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Science and Mathematics Achievements at the Junior Secondary Level in Hong Kong

A summary report for Hong Kong in the
Third International Mathematics and Science Study (TIMSS)

Edited by: Nancy Law

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The smooth coordination and administration of the Study has been made possible by the various research staff involved in various stages of the project, especially the senior research assistant, Ms. Maggie Wong and technician assistant, Mr. Wilson Ngai. The study Center is grateful to Mr. Samsom Liu and Mr. Leon Lam for helping with the production of this report under tremendous pressures of time.

1. INTRODUCTION

The Third International Mathematics and Science Study (TIMSS) is a very large scale study, in fact the largest so far in terms of international comparative studies under the auspices of the International Association for the Study of Educational Achievement (IEA), with more than forty countries participating in the various components of the Study. Furthermore, this is the first time when both the Mathematics and Science Studies take place together as an integrated study. This study is significant not simply because of its magnitude. It reflects much of the latest thinking in terms of comparative curriculum and has incorporated some innovative approaches to the assessment of learning outcomes.

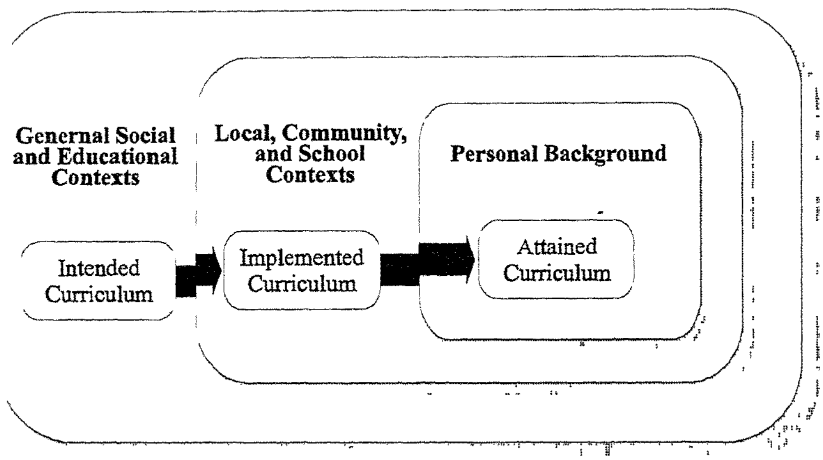
The main purpose of TIMSS is to focus on educational policies, practices, and outcomes in order to enhance mathematics and science learning within and across different systems of education. To this end, TIMSS has studied different aspects of the school curriculum from curriculum intentions, contextual factors affecting learning outcome, to different aspects of student achievement using a variety of techniques and instruments. The first part of this report gives a brief overview of the entire Study, its conceptual framework, the various components of the study and the design of the achievement instruments. The second part of the report provides a summary of the science and mathematics achievement of students in the two grades with the largest proportion of 13-year-olds, which in the context of Hong Kong corresponds to the levels secondary one and secondary two. Most of the descriptions and analyses are focused on the upper level, secondary two, to be consistent with the orientation taken in international reporting of this Study. Further reports covering other components of the Study as well as giving greater details and deeper analysis of the achievement data will be published at a later date.

1.1 Conceptual Framework for TIMSS

An important characteristic of IEA studies has been the recognition given to the importance of curriculum as a variable in explaining differences among national school systems and in accounting for differences among student outcomes. The studies should not be seen as "horse races" or "academic Olympiads" but rather as efforts to know the "why's of outcomes (Robitaille, et. al., 1993).In order to understand educational systems and to be able to draw valid comparisons among them, curriculum and instructional practices have to be investigated and characterized together with student learning outcomes. These three factors thus form the three major foci for TIMSS. It is hoped that differences in achievement outcomes can be explained in terms of variations in curriculum, instructional practices or some other variables. Such explanatory materials would be useful to countries in their evaluation of national curricula and in providing a research basis for future curriculum reform.

The general conceptual model for TIMSS was derived largely from models used in earlier IEA studies, especially SIMS (Second International Mathematics Study) and SISS (Second International Science Study). In this model, three "levels" of curriculum are envisaged (see fig. 1.1): intended, implemented and attained. The variety of factors that make up the educational environment is to be understood from the perspective of these three levels of curriculum and implicit within this model is the assumption that the sets of variables that impinge on educational achievement are composed of more than just those variables directly associated with schooling. For each level of curriculum, there is a unique set of contextual factors influencing the educational decisions at that level and these are seen as a series of embedded contexts starting from the most global and moving to the most personal. The narrow contexts are perceived as influenced by the broader ones, but not as subsets of the latter.

Fig. 1.1 Conceptual Framework for TIMSS (Robitaille, et. al.(1996). p.37)



This conceptual model provides a rationale and a context for the focal research questions in the TIMSS project. Four questions lie at the core of the study:

1. What mathematics and science concepts, processes, and attitudes have students learned, and what factors are related to students' opportunity to learn those concepts, processes and attitudes?

2. How do educational systems vary in the intended learning goals for mathematics and science, and what characteristics of educational systems, schools, and students are related to the development of those learning goals?
3. What opportunities are provided for students to learn mathematics and science, how do instructional practices in mathematics and science vary among educational systems, and what factors are related to this variation?
4. How are the intended curriculum, the implemented curriculum, and the attained curriculum related with respect to the context of education, the arrangements for teaching and learning, and the outcomes of the educational process?

1.2 The TIMSS Curriculum Framework

Central to the concept of curriculum as a variable is a framework for the description of the three levels of curriculum. In context of the TIMSS curriculum framework, curriculum consists of the concepts, processes, and attitudes of school mathematics and science that are intended for, implemented in, or attained during students' schooling experiences. This framework allows for a given assessment item or proposed instructional activity to be categorized in its full complexity, characterized in terms of three parameters: ***subject matter content, performance expectations***, and ***perspectives*** or context. The detail categories and subcategories within the mathematics and science frameworks differ, but the structure and rationale of the two frameworks are the same, allowing for comparisons across the two curriculum areas (see fig. 1.2 & 1.3).

The content aspect represents the content of school mathematics or of school science, depending upon the framework being considered. The performance expectations aspect is a reconceptualization of the cognitive behaviour dimension in earlier IEA studies. The goal of this aspect is to describe, in a non-hierarchical scheme, the many kinds of performances or behaviours that a given test item or block of content might be expected to elicit from students. The perspectives aspect has particular relevance for analysis of documents such as textbooks, and is intended to permit the categorization of curricular components according to the view of the nature of the discipline exemplified in the materials, or the context within which the material is presented. The last two aspects thus represent a finer categorization and distinction in the categories that were classified under the "process skills" dimension in the SISS framework.

Fig. 1.2. The Three Aspects and Major Categories of the Mathematics Framework (Robitaille, et. al.(1993). p.46)

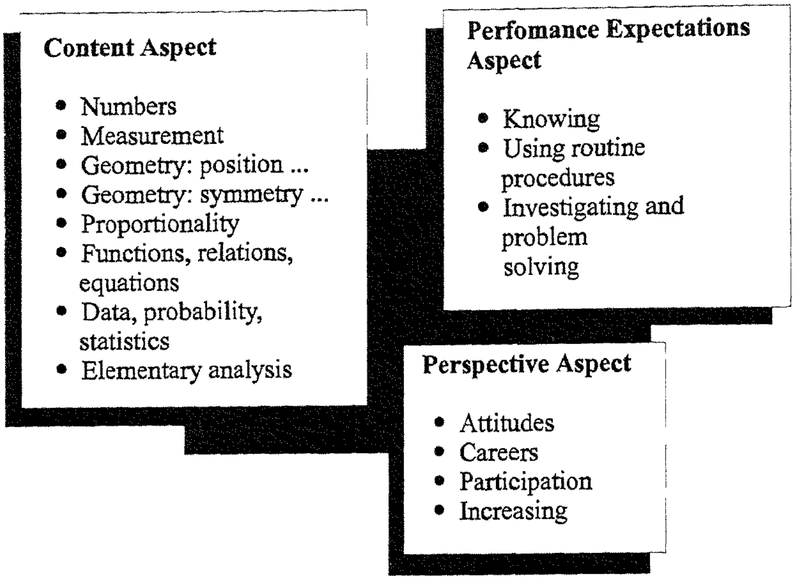
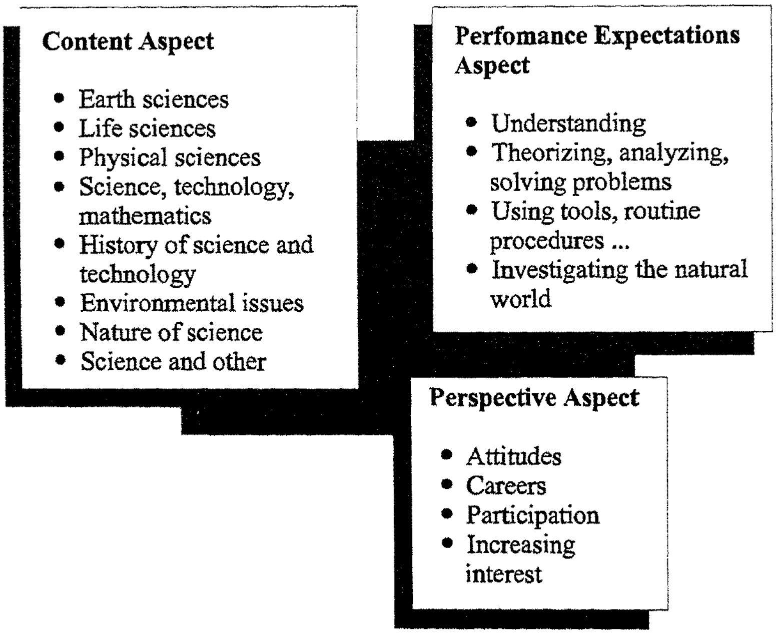


Fig 1.3. The Three Aspects and Major Categories of the Science Framework (Robitaille, et. al., (1993). p.46)



Each of the three aspects is itself partitioned into a number of categories and sub-categories. Hierarchies in the case of these frameworks are limited to those within categories, and no hierarchy is to be implied either among the three aspects or among the major categories within an aspect. Further, there is no longer a strict one-to-one mapping of curriculum elements to the cells of a grid. Instead, the TIMSS framework can be described as a multi-aspect, multi-category system where a test item or block of content can be related to any number of categories within each aspect, and to one or more of the three aspects. It is no longer appropriate to think of the framework as consisting of disjoint "cells" since the hierarchical levels within a category make overlapping cells possible (Robitaille, et. al., 1993). An achievement item or a piece of curricular material may thus be associated with many combinations of aspect categories in the TIMSS framework. It is believed that this framework will provide a more realistic depiction of the complex nature of elements of curriculum and is more suited to the complexity of student activities emerging from the various national reforms of school mathematics and science, and more suited to the rich, integrated performances expected of students in the new forms of assessments that are emerging along with the curricular reforms.

1.3 Student Populations in TIMSS

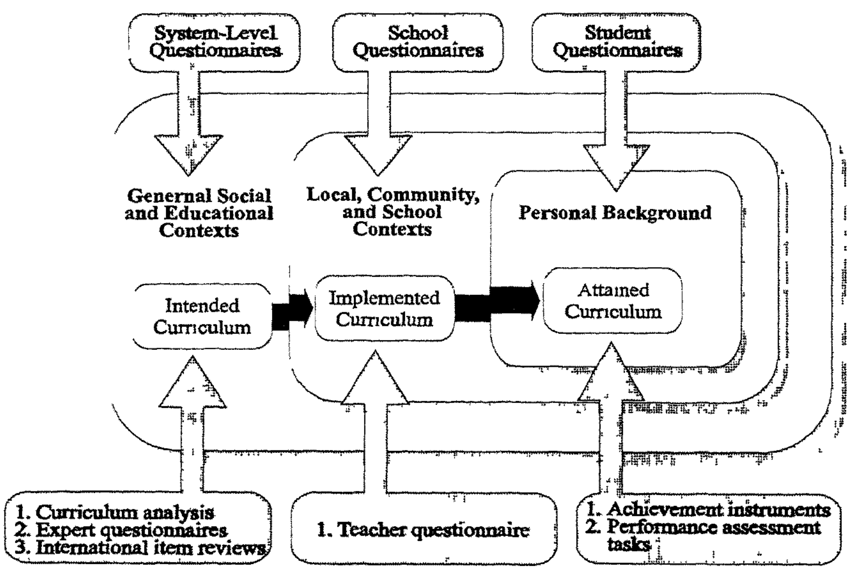
Three age levels had been selected as the foci for TIMSS and were referred to as Populations 1, 2 and 3. Population 1 included all students in the levels or grades that include almost all 9-year-olds. Population 2 includes all students in the grades or levels encompassing almost all 13-year-olds. Age was taken as the age of the student at the time of the achievement test. Thus, in the context of the Hong Kong study, as in many other countries, a near exhaustive coverage of a target age group would involve testing at three grade levels and was considered unrealistic in terms of resource implications. TIMSS thus confined each population to the two grade levels that has the most numbers of students in the target age groups. For Hong Kong, Population 1 included all students in primary 3 and primary 4, and Population 2 included all students in secondary 1 and secondary 2.

