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Singapore Primary School TIMSS Data: Data Representation, Analysis and Probability and Patterns, Relations and Functions

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Abstract

This is the final article on the performance of Singapore's population 1 students in the Third International Mathematics and Science Study (TIMSS). Students' performance on Data Representation, Analysis and Probability and Patterns, Relations and Functions show some clear trends. They are: (1) Primary four (Upper grade) students outperform primary three (Lower grade) students; (2) Singapore's population 1, i.e. primary school, students outperform their corresponding International cohort; (3) Girls outperform boys on Data Representation, Analysis and Probability, but the results are mixed for Patterns, Relations and Functions; and (4) Boys tend to leave questions blank more often than girls.

Finally, the analysis of the data from all the topics shows that students perform well in routine situations. They have difficulty comprehending concepts or applying information in non-familiar contexts and the school curriculum operates as an upper limit on the mathematics they learn. Activities that address these difficulties need to be integral part of the school curriculum.

This is the final paper in the series examining the performance of Singapore students in the Third International Mathematics and Science Study (TIMSS). The previous two papers reviewed the performance on Whole Numbers, and Fractions and Proportionality (Kaur and Pereira-Mendoza, 1999) and Geometry, and Measurement, Estimation and Number Sense (Pereira-Mendoza and Kaur, 1999). This paper will review the last two content strands: (1) Data Representation, Analysis and Probability and (2) Patterns, Relations and Functions and provide a summary of the key conclusions from the three papers. As with all

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the papers the following analysis is based *solely on the released items* (Website: http://wwwcsteep.bc.edu/timss; IEA: TIMSS, 1997).

The Data Representation, Analysis and Probability Data

There were a total of 9 released items on Data Representation, Analysis and Probability (4 multiple choice, 2 short answer and 3 extended response). The data of these items show some of the same trends discussed in the other papers.

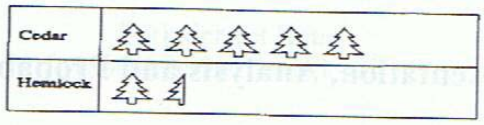
(a) *Primary 3 versus Primary 4.* The primary four students performed better than primary three on all the items except item L1 (74% correct for primary three versus 60% correct for primary 4). This item dealt with pictographs and required pupils to find the scale of a complete pictograph which displayed the given data. It is possible that since primary three students had been introduced to this topic more recently, they would have recalled more easily the procedure to solve the problem.

Table 1. Performance on Data Representation, Analysis and Probability Items *

Item	Primary 3 (%)	Primary 4 (%)	Grade 3 (%) (International)	Grade 4 (%) (International)
J3	77	90	62	75
K4	49	69	34	50
L2	44	60	40	51
M1	60	70	69	78
L1	74	60	34	49
M2	56	73	39	55
S1	46	73	24	41
T1a**	90	95	60	75
T1b**	63	80	19	37

* All figures show the percentage of students responding correctly.
** Item T1 had two parts

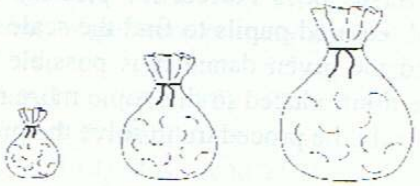
L1. **The graph shows 500 cedar trees and 150 hemlock trees.**



How many trees does each  **represent?**

Answer: _____

L2. There is only one red marble in each of these bags.



10 Marbles 100 Marbles 1000 Marbles

Without looking in the bags, you are to pick a marble out of one of the bags. Which bag would give you the greatest chance of picking the red marble?

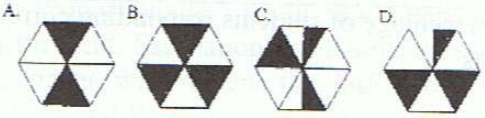
A. The bag with 10 marbles

B. The bag with 100 marbles

C. The bag with 1000 marbles

D. All bags would give the same chance.

M1. Samantha drops a stone onto each of these targets. The stone has the best chance of landing on a shaded space in which target?



