Lin, P. J. & Tsai, W. H. (2005). Teacher factor and its effect on mathematics achievement: Result From TIMSS2003. Paper presented at the Conference of *Japan-Taiwan Bilateral Symposium on the Issues of Enhancing Student's Mathematical and Scientific Capabilities*. Nov.8-10, Taiwan: National Taiwan Normal University.

TEACHER FACTOR AND ITS EFFECT ON TAIWANESE FOURTH-GRADERS' MATHEMATICS ACHIEVEMENT: RESULT FROM TIMSS2003[1]

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ABSTRACT

This paper reports Taiwanese fourth-graders performing in mathematics in TIMSS2003 study. 4661 Taiwanese fourth-graders outperformed their peers in 21 of the other 24 countries and performed lower than their peers in 3 countries (Singapore, Hong-Kong, and Japan). The paper examines the teacher factor affecting on students' performance. The teacher factor includes the information about the requirement for being a mathematics teacher, teachers' background characteristics, and their participation of professional development.

The result suggests that the normal distribution of Taiwanese students is more convergent than the first top performance country Singaporean students. Taiwanese scoring the fourth place in the overall achievement also tends to be the fourth-place in three mathematical content areas, number, algebra, and data and the third place in two content areas, measurement and geometry.

It is found that students outperform were not resulted from teacher's age and years of teaching, but students whose teachers are female performed better in mathematics. Teachers' participation of professional development and types of interaction with their colleagues are not important influence on students' mathematics achievement.

Key words: TIMSS 2003, mathematics achievement, teacher, fourth-grade

[1] The data of the paper is based on the following report:

Mullis, I. V. S., Martin, K. D., Gonzalez, E. J., & Chrostowski, S. J. (2004). *TIMSS 2003 International mathematics report: Findings from IEA's trends in international mathematics and science study at the fourth and eight grades (Eds.)*. Chestnut Hill, MA: TIMSS International Study Center, Boston College.

Lin, P. J. & Tsai, W. H. (2005). Teacher factor and its effect on mathematics achievement: Result From TIMSS2003. Paper presented at the Conference of *Japan-Taiwan Bilateral Symposium on the Issues of Enhancing Student's Mathematical and Scientific Capabilities*. Nov.8-10, Taiwan: National Taiwan Normal University.

INTRODCUTION

TIMSS 2003 is the third in a continuing cycle of international mathematics and science assessments conducted every four years. TIMSS 2003 was administered at the eight and fourth grades. The aim of TIMSS is to improve the teaching and learning mathematics by providing data about students' achievement in relation to different types of curricula, instructional practices, and school environments. TIMSS asks students, their teachers, and their school principals to complete questionnaires about the curriculum, schools, classrooms, and instruction. For fourth grade, 25 countries participated in TIMSS 2003 and 15 participated in TIMSS 1995. A number of participating countries changes in mathematics achievement can be documented over 8 years, from 1995 to 2003. Taiwan is a new country to the TIMSS 2003 study, so that the data of Taiwanese fourth-graders collected in 2003 is unable to measure trends in students' mathematics achievement. However, for Taiwan, the TIMSS 2003 results enable us to compare our fourth graders' mathematics achievement with the other 24 countries around the world. Preliminary analysis of the data has already been carried out by the International Study Center (ISC) in Boston and the national report of Taiwan. In order to capitalize on the rich data set so as to benefit the education community in Taiwan, it is important that secondary analysis of the data relating the mathematics achievement to other factors be performed. Results of the secondary analysis should be able to provide both decision makers and classroom teachers in valuable information on how the curriculum of Taiwan can be better designed and how mathematics teaching can be better conducted.

Therefore, the purpose of the secondary analysis is to learn valuable lessons from our Asian counterparts to update Taiwanese educational system to ensure that it can meet the demands of the new society for people with creativity, critical thinking, and good communication skills. Much has been written about the fact that Asian students show superior performance in international mathematics assessments compared with their non-Asian counterparts. To interpret what the comparative studies results mean and how they may be used to improve student learning in mathematics, mathematics educators attribute the high achievement to the contexts in which students learn. The high achievement of Asian students seems to be a result of a combination of various factors. They identified the factors as mathematics curricula, parental commitment to their children's education, teacher' preparation and in-service support, and the significance of mathematics for every student's successful future.

