mathematical-relevant development all could be found in the lesson plans. The objectives of two lessons were shown as following:

> Help students (1) estimate the range of the product of 2-digit by 3 digit multiplication in a specific context, and calculate the 2-digit by 3 digit multiplication by listing vertical formula; (2) explore the methods of 2-digit by 3 digit multiplication, compute correctly, and be willing to exchange the methods with others; (3) develop the interests in calculating and a good habit, and improve the ability to use multiplication to solve practical problems; and stimulate studentss enthusiasm to love science by introducing current events. (Extracted from the plan of lesson I "2-digit by 3 digit multiplication")

> Help students (1) construct the preliminary concept of fractions based on their exploring and discussing the things in their real-life and geometric figures, correctly read and write simple fractions, and explain the meaning of a fraction by using geometric figures; (2) compare two fractions whose numerators are 1 by using geometric figures; (3) develop students' awareness of collaboration with others, and their ability of observation and analysis, hands-on skills and language skills, and develop students' mathematics thinking. (Extracted from the plan of lesson B "Knowing and understanding fractions")

The traditional mathematics teaching has been criticized for its over-emphasis on the results of learning (mathematical knowledge and skills) and neglecting the learning process. According to the objectives listed in the lesson plans, we found the learning results as long as the learning process was taken into consideration by teachers. Furthermore, some non-mathematics-relevant skills, such as the awareness of cooperation, communication, and interests, also were covered in the instruction objectives. The broader scope of the objectives indicated that students' over-all development was considered by these lessons.

4.1.2 Mathematics was connected with real-life

By analysing the lesson videos, it was found that all the lessons contained the real-life contexts during which mathematics was taught and learned. Three strategies were found in these lessons to create such a context. One is to begin a lesson with a real-life event or problem. All the lessons used this kind of strategy. The contexts created in these lessons were summarized as shown in table 2.

Table 2: The context of teaching and learning at the beginning of each lesson

Lesson	The context
A	Watched video: Opening ceremony of Olympic Games. Felt the scene of countdown. Led to the time unit "Second". Then students gave examples that they used "Second" in daily life.
B	Students alloted several types of learning tools equally with their deskmates, and recorded the numbers of each type of learning tool that each student received. They finally found that a half could not expressed by any whole number. So 1/2 was introduced.
C	Students played the game of splicing flowers with 12 petals. Two results emerged: one is all the petals were used; the other is one or several petals was/were left. These lead to the "divisible division" and the "division with divisor".
D	Watched video: Opening ceremony of Olympic Games. Felt the scene at the time, recalled the date of the Olympic Games, lead to the topic of "Year, Month, and Day".
E	Watched the pictures of history events and holidays, students answered the dates of these events and holidays, and then the topic of "Year, Month, and Day" was introduced.
F	Students interchanged the memories about the Olympic Games, introduced the topic of "Year, Month, and Day" from the date of Olympic Games

H	The teacher played cards with the class. The teacher always won the game by using countermeasure. Students felt curious. Then the topic of "countermeasure" was introduced.
I	Students watched a simulative animation in which a satellite was running around the Earth. After having known the circumference of the orbit, students were asked to raise mathematical problems from this event.
J	Students sorted 13 pieces of playing cards (2 to 10, and J to A). Students looked J, Q, K, and A as the number of 11, 12, 13, and 14. Then the topic "Using letters to present numbers" was introduced.
K	Students made up a big rectangle with 12 small squares, and then expressed the length and width of the rectangle with a multiplication formula. They found, with the different splicing method, the multiplication formula was different. This led to multiples and factors.
L	Students observed their finger spacing, gave examples of spacing in daily life, then raised the problem of planting trees.
M	Appreciated the picture of the urban landscape, led to the topic of urban greening, and then raised the problem of planting trees.
N	Began from a riddle: "Two trees have 10 branches, but they have not leaves and do not flower" (The answer is two hands). Students observed finger spacing, and then gave examples of spacing in daily life, which led to the problem of planting trees.