(b) *Singapore versus the International cohort.* The Singapore students outperformed the International cohort on all items except item M1 (Table 1). Item M1 deals with probability, a topic that is not part of the Singapore Primary School Mathematics Curriculum (Curriculum Planning Division, 1995). Item L2 also deals with probability, but the students performed better than their International counterparts on this item. There is no obvious reason for the differences in relative performance between the local and international cohort and since the students were not interviewed, the authors can only speculate as to the reason. It is worth noting that students would be familiar with the presentation of item M1 from their experience with fractions and this may explain the better performance of the students on item M1 as compared to item L2.

(c) *Performance of boys versus girls.* Singapore girls outperformed the boys on 6 of 8 items (with one item equal) at primary three and 7 of 9 items at primary four (Table 2). The differences are not large, but the trend implies that at this level girls do better than boys, which is a similar result to that for whole numbers (Kaur and Pereira-Mendoza, 1999).

Table 2. Performance of Singapore Students (Data Representation, Analysis and Probability) – Boys versus Girls *

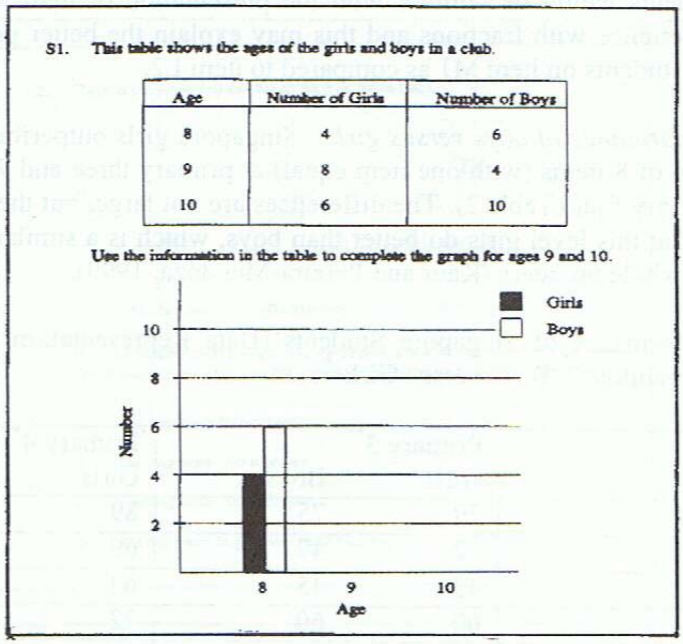
Item	Primary 3**		Primary 4**	
	Girls	Boys	Girls	Boys
J3	79	75	89	90
K4	52	47	69	70
L2	43	45	62	59
M1	60	60	72	69
L1	61	60	76	73
M2	58	54	78	69
S1	48	44	77	69
T1a***	91	89	96	94
T1b***	65	61	82	79

* Number of boys and girls varies between items and levels. There were between 900-950 boys and 800 – 850 girls writing any individual item at a specific level.

** All figures show the percentage of students responding correctly.

*** Item T1 had two parts

(d) *Leaving answers blank.* In most cases Singapore students answered the questions. However, in the few cases where the questions were not answered, boys were more likely than girls to do so. This is the same pattern as reported in the previous papers. It is of interest to note that on one item, S1, there was a large percentage of blank answers at primary three, with 11% of girls and 12% of boys leaving it blank. This involved completing a bar graph with one pair of bars given and the data presented in a table. Such a task would be unfamiliar to primary three students and they may have had no strategy to attempt this extended response item.



S1. This table shows the ages of the girls and boys in a club.

Age	Number of Girls	Number of Boys
8	4	6
9	8	4
10	6	10

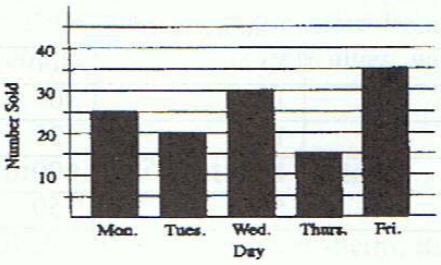
Use the information in the table to complete the graph for ages 9 and 10.