The role of teachers is critical in children's education. Teacher is central in creating a classroom environment that supports learning mathematics. Whang (2001) explains that the high achievement of Korean students in mathematics than students in

the United States seems to be a result of teacher's preparation. Ng (2001) analyzes that Singaporean students' superior performance is as a result of their initial teacher induction program. Studies have suggested that students learn more when taught by experienced teachers than they do when taught by teachers with just a few years' experience. These studies indicate that teacher preparation and in-service teacher support is an essential factor contributing to students' mathematics achievement. Moreover, information on how teachers allot their time to such activities as lecture-style presentation, teacher-guided student practice, small group work, and independent practice, provides useful evidence about the predominant pedagogic approaches in the classroom. Thus, to perform secondary analysis of the TIMSS 2003 data, the factor of teachers of mathematics that might contribute to the superior performance will be identified between Taiwan and Japan so as to make recommendations on teacher education.

RESEARCH DESIGN

Samples

150 schools and 4661 fourth-grade students drawing randomly from 2154 target population schools and from 73232 target population students participated in the study. The mean age of students tested is 10.2 years old.

At the fourth grade, the aim was to assess students having had four years of formal schooling. Students in most countries average between 10 to 11 years old. The international average of age is 10.3. Students in Asian counties including Singapore, Hong Kong, Japan, and Taiwan averaged 10.3, 10.2, 10.4, and 10.2, respectively.

Design of Students' Mathematics Assessment

The mathematics assessment frameworks for TIMSS 2003 are framed by two dimensions, a content domain and a cognitive domain (Mullis, Martin, Smith, Garden, Gregory, Gonzalez, Chrostowski, & O'Connor, 2003). The five content domains in mathematics are number, algebra, measurement, geometry, and data. The cognitive domains in mathematics define the sets of behaviors expected of students as they engage with the mathematics content. The four cognitive domains include knowing facts and procedures, using concepts, solving routine problems, and reasoning.

In accordance with the framework, 161 items in mathematics are included in 14 student booklets. Not all of the items in the TIMSS 2003 assessment were newly developed for 2003. At fourth grade, 37 multiple-choice items came from 1995, and the remaining 124 new items including 55 multiple-choice and 69 constructed response items from TIMSS 2003. Some constructed-response questions asked for

short answers while others required extended responses with students showing their work or providing explanations for their answers. In scoring the items, correct answers of multiple choice items were worth one point. However, responses to those requiring extended responses were evaluated for partial credit, with a fully correct answer being awarded two points. The total number of score points available for analysis thus somewhat exceeds the number of items. Table 1 shows the distribution of new and trend items in the TIMSS 2003 for fourth graders.

Table 1 Distribution of New and Trend items in the TIMSS 2003 for Fourth Graders

Items Format	Number of items				
	New items	Trend items	Total items	Total scores	% of scores
Multiple choice	55	37	92	92	54%
Constructed response	69	0	69	77	46%
Total	124	37	161	169	100%

In the TIMSS 2003 assessment design, the 161 fourth-grade mathematics items were divided among 14 item blocks labeled M01 through M14. The assessment blocks were assembled to create a balance across blocks and booklets with respect to content domain, cognitive domain, and item format. There were 12 student booklets at fourth grade. On average, there are 6-7 multiple-choice items, 4-5 short-answer items, and 0-1 extended-response items per block at the fourth grade. The total number of items in a block ranges from 10 to 13 at fourth grade.

Table 2 shows the distribution of score points across content and cognitive domains in the fourth-grade mathematics assessment. The percentages of number, measurement, geometry, patterns and relationship, and data are 40%, 20%, 15%, 15%, and 11% respectively. The percentages of knowing facts, using concepts, solving routine problems, and reasoning are 40%, 15%, 20%, 15%, and 11% respectively.