Population 3 included all students in their last year of secondary education, regardless of the kind of program in which they were enrolled and regardless of whether they were currently studying mathematics, science or neither. Population 3 students who were specializing to some degree in either mathematics or physics had been identified as two subgroups of special interest. Understandably, such a broad definition created difficulties in actual implementation and different countries had to interpret and adapt the population definition to fit into their own national context. Hong Kong is amongst those participating countries that did not participate in the population 3 achievement test.

1.4 General Design of the TIMSS Study

An overview of the various instruments used in the TIMSS Study is given in fig. 1.4. Besides the curriculum analysis and achievements & tests, questionnaires were administered at three levels with different objectives. First, four questionnaires were administrated at the system level at various times in the course of study. Two of these questionnaires focus on organizational structure, courses, demographics, and teacher credentials, and were completed by people knowledgeable about the structure of their educational system. Two other questionnaires were for curriculum specialists, the so-called expert questionnaires, seeking information about system-level curriculum plans, reforms, issues, and policies with respect to mathematics and science curricula. Each of the two questionnaires will be completed either by a mathematics or a science curriculum specialist. The expert questionnaires would obtain significant information about present and future curricular goals and content changes, information that would not be communicated in curriculum guides. Curriculum specialists will respond to questions about recent curriculum innovations, national assessment practices, instructional goals, the prevalence of textbooks and teachers' manuals and policies regarding curriculum guides, assessment, and student tracking.

Fig 1.4 Relationship of TIMSS Data Collection Instruments to the Conceptual Framework(Robitaille, et. al., (1996). p. 50)



The purpose of these four questionnaires was to gain an understanding of the contexts of the educational systems, and their impact on the intended and the implemented curricula. To obtain information about how the contexts of education might vary within a country, the system level data were supplemented with data collected at the school level.

A 1-hour school questionnaire was designed to be completed by the principal or the headmaster in each sampled school. The results from these questionnaires should provide a good representation of schools in the educational system. Among the topics addressed in the school questionnaire were enrolment, demographics, course selection, as well as administrative, curricular, budgetary, and social issues. The questionnaires for the primary and secondary levels were similar in content, but some questions were added or deleted as appropriate to the level.

Three teacher questionnaires were developed in TIMSS to obtain information about the implemented curriculum, one for Population 1 teachers and two for Population 2 mathematics and science teachers respectively. Each of the questionnaires addressed 5 topics: teachers' background (age, teaching credentials, teaching experiences, etc.), beliefs about pedagogy and learning, expectations for students, instructional practices, and interests and opinions about mathematics and science. Many of the questions in the three questionnaires were common, the variation lied mostly in the subject-specific questions.

Three students questionnaires were developed for TIMSS, one for each population. These were similar in organization and content, and cover student backgrounds, opinions and attitude towards mathematics and science.

1.5 The TIMSS Achievement Instruments

Large-scale surveys of students' achievement have traditionally utilized items in multiple-choice format. Well-constructed tests composed of these items typically have high reliability and high validity. In addition, a number of practical considerations make multiple-choice items popular in many applications: test conditions can be easily standardized, the administrative costs are low, and the speed of machine-scoring allows very large samples. Multiple-choice items have served IEA studies well, and they are likely to continue to do so.

In the past years, there has been a growing awareness among educators that some important achievement outcomes are either impossible to measure, or difficult to measure well, using multiple-choice items. The ability to construct a proof in mathematics, or to communicate findings in mathematics or science, or to make a case for action based on scientific principles, all require skills for which multiple-choice items seem to be unsuitable. Accordingly, it was decided that the TIMSS test should employ a variety of items to maximize coverage of desired outcomes of school mathematics and science education. Four types of achievement items are included in the item pool for TIMSS:

1. Multiple-choice items
2. Short-answer items
3. Extended-response items
4. Performance tasks

Multiple-choice items used in TIMSS consist of a stem and either 4 or 5 answer choices, of which only one is the best or the correct answer. Neither "I don't know" nor " None of the above" is utilized as a choice. In the instructions to students at the front of the test booklets, students are encouraged to choose the answer they think is best when they are unsure about an answer. The instructions do not suggest or imply that students should guess in cases where they do not know the answer.

In both short-answer and extended-response items students are required to write their responses, and these are coded using a set of 2-digit codes developed for use in the study. The first digit is coded for correctness(correct, partly correct, or incorrect), and the second digit is a code to identify qualities of the student's response: for example, strategy used, specific common errors, common misconceptions, or a student's use of a particular example germane to the question. For the short-answer items, students are required to write a brief verbal or numerical answer. The items are coded as either correct or incorrect, and the students are not required to show details of the approach they use or the calculations they perform on such items. Extended-response items are assigned score values of between 2 and 5, making it possible for coders to award partial credit for solutions. For these items, students are required to present detailed solutions. The multiple-choice items, short-answer items and extended-response items are randomized in their sequence of presentation in the test booklets so as to avoid the systematic non-completion of particular item types by students.

Some of the skills and abilities with which mathematics and science programs are designed to equip students cannot be readily assessed by the kinds of items usually found in a written test. Performance tasks are needed in order for students to demonstrate their ability to make, record, and communicate observations correctly; to make measurements or to collect experimental data, and to present them systematically; to design and to conduct a scientific investigation; or to solve certain types of problems. A set of performance tasks was developed for the study and included in the achievement component of the study. Training programs to maximize reliability of results were carried out to ensure uniformity of equipment and administration, as well as detailed coding instruments for scoring.

2. SAMPLING AND ADMINISTRATION OF THE HONG KONG POPULATION 2 STUDY

The target population was defined to be the Secondary 1 and Secondary 2 pupils in all day schools taking the local curriculum. As a result, pupils in the International Schools and Special Schools were excluded from the study. The exclusions only comprise 2.1% of the target age group. A multi-stage sampling scheme was employed. Schools with the target population of pupils were stratified according to the gender (single-sex or co-educational), medium of instruction (English or Chinese) and funding-mode (government, aided or private) of the school. There should be (2×2×3=)12 combinations in the stratification of schools. However, it was found that there was no schools in two of the combinations, namely single-sex Chinese-medium private schools and single-sex Chinese-medium government schools.

Table 2.1
Total Number of Schools, Number Selected and Number Participated for Each Sampling Stratum.

Category	Total no. of schools	No. selected	No. participated
single-sex, Chinese, aided	7	2	2
single-sex, English, govt.	8	2	2
single-sex, English, aided	70	18	14
single-sex, English, private	7	2	1
co-ed, English, govt.	23	6	6
co-ed, English, aided	228	60	52
co-ed, English, private	23	7	5
co-ed, Chinese, govt.	5	2	1
co-ed, Chinese, aided	11	3	1
co-ed, Chinese, private	10	2	2
Total	392	102	86

The achievement test and student questionnaires were administered in May 1995 and the scoring of free-response items was completed in June. The number of schools (for 1994/95) in each of the remaining strata is shown in Table 1. For each stratum, schools were randomly selected with probability proportional to the number of pupils (based on data collected by the Education Department in September 1994) in Secondary 1 and Secondary 2 of the school. The number of schools chosen for each of the stratum is shown in Table 1. A total of 104 schools were selected, 86 of which participated in the study and the response rate in terms of the number of schools was 82.7%. In each of the participating schools, one class was randomly selected from each of the school levels Secondary 1 and Secondary 2. The total number of pupils in the study was 6,750. In the computation, the scores of pupils from each stratum were weighted so that the resulting mean score obtained from the study would be an unbiased estimate of the population mean.

3 HONG KONG STUDENTS' SCIENCE ACHIEVEMENT IN THE INTERNATIONAL COMPARSION

This section reports on Hong Kong students' performance in the written science achievement test. Result of the performance assessment task will be reported in later reports.

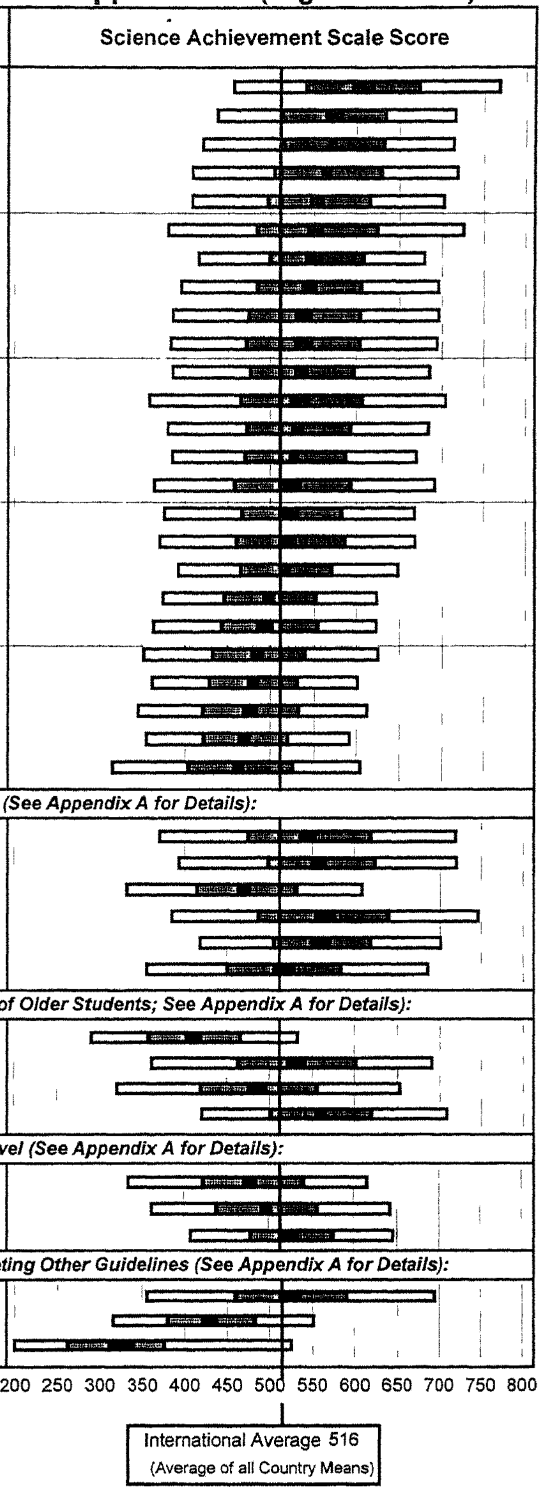
3.1. Overall Performance in Science

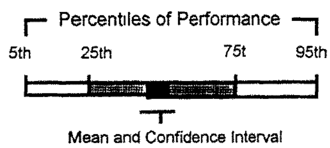
Table 3.1 presents the mean (or average) achievement for 41 countries at the eighth grade (this is the upper grade for the two grade levels tested, and in the context of Hong Kong corresponds to Secondary Two). The scale score is a score computed using item response theory to account for sampling weights and the differences in the difficulty of items. This scaling also allows the students' performance to be summarized on a common scale even though individual students responded to different items in the test according to the rotation design of the test administration (Robitaille, et. al., 1996, pp. 89-93).

Table 3.1

Distributions of Achievement in the Sciences - Upper Grade (Eighth Grade*)

Country	Mean	Yrs of Formal Schooling	Mean Age
Singapore	607 (5.5)	8	14.5
Czech Republic	574 (4.3)	8	14.4
Japan	571 (1.6)	8	14.4
Korea	565 (1 9)	8	14.2
Hungary	554 (2.8)	8	14.3
† England	552 (3.3)	9	14.0
† Belgium (Fl)	550 (4.2)	8	14.1
Slovak Republic	544 (3.2)	8	14.3
Russian Federation	538 (4.0)	7 or 8	14.0
Ireland	538 (4.5)	8	14.4
Sweden	535 (3.0)	7	13.9
† United States	534 (4.7)	8	14.2
Canada	531 (2.6)	8	14.1
Norway	527 (1.9)	7	13.9
New Zealand	525 (4.4)	8.5 - 9.5	14.0
Hong Kong	522 (4.7)	8	14.2
1 Switzerland	522 (2.5)	7 or 8	14.2
Spain	517 (1.7)	8	14.3
France	498 (2.5)	8	14.3
Iceland	494 (4.0)	8	13.6
† Latvia (LSS)	485 (2.7)	8	14.3
Portugal	480 (2.3)	8	14.5
1 Lithuania	476 (3.4)	8	14.3
Iran, Islamic Rep.	470 (2.4)	8	14.6
Cyprus	463 (1.9)	8	13.7
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	545 (3.9)	8 or 9	14.2
Austria	558 (3.7)	8	14.3
Belgium (Fr)	471 (2.8)	8	14.3
Bulgaria	565 (5.3)	8	14.0
Netherlands	560 (5.0)	8	14.3
Scotland	517 (5.1)	9	13.7
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	411 (4.1)	8	15.7
† Germany	531 (4.8)	8	14.8
Romania	486 (4.7)	8	14.6
Slovenia	560 (2.5)	8	14.8
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	478 (3.1)	7	13.9
Greece	497 (2.2)	8	13.6
Thailand	525 (3.7)	8	14.3
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
† Israel	524 (5.7)	8	14.1
Kuwait	430 (3.7)	9	15.3
South Africa	326 (6.6)	8	15.4





*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95

As is evident from table 3.1, there are substantial differences in science achievement across and within countries. The average performance of Hong Kong students is below or only comparable to the 25th percentile of the best performing countries like Singapore and Japan, and only the top 5% of our students can match the performance of the top 25% of Singaporean students at grade 8 (secondary 2).

