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## **TIMSS - Students' and Teachers' Perspectives on Mathematics Instruction in Singapore Schools**

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**Abstract:** *As part of the Third International Mathematics and Science Study (TIMSS), 14 140 primary school students and 8238 secondary school students in Singapore completed the student questionnaire in 1994. This questionnaire sought their perceptions on how they were learning mathematics in school, spending their time in and out of school and also information on some background variables such as family size, expectations of parents and teachers, and socio-economic status. As part of the same study 380 primary school teachers and 272 secondary school teachers too completed the teacher questionnaire in 1994. These teachers were then teaching mathematics to the students in the study. The teacher questionnaire sought data on background variables such as age, gender, qualifications, and so on; and on pedagogical practices and concerns of the teachers. This paper will report on the findings of the surveys and shed light on students' and teachers' perspectives on mathematics instruction in Singapore schools (primary and secondary).*

### **Introduction**

The TIMSS study provides a wealth of data on achievement, attitudes, classroom practice, and so on, in mathematics. The achievement data of Singapore students has been reported in other papers (Kaur & Pereira-Mendoza, 1999a, 2000a, 2000b); Pereira-Mendoza & Kaur, 1999b, 1999c) as well as the findings from the student questionnaires at a conference (Kaur & Pereira-Mendoza, 1999d).

This paper will focus on some of the findings that were derived from the student and teacher questionnaires. Altogether 14 140 primary school students (primary three and primary four) completed the Population 1 Student Questionnaire (IEA:TIMSS, 1994a) and 8238 secondary school students (secondary one and secondary two) completed the Population 2 Student Questionnaire (IEA:TIMSS, 1994b). These questionnaires provide researchers with a student's perspective of the educational environment in Singapore, particularly as it relates to mathematics learning.

Teachers then teaching mathematics to these students too completed a questionnaire each. Three hundred eighty primary school teachers completed the Population 1 Teacher Questionnaire (IEA:TIMSS, 1994c) and 272 secondary school teachers completed the Population 2 Teacher Questionnaire (IEA:TIMSS, 1994d). These questionnaires provide researchers with a teacher's perspective of the educational environment in Singapore, particularly as it relates to mathematics learning.

The following analysis is based *solely on released data available on the WWW* (Website: <http://wwwwcsteep.bc.edu/timss>). Please note that all the percentages in the following are approximate, but are accurate to the nearest percent.

### **Mathematics Instruction - Students' Perspective**

Students in Population 1 were 9 years of age and were either in their third or fourth year of primary school. Students in Population 2 were 13 years of age and were either in their first or second year of secondary school. Students in both populations were asked how often the following happened in their mathematics lessons:

- the teacher shows us how to do mathematics problems;
- we copy notes from the board;
- we have a quiz or test;
- we work from worksheets or textbooks on our own;
- we work on mathematics projects;
- we use calculators;
- we use computers;
- we work together in pairs or small groups;
- we use things from everyday life in solving mathematics problems;
- the teacher gives us homework;
- we can begin our homework in class;
- the teacher checks homework;
- we check each other's homework; and
- we discuss our completed homework.

Secondary students responded by indicating whether the above happened almost always, pretty often, once in a while or never while primary students responded by indicating whether the above happened in most lessons, some lessons or never. This makes the direct comparison of the results difficult. In the following discussion, unless stated otherwise the percentages for secondary students are those who indicated that the activity mentioned almost always happens or pretty often happens. For primary students the results are usually discussed in terms of the combined percentages, but the breakdown for most and some lessons is given to provide the reader with more accurate information.

Teachers show students how to do problems in virtually all lessons (95% for secondary, 65% for most primary lessons and 33% for some primary lessons). Students copy notes from the board more often in the primary classes than in the secondary classes (57% for secondary, 21% for most primary lessons and 56% for some primary lessons). The teacher assigns homework (95% for secondary, 70% for most primary lessons and 25% for some primary lessons) and checks the homework (85% for secondary, 67% for most primary lessons and 25% for some primary). Students discuss their completed homework more often in the primary classes than the secondary classes (59% for secondary, 49% for most primary lessons and 42% for some primary lessons). Students begin their homework in class more often in the primary classes than in the secondary classes (56% for secondary, 27% for most primary lessons and 57% for some primary lessons). The teacher checks homework far more often than the students check each other's homework.

