Knowledge & Human Development Authority

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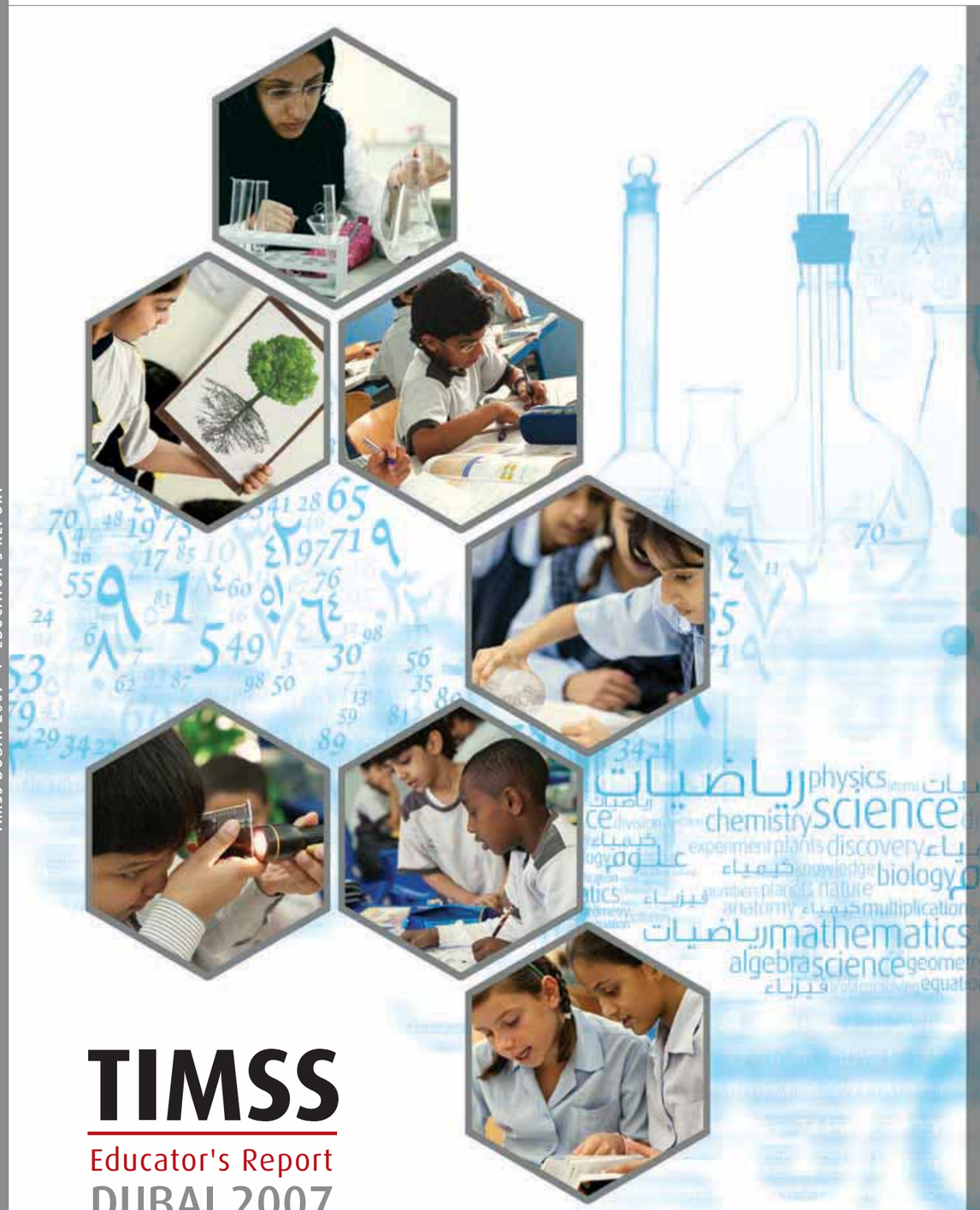
هيئة المعرفة و التنمية البشرية
KNOWLEDGE & HUMAN DEVELOPMENT AUTHORITY

حكومة دبي
GOVERNMENT OF DUBAI



TIMSS

Educator's Report
DUBAI 2007

Trends in International Mathematics and Science Study

TIMSS Dubai 2007

IEA TIMSS 2007

TIMSS

Educator's Report

DUBAI 2007

Trends in International Mathematics and Science Study

Dr. Abdulla Al Karam

Chairman of the Board of Directors and Director General
Knowledge and Human Development Authority
Government of Dubai

Reforming how we acquire and gain knowledge will only work if we approach it all together, as educators, students and parents – in short the entire community. Reform cannot be imposed from above; it must be generated from within. Providing everyone with transparent information enables us all to contribute to achieving the improvements we seek. Our mission to build a human development landscape demands that we base our strategy and policies on evidence and data. By establishing a baseline for our efforts going forward we strengthen our accountability to the public in our responsibility to deliver world-class education to the community. As an Authority and as educators, our full disclosure of the TIMSS results highlights these commitments.