Table 2 Distribution of Scores in TIMSS 2003 by Content and Cognitive Domain

Content domain	Scores of Cognitive domain (items)				Total scores	% of scores
	Knowing facts and procedures	Using concepts	Solving routine problems	Reasoning		
Number	15(15)	17(16)	27(26)	9(6)	68(63)	40%
Measurement	9(9)	3(3)	12(12)	9(9)	33(33)	20%
Geometry	12(11)	8(8)	4(4)	1(1)	25(24)	15%
Patterns and relationship	3(2)	5(5)	9(9)	8(7)	25(24)	15%
Data	0(0)	6(5)	9(9)	3(3)	18(17)	11%
Total scores	39(38)	39(37)	61(60)	30(26)	169(161)	100%
% of scores	23%(23%)	23%(24%)	36%(37%)	18%(16%)	100%	

Table 3 shows the fourth-grade mathematics items and scores by item type and content domain. To facilitate linking to previous assessments, TIMSS 2003 includes items from 1995 in the fourth grade in each content domain. There are 37 trend items from 1995 and 124 items new in 2003 and 80 items in 2003 and 81 secure items for trending in 2007. Approximately half of the items overall and in each content domain are released and half are kept secure.

Table 3 Distribution of Mathematics Items and Scores by Item Type and Content Domain

Content domain	Item type			Items (Scores)		Total Items(scores)	# of released	# of secure
	Multiple choice	Short answer	Extended response	From 1995	New in 2003			
Number	30	31	2	19	44(49)	63(68)	39	24
Measurement	23	10	0	8	25(25)	33(33)	14	19
Geometry	12	11	1	4	20(21)	24(25)	12	12
Pattern and relationship	16	7	1	2	22(23)	24(25)	7	17
Data	11	5	1	4	13(14)	17(18)	8	9
Total items	92	64	5	37	124(132)	161(169)	80	81

Before the translated instruments were administered to students, they went through a rigorous process of translation verification and review to ensure that they were translated accurately and were internationally comparable. TIMSS 2003 recommended that scorers be organized into teams of about six, headed by a team leader. The leader's primary responsibility was to monitor scoring reliability by continually checking and rechecking the scores that scorers had assigned. In constructed-response questions including short answer and extended response, students were required to write their responses. To achieve consistent level, TIMSS 2003 provided training packets with scoring guide and practicing scoring. To provide a rich database for research on students' cognitive processes, various strategies, and common misconceptions, TIMSS develops a two-digit coding scheme to diagnose students' various answers. The first digit registered the degree of correctness while the second digit was used to code the type of correct and incorrect answer given. Each short-answer item or multiple-choice item is scored 1 point and each extended-response item is scored 2 points.

To establish the reliability of the scoring within each country, national research coordinators were required to have a random sample of at least 100 booklets of each of the 12 student test booklets scored independently by tow different scorers. The inter-rater agreement across items was .98 for multiple-choice and .96 for diagnostic items (Martin, Mullis, & Chrostowski, 2004)..

To understand what the scores on the TIMSS mathematics achievement scales mean, TIMSS used scale anchoring to summarize and describe students' achievement at four points on the mathematics scales: advanced benchmark (625), high benchmark (550), intermediate benchmark (475), and low benchmark (400). Table 4 represents the number of items per content area that met one of the anchoring criteria, at each international benchmark, and the number of items that were too difficult for the advance benchmark.

Table 4 Number of Items Anchoring at Each Anchor Level by Content Domain

	Low (400)	Intermediate (475)	High (550)	Advanced (625)	Too difficult to anchor	Total
Number	7	18	22	12	4	63
Measurement	2	5	11	13	1	32
Geometry	5	6	10	2	1	24
Patterns and relationships	1	6	8	4	4	23
Data	2	8	5	2	0	17
Total	17	43	56	33	10	159[a]

a: 2 items by item reviewers were deleted out of 161 items, resulting in 159 items.