In terms of the average scale score, Hong Kong's performance is very close to the international average. However, with the exception of two countries, Hong Kong's results are significantly lower than all the other developed countries participating in the test.

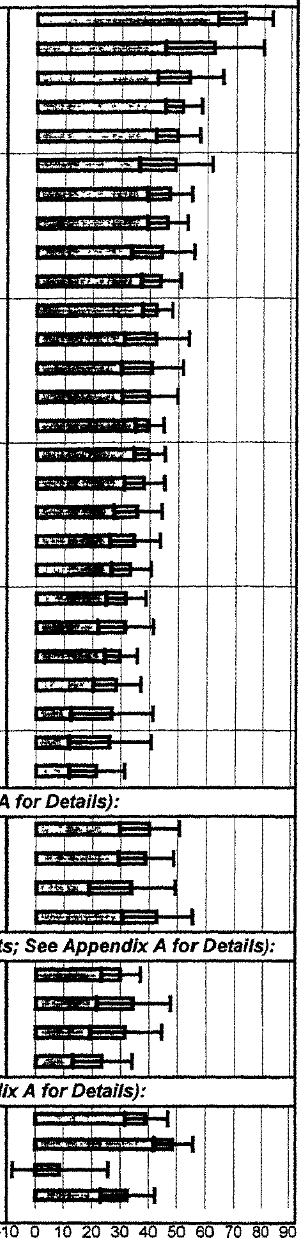
3.2 Achievement Differences in Science Between the Eighth and the Seventh Grades

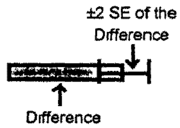
Performance at the eighth grade is naturally somewhat higher than that in the seventh grade, since the eighth-graders have had one more year of schooling. The international average at the eighth grade (516) is 37 points higher than the international average at the seventh grade. It is worrying to note in this context that the improvement in performance between the two grade levels in Hong Kong was only 27 points, and is amongst the lowest in all the participating countries on this measure student progress (table 3.2).

Table 3.2

Achievement Differences in the Sciences Between Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Seventh Grade Mean	Eighth Grade Mean	Eighth-Seventh Difference
† Lithuania	403 (3.4)	476 (3.4)	73 (4.8)
Singapore	545 (6.6)	607 (5.5)	63 (8.6)
Russian Federation	484 (4.2)	538 (4.0)	54 (5.8)
Portugal	428 (2.1)	480 (2.3)	52 (3.1)
1 Latvia (LSS)	435 (2.7)	485 (2.7)	50 (3.8)
† Scotland	468 (3.8)	517 (5.1)	49 (6.4)
Sweden	488 (2.6)	535 (3.0)	47 (3.9)
France	451 (2.6)	498 (2.5)	46 (3.6)
New Zealand	481 (3.4)	525 (4.4)	44 (5.5)
Norway	483 (2.9)	527 (1.9)	44 (3.5)
Cyprus	420 (1.8)	463 (1.9)	43 (2.7)
Ireland	495 (3.5)	538 (4.5)	43 (5.7)
Czech Republic	533 (3.3)	574 (4.3)	41 (5.4)
2 England	512 (3.5)	552 (3.3)	40 (4.8)
Japan	531 (1.9)	571 (1.6)	40 (2.5)
Spain	477 (2.1)	517 (1.7)	40 (2.7)
1 Switzerland	484 (2.5)	522 (2.5)	38 (3.5)
Hungary	518 (3.2)	554 (2.8)	36 (4.2)
Slovak Republic	510 (3.0)	544 (3.2)	35 (4.4)
Iran, Islamic Rep.	436 (2.6)	470 (2.4)	33 (3.5)
Canada	499 (2.3)	531 (2.6)	32 (3.5)
Iceland	462 (2.8)	494 (4.0)	32 (4.9)
Korea	535 (2.1)	565 (1.9)	30 (2.9)
† Belgium (Fr)	442 (3.0)	471 (2.8)	29 (4.2)
Hong Kong	495 (5.5)	522 (4.7)	27 (7.2)
† United States	508 (5.5)	534 (4.7)	26 (7.2)
† Belgium (Fl)	529 (2.6)	550 (4.2)	22 (4.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	504 (3.6)	545 (3.9)	40 (5.3)
Austria	519 (3.1)	558 (3.7)	39 (4.8)
Bulgaria	531 (5.4)	565 (5.3)	34 (7.6)
Netherlands	517 (3.6)	560 (5.0)	43 (6.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Slovenia	530 (2.4)	560 (2.5)	30 (3.4)
Romania	452 (4.4)	486 (4.7)	34 (6.5)
1 Germany	499 (4.1)	531 (4.8)	32 (6.3)
Colombia	387 (3.2)	411 (4.1)	24 (5.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	439 (2.1)	478 (3.1)	39 (3.8)
Greece	449 (2.6)	497 (2.2)	49 (3.4)
† South Africa	317 (5.3)	326 (6.6)	9 (8.5)
Thailand	493 (3.0)	525 (3.7)	33 (4.8)





*Seventh and eighth grades in most countries; see Table 2 for infomation about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

3.3 Gender Differences in Sciences Achievement

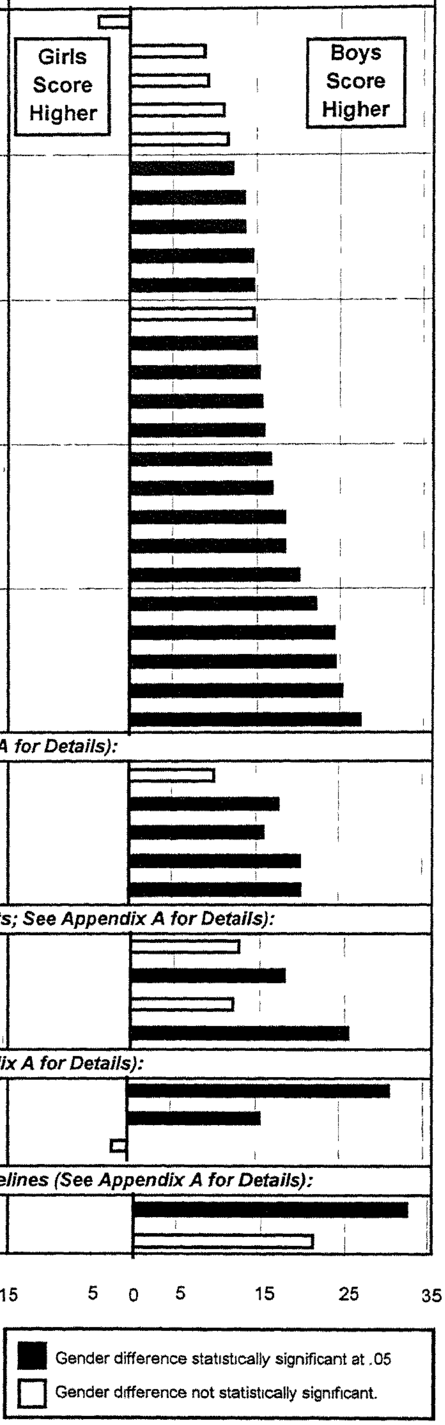
The TIMSS results reveal that in many countries, boys have significantly higher mean science achievement than girls at both the seventh and eighth grades. As table 3.3 reveals, Secondary Two girls in Hong Kong have an average performance of 27 scale points below that of their male counterparts, and this difference is amongst the greatest internationally. It is also sad to note that the gender differences in Hong Kong have increased markedly from Secondary One (18 scale points) to Secondary Two (27 scale points). Internationally, countries were grouped into 5 categories according to the magnitude of their gender differences in science performance. Hong Kong has moved from the group of countries with the second largest gender differences in the seventh grade to the group of countries with the largest gender differences at the eighth grade. In fact, Hong Kong has the largest gender difference in science performance at grade 8 amongst those participating countries that meet the sampling and participation requirements for international comparison.

Table 3.3

Gender Differences in Achievement in the Sciences - Upper Grade (Eighth Grade*)

Country	Boy's Mean	Girl's Mean	Difference Absolute Value
Cyprus	461 (2.2)	465 (2.7)	4 (3.4)
† United States	539 (4.9)	530 (5.2)	9 (7.2)
Singapore	612 (6.7)	603 (7.0)	9 (9.7)
Russian Federation	544 (4.9)	533 (3.7)	11 (6.2)
Ireland	544 (6.6)	532 (5.2)	12 (8.4)
Canada	537 (3.1)	525 (3.7)	12 (4.8)
Norway	534 (3.2)	520 (2.0)	14 (3.8)
[1] Lithuania	484 (3.8)	470 (4.0)	14 (5.5)
Sweden	543 (3.4)	528 (3.4)	15 (4.8)
[1] Latvia (LSS)	492 (3.3)	478 (3.2)	15 (4.6)
† Belgium (Fl)	558 (6.0)	543 (5.8)	15 (8.4)
[1] Switzerland	529 (3.2)	514 (3.0)	15 (4.4)
Slovak Republic	552 (3.5)	537 (3.9)	15 (5.2)
Iceland	501 (5.1)	486 (4.6)	16 (6.9)
France	506 (2.7)	490 (3.3)	16 (4.3)
Japan	579 (2.4)	562 (2.0)	17 (3.1)
Iran, Islamic Rep.	477 (3.8)	461 (3.2)	17 (4.9)
Spain	526 (2.1)	508 (2.3)	18 (3.1)
Hungary	563 (3.1)	545 (3.4)	18 (4.7)
[2] England	562 (5.6)	542 (4.2)	20 (7.1)
Portugal	490 (2.8)	468 (2.7)	22 (3.9)
Czech Republic	586 (4.2)	562 (5.8)	24 (7.2)
Korea	576 (2.7)	551 (2.3)	24 (3.6)
New Zealand	538 (5.4)	512 (5.2)	25 (7.6)
Hong Kong	535 (5.5)	507 (5.1)	27 (7.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	550 (5.2)	540 (4.1)	10 (6.6)
Austria	566 (4.0)	549 (4.6)	18 (6.1)
Belgium (Fr)	479 (4.8)	463 (2.9)	16 (5.6)
Netherlands	570 (6.4)	550 (4.9)	20 (8.1)
Scotland	527 (6.4)	507 (4.7)	20 (7.9)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	418 (7.3)	405 (4.6)	13 (8.6)
[1] Germany	542 (5.9)	524 (4.9)	18 (7.6)
Romania	492 (5.3)	480 (5.0)	12 (7.3)
Slovenia	573 (3.2)	548 (3.2)	25 (4.5)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	494 (3.6)	463 (3.9)	31 (5.3)
Greece	505 (2.6)	489 (3.1)	16 (4.0)
Thailand	524 (3.9)	526 (4.3)	2 (5.8)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
† Israel	545 (6.4)	512 (6.1)	33 (8.9)
South Africa	337 (9.5)	315 (6.0)	21 (11.3)

Gender Difference



International Averages		
Boys	Girls	Difference
525	509	17

(Averages of all country means)

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Further investigations into the gender differences in various performance and content areas using TIMSS data is warranted in order to provide a better understanding of the nature of such differences. The reason for such large gender differences and ways to reduce it certainly deserve serious attention from science educators and curriculum developers.

3.4. Variations in Science Achievement Across the Science Content Areas

An examination of the performance of each country across the five major content areas, earth science, life science, physics, chemistry, environmental issues & the nature of science, shows that countries that did well on the overall test generally did well in each of the various content areas, and those that did poorly overall also tended to do so in each of the content areas. Furthermore, the international averages for the different content areas (these are the average percentages correct for items in each of the five content areas) indicate that the different content areas in the TIMSS test were not equally difficult for the students taking the test. The life science content area was the least difficult for both the seventh and the eighth grades in terms of international performance, and Hong Kong students' performance also exhibited a similar pattern. However, when compared with their overall performance, Hong Kong students performed relatively poorly in earth science and relatively better in Chemistry for both grade levels.

