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Why Singaporean Eighth Graders Did Better Among the Asian Nations in the TIMSS Mathematics: A Secondary Analysis

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Abstract

The Asian nations top the list of TIMSS mathematics achievement. This study looks for possible explanation why Singaporean eighth graders did well in TIMSS Mathematics than those of three other participating Asian nations.

The analysis indicates that this could be partly due to home condition and strong social motivation to do well in general and in Mathematics in particular. Homework and highly positive feelings toward Mathematics played a no small role in Singaporean students' achievement. Singaporean students attributed success more to talent or ability but less to hard work..

Singaporean's teachers spent more time on tests and assignments and used daily matters to make Mathematics lessons more relevant to the students. They also made good uses of assessment information to enhance student learning. In short, Singapore's Mathematics achievement is due to the interaction of home environment, motivation reinforced by the social milieu, teacher quality and devotion and the teaching strategies adopted by the teachers.

Introduction

In earlier secondary analyses, Soh (1998, 1999) compared Maths achievement of fourth graders in Three G7 nations (USA, UK, and Canada) with those in three Little Asian Dragons (Hong Kong, Korea, and Singapore). It was found that the Asian students, who outperformed their European counterparts, spent more time learning Maths. Fewer Asian students possessed the educational aids (dictionary, study desk, and computer) but spent more time doing homework. They did not think it is important to have time to have fun and also believed that their mothers and friends held the same attitudes. Asian teachers spent more time on out-

of-class coaching. They taught larger classes and did less practice of computation in their lessons.

A pertinent question to ask is, Given that the Asian students do better than their European counterparts why, then, did Singaporean students did better among their Asian peers?

This present analysis used the data published in the TIMSS report (Beaton, Mulis, Martin, Gonzalez, Kelly, D. L. & Smith, 1996) and compared Singaporean eighth grade students' and teachers' responses with those of Hong Kong, Korea, and Japan. The objective of this analysis is to uncover differences in various relevant measures that could have contributed to the differential performance.

Method

Data gleaned from the various tables in the TIMSS report (Beaton et. al., 1996) are in the form of percentages of students, of teachers, or hours per day or week. They are grouped under student responses (Table 1) and teacher responses (Table 2), covering the following areas:

Table 1. Student response

	Hong Kong	Japan	Korea	S'pore	Mean	SD	ES
Maths achievement							
Maths achievement	588	605	607	643	610.8	23.1	1.4
Boy-girl difference	20	9	17	2	12.0	8.1	-1.2
Home environment							
Educational aids (Dictionary, desk, Computer)	33	NA	38	47	39.3	7.1	1.1
Books at home (More than 200 books)	10	NA	21	12	14.3	5.9	-0.4
Either parent finished university	7	NA	22	8	12.3	8.4	-0.5

Table 1 (…cont'd)

	Hong Kong	Japan	Korea	S'pore	Mean	SD	ES
Student attitudes							
Self: Important to do well in Maths	96	92	94	99	95.3	3.0	1.3
Self: Important to do well in Science	90	87	91	99	91.8	5.1	1.4
Self: Important to do well in Language	96	91	93	100	95.0	3.9	1.3
Self: Important to have time to have fun	94	99	87	96	94.0	5.1	0.4
Self: Important to be good at sports	83	83	86	89	85.3	2.9	1.3
Perception of mothers' attitudes							
Mother: Important to do well in Maths	93	NA	96	99	96.0	3.0	1.0
Mother: Important to do well in Science	86	NA	92	99	92.3	6.5	1.0
Mother: Important to do well in Language	93	NA	94	99	95.3	3.2	1.1
Mother: Important to have time to have fun	74	NA	85	79	79.3	5.5	-0.1
Mother: Important to be good at sports	71	NA	72	84	75.7	7.2	1.2
Perception of friends' attitudes							
Friends: Important to do well in Maths	86	90	86	97	89.8	5.2	1.4
Friends: Important to do well in Science	74	86	79	96	83.8	9.5	1.3
Friends: Important to do well in Language	87	88	81	98	88.5	7.0	1.3
Friends: Important to have time to have fun	93	99	88	98	94.5	5.1	0.7

Table 1 (...cont'd)