The authors will now discuss some specific items.

Results on some specific data representation, analysis and probability items

Only on the first part of item T1 (i.e. part a) did the students have a high percentage of correct responses, over 90% for both primary three and primary four. This part of the item required students to read data directly from a bar graph.

T1. **The graph shows the number of cartons of milk sold each day of a week at a school.**



How many cartons of milk did the school sell on Monday?

Answer: _____

How many cartons of milk did the school sell that week? Show your work.

Answer: _____

The performance on the following items (L2, M1, K4 and M2) was considerably lower. The reasons for the relatively low performance on the probability items (L2 and M1) were discussed earlier in the paper.

Item K4 has a low level of performance at primary three (49% correct) and a better, although not particularly high level of performance at primary four (69% correct).

K4. Kyle and Bob are playing a game. The object of the game is to get the highest total of points. This chart shows how many points each scored.

Scoreboard

Player	Kyle	Bob
Round 1	125	100
Round 2	125	125
Round 3	150	100
Round 4	50	150

Who won and by how much?

A. Bob won by 250 points
B. Bob won by 100 points
C. Kyle won by 25 points
D. Kyle won by 175 points

Since there does not appear to be any obvious concept that would have caused problems, the difficulty may have been in interpreting the language in the problem. Another item, M2, involved a two-step word problem based on a table and again the performance was not particularly good. The difficulty might be caused by word problems, per se, rather than decoding data from a table.

M2. A team is selling raffle tickets. The table shows how many tickets they have sold so far.

Player's Name	Number of Tickets Sold
Carlos	4
Maria	7
Bill	3
Ted	7
Faye	6
Abby	9

They need to sell 60 tickets altogether. How many more tickets must they sell?

Answer _____

Singapore students did relatively well on data representation, analysis and probability items and better than their International counterparts. The data does not indicate specific difficulties with statistical concepts. There were some difficulties with probability, as expected since it is not part of the primary school mathematics curriculum. Difficulties may stem more from a lack of familiarity with the concepts or word problems than difficulties with topics of data or probability.

The Patterns, Relations and Functions Data

There were a total of 8 released items on Patterns, Relations and Functions data (7 multiple choice and 1 short answer). As with previous strands there are some clear trends.

(a) Primary 3 versus Primary 4. As with all other topics primary four students performed better than primary three (Table 3).

Table 3. Performance on Patterns, Relations and Functions Items*

Item	Primary 3 (%)	Primary 4 (%)	Grade 3 (%) (International)	Grade 4 (%) (International)
I7	57	74	49	62
J5	43	54	27	39
K3	50	65	37	53
K6	65	74	52	63
L4	72	84	61	72
L9	60	71	55	63
M9	73	86	55	70
U4	70	77	41	57

* All figures show the percentage of students responding correctly.

(b) *Singapore versus the International cohort.* The primary three and primary four outperformed their corresponding International cohort on all items (Table 3).

(c) *Performance of boys versus girls.* This comparison produced different results from that for data representation, analysis and probability. Girls

outperformed boys and vice-versa on approximately the same number of items (Table 4). However, the differences are not large.

Table 4. Performance of Singapore Students (Patterns, Relations and Functions) – Boys versus Girls *

Item	Primary 3 **		Primary 4 **	
	Girls	Boys	Girls	Boys
I7	58	56	79	68
J5	43	42	52	56
K3	48	52	63	66
K6	66	64	73	74
L4	74	70	88	84
L9	57	64	69	74
M9	72	73	88	85
U4	72	69	79	76

* Number of boys and girls varies between items and levels. There were between 900-950 boys and 800 – 850 girls writing any individual item at a specific level.

** All figures show the percentage of students responding correctly.

(d) *Leaving answers blank.* As with all the other topics there were relatively few blank answers, but again the data shows that girls are less likely to leave an answer blank than boys.

Again the overall data shows that Singapore students did well relative to the International cohort, but there were no items with exceptionally high or low performance. The authors will now focus on some specific items.