Design of Teachers Questionnaires

For a fuller appreciation of what the TIMSS achievement results mean and how they may be used to improve student learning in mathematics, it is important to understand the contexts in which students learn. In addition to testing students' achievement in mathematics, TIMSS collects a range of information about the contexts for learning mathematics. The Contextual Frameworks encompasses five broad areas: curriculum, schools, teachers and their preparation, classroom, activities and characteristics, and students (Mullis, et al., 2003). The teacher questionnaire collected information about the teachers' preparation and professional development, their pedagogical activities and the implemented curriculum.

To collect information from teachers, TIMSS administered a questionnaire in which teachers were asked to provide information about the requirement to be mathematics teacher, teachers' background, training and their instructional practices. The background characteristics of mathematics teachers include age, gender, certification status, and number of years of teaching experience. Three categories of questionnaires to investigated professional development support. Regarding the professional development opportunities provided to teachers in five major areas: supporting implementation of the official curriculum, supporting school-level goals, improving content knowledge, improving teaching skills, and using technology. Teachers' professional development participation includes six different aspects of

mathematics teaching. The third category of professional development is the types of interactions among mathematics teachers including discussion about how to teach a particular concept, working on preparing instructional materials, classroom observation, and classroom to be observed.

The amount of time students spend on homework assignment is an important consideration in examining their opportunity to learn mathematics. TIMSSS 2003 study creates the index of teachers' emphasis on mathematics homework. The index is based on students' responses to two questions about how often hey usually assign mathematics homework and how many minutes of mathematics homework they usually assign. High level indicates the assignment of more than 30 minutes of homework about half of the lessons or more. Low level indicates no assignment or the assignment of les than 30 minutes of homework about half of the lessons or less. Medium level indicates all other possible combinations of responses.

FINDINGS

Mathematics Achievement Across Content Areas

The international average of 495 at the fourth grade was obtained by averaging across the mean scores for each of the 25 participants' countries. Taiwanese fourth-grade students scored 564, exceeding the international average of 495. Taiwanese fourth-graders outperformed their peers in 19 of the other 24 participating countries and performed lower than their peers in 4 countries. Data in Table 5 shows how an Asian country's average achievement in mathematics compared to achievement in the other countries. Based on the data of Table 5, Taiwan placing on the fourth position, but it is located in the third top performing group, since Japan in the third position and Taiwan in the fourth position are not significantly different.

Table 5 Multiple comparison of achievement in Asia countries

	Singapore (594)	Hong Kong (575)	Japan (565)	Chinese Taipei (564)
Singapore		▲	▲	▲
Hong Kong			▲	▲
Japan				△
Chinese Taipei				

▲ significantly higher performance than the comparison country listed.

△ no significantly higher performance than the comparison country listed.

Table 6 shows that Singapore students were outperformed than other participating countries in number, geometry, pattern and relationships, while Japan were outperformed than other countries in measurement and algebra. Taiwanese

fourth-graders' performance of number, patterns and relationships, and data were ranked in the third position and measurement and geometry were ranked in the fourth position. In each mathematics content domain, the first four positions were covered by Asian countries. Japanese students performed best in two mathematics content domains: measurement and data.

Table 6 Multiple Comparison of Achievement in Asian Countries Across Mathematics Content

Mathematics / Countries	Number		Measurement		Geometry		Patterns and Relationships		Data	
	Score (S.E)	Rank	Score (S.E)	Rank	Score (S.E)	Rank	Score (S.E)	Rank	Score (S.E)	Rank
Singapore	612 (6.0)	1	566 (1.6)	2	570 (5.5)	1	579 (5.4)	1	575	2
Hong Kong	574 (3.3)	2	563 (2.7)	3	557 (2.9)	3	568 (3.5)	2	562	4
Chinese Taipei	568 (1.8)	3	557 (1.6)	4	553 (2.5)	4	555 (2.4)	3	564	3
Japan	556 (2.0)	4	568 (1.6)	1	559 (1.9)	2	554 (1.4)	4	593	1
Belgium	549 (1.9)	5	550 (1.4)	5	533 (1.8)	6	542 (1.9)	6	548	7
Netherlands	536 (2.2)	6	545 (2.2)	7	—	—	527	10	553	5
England	—	—	535 (3.3)	10	542 (3.7)	5	—	—	—	—
Hungary	—	—	—	—	—	—	545 (3.7)	5	—	—
International average	495(0.7)		495(0.7)		495(0.7)		495(0.7)		495(0.7)	

Table 7 shows the average scores of Taiwanese in five mathematics content areas. The highest scores to the lowest scores in five content areas students performed were sequenced as number, data, measurement, algebra, and geometry. The data compared to international average to obtain the differences. The differences are more than around 60 score points.