	Hong Kong	Japan	Korea	S'pore	Mean	SD	ES
Friends: Important to be good at sports	76	81	78	86	80.3	4.3	1.3
Homework							
Out-of-school hours/day for Maths homework	0.9	0.8	0.8	1.4	1.0	0.3	1.5
More than three hours/day homework	30	28	29	78	41.3	24.5	1.5
Total homework hours/day	2.5	2.3	2.5	4.6	3.0	1.1	1.5
Leisure activities							
TV/video hours/day	2.6	2.6	2.0	2.7	2.5	0.3	0.7
TV/video more than five hours/day	11.0	9.0	7.0	6.0	8.3	2.2	-1.0
Computer games hoursday	0.8	0.6	0.3	0.6	0.6	0.2	0.1
Read a book for enjoyment hours/day	0.9	0.9	0.8	1.1	0.9	0.1	1.4
Views on Maths achievement							
Strongly agree that usually doing well in Maths	5	4	6	11	6.5	3.1	1.4
Like Maths a lot	17	10	14	28	17.3	7.7	1.4
Strong positive overall attitude towards Maths	9	3	5	20	9.3	7.6	1.4
Necessary to do Maths well: Natural talent/ability	77	82	86	84	82.3	3.9	0.5
Necessary to do Maths well: Good luck	38	59	63	41	50.3	12.6	-0.7
Necessary to do Maths well: Hard work	95	98	98	92	95.8	2.9	-1.3
Necessary to do Maths well: Memorise	69	92	73	32	66.5	25.1	-1.4
Need to do Maths well: Get desired job	24	12	13	37	21.5	11.7	1.3

Table 1 (…cont'd)

	Hong Kong	Japan	Korea	S'pore	Mean	SD	ES
Need to do Maths well: Please parents	16	6	11	20	13.3	6.1	1.1
Need to do Maths well: Get into university	32	35	35	51	38.3	8.6	1.5

1. Maths achievement
2. Home environment
3. Student attitudes
4. Perception of mothers' attitudes
5. Perception of friends' attitudes
6. Homework
7. Leisure activities
8. Views on Maths achievement

Table 2. Teacher Response

	Hong Kong	Japan	Korea	S'pore	Mean	SD	ES
Maths teachers							
Male Maths teachers	60	72	55	40	56.8	13.3	-1.3
More than 20 years teaching Maths	15	19	20	48	25.5	15.2	1.5
75% or more time teaching Maths	36	37	10	25	27.0	12.6	-0.2
Hours/week preparing and grading tests	2.4	2.0	1.7	3.4	2.4	0.7	1.4
Hours/week grading students work	3.1	1.8	1.5	4.1	2.6	1.2	1.2
31-40 students per Maths class	56	88	4	72	55.0	36.4	0.5
Instructional strategies							
Reasoning tasks in most lessons	58	55	72	57	60.5	7.8	-0.5
Often use everyday things in problem solving	20	16	13	30	19.8	7.4	1.4

Table 2 (...cont'd)

	Hong Kong	Japan	Korea	S'pore	Mean	SD	ES
Students use calculators almost everyday	67	2	1	82	38.0	42.6	1.0
Students use computer always or pretty often	3	4	2	2	2.8	1.0	-0.8
Homework three times or more often weekly	14	6	18	58	24.0	23.2	1.5
Always collect, correct and return assignments	87	21	28	94	57.5	38.3	1.0
Assessment: To provide grades or marks	72	73	39	71	63.8	16.5	0.4
Assessment: To provide student feedback	82	60	42	87	67.8	20.8	0.9
Assessment: To diagnose learning problems	81	66	65	88	75.0	11.3	1.1
Assessment: To report to parents	13	9	10	39	17.8	14.3	1.5
Assessment: To assign students to tracks	13	29	3	31	19.0	13.4	0.9
Assessment: To plan for future lessons	74	58	56	76	66.0	10.5	1.0

9. Maths teachers
10. Instructional strategies

For each variable, the mean and standard deviation (of percentages) were first calculated and how far Singapore deviates from the mean was shown in terms of effect size. This was done by first finding the difference between Singapore's percentage and the overall mean percentage. The difference was then expressed in standard deviation unit for effect size (ES). Although, the effect size is usually used for experimental studies, it is used here as a convenient index of the magnitude of observed deviation. An effect size of |.5| is considered large enough for attention to be paid to it, in accordance with the research convention.

Results

Student Response (See Table 1)

Maths achievement While Singapore is far above the mean of the four nations, with a positive ES 1.4, it is also unique in that there is a negative ES 1.2 for boy-girl difference in Math achievement. The latter finding suggests that Singapore's standing among the four nations could well have been a contribution of girls' better performance compared with their peers in the other nations. By comparison, Hong Kong has the highest ES +1.0, followed by Korea's +.6, and then Japan's -.4.