The second strategy is to use real-life tasks or problems during teaching and learning the new content. The third strategy is to provide opportunity for students to apply the learned new content to the real-life.

4.1.3 Inquiry learning and collaborative learning occurred during lessons

It was found that inquiry learning and collaborative learning existed in all of the lessons. The students had the opportunities of exploring knowledge and methods by themselves and communicating or discussing their opinions or findings with deskmates or group members. The inquiry learning and collaborative learning in these lessons were summarized as shown in table 3.

Table 3: Overview of the inquiry learning and collaborative learning in selected lessons

Lesson	Summary of the inquiry learning or collaborative learning
A	Groups studied how to prove one minute was equal to 60 seconds.
B	Students communicated how they got the fractions that they wanted to learn by folding square papers. Students divided a square paper into 8 equal parts with different methods. Then they were asked to discuss in pairs whether two parts in different shapes were in the same

	size.
C	Groups played the game of splicing 5-petal flowers to investigate the relationship between the remainder and the dividend. Students discussed the problem of planning a schedule for cleaning.
D	Students observed the calendar independently, and then shared their findings with deskmates.
E	Students observed calendar in groups and collected the data about year, month, and day. Then the whole class compared and analysed the data to investigate the relationship between year, month, and day. Students discussed the methods of calculating the days of a common year. Students communicated the methods of calculating the days of a leap year.
F	Students observed the calendar independently. Then they found there were 12 months in a year, and the number of days varied in the 12 months.
H	Groups designed the program of horse racing with the method of countermeasure. Pairs played a game to apply the method of countermeasure.
I	Pairs communicated the methods of estimating. Groups compared two different methods of calculation.
J	Groups discussed how to present the relationship of two persons' ages that were increasing simultaneously.
K	Groups communicated the methods of enumerating the factors of a number.
L	Groups studied the different methods of planting trees and recorded the number of trees and corresponding spacings. Then students analysed the data to find the relationship between the numbers of trees and spacings.
M	Groups discussed why the number of planted trees was one more than the number of spacings.
N	Groups studied the relationship between the number of spacings and the number of trees. Groups discussed the relationship between the number of spacings and the number of trees in two different situations (planting trees from one end to another end of a line, and planting trees in a line without planting at the two ends.

4.1.4 Teacher adapted the textbook and exploited other resources for teaching

By contrasting the curriculum resources used in the lessons with the resources listed in the corresponding textbook, it was found that none of the 13 lessons completely conform to the textbook. In these lessons, the teachers selected some resources, such as the pictures, examples and exercises, from the textbook for their teaching and also exploited various resources by themselves. These results reveal that the teachers have made their adaption and creation while they designed and implemented their lessons. This is consistent with the ideas advocated by the new curriculum that the teachers should actively utilize various teaching resources and creatively use the textbook. However, a further analysis showed that, although the adaptations on the textbooks and the development of new resources were made in all of the lessons, the content of teaching and learning in the lessons do not show differences from the content in the textbooks regarding of the coverage on mathematical knowledge and skills. Therefore, from the ways in which teachers used textbooks, we can see the teachers in the selected lessons did not depend on the resources in the textbook, but intended to follow the mathematical objectives embodied in the textbook.

4.2 Other common features

Except the features reported above, some other common features were also found existing in the selected lessons.

4.2.1 Features of lesson structure

Seven types of teaching activities with different purposes for student's learning were found in the 13 lessons. They are defined in table 4.