Table 3.4

Average Percent Correct by Science Content Areas

Science content area	Hong Kong average	International average
Earth science	49	50
Life science	56	53
Physics	55	53
Chemistry	49	43
Environmental issues & nature of science	51	47

3.5 Variations in Science Achievement Across Test Item Types

As explained earlier, the written achievement test composes of two kinds of items, multiple-choice and free-response items (which include both short-answer items and extended-response items). The international average percentage correct for the two kinds of items are rather different: 59.01% in the multiple-choice items and 49.08% in the free-response items. This pattern of relatively poorer performance in the free-response items is even more marked in Hong Kong students' test performance: a difference of nearly 20%.

Table 3.5
Average Percent Correct Across Test Item Types

	Hong Kong average	International average
Multiple-choice items	63.59	59.01
Free-response items	43.68	49.08
Overall average	58	56

The percentage correct performance for the free-response items is 25% below that of the average test performance for Hong Kong students (compared to only 12% for the international figure). This weak performance in free-response items should be investigated further to explore the nature of the weakness and the possible reasons leading to such weak performance.

3.6. Variations in Science Achievement Across Different Performance Expectations

In the design of the test items, there was an intention that each item was not only testing knowledge in a particular area, but would also be requiring different kinds of skills in their successful completion. Each item was given a primary coding for the performance expectation, as consistent with the curriculum framework of the Study.

Table 3.6

Distribution of Items Across Different Performance Expectation Areas for Multiple Choices and Free-Response Items.

code	Performance Expectation	MC items			Free-response items		
		no of item	hk mean	hk-int	score points	hk mean	hk-int
211	understanding simple info	53	65.56	5.66	2	47.40	3.00
212	understanding complex info	29	61.25	2.31	12	51.08	-7.72
221	abstracting & deducing scientific principles	2	69.05	10.05	1	48.20	9.60
222	applying sc. principles to solve quant. prob.	3	59.97	6.37	3	35.40	2.27
223	applying sc. principles to develop explanations	3	74.74	9.47	20	42.70	-7.66
224	constructing,interpreting & applying models	1	51.3	-3.0			
225	making decisions				3	46.07	1.20
232	conducting routine expt. operations	1	62.2	9.6			
233	gathering data	2	44.5	-11.75			
234	organizing & representing data	1	58.1	20			
235	interpreting data	4	71.3	4.45			
241	identifying questions to investigate	1	48.9	-4.6			
242	designing investigations	2	49.2	8.1	3	22.57	-6.03
total		102			44		
average			63.59	4.58		43.68	-5.40

Table 3.6 lists the performance of students in the various performance expectations areas for both the multiple choice and free-response items. As can be seen from the Table, there are variations in relative performance compared with the international average across the different performance expectations. Since the number of score points in some categories are very few, it is difficult in many instances to draw conclusions on such variations. Nonetheless, some interesting observations can still be gauged.

Most of the multiple choice items test understanding of knowledge, with 53 items testing the understanding of simple information and 29 testing the understanding of complex information, out of a total of 102 items. It is evident from the results that Hong Kong students' performance relative to the international mean is better for items on simple understanding rather than complex information.

As there are fewer free-response items, these items did not appear in many performance expectation areas. It is still worth noting that even though Hong Kong performed poorly overall in free-response items, the performance actually compares favorably with the international average for the lower level performance expectations. However, the performance dropped significantly for questions that test students' ability to understand complex information, to apply scientific principles to develop explanations, and to design investigations.

3.7 Relationship of Science Achievement with the Opportunity to Learn through the School Curriculum

In general, one would expect students' performance in achievement tests to depend on whether the knowledge or skill(s) tested by the items were taught in the curriculum or not. Within TIMSS, there are two sets of questionnaires called "Test-Curriculum Matching Analysis", one each for science and mathematics respectively, to be completed by curriculum experts who has a clear knowledge of what should be covered in the school curriculum in the subject areas concerned for both the lower and the upper grade tested. This questionnaire required the curriculum expert to indicate for each item in the test booklets, whether students were expected to be taught the knowledge/skills required to answer the item by the end of the school year. This set of data can thus act as an indicator for students' opportunity to learn through the school curriculum. Table 3.8 and 3.9 summarizes the difference in performance between the mean Hong Kong score and the international mean score for upper grade students for various science subject areas and for the various performance expectation areas respectively, according to wherther the items have been taught to Hong Kong students.
The average difference in performance between Hong Kong and the international mean in various performance expectation areas for the upper grade is shown in table 3.7 and 3.8. These are only preliminary results of performances related to students' opportunity to learn. Further analysis on this have to be conducted.

As can be seen from the Tables, students' performance are slightly better for items in topic areas that have been taught in the school curriculum. The difference seem to be marginal for the free-response items but slightly bigger for the multiple choice questions. It thus seem to indicate that the inclusion of a topic in the intended curriculum does not necessarily help students in improving their performance, especially in the answering of free-response items. Further, it is worth noting that while among the items concerned with testing the understanding of simple information (code 211), those being included in the intended curriculum have better student performance, however, the reverse was found for those items testing the understanding of complex information (code 212).

Table 3.7

Table Summarizing the Difference in Performance Between Hong Kong and the International Mean in Various Content Areas and the Relationship to Students' Opportunity to Learn for the Upper Grade.

Code	content scale	Average difference in item difficulty between Hong Kong & International performance for MC items in each performance area			Average difference in item difficulty between Hong Kong & International performance for Free-Response items in each performance area		
		otl=0* (no. of items)	otl=1 (no. of items)	mean	otl=0 (score points	otl=1 (score points)	mean
A	earth features	-2.43 (3)	-1.25 (6)	-1.64 (9)	1.40 (1)	-4.75 (2)	-2.70 (3)
B	other earth sciences	4.70 (2)	5.70 (6)	5.54 (8)	-30.40 (1)	-5.07 (3)	-11.40 (4)
C	human biology	-0.02 (4)	3.68 (5)	2.03 (9)	-4.63 (4)	-8.80 (2)	-6.02 (6)
D	other life sciences	7.07 (16)	11.72 (6)	8.34 (22)	-17.30 (6)	12.30 (1)	-13.10 (7)
E	energy types	11.50 (1)	0.32 (4)	2.99 (5)	0.00 (0)	-5.50 (2)	-5.50 (2)
F	light	2.48 (6)	4.50 (2)	2.99 (8)	-1.90 (3)	0.00 (0)	-1.90 (3)
G	other physics	1.50 (5)	8.63 (10)	6.25 (15)	1.44 (5)	-9.30 (4)	-3.33 (9)
H	chemistry	3.24 (10)	9.18 (5)	5.22 (15)	0.80 (4)	-6.75 (2)	-1.72 (6)
I	environment	4.90 (3)	-0.70 (2)	2.66 (5)	0.00 (0)	-7.60 (2)	-7.60 (2)
J	other content	3.97 (3)	0.87 (3)	2.42 (6)	6.30 (1)	9.60 (1)	7.95 (2)
TOTAL		3.93 (53)	5.29 (49)	4.58 (102)	-5.62 (25)	-5.12 (19)	-5.40 (44)

* otl=0 refer to those items which the curriculum expert considered to be not taught by the end of the upper grade, and otl=1 refer to those items that were considered to be taught in the school curriculum by that time.

Table 3.8

Table Summarizing the Difference in Performance Between Hong Kong and the International Mean in Various Performance Expectation Areas and the Relationship to Students' Opportunity to Learn for the Upper Grade.

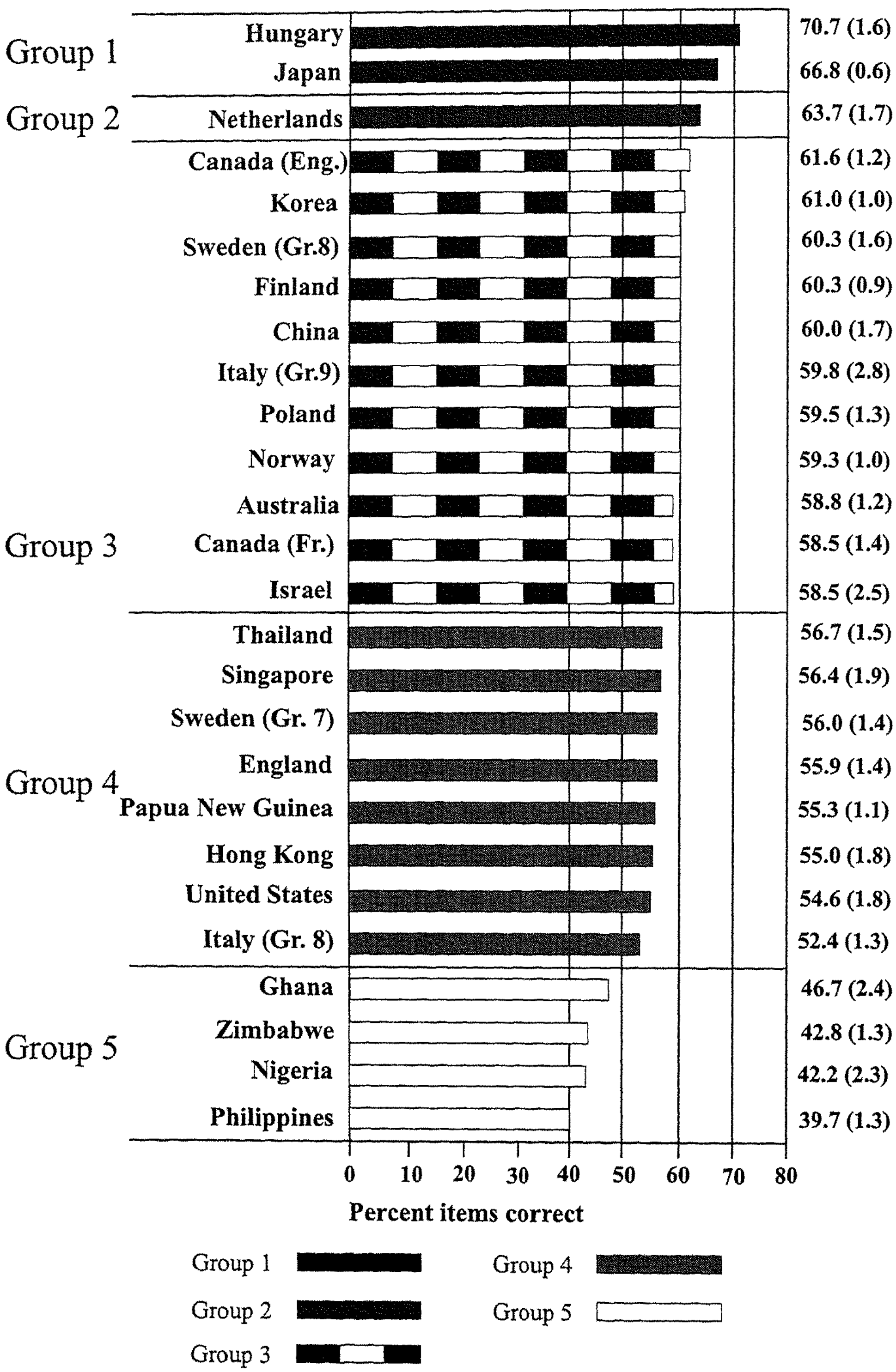
code	description	Average difference in item difficulty between Hong Kong & International performance for MC items in each performance area			Average difference in item difficulty between Hong Kong & International performance for Free-Response items in each performance area		
		otl=0* (no. of items)	otl=1 (no. of items)	mean	otl=0 (score points)	otl=1 (score points)	mean
211	understanding simple info	4.57 (33)	7.46 (20)	5.66	3.00 (2)		3.00
212	understanding complex info	3.55 (13)	1.31 (16)	2.31	-9.40 (11)	12.3 (1)	-7.72
221	abstracting & deducing scientific principles	15.30 (1)	4.80 (1)	10.05		9.6 (1)	9.60
222	applying sc. principles to solve quant. prob.	-1.10 (1)	10.10 (2)	6.37	17.80 (1)	-5.5 (2)	2.27
223	applying sc. principles to develop explanations	1.00 (1)	13.70 (2)	9.47	-7.88 (8)	-7.51 (12)	-7.65
224	constructing,interpreting & applying models		-3.00 (1)	-3.00			
225	making decisions				1.20 (3)		1.20
232	conducting routine expt. operations		9.60 (1)	9.60			
233	gathering data	-9.70 (1)	-13.80 (1)	-11.75			
234	organizing & representing data		20.00 (1)	20.00			
235	interpreting data	5.70 (1)	4.03 (3)	4.45			
241	identifying questions to investigate	-4.60 (1)		-4.60			
242	designing investigations	4.60 (1)	11.60 (1)	8.10		-6.03 (3)	-6.03
TOTAL		3.93 (53)	5.29 (49)	4.58	-5.62 (25)	-5.12 (19)	-5.40

* otl=0 refer to those items which the curriculum expert considered to be not taught by the end of the upper grade, and otl=1 refer to those items that were considered to be taught in the school curriculum by that time.