Results on some specific Patterns, Relations and Functions items

Items such as L4 and U4 where the students did relatively well are routine type patterns.

L4. These shapes are arranged in a pattern.

○△○○△△○○○△△△

Which set of shapes is arranged in the same pattern?

A. ★□★□★★□□★★□□

B. □★□□★□□□★□□□□

C. ★□★★□□★★★□□□

D. □□★★□★□□★★□★

U4. There numbers are part of a pattern

50 , 46 , 42 , 38 , 34 , …

What do you have to do to get the next number?

Answer: _____

The performance was lowest on items J5 and K3.

J5. What do you have to do to each number in Column A to get the number next to it in Column B?

Column A	Column B
10	2
15	3
25	5
30	10

A. Add 8 to the number in Column A
B. Subtract 8 from the number in Column A
C. Multiply the number in Column A by 5
D. Divide the number in Column A by 5

K3. Which pair of numbers follows the rule "Multiply the first number by 5 to get the second number?

A. 15 → 3
B. 6 → 11
C. 11 → 6
D. 3 → 15

It is possible that the presentation format/question may not be familiar to the students and have caused some confusion. For example, in item K3 most students who select the wrong answer chose A. This suggests that they comprehend the relationship of multiplying by five but may have misinterpreted what the arrow implies.

L9. Henry is older than Bill, and Bill is older than Peter. Which statement must be true?

A. Henry is older than Peter?
B. Henry is younger than Peter?
C. Henry is the same age as Peter?
D. We cannot tell who is oldest from the information?

Item L9 required students to apply logical reasoning to select the true statement. The performance was reasonably good. The most common incorrect response was D. This suggests that these students are able to realise that the conditions suggested in B and C are not true, but are not able to make the leap to the logical conclusion that A ***must*** follow.

Conclusions

The three papers have analysed the six content topics within the TIMSS population 1 data. It is clear from the analyses that Singapore students did well relative to their International counterparts, primary four students outperformed primary three students on most items and girls performed better than boys on most topics. The conclusions that have specific implications for teaching are:

(a) Students do not perform well on content that is not an integral part of the local curriculum. The school curriculum operates as an upper limit on the mathematics that students learn.

(b) Students have difficulty where the language or terminology may be difficult or unfamiliar.

(c) Students have difficulty with items that require them to comprehend concepts or apply information is non-familiar contexts. Many of the items that were included in TIMSS would be of a routine nature for Singapore students.

Implications for teaching

The previous articles included some specific activities that would help overcome difficulties within the specific topics. As a conclusion the authors are suggesting some general considerations for teaching mathematics.

1. Focus instruction on relational understanding and not instrumental understanding (Skemp, 1976). As Kaur and Yap (1999) noted proficiency in mathematics is necessary but not sufficient requirement to be able to apply mathematics. What is being suggested is a refocusing on mathematics instruction. It is not a matter of replacing routine skills, it is a matter of providing a greater balance between skills and concept development.

2. Terminology plays an important role in mathematics. However, some terminology is usually not used outside the classroom (e.g. fractions), while other terminology may have a different or looser meaning in everyday life than in mathematics (e.g. chance). The terminology needs to be carefully developed being cognisant of the fact that pre-existing meanings may exist for the student.

3. Students need experience of applying mathematics in both familiar and unfamiliar contexts. Activities involving both familiar and unfamiliar contexts need to be an integral part of the school mathematics curriculum. Exposing students to a variety of contexts provide them with an opportunity to use their "skills" in different situations.

4. As well as varying the context, students need experience with problems that are posed in verbal, symbolic and pictorial form.

Soh (1999) claims that hardworking teachers and pupils and a sound mathematics curriculum may be the reasons Singapore students outshine their international peers in mathematics tests. The three papers in the series that examined the performance of primary three and primary four Singapore students in the Third International Mathematics and Science Study (TIMSS) do not refute Soh's claim. They show if our pupils are to progress further there needs to be a shift in the focus of current pedagogical practices in our primary mathematics classrooms.

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TIMSS Website: http://wwwcsteep.bc.edu/timss.