Table 4: Seven types of teaching activities and their purposes

Type	Purpose
Introducing topic	To arouse students' interests or to activate students' previous experience relevant to the topic of current lesson (including reviewing previous lesson), and then introduce the topic.
Teaching and learning new content	To acquire knowledge, concepts, skills, or procedures that have not been learned in earlier lessons.
Practicing the new content	To consolidate the new content or to apply it in a new situation, including solving routine exercise and non-routine problems.
Summary	To help students get an overall view on the previously learned new content or previous teaching activity in the current lesson
Homework assignment	To give students assignment for them to accomplish at home.
Extended learning on non-mathematical content	To have a relaxation or celebration, or to introduce a current social event. The content or activity is irrelevant to mathematics.
Proposing problems for	To invite students raise questions or problems for studying in future

future study	lessons.

The "Extended learning on non-mathematical content" only existed in three lessons. For example, in the lesson H "solving the problem of planting trees", students sung a "*Tree-planting Song*" to celebrate their accomplishment of previous learning. Taking another example, at the end of the lesson M (Multiplication: 3-digit by 2-digit), the teacher introduced a current affair of the manned space rocket. Only lesson L had the "Proposing problems for future study". Lesson D, E, and J had "Homework assignment". By contrast with these three types of activities, the other four types of activities were very popular in all of the 13 lessons.

Figure 1 shows a picture of the lesson structure, in which each type of activity was presented according to its location in the teaching process and the percentage of its duration to the whole lesson. As it is shown in this figure, in all of the lessons, it started with introducing the topic of current lesson, during which the students' interests were aroused and their previous experience was activated. After introducing the topic, the new content was taught and learned. The new content was divided into several parts and each part was taught and learned gradually. Practices were set following some parts (not all) of the new content or were set after all of the new contents were finished. One or more summary was/were given during the lesson or at the end of the lesson. Overall, all the lessons showed three features as following: (1) introducing topic; (2) teaching and learning new content accompanied by practicing; (3) summarizing during the lesson or near to the end of the lesson.