3.8 How Has HK Changed in its Science Achievement since SISS?

As can be seen from fig. 3.1, Hong Kong students' science performance in the Second International Science Study (SISS) was very low for the 14-year-old level. Hong Kong was placed in the fourth group of countries in terms of student achievement and was only significantly better than a few third world countries that had low levels of economic development.

Fig. 3.1 Science Performance at the 14-Year-Old Level, 1983-84 (the figures denote the mean scores and two standard error (in brackets)) (Keeves. (1992). p. 13)



Even though the mean science achievement for Hong Kong students is very close to the international mean, Hong Kong is still among the lowest achieving group of countries when compared with those that also participated in SISS.

3.9 Studying Achievement in a Curriculum Context - A Search for Determinants

The main motivation for undertaking such a large scale study as TIMSS was not simply to find out how Hong Kong performed compared to other countries. It gives us a rare opportunity to find out about the learning outcomes of our students according to a rich curriculum rubric provided by the TIMSS study design. From the preliminary analysis detailed above, it is evident that since SISS, Science Achievement of Hong Kong junior secondary students relative to other developed countries has remained low. There were large gender differences between boys and girls in science achievement and this difference was found to be even greater at Secondary 2 level. Furthermore, the improvement in achievement between Secondary 2 and Secondary 1 levels is amongst the lowest internationally. These are worrying results that need further studies and analysis. The patterns of achievement should also be investigated further. Hong Kong students performed relatively better in multiple choice questions but rather poorly in free response items. The performance is also found to be relatively better for items testing at the lower level performance expectations and rather low at the higher level ones. Effects of opportunity to learn on achievement should also be further investigated. This preliminary analysis does not yield clear evidence that an item's inclusion in the intended curriculum leads to better achievement results.

Besides the achievement tests, the TIMSS Study has provided us with very rich data relating to all three levels of curriculum (fig. 1.4) with which we could explore possible factors influencing students' learning outcomes. One important strength of TIMSS compared to earlier Science and Mathematics Studies is that it has conducted as part of the Study a large scale Curriculum Analysis which provides rich information on the intended curriculum in terms of curriculum guides and textbooks (Schmidt, et.al., 1996). A preliminary analysis of the Hong Kong Science Curriculum data from this study has also yielded interesting insight and perspectives on our science curriculum at various subject levels (Law, 1996). This should be considered in conjunction with the Science achievement results to explore the possible relationships between the intended curriculum and the attained curriculum.

Further investigations using the TIMSS data should also take advantage of the Study being part of a large scale international study and that it is the third of a series of similar studies. One possible line of investigation is to note that whilst Hong Kong, Singapore and England were in group 4 for population 2 in SISS, Singapore has risen to the top and England has risen to the sixth position in TIMSS in this population, and to ask in this context what might have changed or remained unchanged in these three systems that might have led to such changes over time. In short, our task now is to seek determinants of student achievement using the TIMSS curriculum framework.

4. HONG KONG STUDENTS' MATHEMATICS ACHIEVEMENT IN THE INTERNATIONAL COMPARISON

4.1 Overall Performance in Mathematics

Tables 4.1 and 4.2 present the mean (or average) achievement for 41 countries at the eighth and seventh grade respectively. The results reveal substantial differences in average mathematics achievement between the top and the bottom-performing countries. As shown in the tables, the average performance of Hong Kong students is at the top fourth among all participating countries in both grades. Interestingly, the four best countries in mathematics achievement are all East Asian countries. Hong Kong actually ranks bottom among the four East Asian countries, although Singapore is the only country that has a significantly higher achievement than Hong Kong in both grades.

4.2 Achievement Differences in Mathematics Between the Eighth and the Seventh Grades

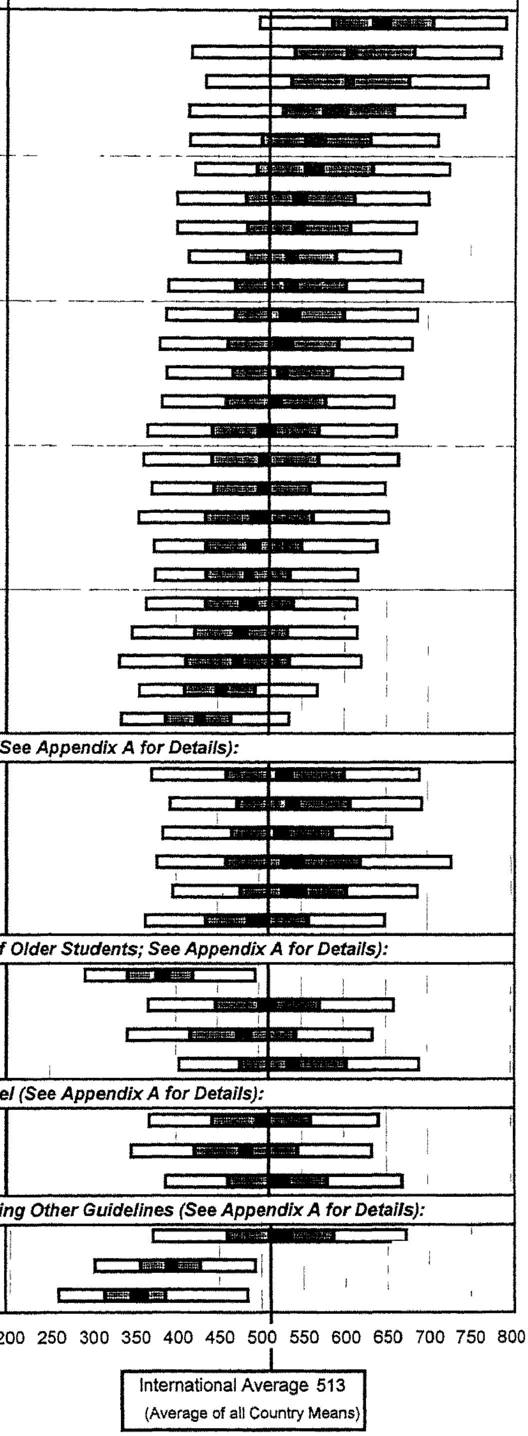
Table 4.3 shows the differences in mean achievement between the two grades tested in each participating country. Countries in this table are listed in descending order of achievement differences between the eighth and the seventh grades. Naturally, students from the eighth grade have higher means than students from the seventh grade. However, increase in mean performance between the two grades differs widely among different countries, with differences ranging from 8 (Belgium) to 49 points (Lithuania). Hong Kong is situated at the bottom fourth of the list, with a difference of 24 points. This degree of increase is lower than the difference of 29 points between the international average of 513 at eighth grade and that of 484 at seventh grade. It means that the improvement of Hong Kong students in mathematics achievement between the two grades is lower than average. This may suggest ineffectiveness of the mathematics instruction, or may be a result of the fact that most of the contents tested are covered at the lower grade (grade seven) so that instruction at the upper grade does not make too much difference in student achievement.

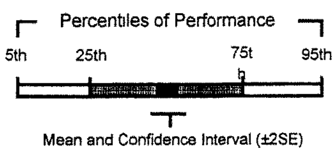
Table 4.1

Distributions of Mathematics Achievement - Upper Grade (Eighth Grade*)

Country	Mean	Yrs of Formal Schooling	Mean Age
Singapore	643 (4.9)	8	14.5
Korea	607 (2.4)	8	14 2
Japan	605 (1.9)	8	14.4
Hong Kong	588 (6.5)	8	14.2
† Belgium (Fl)	565 (5.7)	8	14.1
Czech Republic	564 (4.9)	8	14.4
Slovak Republic	547 (3.3)	8	14.3
[1] Switzerland	545 (2.8)	7 or 8	14.2
France	538 (2.9)	8	14.3
Hungary	537 (3.2)	8	14.3
Russian Federatio	535 (5.3)	7 or 8	14.0
Ireland	527 (5.1)	8	14.4
Canada	527 (2.4)	8	14.1
Sweden	519 (3.0)	7	13 9
New Zealand	508 (4.5)	8.5 - 9.5	14 0
† England	506 (2.6)	9	14 0
Norway	503 (2 2)	7	13.9
† United States	500 (4.6)	8	14.2
[1] Latvia (LSS)	493 (3.1)	8	14.3
Spain	487 (2.0)	8	14.3
Iceland	487 (4.5)	8	13.6
[1] Lithuania	477 (3.5)	8	14.3
Cyprus	474 (1.9)	8	13.7
Portugal	454 (2.5)	8	14.5
Iran, Islamic Rep.	428 (2.2)	8	14.6
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	530 (4.0)	8 or 9	14.2
Austria	539 (3.0)	8	14.3
Belgium (Fr)	526 (3.4)	8	14.3
Bulgaria	540 (6.3)	8	14.0
Netherlands	541 (6.7)	8	14.3
Scotland	498 (5.5)	9	13.7
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	385 (3.4)	8	15.7
† Germany	509 (4.5)	8	14.8
Romania	482 (4.0)	8	14.6
Slovenia	541 (3.1)	8	14.8
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	502 (2.8)	7	13.9
Greece	484 (3.1)	8	13.6
Thailand	522 (5.7)	8	14.3
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
[1] Israel	522 (6.2)	8	14.1
Kuwait	392 (2.5)	9	15.3
South Africa	354 (4.4)	8	15.4

Mathematics Achievement Scale Score





*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2) Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

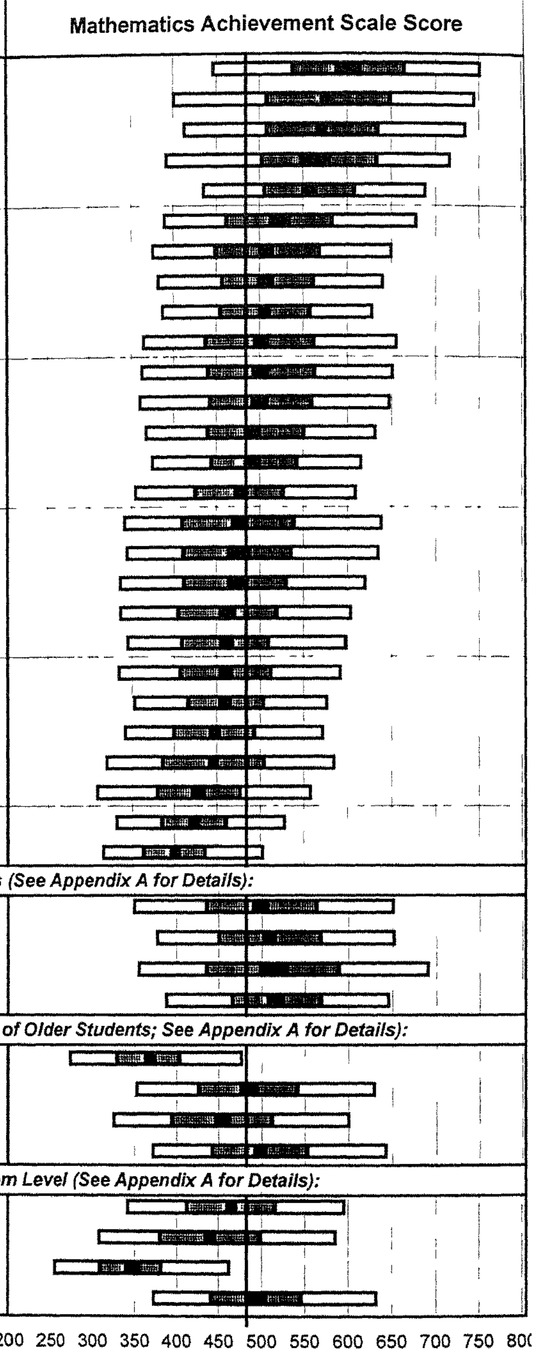
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent

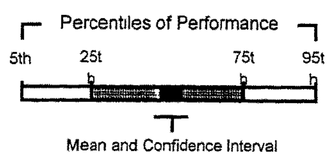
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.2

Distributions of Mathematics Achievement - Lower Grade (Seventh Grade*)