Figure 1 describes further fourth-grade mathematics achievement at each of the international benchmarks. Figure 1 exhibits 99 % of the Taiwanese fourth-grade students reached the low benchmarks while only 16 % of the students reached the advanced benchmark.

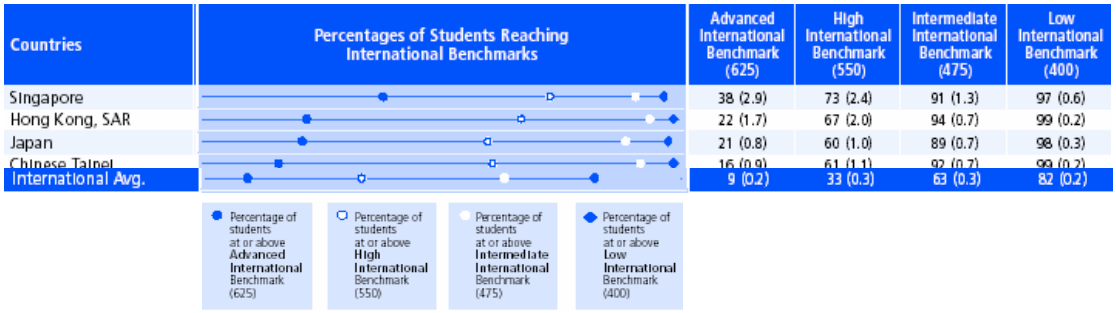


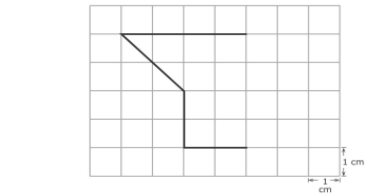
Figure 1 % of Students Reaching TIMSS2003 International Benchmarks of Achievement

The percentage of Taiwanese students reaching the advanced level was half as many as Singaporean (38%) and lower than Hong Kong and Japan as well. Taiwanese students located at advanced, high, intermediate, and low benchmark are 16%, 45%, 31%, and 7% respectively. There was no Taiwanese student without reaching low benchmark. Taiwan had fewer students without reaching the low benchmark than Singapore and Japan. This indicates that the distribution of fourth-graders plotted in normal curve was more convergent than Singapore and Japan.

Students at the advanced benchmark showed the ability to apply their understanding and knowledge in a wide variety of relatively complex situations, while those at the low benchmark demonstrated an understanding of whole numbers, the properties of basic geometric shapes and how to read simple bar graphs. At the advanced benchmark, students show an understanding of area in that they can determine the area of a figure composed of squares and half squares (seen as Table 7). Students also can complete an irregular figure on a grid so that it has a given area, and recognize that does not change when a figure is cut into parts and rearranged.

There are 66% of fourth-grade students performing successfully on the item. Internationally, on average, 29% of fourth-grade students succeed in this item.

Table 7　An Example that Students Reaching the Advanced Benchmark

ID：M031298 Mathematics topic：Measurement（Tools, techniques, and formula） Cognitive domain：Reasoning	Country	% Correct
 The squares in the grid above have areas of 1 square centimeter. Draw lines to complete the figure so that it has an area of 13 square centimeters.	Japan	68（2.1）
	Taiwan	66（1.8）
	Hong Kong	52（2.8）
	Singapore	43（2.2）
	Latvia	43（2.9）
	Lithuania	40（2.5）
	Netherlands	37（2.6）
	International	29（0.4）