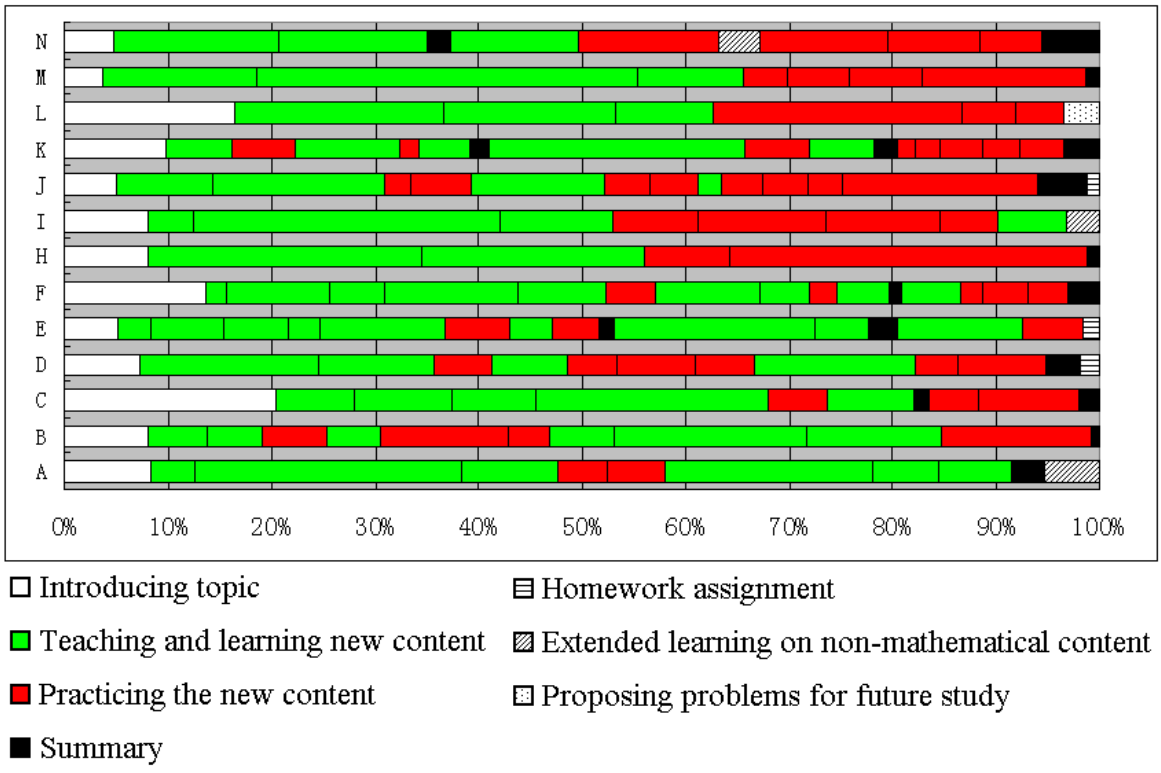

Figure 1. Lesson structure

4.2.2 Teaching and learning new content accompanied by practicing

Practices were found in all of the lessons. The type of these lessons is "Xinshou Ke", which means that teaching and learning the new content is the main purpose of these lessons. However, most of the lesson time was not only spent on teaching and learning new content but on both teaching and learning new content and practicing the new content. The percentages of time spent on teaching and learning new content and practicing in each lesson are shown in figure 2. As far as the percentages of time spent on "practicing" is concerned, the highest one is lesson M (48.3%), and the lowest one is lesson D (10.5%). Nine lessons spent more than 30% of their lesson time on practicing. In some lessons (H, J, K, L, M), the total time spent on practicing was nearly as much as the time spent on teaching and learning new content. Therefore, the selected lessons showed an obvious feature that teaching and learning new content was accompanied by practicing.

A further analysis found that two strategies were used for accompanying practicing with teaching and learning new content. One is to arrange the practice after all of the new content was taught and learned (e.g. lesson H, L, M, and N, see figure 1). Another one is to place one or more practice between the sections of teaching and learning new content (e.g. lesson B, D, K, et al. See figure 1).

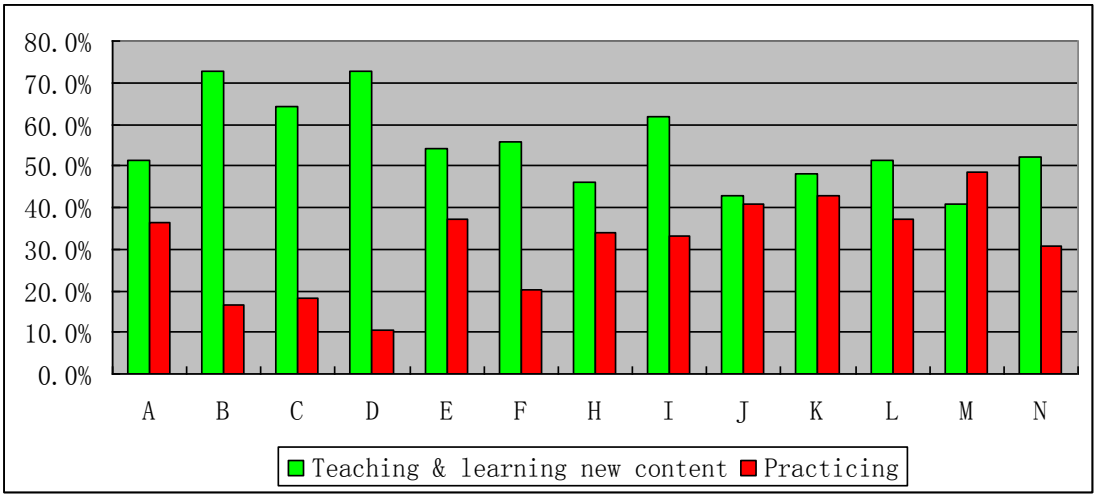

Figure 2. The percentages of time spent on teaching and learning new content and practicing