HE Fatma Al Marri

CEO - Dubai School Agency
Knowledge & Human Development Authority
Government of Dubai

I salute everyone in the community for their hard work in making possible Dubai's participation in the TIMSS 2007 academic assessments. From the students and their parents to principals, teachers and administrators, pulling off an assessment like TIMSS is an extraordinary accomplishment and I thank all of you. A glimpse of the extensive data that TIMSS provides us with is in this report. The Dubai School Agency is determined to work hand in hand with the community at large to help deliver the education it deserves at the beginning of the 21st century. Collaborating to help us assess ourselves, the public's participation in TIMSS is a great first step between us all. Thank you again to everyone.

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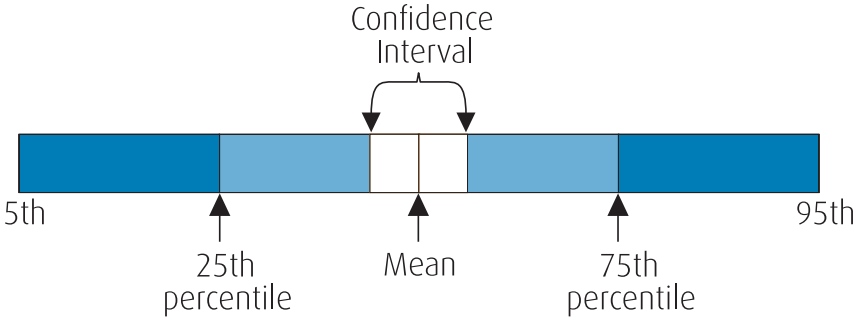
READER'S GUIDE

TIMSS scale average

The TIMSS scale average is calibrated to be 500, with a standard deviation of 100 score points. The international average is the average of all participating countries (excluding benchmarking entities).

READING THE GRAPHS



Each country's results are represented in horizontal bars with various colours. On the left end of the bar is the 5th percentile – this is the score below which 5 percent of the students have scored. The next line indicates the 25th percentile. The next line at the left of the white band is the lower limit of the confidence interval for the mean – i.e. there is 95 percent confidence that the mean will lie within this white band. The line in the centre of the white band is the mean. The lines to the right of the white band indicate the 75th and 95th percentiles.

Throughout this report, the symbol ▲ is used to indicate that a score is significantly higher than another score, ● to indicate no significant difference, and ▼ to indicate a score is significantly lower than another.

Rounding Of Figures

Because of rounding, some figures in tables may not exactly add to the totals. Totals, differences and averages are always calculated on the basis of exact numbers and are rounded only after calculation. When standard errors have been rounded to one decimal place and the value 0.0 is shown, this does not imply that the standard error is zero, but that it is smaller than 0.05 or 0.005 respectively.

Confidence intervals and standard errors

In this and other reports, student achievement is often described by a mean score. For TIMSS, each mean score is calculated from the sample of students who undertook the TIMSS assessment, and is referred to as the sample mean. These sample means are an approximation of the actual mean score, known as the population mean, which would have been derived had all students in Dubai actually sat the TIMSS assessment.

If another sample of students was chosen on a different day, it is highly likely that the sample mean would be slightly different. Indeed the sample mean is just one point along the range of student achievement scores, and so more information is needed to gauge whether the sample mean is an underestimation or overestimation of the population mean.

The calculation of confidence intervals can assist our assessment of a sample mean's precision as a population mean. Confidence intervals provide a range of scores within which we are 'confident' that the population mean actually lies. In this report, sample means are presented with an associated standard error. The confidence interval, which can be calculated using the standard error, indicates that there is a 95 percent chance that the actual population mean lies within plus or minus 1.96 standard errors of the sample mean.

Statistical significance

The term 'significantly' is used throughout the report to describe a difference that meets the requirements of statistical significance at the 0.05 level, indicating that the difference is real, and would be found in at least 95 analyses out of 100 if the comparison were to be repeated. It is not to be confused with the term 'substantial', which is qualitative and based on judgement rather than statistical comparisons. A difference may appear substantial but not be statistically significant (due to factors that effect the size of the standard errors around the estimate, for example) while another difference may seem small but reach statistical significance because the estimate was more accurate.