Another important factor is 70% of secondary students indicated that they had a quiz or test almost always or pretty often during mathematics lessons. As for the primary students 24% indicated this happened in most lessons while 71% indicated this happened in some lessons. During mathematics lessons 65% of secondary students indicated that they worked from worksheets or textbooks on their own. As for the primary students 42% indicated this happened in most lessons while 47% indicated this happened in some lessons.

Working in pairs or groups is not that common, with only 15% of the secondary students indicating that this occurred. Even for primary students 25% indicated that it never occurred and only 9% indicated that it occurred in most lessons. Eighty percent of secondary students used calculators in their classes while 90% of primary students never used calculators in their classes. Computers were rarely used in secondary classes with 90% indicating they were never used. For primary classes 60% of students indicated that they were never used and 30% indicated that they were used in some lessons. It should be noted that at the time of carrying out this study many schools did not have computer labs, but this has changed drastically with all students spending some time on using the computer for mathematics. Less than 50% of the secondary students indicated that they used things from everyday life in solving mathematics problems. For primary students 28% indicated that everyday life situations were used in most lessons and another 55% indicated they everyday life situations were used in some lessons. Students in the secondary classes seldom worked on mathematics projects (7%) while for students in the primary classes 9% did mathematics projects in most lessons and 30% did them in some lessons.

Only the Population 2 (secondary) students were asked how often the following happened when they began a new topic in mathematics:

- the teacher explain the rules and definitions;
- discuss a practical or story problem related to everyday life;
- work together in pairs or small groups on a problem or project;
- the teacher ask us what we know related to the new topic;
- look at the textbook while the teacher talks about it; and
- try to solve an example related to the new topic.

Students responded by indicating whether these happened almost always, pretty often, once in a while or never. In the following discussion, unless stated otherwise the percentages are those who indicated that the activity mentioned almost always happens or pretty often happens.

It appears that in the secondary classes a new topic in mathematics was very often introduced via the teacher explaining the rules and definitions (94%); students trying to solve an example related to the new topic (80%); and students looking at the textbook while the teacher talks about it (75%). About half (51%) of the students indicated their teacher asked them what they knew related to the new topic when beginning it. Students did not often discuss a practical or story problem related to everyday life (34%) nor work together in pairs or small groups on a problem or project when beginning a new topic in mathematics (14%).

### **Mathematics Instruction – Teachers' Perspective**

A total of 652 mathematics teachers from Singapore participated in TIMSS. Three hundred eighty primary school teachers of which 65 were male and 315 female completed the Population 1 Teacher Questionnaire and 272 secondary school teachers of which 114 were male and 158 female completed the Population 2 Teacher Questionnaire. All the teachers were teaching full-time. In both groups of teachers 64 % had more than 10 years of teaching experience and 99 % had a teaching qualification. 60% of the secondary school teachers were above the age of 39 years while 52% of the primary school teachers were in the same age range. Fifty-five percent of the secondary school teachers had a university degree as an academic qualification while only 9% of the primary school teachers had similar academic qualifications.

Data collected from the teachers is discussed under the following headings: Knowledge of Curriculum / Professional Development, Lesson Planning, Classroom Teaching, and Homework. The perspectives of the Primary School teachers are followed by those of the Secondary School teachers.