4.2.3 Most lessons included summary, and some of which were made by students

Except lesson I and lesson L, the other 11 lessons all contained at least one section of summary. There were two types of summary: (1) it took place during the process of teaching and learning and intended to in review the key points of the just learned content or the just accomplished activity; (2) it occurred near to the end of a lesson and intended to review the whole lessons. From figure 1, we can conclude that the lesson A, B, D, H, J, and M used the

first type of summary, while the lesson C, E, F, K, and N used both types of summary. A further analysis found that the teachers always invited students to give summary during the second type of summary. In this occasion, several students reflect what they had acquired in the lesson, including the knowledge and skills, as well as their experience and affection.

4.2.4 Public interaction dominated the lessons

It was found that, although the students had opportunities to explore mathematics knowledge by themselves or to discuss and cooperate with their classmates, most of lesson time was spent on the whole-class work. By referring to the TIMSS 1999 Video Study (Hiebert, et al., 2003, pp. 53-54), two categories of classroom work patterns were used in this study. One is public interaction, in which the teacher and students interact publicly, with the intent that all students give their attention to the presentation by the teacher or one or more students. Another category is private interaction, in which students complete assignments either individually, in pairs, or in small groups. An analysis of the different types of interaction showed that more than 70% of lesson time in the selected lessons was spent in public interaction. The percentage of private interaction in most of lessons was not more than 20%. It was under 10% in seven lessons. This indicates that all these lessons were dominated by public interaction (more details see figure 3).

The private interaction in the 13 lessons included the students discussing or communicating in pairs or groups, working with tasks individually or collaboratively, doing exercise at seat, and reading textbook. The public interaction included presenting information by teachers (such as explaining, questioning, and blackboard writing) and by students (such as answering questions, reporting findings, demonstrating personal or group work). Most of the public interaction took place in the form of dialogue between teacher and students.

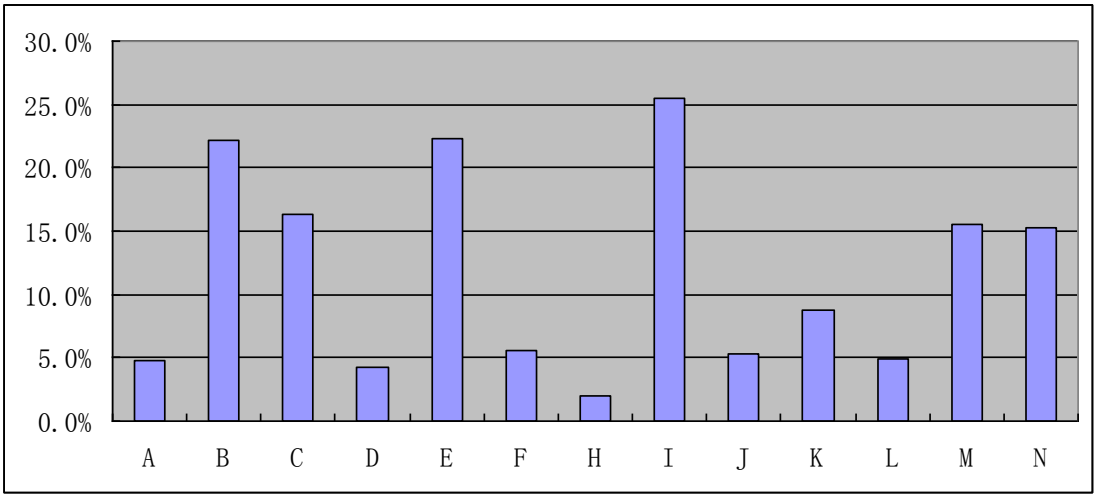

Figure 3. Percentage of time duration of private interaction

4.2.5 Teacher had more opportunities to talk, and students' talking in chorus was obvious

It has found that most of the public interactions were in form of dialogue between teacher and students. The discourse of teacher's and students' was analysed for further examining the dialogue between teacher and students. By watching lesson videos, we found there were four types of talking during the public interaction. They were: (1) the teacher talking individually; (2) single student talking; (3) students talking in chorus without teacher's participation, in which two or more students talked together; and (4) teacher and students talking in chorus, in which the talk made by two or more students accompanied their teacher. In this study, the teacher talking includes both (1) and (4), while the student talking refers to all of the (2), (3), and (4).