Code	**Correct response**	% (Taiwan, International)
10	Lines drawn to give area of 13 square cm	（65.8%, 29.2%）
	Incorrect response	
70	Error due to counting half squares as full square centimeters	（0.7%, 3.4%）
71	One line drawn to close given figure	（5.6%, 9.2%）
72	Symmetrical figure drawn	（6.8%, 18.0%）
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task)	（18.2%, 28.0%）
	Non response	
99	Blank	（2.8%, 12.2%）

At the low benchmark, students can add a four-digit and a three-digit number multiply a two-digit or by a one-digit whole number (seen as Table 8) and subtract two fractions with the same denominator. 94 % of fourth-grade students from Taiwan are outperforming this item with low benchmark.

Table 8　An Example That Students Reaching the Low Benchmark

ID：M031305 Mathematics topic：Whole number Cognitive domain：Knowing fact and procedure	Country	% Full credit
$15 \times 9 =$ Answer: _____	Taiwan	94（1.0）
	Singapore	93（1.0）
	Hong Kong	91（1.0）
	Russian	90（1.3）
	Moldova	88（1.2）
	Lithuania	87（1.7）
	Japan	86（1.6）
	International	72（0.4）

Code	**Correct response**	% (Taiwan, International)
10	135	(93.8%, 72.0%)
	Incorrect response	
79	Incorrect (including crossed out/erased, stray marks, illegible, or off task)	(5.9%, 23.4%)
	Non response	
99	Blank	(0.3%, 4.6%)

Mathematics Teacher Factor Contributing to Mathematics Achievement

Current requirement for being a mathematics teacher

In TIMSS 2003 study found that the Japanese to be a mathematics teacher required highly demand requirements. These requirements include some type of practicum for certification, passing an examination, a university degree, completion of a probationary period, and completion of an induction program. On the counterpart, Taiwanese to be a mathematics teacher do not require completion of an induction program and pass an examination, but the latter is required from Year 2004.

Background characteristics of mathematics teachers

The background characteristics of mathematics teachers include age, gender, certification status, and number of years of teaching experience. Table 9 exhibits the percentages of gender, age, and years of teaching of teachers. Typically, larger percentages of students were taught mathematics by female teachers than male teachers, particularly, at the fourth grade. In TIMSS 2003 study, on average, internationally, four-fifths of the mathematics teaching force was female. However, Japan is not in the case. The proportion of the female teachers of fourth grade to male

is 6:4. On average, students whose teachers are female performed better in mathematics achievement than students whose teachers are male.

The data of Table 9 shows that 44% of the Taiwanese fourth graders are taught by the teachers in age 30 to 39. The age of most of forth-grade students of Taiwan was ranged from 30 to 39, while the age of Japanese fourth-grade teachers was ranged from 40 to 49 and the age of Singaporean was younger than 30. Only Singapore with the most students (more than 40%) was taught by teachers younger than age 30. This indicates that the average age of Singaporean teachers is younger than other Asian countries. Taiwanese fourth-grade teachers' age with more than 50 years old is fewer than the other three Asian countries. Generally, Japanese fourth-grade teachers are older than other three countries.

The data of Table 9 seems to show that the students who were taught by teachers with 40 to 49 years old performed a little better, while the students who were taught by teachers with fewer than 29 years old performed a little worse. The result indicates that there is no positive correlation between teacher's age and students' mathematics achievement. That is, teacher's age was not a factor of influencing students' mathematics achievement.

Regarding the years of teaching experience, Japanese fourth-grade teachers with 19 years of teaching had more experience of teaching than Taiwanese.