## **Primary School Teachers' Perspectives**

### **Knowledge of Curriculum / Professional Development**

Almost all the teachers (99%) were familiar (fairly or very) with the National Curriculum Guide for Mathematics (i.e., Ministry of Education's Mathematics Syllabus document), their School's Curriculum Guide and the National Examination Specifications (i.e., the Primary School Leaving Mathematics Examination Papers and their format). Textbooks used in Singapore schools have to be approved by the Ministry of Education. Approval is usually granted for textbooks that adhere closely to the National Curriculum. All the teachers used a textbook for their teaching and 63% of them used it at least half the time in their classes. Eighty-nine percent of them also meet the other mathematics teachers in their school to discuss and plan curriculum or teaching approaches at least once in ten weeks. Three fifths of the teachers also claimed that they spend on the average two or less hours each week, outside the formal school day, on professional reading or development activities related to their teaching.

### **Lesson Planning**

More than 80% of the teachers spent more than one hour each week, outside the formal school day, planning their lessons. When planning what to teach or which mathematical tasks to use during their lessons 79% consult the school curriculum or national curriculum guide to decide on the topic, 63% consult the textbook (student edition) to select problems and exercises for work in class and at home, and 82% consult other resource books or past examination papers to select problems and applications for assessment and evaluation. When planning how to teach or develop the lesson in class teachers rely (quite a lot or a great deal) on their previously prepared lessons (82%), a written plan compiled by teachers in the school (95%), student textbook (94%), other textbooks or resource books (94%), teacher guides or teacher edition of textbook (96%), other teachers or mathematics specialists in their school or department (53%). The one thing that teachers don't rely on or rely a little is external examinations or standardised tests (83%).

### **Classroom Teaching:**

#### **Limiting and Non-limiting factors**

Teachers were asked in the questionnaire the extent to which some given factors limit the way they teach their class. More than half of the teachers claimed that students with different academic abilities (65%), uninterested students (53%), and high student/teacher ratio (62%) do limit quite a lot or a great deal the way they teach their class mathematics.

Also, more than half of them claimed that the following did not limit or limit only a little the way they teach their class mathematics:

- students who come from a wide range of backgrounds (58%),
- students with special needs (74%),
- disruptive students (51%),
- parents interested in their children's learning and progress (81%),
- parents uninterested in their children's learning and progress (51%),
- shortage of computer hardware (87%),
- shortage of computer software (87%),
- shortage of other instructional equipment for students' use (77%),
- shortage of equipment for teacher's use in demonstrations and other exercises (73%),
- inadequate physical facilities (79%),
- low morale among fellow teachers (75%),
- low morale among students (66%), and
- threat(s) to personal safety or the safety of students (76%).

### **Student Learning**

The questionnaire data show that in some, most or every mathematics lesson teachers usually ask students to explain the reasoning behind an idea (97%), represent and analyse relationships using tables, charts or graphs (90%), work on problems for which there is no immediately obvious method of solution (65%), write equations to represent relationships (63%), and practice computational skills (93%). Sixty-nine percent of the teachers never ask students to use computers to solve exercises or problems during their lessons.

Less than a quarter of the teachers had students

- work together as a class with students responding to one another (21%),
- work in pairs or small groups without assistance from the teachers (10%),
- work in pairs or small groups with assistance from the teacher (21%)

in most or every lesson of theirs. A higher percentage of teachers had students work individually without assistance from them (44%) compared to students work individually with assistance from them (32%) in most or every lesson of theirs. Sixty-seven percent of the teachers had students working together as a class while they taught them in most or every lesson of theirs.

### **Homework**

From the questionnaire data, it seems that homework appears to be an integral part of the mathematics learning outside class time. Eighty percent of the teachers appear to assign their students' homework at least 3 or 4 times a week. Ninety-seven percent of the teachers claim that they usually assign their students homework

that would take more than 15 minutes to complete. The type of mathematical tasks that are always or sometimes assigned for homework are worksheets / workbook (97%), problem / question sets in textbook (94%), and reading in a textbook or supplementary materials (61%). The types of mathematical tasks that are never or rarely assigned are:

- writing definitions or other short writing assignment (83%),
- small investigation(s) or gathering data (64%),
- working individually on long term projects or experiments (88%),
- working as a small group on long term projects or experiments (82%),
- finding one or more uses of the content covered (60%),
- preparing oral reports either individually or as a small group (79%), and
- keeping a journal (92%).