Sample surveys

TIMSS is conducted as a sample survey in most countries. In surveys such as TIMSS a sample of students is selected to represent the population of students at a particular grade in that country. The samples are designed and conducted so that they provide reliable estimates about the population which they represent. Sample surveys are cheaper to undertake and less intrusive on schools than a full census of the particular population.

The basic sample design for TIMSS is generally referred to as a two-stage stratified cluster sample design. The first stage generally consisted of a sample of schools (in Dubai all schools were invited to participate but not all did so), and the second stage consisted of a single mathematics classroom selected at random from the target year level in sampled schools.

The students in the selected classroom are representative of the students in the population and weights are used to adjust for any differences arising from intended features of the design (e.g. to over-sample minorities) or non-participation by students who were selected. In this way we can provide measures of achievement for the population, based on the responses of a sample of students, along with the confidence interval to indicate the precision of those measures.

This report

This report was prepared by the Australian Council for Educational Research (ACER).

ACER is an independent Australian educational research organisation which has a long history and solid reputation as a provider of reliable support to education policy makers and professional practitioners. This includes the management of TIMSS within Australia, and the associated data analysis and national reporting.

ACER is one of the world's leading educational research centres, committed to creating and distributing research-based knowledge, products and services to improve learning across the lifespan in both formal and informal settings.

Introduction

In 2007, Dubai participated for the first time in the Trends in International Mathematics and Science Study (TIMSS 2007). TIMSS 2007 is the fourth in a cycle of internationally comparative assessments dedicated to improving teaching and learning in mathematics and science for students around the world. Carried out every four years at Year 4 and Year 8, TIMSS provides data about trends in mathematics and science achievement over time. To inform educational policy in the participating countries, this world-wide assessment and research project also routinely collects extensive background information that addresses concerns about the quantity, quality, and content of instruction. For example, TIMSS 2007 collected detailed information about mathematics and science curriculum coverage and implementation, as well as teacher preparation, resource availability, and the use of technology.

Towards the end of 2007, just over 6,000 Dubai students in Year 4, Year 5, Year 8 and Year 9 participated in TIMSS 2007. This entailed a sample of all students in one classroom at the target year level from all schools in Dubai, although due to circumstances not every school participated. The selected students completed tests in mathematics and science achievement, and answered questionnaires on their background and experiences in learning mathematics and science at school. School principals and the students' mathematics and science teachers also completed detailed questionnaires. In 65 countries, regions and other benchmarking entities, selected students, teachers and principals also completed questionnaires.

TIMSS main objectives

The main goal of TIMSS is to assist countries to monitor and evaluate mathematics and science teaching and learning across time at two year levels. TIMSS offers countries an opportunity to find out:

- What are mathematics and science students around the world expected to learn?
- What opportunities are provided for students to learn mathematics and science?
- What mathematics and science concepts, processes and attitudes have students learned?
- What factors are linked to student's opportunity to learn?
- How do these factors influence student achievement?

What did TIMSS 2007 participants do?

As the focus of TIMSS is on international curricula in mathematics and science, a large number of test items were required to cover the range of topics and abilities, at both Year 4 and Year 8. For each year level, mathematics and science items were grouped into clusters, which were then rotated through 14 booklets, with each cluster found in more than one booklet. The booklets were designed to be administered in two sessions, separated by a short break. Each session was of 45 minutes duration at Year 8 and 36 minutes at Year 4. Each booklet contained both mathematics and science items, and included both multiple choice and constructed response items. Participating students completed only one of these booklets, which were evenly distributed within classes. This meant that only two or three students in each class completed each particular booklet.

To prepare the TIMSS 2007 instruments for national use, the Dubai School Agency (DSA) had to make certain changes, selections, and adaptations to the survey instruments. These changes were suggested by highly qualified mathematics and science inspectors. Procedures for administering the test were determined by the TIMSS International Study Center so that data from all students from all schools in all countries could be considered equivalent. These were administered by National Centres in each country, such as the DSA in Dubai.

School coordinators, nominated by the school principal, assisted the DSA with the management of TIMSS within the school, including administering the School and Teacher questionnaires. The actual test and student questionnaires were administered, in most cases, by a teacher from the school. The Test Administrator followed strict guidelines and had to complete a report about any situation that constituted a deviation from these guidelines. A number of National Quality Control Monitors visited 10% of schools to observe the test administration under the guidance of an International Quality Control Monitor, who also oversaw the operations of the DSA.

The internationally standard Student Questionnaire sought information on students and their family background, aspects of learning and instruction in science, and context of instruction including instructional time andclass size.

The Teacher Questionnaire examined a variety of issues related to recruitment, pedagogical practices, teaching styles, use of technology, assessment and assignment of homework, and classroom climate.