Table 9 Relationship Between Students Mathematics Achievement and Teachers' Gender, Age, and Number of Years of Teaching

% of Students by Teacher's Characteristics								
	Country							
	Singapore		Hong Kong		Japan		Taiwan	
	%	Scores	%	Scores	%	Scores	%	Scores
Teacher's Gender								
Female	82	603.5	73	576.5	63	564.6	80	566.1
Male	18	555.0	27	569.5	37	564.5	20	555.4
Teacher's Age								
< 29	41	603.9	34	572.8	11	558.9	26	559.4
30-39	38	582.2	34	578.3	27	562.5	44	562.8
40-49	7	606.6	15	578.2	39	564.4	23	571.2
≥ 50	15	605.7	17	576.5	23	564.8	7	564.8
Years of Teaching	10		13		19		11	

Professional development opportunities for teachers in mathematics

Table 10 shows school's reports about the opportunities provided to teachers in

five major areas. At fourth grade, schools reported that their professional development programs emphasized improving content knowledge and teaching skills. Schools or other organizations in Taiwan provided teachers' opportunities of using information technology for educational purposes were twice as many as Japan.

Table 10 Percentages of Students by Their Teachers' Involvement in Professional Development Opportunity in Mathematics

Percentage / Countries / Activities	Fourth grade			
	Japan		Taiwan	
	3 times or more/year	Never	3 times or more/year	Never
Professional Development Opportunities				
Supporting the implementation of the curriculum	7(2.2)	66(3.7)	3 (1.4)	67(3.8)
Supporting school-level goal	24(3.3)	30(3.7)	25(3.8)	14(2.7)
Improving content knowledge	44(4.2)	9(2.2)	47(4.0)	6(2.1)
Improving teaching skills	49(4.2)	5(1.8)	53(4.3)	4(1.7)
Using IT for educational purposes	23(3.5)	39(4.1)	46(4.1)	4(1.6)

Table 11 also exhibits the teachers' report about their professional development participation in six different aspects of mathematics teaching. The results were not relatively consistent across the six topics: content, pedagogy, curriculum, technology, problem solving, and assessment.

For Japan, the highest percentages were for the areas of content and pedagogy. For Taiwan, the highest percentages were pedagogy, curriculum, and content. Overall, Taiwanese teachers' professional development participation was more frequent than Japanese teachers. However, Taiwanese students did not perform better than Japanese. The result indicates that teachers' participation of professional development was not an important influence on students' mathematics achievement.

Table 11 shows that 50 % of teachers reported their weekly interaction about instructional issues. However, observing other teachers or being observed themselves was relatively infrequent. Table 11 exhibits that the Japanese teachers spent more time on working with their colleagues for the preparation of instructional materials than Taiwanese teachers, 41 % and 24 % respectively. Excepting the interaction of working on preparing instructional materials, the percentages of the types of interactions among Japanese mathematics teachers were as many as those teachers from Taiwan. Again, teachers' interaction with their colleagues in the school was not a significant factor of affecting students' mathematics achievement.

Table 11 Relationship Between Teachers' Involvement in Professional Development Opportunity in Mathematics and Students' Mathematics Achievement

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Countries / Percentage / Activities	Fourth grade							
	Japan				Taiwan			
	Yes		No		Yes		No	
	%	Scores	%	Scores	%	Scores	%	Scores
Teacher's participation in professional development								
Mathematics content	40	565.7	60	563.8	57	562.8	43	565.4
Mathematics pedagogy	43	564.8	57	563.4	73	564.9	27	561.3
Mathematics curriculum	19	561.6	81	565.3	61	564.8	39	562.7
Integrating IT into mathematics	16	559.9	84	565.5	45	561.5	55	565.9
Improving students critical thinking or problem skills	22	568.2	78	563.5	37	566.3	63	562.5
Mathematics assessment	30	562.0	70	565.6	49	565.8	51	562.5
Types of interactions among mathematics teachers								
	Weekly		Never		Weekly		Never	
	%	Scores	%	Scores	%	Scores	%	Scores
Discussion about how to teach a particular concept	52	569.4	11	562.5	54	565.4	2	566.3
Working on preparing instructional materials	41	565.1	14	562.1	24	580.1	25	562.4
Visit to another teacher's classroom	4	590.7	45	562.2	6	562.6	37	563.4
Observing by another teacher	10	569.2	69	562.7	7	573.2	67	562.8

Teachers' Emphasis on Mathematics Homework

Table 12 presents the index of the teachers' emphasis on mathematics homework. On average, internationally, only 14 % of the fourth-grade students were in the high emphasis level. About half (49%) were in the medium category and 37 % were in the low category. In Taiwan and Japan, the fourth-grade students in the high emphasis category had the lowest mathematics achievement, suggesting that homework often was being used for remedial purposes. However, in Singapore, students in the low emphasis level had the highest mathematics achievement. In Hong Kong, students in the low emphasis category had the lowest mathematics achievement. The results show substantial variation across countries in the emphasis placed on homework and contributing to inconstant performance.