Home environment With ES +1.1, Singapore is ahead of Hong Kong and Korea (Japan's data not available) in the availability of educational aids (dictionary, study desk, and computer), though not in terms of books at home (ES -0.4). In terms of parents' educational level Singapore (ES -0.5) is on par with Hong Kong while both nations are far below that of Korea (ES +1.2). These suggest that while Singapore students might have been advantaged in the availability of educational aids, they might have been disadvantaged by the lower percentage of either parent being a university graduate.

Student attitudes Student attitudes are highly positive in all four nations. However, Singaporean students are ahead in the importance they placed on doing well in Maths (ES +1.3), Science (ES +1.4), and Language (ES +1.3) and to be good at sports (ES +1.3). On the other hand, where the importance to have time to have fun is concerned, Singaporean students (ES +0.4) are very much like those of the other nations. These findings might well reflect the high achievement motivation or general competition orientation of Singaporean students.

Perception of mothers' and friends' attitudes The students of three nations (excluding Japan) perceived their mothers' attitudes being highly positive, consistent with their own attitudes. However, Singaporean students perceived their mothers' attitudes to be even more positive (ES's +1.0 for Maths, +1.0 for Science, +1.1 for Language, and +1.2 for sports). The exception is with the attitude to have time to have fun, for which Singaporean mothers were not different from those of Hong Kong and Korea, in the eyes of the students.

Here, again, the Singaporean students' attitudes are more positive than those of the other three nations, while the attitudes are generally highly positive (ES's +1.4 for Maths, +1.3 for Science, +1.3 for Language, and +1.3 for sports). As for importance to have time to have fun, Singaporean students were higher than the

average, with ES +0.7, and practically on par with Japanese students. Here, Korea has the lowest ES –1.3, followed by Hong Kong (ES -0.3).

The above findings suggest that the Singaporean students attitudes could well have been influenced by those of their mothers and friends. Taking these together, it is obvious that strong achievement motivation or general competition orientation is a norm of Singapore.

Homework On all three measures of homework, Singapore is above the average for the four nations. Singaporean students spent almost twice as much time on homework in Maths as well as in general when compared with students of the other three nations. Moreover, the percentage of Singaporean students who did homework for more than three hours daily is more than double when compared with the other nations. ES's are all +1.5 for Singapore. It is highly probable that this is a crucial factor contributing to Singapore's high achievement in TIMSS mathematics, as the time-on-task literature would suggest.

Leisure activities Interestingly, while Singapore students spent more time doing homework, they also had more time for leisure activities such as watching TV or video (ES +0.7) and reading a book for enjoyment (ES +1.4). There is an indication of a better-controlled use of TV/video among Singaporean students (especially when compared with Hong Kong). The percentage of Singaporean students spending more that five hours a day on such activity is the lowest (ES -1.0), although practically on par with that of Korea. However, where time spent on playing computer games is concerned, Singaporean students (ES +1.0) are not different from those in the other nations. Obviously, Singaporean students somehow managed to have a more balanced allocation and interest in the use of their spare time, if they have at all.

Views on Maths achievement Proportionately more Singaporean students felt that they were doing well in Maths (ES +1.4). By comparison, much more Singaporean students liked Maths a lot (ES +1.4) and held a strong positive overall attitude towards the subject (ES+1.4). It is also interesting that Singaporean students attributed their success in Maths to having natural talent or ability (ES +0.5) but not to good luck (ES -0.7), hard work (ES -1.3), and memorization (ES -1.4). Also, more Singaporean students were motivated to do well in Maths for getting a desired job (ES +1.3) pleasing their parents (ES +1.1) and getting into the desired university in the future (ES +1.5). These suggest a mixed picture of the Singaporean students' views on Maths. While their views are generally positive reflecting their confidence and interest, their attribution of maths achievement solely to natural talent or ability is worrisome, as the "talent account" of

outstanding performance in various fields has recently been seriously doubted (Howe, 1999). Attributing success to inborn talent or ability, thus de-valuing hard work, is also inconsistent with the Asian work ethic that emphasizes conscientious effort and perseverance.

Teacher Response (See Table 2)