All of the discourse during the public interaction were transcribed verbatim, based on the frequency of teacher talking (FT), frequency of student talking (FS), ratio of FT to FS, number of teacher's words (TW), number of students' words (SW), and the ratio of TW to SW were analysed quantitatively. The results are shown in Table 5.

Table 5: The results of quantitative analysis in dialogue during public interaction

	A	B	C	D	E	F	H	I	J	K	L	M	N
FT	214	215	239	184	197	245	147	158	259	396	149	137	154
FS	223	164	217	155	181	210	149	135	205	325	139	118	142
FT : FS	1.0	1.3	1.1	1.2	1.1	1.2	1.0	1.2	1.3	1.2	1.1	1.2	1.1
TW	3336	3921	5007	3596	3915	5739	3525	3456	4030	5238	4080	3218	3985
SW	1753	2015	1629	1842	2130	1621	1451	2125	1834	2114	1587	1656	1433
TW : SW	1.9	1.9	3.1	2.0	1.8	3.5	2.4	1.6	2.2	2.5	2.6	1.9	2.8

As shown in table 3, the ratios of FT to FS ranged from 1.0 to 1.3, which indicates the FT is not much more than the FS. In another words, the opportunity for students talking was near to that for teachers. In addition, the frequencies of student talking in the 13 lessons are all more than 100. This reveals that the students in these lessons were not the passive, quiet listeners.

Regarding the spoken words during the public interaction, it could be seen in table 3 that the ratios of TW to SW in the 13 lessons are different to some extent, among which the highest one is 3.5:1 and the lowest one is 1.6:1. However, the feature that the teachers talked more than their students was shared by all of the lessons. The ratio of average TW to average SW is 2.3:1.

A further analysis in the amount of student talking found that the student talking in chorus (including the chorus accompanied teacher's participation) was frequent. More than 25% of student talking was in chorus. The highest frequency was found in lesson E (66%).

4.2.6 Questioning-responding occurred frequently, but students rarely asked questions

We found that many dialogues between the teacher and students appeared in the way of teacher's asking questions and the students' responding. The frequency of mathematical questioning (not including the questioning for lesson management) during each lesson is all more than 40. The questioning and responding took place not only during teaching and learning new content, but also occurred in other sections of a lesson.

However, nearly all mathematical questions were raised by the teachers. Students' asking question on their own initiative (not including the questioning motivated by teacher's invitation) was found only in three lessons (once in lesson B, once in lesson J, 5 times in lesson A). No student presented any questions in any of the other ten lessons.

5 DISCUSSION AND IMPLICATION

5.1 Discussion

By analysing 13 elementary lessons, we found some features of the exemplary lessons under the curriculum reform in China. On one hand, some of the features were consistent with the ideas advocated by the new curriculum, such as emphasizing on student's overall development, connecting mathematics to real-life, providing students opportunities of inquiring and collaborating, and exploiting various of resources for teaching. These features have demonstrated the possibility of the further improvement of mathematics teaching. If the current curriculum reform could be implemented efficiently and continuously, we may expect that China's mathematics classroom will show many differences from that of the classroom in past decades.