There was not a positive relationship between teachers assigning more homework and students having higher mathematics achievement. For the majority of countries, most students were in the medium category. More than half the students of Japan were in the low category. It can be noted that students in Japan may be more likely to spend extra time in tutoring and cramming schools than doing homework.

The data indicates teachers gave students medium assignments contributing to students' highest performance. The medium emphasis means giving students assignment three times in each week and half-hour for each assignment.

Table 12 Relationship Between Students' Mathematics Achievement and Index of Teachers' Emphasis on Mathematics Homework

Emphasis on Homework		Country				
		Singapore	Hong Kong	Japan	Taiwan	Int.
High emphasis	% of students	35 (4.2)	33(4.7)	3(1.5)	11(2.7)	14(0.6)
	Average scores	593(7.7)	575(5.3)	563(7.9)	555(8.4)	491(2.7)
Medium emphasis	% of students	49(3.8)	63(4.7)	40(4.3)	52(4.3)	49(0.7)
	Average scores	596(8.7)	577(4.1)	567(2.4)	568(2.7)	503(1.4)
Low emphasis	% of students	16(2.8)	4(1.7)	57(4.4)	37(3.9)	37(0.6)
	Average scores	598(11.0)	552(8.9)	563(2.5)	561(3.2)	498(2.1)

CONCLUSION

The analysis of TIMSS 2003 study suggests that Asian students showed superior performance in international mathematics assessments compared with their non-Asian counterparts. Overall, background characteristics of teacher are not essential factors contributing to students' superior performance of mathematics, excepting teacher's gender factor. Students' well performance is not the result of teachers' participation of professional development and types of interaction among teachers.

Regarding mathematics achievement from TIMSS 2003 study, it is found that the top four outperforming countries were Singapore, Hong Kong, Japan, and Taiwan, but Japan and Taiwan were not significantly different. The normal distribution of Taiwanese students was more convergent than Singapore. Taiwanese scoring the fourth place in the overall achievement also tended to be the fourth-place in three mathematical content areas, number, algebra, and data and the third place in two content areas, measurement and geometry.

The requirement for being a mathematics teacher in Japan was more demanding than Taiwan. Japanese to be a mathematics teacher required to have induction training and pass an examination for awarding qualified teacher status. On average, internationally, the ratio of female teachers to male teachers was 4:1, but Japan was not in the case. The ratio of Japan female and male teachers was 6:4. The students whose teachers are female performed better than the students whose teachers are male. Teacher's gender contributed to students' mathematics achievement.

Besides, the age of most of the forth-grade students of Taiwan was ranged from 30 to 39, while the age of Japanese fourth-grade teachers was ranged from 40 to 49. Japanese fourth-grade teachers were older and had more experience of teaching than the other three Asian countries, while Singaporean teachers were the youngest of the four Asian countries. On average, Japanese fourth-grade teachers had been taught 19 years and Taiwanese fourth-grade teachers had been 11 years in their teaching career.

The result of TIMSS 2003 indicates that teachers' participation of professional development was not an important influence on students' mathematics achievement. Overall, schools provided teachers professional development programs emphasized on the two aspects: improving content knowledge and teaching skills. Taiwanese teachers' professional development participation was more frequent than Japanese teachers. However, Taiwanese students did not perform better than Japanese. The result indicates that teachers' participation of professional development was not an important influence on students' mathematics achievement.

There was not a positive relationship between teachers assigning more homework and students having higher mathematics achievement. However, teachers gave students medium assignments contributing to students' highest performance. The medium emphasis means giving students assignment three times in each week and half-hour for each assignment.

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