Country	Mean	Yrs of Formal Schooling	Mean Age
Singapore	601 (6.3)	7	13.3
Korea	577 (2.5)	7	13.2
Japan	571 (1.9)	7	13.4
Hong Kong	564 (7.8)	7	13.2
† Belgium (Fl)	558 (3.5)	7	13.0
Czech Republic	523 (4.9)	7	13.4
Slovak Republic	508 (3.4)	7	13.3
† Belgium (Fr)	507 (3.5)	7	13.2
1 Switzerland	506 (2.3)	6 or 7	13.1
Hungary	502 (3.7)	7	13.4
Russian Federati	501 (4.0)	6 or 7	13.0
Ireland	500 (4.1)	7	13.4
Canada	494 (2.2)	7	13.1
France	492 (3.1)	7	13.3
Sweden	477 (2.5)	6	12.9
† England	476 (3.7)	8	13.1
† United States	476 (5.5)	7	13.2
New Zealand	472 (3.8)	7.5 - 8.5	13.0
† Scotland	463 (3.7)	8	12.7
1 Latvia (LSS)	462 (2.8)	7	13.3
Norway	461 (2.8)	6	12.9
Iceland	459 (2.6)	7	12.6
Spain	448 (2.2)	7	13.2
Cyprus	446 (1.9)	7	12.8
1 Lithuania	428 (3.2)	7	13.4
Portugal	423 (2.2)	7	13.4
Iran, Islamic Rep.	401 (2.0)	7	13.6
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	498 (3.8)	7 or 8	13.2
Austria	509 (3.0)	7	13.3
Bulgaria	514 (7.5)	7	13.1
Netherlands	516 (4.1)	7	13.2
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	369 (2.7)	7	14.5
† Germany	484 (4.1)	7	13.8
Romania	454 (3.4)	7	13.7
Slovenia	498 (3.0)	7	13.8
Countries With Unapproved Sampling Procedures At The Classroom Level (See Appendix A for Details):			
Denmark	465 (2.1)	6	12.9
Greece	440 (2.8)	7	12.6
† South Africa	348 (3.8)	7	13.9
Thailand	495 (4.8)	7	13.5





*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A 2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

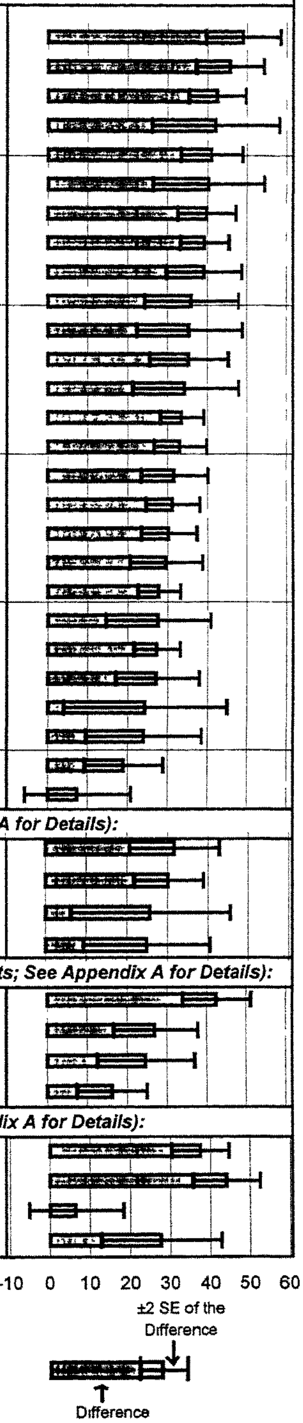
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsiste

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.3

Achievement Differences in Mathematics Between Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Seventh Grade Mean	Eighth Grade Mean	Eighth-Seventh Difference
† Lithuania	428 (3.2)	477 (3.5)	49 (4.7)
France	492 (3.1)	538 (2.9)	46 (4.3)
Norway	461 (2.8)	503 (2.2)	43 (3.6)
Singapore	601 (6.3)	643 (4.9)	42 (8.0)
Sweden	477 (2.5)	519 (3.0)	41 (3.9)
Czech Republic	523 (4.9)	564 (4.9)	40 (7.0)
1 Switzerland	506 (2.3)	545 (2.8)	40 (3.6)
Spain	448 (2.2)	487 (2.0)	39 (3.0)
Slovak Republic	508 (3.4)	547 (3.3)	39 (4.7)
New Zealand	472 (3.8)	508 (4.5)	36 (5.9)
† Scotland	463 (3.7)	498 (5.5)	36 (6.6)
Hungary	502 (3.7)	537 (3.2)	35 (4.9)
Russian Federation	501 (4.0)	535 (5.3)	35 (6.6)
Japan	571 (1.9)	605 (1.9)	34 (2.7)
Canada	494 (2.2)	527 (2.4)	33 (3.3)
1 Latvia (LSS)	462 (2.8)	493 (3.1)	32 (4.2)
Portugal	423 (2.2)	454 (2.5)	31 (3.3)
Korea	577 (2.5)	607 (2.4)	30 (3.5)
2 England	476 (3.7)	506 (2.6)	30 (4.5)
Cyprus	446 (1.9)	474 (1.9)	28 (2.7)
Ireland	500 (4.1)	527 (5.1)	28 (6.6)
Iran, Islamic Rep.	401 (2.0)	428 (2.2)	27 (2.9)
Iceland	459 (2.6)	487 (4.5)	27 (5.2)
Hong Kong	564 (7.8)	588 (6.5)	24 (10.2)
† United States	476 (5.5)	500 (4.6)	24 (7.2)
† Belgium (Fr)	507 (3.5)	526 (3.4)	19 (4.9)
† Belgium (Fl)	558 (3.5)	565 (5.7)	8 (6.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	498 (3.8)	530 (4.0)	32 (5.5)
Austria	509 (3.0)	539 (3.0)	30 (4.3)
Bulgaria	514 (7.5)	540 (6.3)	26 (9.8)
Netherlands	516 (4.1)	541 (6.7)	25 (7.8)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Slovenia	498 (3.0)	541 (3.1)	43 (4.3)
Romania	454 (3.4)	482 (4.0)	27 (5.3)
1 Germany	484 (4.1)	509 (4.5)	25 (6.1)
Colombia	369 (2.7)	385 (3.4)	16 (4.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	465 (2.1)	502 (2.8)	37 (3.5)
Greece	440 (2.8)	484 (3.1)	44 (4.2)
South Africa	348 (3.8)	354 (4.4)	7 (5.9)
Thailand	495 (4.8)	522 (5.7)	28 (7.5)



*Seventh and eighth grades in most countries; see Table 2 for infomation about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent.
SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

4.3 Gender Differences in Mathematics Achievement

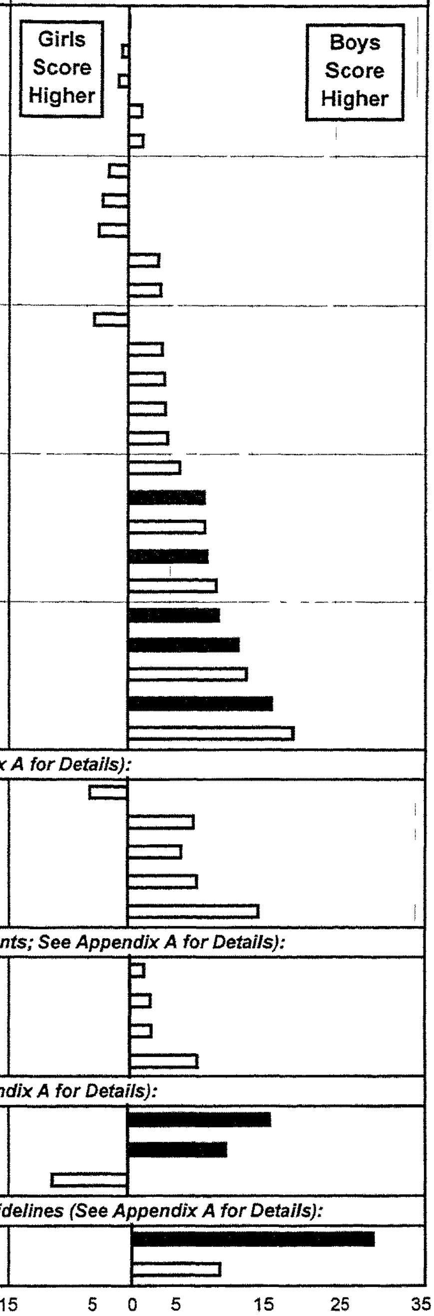
Tables 4. 4 and 4.5 present the mean mathematics achievement separately for boys and girls in the two grades in each of the participating country. The length of the bar in each country represents the amount of the difference; and if the difference is statistically significant the bar is darkened. The figures show that in many countries the differences favour boys at both grades, although in most cases, the differences are not statistically significant. It should be noted that although Hong Kong has the highest absolute difference in achievement between boys and girls (in favour of boys), the difference is not statistically significant. This means that based on the data, we cannot be certain that boys perform better than girls in Hong Kong.

Table 4.4

Gender Differences in Mathematics Achievement - Upper Grade (Eighth Grade*)

Country	Boy's Mean	Girl's Mean	Difference Absolute Value
Hungary	537 (3.6)	537 (3.6)	0 (5.1)
[1] Lithuania	477 (4.0)	478 (4.1)	1 (5.7)
Russian Federation	535 (6.3)	536 (5.0)	1 (8.0)
Iceland	488 (5.5)	486 (5.6)	2 (7.8)
Sweden	520 (3.6)	518 (3.1)	2 (4.7)
Singapore	642 (6.3)	645 (5.4)	2 (8.3)
Cyprus	472 (2.8)	475 (2.5)	3 (3.7)
Canada	526 (3.2)	530 (2.7)	4 (4.2)
Slovak Republic	549 (3.7)	545 (3.6)	4 (5.2)
Norway	505 (2.8)	501 (2.7)	4 (3.9)
† Belgium (Fl)	563 (8.8)	567 (7.4)	4 (11.5)
[2] England	508 (5.1)	504 (3.5)	4 (6.2)
[1] Latvia (LSS)	496 (3.8)	491 (3.5)	4 (5.2)
† United States	502 (5.2)	497 (4.5)	5 (6.9)
[1] Switzerland	548 (3.5)	543 (3.1)	5 (4.7)
France	542 (3.1)	536 (3.8)	6 (4.9)
Japan	609 (2.6)	600 (2.1)	9 (3.3)
New Zealand	512 (5.9)	503 (5.3)	9 (7.9)
Spain	492 (2.5)	483 (2.6)	10 (3.6)
Czech Republic	569 (4.5)	558 (6.3)	11 (7.7)
Portugal	460 (2.8)	449 (2.7)	11 (3.9)
Iran, Islamic Rep.	434 (2.9)	421 (3.3)	13 (4.4)
Ireland	535 (7.2)	520 (6.0)	14 (9.3)
Korea	615 (3.2)	598 (3.4)	17 (4.7)
Hong Kong	597 (7.7)	577 (7.7)	20 (10.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	527 (5.1)	532 (4.6)	5 (6.9)
Austria	544 (3.2)	536 (4.5)	8 (5.6)
Belgium (Fr)	530 (4.7)	524 (3.7)	6 (6.0)
Netherlands	545 (7.8)	536 (6.4)	8 (10.1)
Scotland	506 (6.6)	490 (5.2)	16 (8.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	386 (6.9)	384 (3.6)	2 (7.7)
[1] Germany	512 (5.1)	509 (5.0)	3 (7.1)
Romania	483 (4.8)	480 (4.0)	3 (6.2)
Slovenia	545 (3.8)	537 (3.3)	8 (5.0)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	511 (3.2)	494 (3.4)	17 (4.7)
Greece	490 (3.7)	478 (3.1)	12 (4.8)
Thailand	517 (5.6)	526 (7.0)	9 (9.0)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):			
† Israel	539 (6.6)	509 (6.9)	29 (9.6)
South Africa	360 (6.3)	349 (4.1)	11 (7.5)

Gender Difference



Gender difference statistically significant at .05

Gender difference not statistically significant

International Averages		
Boys	Girls	Difference
519	512	8

(Averages of all country means)

*Eighth grade in most countries, see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

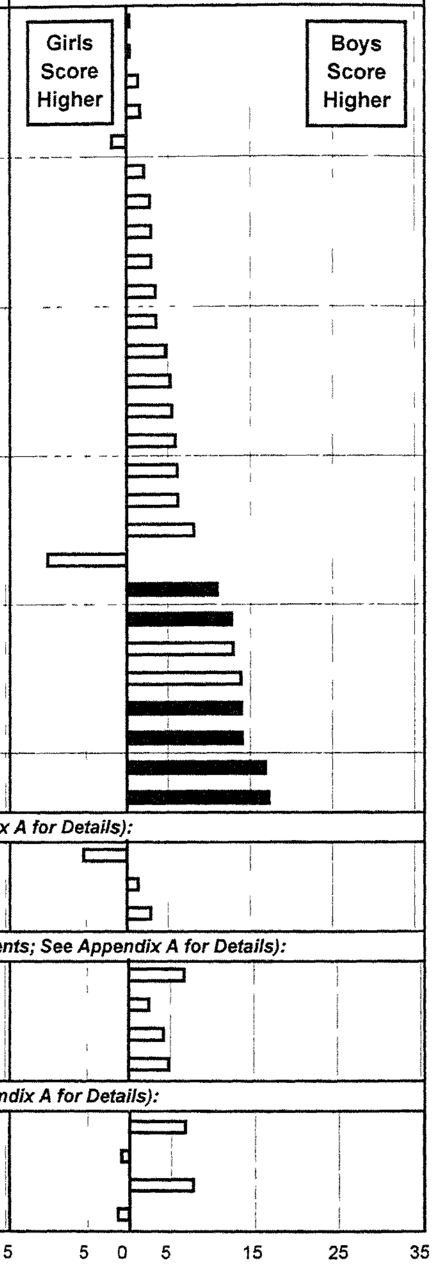
SOURCE. IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.5