On the other hand, the selected lessons in this study also shared many other common features in the lesson structure, interaction between the teacher and students, classroom discourse. Some of these features are consistent with the findings of other studies on Chinese mathematics classroom. For example, regarding the lesson structure, all the selected lessons began with introducing topic, accompanied teaching and learning new content by practicing, and summarized during the lesson or near to the end of the lesson. This is consistent with the findings of Zhao and Ma (in press)'s comparative analysis of four exemplary lessons in different decades in China. Chen & Li (2010)'s study on a Chinese competent teacher's four consecutive lessons also found that the teacher tended to structure the lesson into reviewing previous lesson, teaching and learning new content, and summary, which resulted in an instructional coherence. Other studies reveal the instructional coherence seems be a characteristics of Asian mathematics classroom. For example, Shimizu (2007) found the summary also played an important role in Japanese mathematics classroom.

The selected lessons in this study also showed a feature that teaching and learning new content was accompanied by practicing. This feature also was found in Zhao and Ma (in press)'s study. It is well known that the Chinese mathematics classroom in the last half of 20th century, had been predominated by the belief that "students should have sufficient exercises in order to consolidate the learned knowledge" (Zhang, Li, & Tang, 2004) and that "practice makes perfect" (Li, 2006). We could not conclude whether the practice in the lessons in this

study was emphasized as much as it was in traditional classrooms, but it is evident that none of the lessons in this study neglected the role of practice.

It was also found that all the lessons in this study were dominated by public interaction, and teachers talked more than their students. These two features are consistent with the findings of TIMSS 1999 Video Study (Hiebert, et al., 2003) on eight-grade mathematics lessons in seven countries. However, it should be noted that the ratio of teacher's words to students' words in this study is 2.3:1, which is much less than the ratio found in TIMSS 1999 Video Study[2]. Based on the data of Learner's Perspective Study (LPS) (Clarke, et al., 2006), Cao, Wang, and Wang (2008) analysed the discourse in Chinese competent mathematics teachers' lessons. It was found the ratio of average teacher words to average students' words is 6.6:1. Taking these findings as a whole, we may hypothesize that the differences might exist in the discourse between classrooms in different stage of schooling.

In addition, the phenomenon of students' talking in chorus found in this study is similar to the findings of Wang (2010)'s study on two elementary mathematics classrooms in China. And the feature of frequent questioning-responding in the lessons in this study also was found in other studies on Chinese exemplary mathematics lessons in different decades (Zhao & Ma, in press; Huang, Pang, & Li, 2009).

By reviewing the existing studies and comparing their findings with the features found in this study, we may find the lessons in this study embodied some elements that might be the stable characteristics of Chinese mathematics education. Stigler and Hiebert (1999, p. 86) pointed out that the teaching is a cultural activity. As a cultural activity, teaching has its relative stability. Therefore, it is understandable that both differences and similarities exist in mathematics lessons of different periods of time.

5.2 Implication

In this paper, we have reported the features of 13 exemplary lessons under the curriculum reform in China. We hope our findings could help you understand the current changes in elementary mathematics classroom. In addition, as noted above, the classroom under the reform not only reveals the new ideas advocated by the reform, it also contains some stable elements that might be inherited from the traditional classroom. This reminds us that the classroom under the reform and traditional classroom are not completely conflicting and exclusive. We should not ignore reflecting upon the tradition while implementing the new ideas. The traditional mathematics classroom may contain the asset that is worth preserving and carrying forward, and may also hide the drawbacks to be discovered. From this point, the teaching reform is a successive and gradual changing process, during which the reflection on present and history is always needed. This is the implication drawn from our study. Perhaps it also could be a reference for mathematics educators in a reform.

Last names of authors in order as on the paper

Note:

[1] Compulsory education at the present time in China includes 9-year schooling from elementary school to junior high school.

[2] In TIMSS 1999 Video Study, the average number of teacher words to every on student word per eighth-grade mathematics lesson in six countries/regions was reported. They were as following: Australia, 9:1; Czech Republic, 9:1; Hong Kong SAR, 16:1; Japan, 13:1; Netherlands, 10:1; and United States, 8:1. (Hiebert, et al., 2003, pp. 109-110)

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