It appears that teachers expend considerable effort monitoring the homework students do. Most teachers (88%) sometimes or always record whether or not students complete their homework. Eighty-eight percent of the teachers claim that they spent up to 2 hours per week, outside the formal school day, keeping students' records. All the teachers always collect in, correct and then return homework assignments to their students. Sixty-five percent of the teachers claim that they spent a minimum of four hours per week outside the formal school day, reading and grading student work. Almost all teachers (97%) give feedback on homework to the whole class and 85% of them use the homework as a basis for class discussion. Half the teachers never use the homework assignments to contribute towards students' grades or marks.

### **Secondary School Teachers' Perspectives**

#### **Knowledge of Curriculum / Professional Development**

Almost all the teachers (95%) were familiar (fairly or very) with the National Curriculum Guide for Mathematics (i.e., Ministry of Education's Mathematics Syllabus document), their School's Curriculum Guide and the National Examination Specifications (i.e., the GCE Ordinary Level Mathematics Examination Papers and their format). Textbooks used in Singapore schools have to be approved by the Ministry of Education. Approval is usually granted for textbooks that adhere closely to the National Curriculum. All the teachers used a textbook for their teaching and almost all of them used it at least half the time in their classes. Ninety percent of them also meet the other mathematics teachers in their school to discuss and plan curriculum or teaching approaches at least once in ten weeks. Four fifths of the teachers also claimed that they spend on the average two or less hours each week, outside the formal school day, on professional reading or development activities related to their teaching.



## **Lesson Planning**

More than half of the teachers spent three or more hours each week outside the formal school day, planning their lessons. When planning what to teach or which mathematical tasks to use during their lessons 78% consult the school curriculum or national curriculum guide to decide on the topic, 80% consult the textbook (student edition) to select problems and exercises for work in class and at home, and 68% consult other resource books or past examination papers while 22 % consult the textbook to select problems and applications for assessment and evaluation. When planning how to teach or develop the lesson in class teachers rely (sometimes or always) on their previously prepared lessons (84%), a written plan compiled by teachers in the school (89%), student textbook (97%), other textbooks or resource books (92%), teacher guides or teacher edition of textbook (66%), external examinations and standardised tests (67%). The one thing that teachers never or rarely rely on is other teachers or mathematics specialists in their school (64%).

## **Classroom Teaching**

### **Limiting and Non-limiting factors**

Teachers were asked in the questionnaire the extent to which some given factors limit the way they teach their class. More than half of the teachers claimed that students with different academic abilities (58%), uninterested students (52%), and high student/teacher ratio (68%) do limit quite a lot or a great deal the way they teach their class mathematics.

Also, more than half of them claimed that the following did not limit or limit only a little the way they teach their class mathematics:

- students who come from a wide range of backgrounds (61%),
- students with special needs (85%),
- disruptive students (52%),
- parents interested in their children's learning and progress (85%),
- parents uninterested in their children's learning and progress (69%),
- shortage of computer hardware (86%),
- shortage of computer software (83%),
- shortage of other instructional equipment for students' use (82%),
- shortage of equipment for teacher's use in demonstrations and other exercises (75%),
- inadequate physical facilities (82%),
- low morale among fellow teachers (77%),
- low morale among students (55%), and
- threat(s) to personal safety or the safety of students (82%).

### **Use of Calculators**

More than 80% of the teachers claimed that three-quarters or more of their students had access to calculators during their lessons. Their students used the calculator at least once or twice a week to check answers, do routine computations and solve complex problems. Ninety-one percent of teachers also had students using calculators once or twice a month for tests and examinations. Thirty-two percent of them revealed that their students never used calculators in class to explore number concepts.

### **Student Learning**

The questionnaire data shows that in some, most or every mathematics lesson teachers usually ask students to:

- explain the reasoning behind an idea (99%),
- represent and analyse relationships using tables, charts or graphs (80%),
- work on problems for which there is no immediately obvious method of solution (71%),
- write equations to represent relationships (94%),
- practise computational skills (86%).