Gender Differences in Mathematics Achievement - Lower Grade (Seventh Grade*)

Country	Boy's Mean	Girl's Mean	Difference Absolute Value
Cyprus	446 (2 5)	446 (2.6)	0 (3.6)
Singapore	601 (7 1)	601 (8.0)	0 (10.7)
Hungary	503 (3 8)	501 (4.4)	1 (5 8)
Canada	495 (2.7)	493 (2.6)	2 (3.8)
† Belgium (Fl)	557 (4.5)	559 (4.7)	2 (6.5)
Iceland	460 (2.7)	458 (3.2)	2 (4.2)
† Scotland	465 (4.6)	462 (3.8)	3 (5.9)
New Zealand	473 (4.6)	470 (3.8)	3 (5.9)
Russian Federatio	502 (5.1)	499 (3.5)	3 (6.1)
Norway	462 (3.3)	459 (3.2)	4 (4.6)
† Latvia (LSS)	463 (3.5)	460 (3.3)	4 (4.8)
† United States	478 (5.7)	473 (5 7)	5 (8.1)
Sweden	480 (2.8)	475 (3.2)	5 (4.2)
Spain	451 (2 7)	445 (2.7)	5 (3.8)
Slovak Republic	511 (4 4)	505 (3.3)	6 (5 5)
Portugal	426 (2.7)	420 (2.2)	6 (3 5)
Czech Republic	527 (4 8)	520 (5.6)	6 (7.4)
France	497 (3.6)	489 (3.3)	8 (4.9)
[1] Lithuania	423 (3.6)	433 (3.5)	10 (5.0)
Japan	576 (2.7)	565 (2.0)	11 (3.4)
† Belgium (Fr)	514 (4.1)	501 (4.2)	13 (5.9)
Ireland	507 (6.0)	494 (4.8)	13 (7.7)
Hong Kong	570 (9.7)	556 (8.3)	14 (12.8)
Iran, Islamic Rep.	407 (2.7)	393 (2.3)	14 (3.5)
[1] Switzerland	513 (2.9)	498 (2.6)	14 (3.9)
† England	484 (6.2)	467 (4.3)	17 (7.5)
Korea	584 (3.7)	567 (4.4)	17 (5.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix A for Details):			
Australia	495 (5.2)	500 (4.3)	5 (6.8)
Austria	510 (4.6)	509 (3.3)	1 (5.6)
Netherlands	517 (5.2)	515 (4.3)	3 (6.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):			
Colombia	372 (3.8)	365 (3.9)	7 (5.4)
† Germany	486 (4.8)	484 (4.5)	2 (6.6)
Romania	457 (3.7)	452 (3.7)	4 (5.2)
Slovenia	501 (3.5)	496 (3.2)	5 (4.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):			
Denmark	468 (2.8)	462 (2.9)	7 (4.0)
Greece	440 (3.2)	440 (3.0)	1 (4.4)
South Africa	352 (5.3)	344 (3.3)	8 (6.2)
Thailand	494 (4.8)	495 (5.7)	1 (7.5)

Gender Difference



International Averages		
Boys	Girls	Difference
486	481	6

(Averages of all country means)

■ Gender difference statistically significant at .05

□ Gender difference not statistically significant

*Seventh grade in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

4.4 Variations in Achievement Across the Mathematics Content Areas

The mathematics items in TIMSS were designed to enable testing of six content areas in both grade seven and grade eight. The six content areas are: (1) fractions and number sense, (2) geometry, (3) algebra, (4) data representation, analysis, and probability, (5) measurement, and (6) proportionality. Tables 4.6 and 4.7 provide the average percent of correct responses in different content areas for the seventh and eighth grade students. The countries are listed in order of their average percent correct across all items in the test. The results reveal that countries that did well on the overall test generally did well in each of the various content areas. Besides, the international averages show that different content areas in TIMSS are not equally difficult for students taking the test. Data representation, analysis, and probability was the least difficult content area for both grades whereas proportionality was the most difficult content area for both grades.

In order to facilitate comparison across different content area of the same country, TIMSS has developed profiles of relative performance. The profiles are designed to show whether participating countries performed better or worse in some content areas than they did overall. These profiles will be discussed in the main report. It is worth mentioning here that Hong Kong's profiles show that students performed better in algebra and geometry in both grades but poorer in data representation, analysis, and probability in both grades. Hong Kong students also performed relatively poorer in fractions and number sense area in grade seven while performed better in proportionality in grade eight.

In general, we can say that Hong Kong students perform better in the traditional areas of mathematics (algebra and geometry) than in "newer" areas such as statistics and probability, which other countries find relatively easier. This may be due to a difference in curricular emphasis, and may reflect the relative conservatism of the Hong Kong curriculum relative to the curricula in other countries.

Table 4.6
Average Percent Correct by Mathematics Content Areas Higher Grade (Eighth Grade*)

Country	Mathema-tics Overall (151 items)	Fractions & Number Sense (51 items)	Geometry (23 items)	Algebra (27 items)	Data Represent-ation, Analysis and Probab-ility (21 items)	Measure-ment (18 items)	Proportio-nality (11 items)
Singapore	79 (0.9)	84 (0.8)	76 (1.0)	76 (1.1)	79 (0.8)	77 (1.0)	75 (1.0)
Japan	73 (0.4)	75 (0.4)	80 (0.4)	72 (0.6)	78 (0.4)	67 (0.5)	61 (0.5)
Korea	72 (0.5)	74 (0.5)	75 (0.6)	69 (0.6)	78 (0.6)	66 (0.7)	62 (0.6)
Hong Kong	70 (1.4)	72 (1.4)	73 (1.5)	70 (1.5)	72 (1.3)	65 (1.7)	62 (1.4)
[+] Belgium (Fl)	66 (1.4)	71 (1.2)	64 (1.5)	63 (1.7)	73 (1.3)	60 (1.3)	53 (1.8)
Czech Republic	66 (1.1)	69 (1.1)	66 (1.1)	65 (1.3)	68 (0.9)	62 (1.2)	52 (1.3)
Slovak Republic	62 (0.8)	66 (0.8)	63 (0.8)	62 (0.9)	62 (0.7)	60 (0.9)	49 (1.0)
[+] Switzerland	62 (0.6)	67 (0.7)	60 (0.8)	53 (0.7)	72 (0.7)	61 (0.8)	52 (0.7)
Hungary	62 (0.7)	65 (0.8)	60 (0.8)	63 (0.9)	66 (0.7)	56 (0.8)	47 (0.9)
France	61 (0.8)	64 (0.8)	66 (0.8)	54 (1.0)	71 (0.8)	57 (0.9)	49 (0.9)
Russian Federation	60 (1.3)	62 (1.2)	63 (1.4)	63 (1.5)	60 (1.2)	56 (1.5)	48 (1.5)
Canada	59 (0.5)	64 (0.6)	58 (0.6)	54 (0.7)	69 (0.5)	51 (0.7)	48 (0.7)
Ireland	59 (1.2)	65 (1.2)	51 (1.3)	53 (1.3)	69 (1.1)	53 (1.3)	51 (1.2)
Sweden	56 (0.7)	62 (0.8)	48 (0.7)	44 (0.9)	70 (0.7)	56 (0.9)	44 (0.9)
New Zealand	54 (1.0)	57 (1.1)	54 (1.1)	49 (1.1)	66 (1.0)	48 (1.2)	42 (1.0)
Norway	54 (0.5)	58 (0.6)	51 (0.6)	45 (0.7)	66 (0.6)	51 (0.6)	40 (0.6)
[+2] England	53 (0.7)	54 (0.8)	54 (1.0)	49 (0.9)	66 (0.7)	50 (0.9)	41 (1.1)
[+] United States	53 (1.1)	59 (1.1)	48 (1.2)	51 (1.2)	65 (1.1)	40 (1.1)	42 (1.1)
[+] Latvia (LSS)	51 (0.8)	53 (0.9)	57 (0.8)	51 (0.9)	56 (0.8)	47 (0.9)	39 (0.9)
Spain	51 (0.5)	52 (0.5)	49 (0.6)	54 (0.8)	60 (0.7)	44 (0.7)	40 (0.8)
Iceland	50 (1.1)	54 (1.2)	51 (1.4)	40 (1.3)	63 (1.1)	45 (1.4)	38 (1.4)
[+] Lithuania	48 (0.9)	51 (1.0)	53 (1.1)	47 (1.2)	52 (1.0)	43 (0.9)	35 (0.9)
Cyprus	48 (0.5)	50 (0.6)	47 (0.6)	48 (0.7)	53 (0.6)	44 (0.9)	40 (0.7)
Portugal	43 (0.7)	44 (0.7)	44 (0.8)	40 (0.8)	54 (0.7)	39 (0.7)	32 (0.8)
Iran, Islamic Rep.	38 (0.6)	39 (0.6)	43 (0.8)	37 (0.8)	41 (0.6)	29 (1.2)	36 (0.8)
Countries Not Satisfying Guidelines for Sampling Participation Rates (See Appendix A for Details):							
Australia	58 (0.9)	61 (0.9)	57 (1.0)	55 (1.0)	67 (0.8)	54 (1.0)	47 (0.9)
Austria	62 (0.8)	66 (0.8)	57 (1.0)	59 (0.8)	68 (0.8)	62 (1.0)	49 (0.9)
Belgium (Fr)	59 (0.9)	62 (1.0)	58 (1.0)	53 (1.1)	68 (1.0)	56 (1.0)	48 (0.9)
Bulgaria	60 (1.2)	60 (1.4)	65 (1.3)	62 (1.5)	62 (1.1)	54 (1.6)	47 (1.5)
Netherlands	60 (1.6)	62 (1.6)	59 (1.8)	53 (1.6)	72 (1.7)	57 (1.6)	51 (1.9)
Scotland	52 (1.3)	53 (1.3)	52 (1.4)	46 (1.5)	65 (1.3)	48 (1.6)	40 (1.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):							
Colombia	29 (0.8)	31 (0.9)	29 (0.9)	28 (0.9)	37 (1.0)	25 (1.5)	23 (0.9)
[+1] Germany	54 (1.1)	58 (1.1)	51 (1.4)	48 (1.3)	64 (1.2)	51 (1.1)	42 (1.3)
Romania	49 (1.0)	48 (1.0)	52 (0.9)	52 (1.3)	49 (1.0)	48 (1.1)	42 (1.2)
Slovenia	61 (0.7)	63 (0.7)	60 (0.9)	61 (0.8)	66 (0.7)	59 (0.9)	49 (0.8)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):							
Denmark	52 (0.7)	53 (0.9)	54 (0.9)	45 (0.7)	67 (0.9)	49 (1.0)	41 (0.8)
Greece	49 (0.7)	53 (0.8)	51 (0.7)	46 (0.8)	56 (0.8)	43 (0.9)	39 (1.1)
Thailand	57 (1.4)	60 (1.5)	62 (1.3)	53 (1.7)	63 (1.1)	50 (1.4)	51 (1.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):							
[1] Israel	57 (1.3)	60 (1.4)	57 (1.4)	61 (1.6)	63 (1.3)	48 (1.6)	43 1.6
Kuwait	30 (0.7)	27 (0.8)	38 (1.0)	30 (1.0)	38 (1.0)	23 (1.0)	21 0.7
South Africa	24 (1.1)	26 (1.4)	24 (1.0)	23 (1.1)	26 (1.2)	18 (1.1)	21 0.9
International Average Percent Correct	55 (0.1)	58 (0.1)	56 (0.1)	52 (0.2)	62 (0.1)	51 (0.1)	45 (0.2)

*Eighth grade in most countries; see Table 2 for information about the grades tested in each country.

[+]Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2).

[1]Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of Natinal Desired Population (see Table A.2).