Maths teachers Singapore had the lowest percentage of male Maths teachers among the four nations (ES –1.3) but the highest percentage of highly experienced Maths teachers who have taught Maths for more than 20 years(ES +1.5). However, only one quarter of Singaporean Maths teachers spent 75% or more of their teaching hours teaching Maths (ES -0.2), in comparison to more than one third of teachers in Japan (ES +1.8) and Hong Kong (ES +0.7). It is worthy of note that Singaporean teachers, by comparison, spent much more time on preparing and grading tests and reading and grading students' work (ES +1.4). On average, Singaporean teachers spent 3.4 hours per week on this task, the highest of the four when compared with 1.7 h/w for Korean, 2.0h/w for Japanese, and 2.4h/w for Hong Kong teachers. Moreover, Singaporean teachers also spent 4.1 hours per week reading and grading students' work (ES +1.2), again, the highest of the four when compared with 1.5h/w for Korea, 2.0h/w for Japan, and 3/1h/w for Hong Kong. However, 72% of Singaporean Maths teachers had classes of 31-40 students (ES +0.5), somewhat lower than 88% for Japan but definitely higher than 56% for Hong Kong and, especially, 4% for Korea. Putting the two together, it is salutary that in spite of large class size, the Singaporean teachers were able to manage with about 7 hours per week on assessing and marking students' tests and exercises. The time thus spent should enable the teachers with information for monitoring and modifying their own instruction and to provide timely feedback to students in terms of their progress.

Instructional strategies The proportion of teachers incorporating reasoning tasks in most Maths lessons is about the same for Singapore (ES –0.5), Hong Kong, and Japan, while it is much lower than that of Korea (ES +1.5). However, more Singaporean teachers often used everyday things in Maths problem solving (ES +1.4). At the same time, much more Singaporean teachers allowed their students to use calculators in their classes (ES +1.0), especially in contrast with Japan and Korean teachers, although the use of computers in Maths lessons was rather rare in all four nations, averaging only 2.8% for four nations. (Incidentally, the TIMSS was conducted before Singapore introduced her IT Master Plan in the school in 1997. The Plan provides for equipping all schools with computers and training of teachers of all subjects in the use of IT. All teachers are also expected to include IT-based lessons in their teaching.)

Homework played a more important role in Singaporean teachers' teaching strategies (ES +1.5) than in the other nations', with 58% of Singaporean teachers setting three times or more often weekly homework requiring more than three hours of student time. Comparatively speaking, this is very high when the percentages of teachers doing so are only 6% for Japan, 14% for Hong Kong, and 18% for Korea. In connection with this, more than 94% of Singaporean teachers always collected, corrected, and returned assignments to their students (ES +1.5), followed closely by Hong Kong (87%, ES +0.8). However, the percentages for Japan and Korea are rather low, 6% and 18% respectively.

It is interesting to see how Singaporean teachers made use of the assessment information which they spent so much time and effort to obtain. By comparison, Singaporean teachers made more uses of assessment information for various instructional purposes including to provide students with feedback (ES +0.9), to diagnose learning difficulties (ES +1.1) , to report to parents (ES +1.5), to assign students to programmes or tracks ES +0.9), and to plan for future lessons (ES +1.0).

The overall impression of instructional strategies is that, by comparison. Singaporean teachers made Maths learning more meaningful to their students by relating Maths problems to everyday life, allowed the use of calculators in Maths lessons, set and marked students' work consistently, and made assessment information serve some instructional ends.

Conclusion

This study begins with a simple question, Why Singaporean eighth graders did well in TIMSS Maths than those of three other participating Asian nations. As is true of many other investigations into educational phenomena, the answer is much more complex than expected. As the TIMSS is correlational but not experimental in design, assigning of a causal status to any particular variable has to be done with due caution.

Notwithstanding this, the analysis suggests that the outstanding Maths achievement of Singaporean students could be partly due to favourable home condition (as reflected in the availability of educational aids, serving as a proxy measure of it). The strong motivation, social in nature, to do well in general and in Maths in particular, could also be a contributing factor (as reflected in the students' attitudes which are reinforced by the students' perceptions of their mothers' and

friends' attitudes). The amount of homework the Singaporean students had to work on and their highly positive feelings toward Maths would have played a no small role in their achievement. The reasons for them to do well are an added factor. However, the Singaporean students attributed success more to natural talent or ability but less to hard work. As this view is not consistent with the finding of attribution research and the society's value, it is a problem that mathematics educators of Singapore may have to address.

Much of the Singaporean success should be credited to her teachers. They are not only more experienced but also spent more time on tests and assignments, in spite of the class size. Although they did not emphasize reasoning in Maths lessons more than teachers in the other nations, they used daily matters to make Maths lessons more relevant to the students. Strategically important, they made good uses of assessment information to modify their teaching and enhance student learning. Such effort beyond classroom teaching could well be crucial in propelling Singaporean students to excel in Maths in the international arena.

Achievement in Maths, as is true of any other educational achievement, is a multi-faceted phenomenon. As this analysis shows, it takes many ingredients to attain a level of excellence. Going by the findings reported here, Singapore's Maths achievement is the outcome of the interaction of home environment, student motivation (reinforced by the social milieu), teacher quality and devotion and the teaching strategies adopted by the teachers.

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