Ninety percent of the teachers never ask students to use computers to solve exercises or problems during their lessons.

Less than a quarter of the teachers had students work together as a class with students responding to one another (18%), work in pairs or small groups without assistance from the teachers (6%), and work in pairs or small groups with assistance from the teacher (21%) in most or every lesson of theirs. A higher percentage of teachers had students work individually with assistance from them (47%) compared to students work individually without assistance from them (31%) in most or every lesson of theirs. Sixty-two percent of the teachers had students working together as a class while they taught them in most or every lesson of theirs.

### **Homework**

From the questionnaire data, it appears that homework appears to be an integral part of the mathematics learning outside class time. Eighty-one percent of the teachers appear to assign their students' homework at least 3 or 4 times a week. Seventy-one percent of the teachers claim that they usually assign their students homework that would take more than 30 minutes to complete. The type of mathematical tasks that are always or sometimes assigned for homework are worksheets / workbook (80%), problem / question sets in textbook (99%), and reading in a textbook or supplementary materials (58%). The types of mathematical tasks that are never or rarely assigned are:

- writing definitions or other short writing assignment (76%),
- small investigation(s) or gathering data (72%),
- working individually on long term projects or experiments (85%),
- working as a small group on long term projects or experiments (76%),
- finding one or more uses of the content covered (60%),
- preparing oral reports either individually or as a small group (81%), and
- keeping a journal (85%).

It appears that teachers expend considerable effort monitoring the homework students do. Almost all teachers (91%) sometimes or always record whether or not students complete their homework. Eighty-nine percent of the teachers claim that they spent up to 2 hours per week, outside the formal school day, keeping students' records. Ninety-four percent of the teachers always collect, correct and then return homework assignments to their students. Sixty-eight percent of the teachers claim that they spent a minimum of 4 hours per week outside the formal school day, reading and grading student work. Almost all teachers (97%) give feedback on homework to the whole class and 68% of them use the homework as a basis for class discussion. Fifty-eight percent of the teachers never use the homework assignments to contribute towards students' grades or marks.

### **Conclusions**

From the perspective of the students, mathematics instruction in Singapore schools can best be described as one having the following characteristics:

- classroom teaching is predominantly teacher centred with whole class teaching as the norm,
- teachers play a lead role in direct teaching of mathematics, they explain concepts, rules and definitions,
- teachers demonstrate the solutions to mathematical problems and supervise students during class practice,
- students work from workbooks and textbooks during class time and at home,
- students almost always do homework as part of their mathematics learning outside class time, and
- teachers put considerable emphasis on monitoring through quizzes or tests and grading homework assignments.

From the perspective of the teachers, mathematics instruction in Singapore schools can best be described as one having the following characteristics:

- teachers are familiar with the National Mathematics Curriculum and Examination requirements, hence students across the island have uniform content coverage,

- teachers use a textbook for their teaching, and also meet to discuss and plan curriculum or teaching approaches several times a year, hence there is some coherence in the pedagogy
- teachers see lesson planning as an important aspect of their teaching, they rely considerably on textbooks, resource books and past examination papers for mathematical tasks to use in their lessons and on their own previously prepared lessons, written lesson plans available in the school and teacher guides for ideas as to how best develop their lessons,
- students with different academic abilities, uninterested students and a high student/teacher ratio appear to limit the way teachers teach their class,
- during lessons teachers ask students to explain the reasoning behind an idea, represent and analyse relationships using tables, charts or graphs, work on non-routine problems, write equations to represent relationships and practise computational skills,
- only students in the secondary school use calculators in class to check answers, do routine computations and solve complex problems,
- it is common for students to work individually in class with and without assistance from the teacher or together as a class while the teachers teaches them,
- teachers almost always assign their students homework from their textbooks, workbooks or supplementary materials,
- teachers spent considerable time recording the handing in of homework and grading it,
- teachers return students their homework assignments after grading them, give feedback on it to the whole class and use it as a basis for class discussion.

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