( ) Stardard errors appear in parentheses. Because reults are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 4.7
Average Percent Correct by Mathematics Content Areas Lower Grade (Seventh Grade*)

Country	Mathema-tics Overall (151 items)	Fractions & Number Sense (51 items)	Geometry (23 items)	Algebra (27 items)	Data Represent-ation, Analysis and Probab-ility (21 items)	Measure-ment (18 items)	Proportio-nality (11 items)
Singapore	73 (1.3)	79 (1.2)	69 (1.4)	68 (1.4)	72 (1.2)	70 (1.5)	71 (1.4)
Japan	67 (0.4)	71 (0.4)	70 (0.4)	64 (0.6)	73 (0.5)	62 (0.6)	55 (0.6)
Korea	67 (0.6)	70 (0.6)	70 (0.7)	64 (0.7)	73 (0.5)	62 (0.8)	55 (0.7)
Hong Kong	65 (1.8)	67 (1.7)	68 (1.9)	66 (2.0)	69 (1.5)	62 (2.0)	55 (1.7)
[†] Belgium (Fl)	65 (0.8)	72 (0.8)	59 (0.9)	60 (1.0)	73 (0.9)	59 (1.0)	54 (1.0)
Czech Republic	57 (1.2)	61 (1.4)	58 (1.1)	55 (1.2)	61 (1.1)	55 (1.2)	41 (1.3)
[†] Belgium (Fr)	54 (0.9)	59 (1.0)	55 (1.0)	44 (1.0)	64 (1.0)	53 (1.0)	44 (1.0)
Slovak Republic	54 (0.8)	58 (0.9)	57 (0.8)	50 (1.0)	56 (0.7)	52 (1.0)	41 (1.0)
Hungary	54 (0.8)	59 (0.9)	52 (0.9)	52 (1.1)	60 (0.8)	49 (1.0)	38 (1.0)
Ireland	53 (1.0)	62 (1.1)	43 (0.9)	47 (1.1)	64 (0.9)	46 (1.1)	46 (1.1)
[1] Switzerland	53 (0.5)	60 (0.7)	46 (0.6)	41 (0.6)	65 (0.7)	53 (0.8)	44 (0.7)
Russian Federation	53 (0.9)	56 (1.0)	55 (1.2)	55 (1.0)	55 (1.0)	47 (1.0)	40 (1.1)
Canada	52 (0.5)	58 (0.6)	50 (0.7)	43 (0.7)	63 (0.6)	44 (0.6)	42 (0.7)
France	51 (0.8)	53 (0.8)	58 (0.9)	39 (0.8)	63 (0.8)	49 (1.0)	41 (1.0)
[†] United States	48 (1.2)	54 (1.4)	44 (1.1)	44 (1.3)	60 (1.2)	36 (1.4)	38 (1.2)
[†2] England	47 (0.9)	48 (1.0)	49 (0.9)	41 (1.0)	62 (0.9)	43 (0.9)	38 (1.0)
Sweden	47 (0.6)	51 (0.8)	43 (0.6)	35 (0.6)	64 (0.9)	47 (0.7)	36 (0.8)
New Zealand	46 (0.9)	50 (0.9)	46 (1.1)	39 (0.9)	59 (1.0)	40 (1.0)	38 (1.0)
[†] Scotland	44 (0.9)	47 (1.0)	46 (1.1)	36 (0.8)	58 (1.0)	40 (0.9)	34 (0.8)
Norway	44 (0.7)	49 (0.9)	42 (0.7)	32 (0.7)	59 (0.9)	44 (0.9)	34 (0.7)
[1] Latvia (LSS)	44 (0.7)	46 (0.8)	48 (0.8)	43 (1.0)	49 (0.8)	41 (0.8)	33 (1.0)
Iceland	43 (0.7)	49 (1.0)	47 (0.7)	31 (0.6)	56 (0.8)	38 (0.8)	33 (0.7)
Spain	42 (0.6)	43 (0.6)	43 (0.7)	41 (0.7)	52 (0.7)	38 (0.7)	35 (0.7)
Cyprus	42 (0.4)	46 (0.5)	43 (0.6)	39 (0.5)	48 (0.6)	34 (0.5)	36 (0.7)
[1] Lithuania	38 (0.8)	41 (0.9)	38 (1.0)	38 (1.0)	44 (0.9)	32 (0.9)	25 (0.7)
Portugal	37 (0.6)	39 (0.6)	38 (0.8)	31 (0.7)	46 (0.6)	34 (0.7)	25 (0.6)
Iran, Islamic Rep.	32 (0.5)	34 (0.6)	40 (0.9)	28 (0.6)	36 (0.7)	23 (0.7)	30 (0.7)
Countries Not Satisying Guidelines for Sample Participation Rates (See Appendix A for Details):							
Australia	52 (0.8)	56 (0.9)	52 (0.8)	47 (1.0)	63 (0.9)	48 (1.0)	41 (0.9)
Austria	56 (0.7)	61 (0.8)	52 (0.9)	48 (0.8)	63 (0.8)	55 (0.8)	44 (1.0)
Bulgaria	55 (1.7)	56 (1.8)	61 (1.8)	58 (2.2)	56 (1.1)	52 (1.8)	44 (2.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):							
Colombia	26 (0.6)	28 (0.7)	26 (0.9)	24 (0.8)	32 (0.8)	22 (0.7)	21 (0.9)
[†1] Germany	49 (1.0)	55 (1.2)	46 (1.1)	39 (1.4)	61 (1.1)	46 (0.9)	37 (1.0)
Romania	43 (0.8)	43 (0.8)	48 (1.0)	46 (1.0)	44 (0.7)	42 (1.1)	35 (0.9)
Slovenia	53 (0.7)	56 (0.7)	52 (0.8)	48 (0.8)	60 (0.7)	50 (0.8)	39 (0.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):							
Denmark	44 (0.5)	45 (0.7)	46 (0.8)	36 (0.7)	59 (0.8)	41 (0.7)	34 (0.7)
Greece	40 (0.6)	47 (0.7)	39 (0.7)	33 (0.7)	46 (0.7)	35 (0.8)	34 (0.7)
[†] South Africa	23 (0.9)	26 (1.1)	22 (0.9)	20 (0.8)	25 (1.1)	17 (1.0)	20 (0.8)
Thailand	52 (1.2)	56 (1.3)	57 (1.0)	45 (1.3)	57 (1.1)	44 (1.4)	46 (1.3)
International Average Percent Correct	49 (0.1)	53 (0.2)	49 (0.2)	44 (0.2)	57 (0.1)	45 (0.2)	40 (0.2)

*Seventh grade in most countries; See Table 2 for information about the grades tested in each country.

[†]Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

[1]National Desired Population does not cover all of International Desired Population (see Table A.2).
Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

[2]National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

4.5 Performance on Items

This section presents six example items in the mathematics content area of Fractions and Number Sense. Detail analysis of Hong Kong students' performance in other example items will be provided in the main report. The example items were selected to illustrate the different performance expectations and the range of difficulties within the content area.

Tables 4.8 presents the international and Hong Kong average percent correct in the example items. The number in bracket represents the ranking of Hong Kong in that item among all the participating countries. The scale value is the indicator of the level of difficulty of an item and is applicable to both grades and all countries. Students scoring at that scale value were more likely than not (65% probability) to answer the question correctly. In the case of Hong Kong, the average scores in grade 7 and 8 are 564 and 588 respectively. There are two items where the Hong Kong average percent correct in both grades, marked with asterisk, is lower than expectation from the scale value. These example items are shown on the Appendix

The example items in Table 4.8 are arranged in ascending order of item difficulty level. It is worthwhile to note that items requiring students to perform routine procedures are the most difficult as well as the easiest for Hong Kong students. In general, Hong Kong has higher ranking in the difficult items than in the easy items in most of the content areas. Besides,
there are also items, mainly easy ones, where the average percent correct of Hong Kong grade seven is slightly greater than that of grade eight.

Table 4.8
Fraction and Number Sense Example Items

	Scale value	Performance category	International average		Hong Kong average	
			Grade 7	Grade 8	Grade 7	Grade 8
Example 1	360	perform routine procedure	86	86	90(18)	89(2)
Example 2	427	knowing	74	75	86(2)	85(6)
Example 3	484	use complex procedures	62	66	*59(27)	*64(29)
Example 4	546	use complex procedures	47	53	*47(24)	*56(23)
Example 5	610	solve problems	35	39	44(2)	48(6)
Example 6	680	perform routine procedure	23	28	47(2)	54(2)

number in brackets represent the ranking of Hong Kong in that item among participating countries.
* indicates that Hong Kong students' performance is lower than expectation

The following is a brief description of the six example items. Please refer to the Appendix for the actual items.

Example 1 is a subtraction problem involving whole numbers that requires borrowing. The average percent correct of Hong Kong is very high but the ranking is rather low. It is because students in most countries are able to carry out this routine procedure.

Example 2 is a free response item about understanding the relative size of fractions. Hong Kong students perform very well in this item in terms of the average correct percent as well as the rank order.

Internationally, about two-thirds of the students correctly interpreted the information about "scale provided on the map" shown in Example 3 which required using complex procedures. The Hong Kong percent correct is lower than the international one in both grades. Besides, the correct percent is smaller than as expected from the scale value of 484 of this item. Perhaps this type of items are rare in Hong Kong textbooks and Hong Kong students are not familiar with them. This result is quite disappointing as this item is in fact not a complicated or difficult one.

Example 4 required students to demonstrate their understanding of rounded values. The Performance Category of this item is also "using complex procedures". It is another item that the Hong Kong correct percent is smaller than as expected from the scale value. Just like Example 3, this item is not a complicated or difficult question. The relative poor result may reflect that many Hong Kong students have poor concept of rounded values.
Example 5 is a word problem requiring multi-steps and the Performance Category is "solving problems". Less than 50% of the Hong Kong students were correct in this item. Besides, the percent correct of Hong Kong is lower than that of Example 6 which is a harder problem according to the scale value. However, the rank order of Hong Kong is 2 in grade seven and 6 in grade eight, showing that Hong Kong students are doing better than many other countries in this item.

Example 6 is a simple question about percentage increase in price and its Performance Category is "performing routine procedures". Although the percent correct is low, Hong Kong ranks second in both grades. The poor performance in this item suggests that working with percentages is a challenge for students in most countries, including Hong Kong.

From the above analysis, it seems that although Hong Kong performs very well in the test in general, there are still a lot of essential mathematical concepts and skills that many Hong Kong students fail to grasp.

4.6 Conclusion

The results and the brief discussion in the preceding sections show that Hong Kong students performed very well in mathematics internationally. But when compared to East-Asian countries, Hong Kong students' mathematics achievements are less impressive. Although Hong Kong students did well in most of the mathematics content areas, there are still a lot of simple and essential concepts and skills that many Hong Kong students fail to master. We should be proud of our students' achievement, but there is certainly no place for complacency.

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Appendix
Example Items in the Fraction and Number Sence Category

Example Item 1
Fractions & Number Sense

Subtraction problem with whole numbers

Subtract: $\begin{array}{r} 6000 \\ \underline{-2369} \end{array}$

A. 4369

B. 3742

(C.) 3631

D. 3531

Performance Category: Performing Routine Procedures

Example Item 2
Fractions & Number Sense

Write a larger fraction

Write a fraction that is larger than $\frac{2}{7}$.

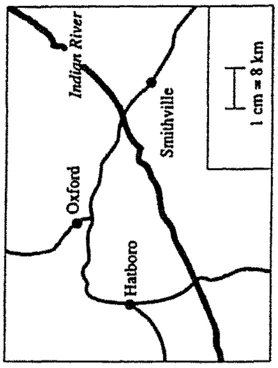
Answer: $\frac{3}{7}$

Performance Category: Knowing

Example Item 3
Fractions & Number Sense

Distance on map

One centimeter on the map represents 8 kilometers on the land.



About how far apart are Oxford and Smithville on the land?

A. 4 km

B. 16 km

(C.) 35 km

D. 50 km

Performance Category: Using Complex Procedures

Appendix (con'd)

EXAMPLE ITEM 4
FRACTIONS & NUMBER SENSE

Actual weight from rounded value

Rounded to the nearest 10 kg the weight of a dolphin was reported as 170 kg. Write down a weight that might have been the actual weight of the dolphin.

Answer: 168

Performance Category: Using Complex Procedures

EXAMPLE ITEM 5
FRACTIONS & NUMBER SENSE

Rate of fuel consumption

A car has a fuel tank that holds 35 L of fuel. The car consumes 7.5 L of fuel for each 100 km driven. A trip of 250 km was started with a full tank of fuel. How much fuel remained in the tank at the end of the trip?

(A.) 16.25 L

B. 17.65 L

C. 18.75 L

D. 23.75 L

Performance Category: Solving Problems

EXAMPLE ITEM 6
FRACTIONS & NUMBER SENSE

Percent increase in price

If the price of a can of beans is raised from 60 cents to 75 cents, what is the percent increase in the price?

A. 15%

B. 20%

(C.) 25%

D. 30%

Performance Category. Performing Routine Procedures