The School Questionnaire, answered by the principal (or the principal's designate), sought descriptive information about the school and information about instructional practices. For example, questions were asked about qualifications of teachers and numbers of staff, teacher morale, school and teacher autonomy, school resources; and school policies and practices such as use of student assessments.

How results are reported

International comparative studies have provided an arena to observe the similarities and differences between educational policies and practices, and enable researchers and others to observe what is possible for students to achieve and what environment is most likely to facilitate their learning. TIMSS provides regular information on educational outcomes within and across countries by providing insight about the range of skills and competencies in mathematics and science at two key year levels.

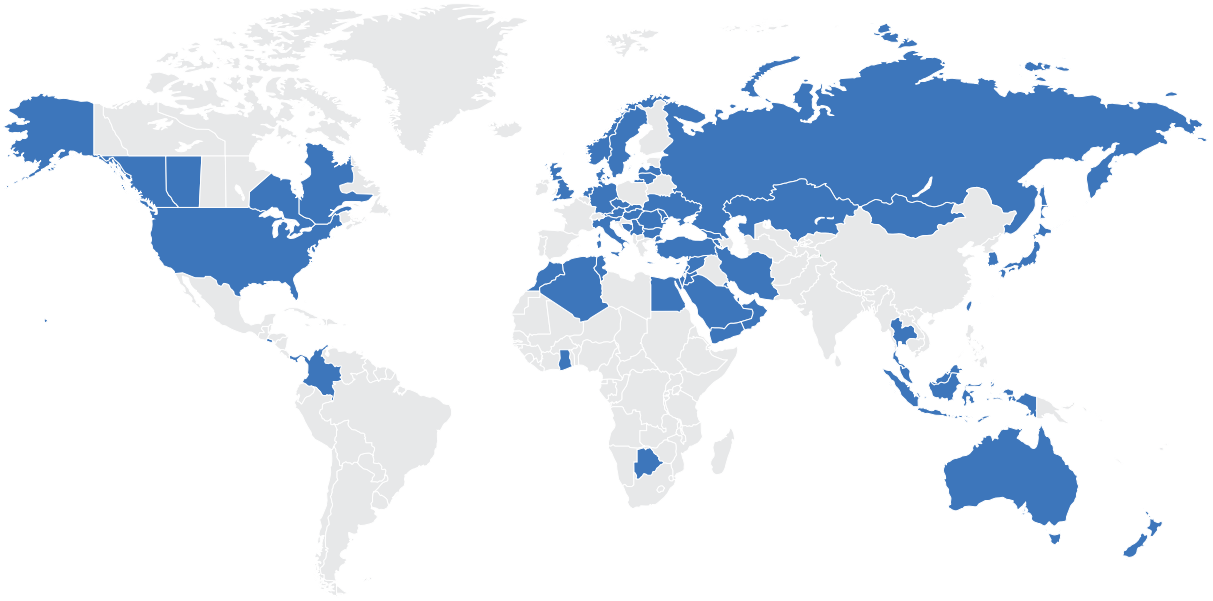
Similar to other international studies, TIMSS results are reported as means that indicate average performance and various statistics that reflect the distribution of performance. School, teacher and student variables further enhance the understanding of student performance. TIMSS also attaches meaning to the performance scale by providing a profile of what students have achieved in terms of 'benchmarks'. Students at a particular benchmark not only typically demonstrate the knowledge and skills associated with that level but also the proficiencies required at lower levels.

It should be noted that the results for Year 4 and Year 8 and the results for mathematics and science, are not directly comparable. While the scales for the two year levels and two subjects are expressed in the same numerical units, they are not directly comparable in terms of being able to say how much achievement or learning at one year level equals how much achievement or learning at the other year level. That is, achievement on the TIMSS scales cannot be described in absolute terms. Comparisons only can be made in terms of relative performance (higher or lower), for example, among countries and population groups as well as between assessments.

Who participates in TIMSS?

Countries

A total of 48 countries at Year 8 and 36 countries at Year 4 participated in TIMSS 2007. In addition four provinces of Canada, two states of the US, Dubai Emirate, UAE and Basque Country, Spain, were also in the study as what are termed benchmarking participants[1]. The participating countries are shown in Figure 1.



Participating Countries

Algeria	Cyprus	SAR	Latvia	Palestinian	Republic
Armenia	Czech	Hungary	Lebanon	Nat'l Auth.	Slovenia
Australia	Republic	Indonesia	Lithuania	Qatar	Sweden
Austria	Denmark	Islamic Rep. of	Malaysia	Romania	Syrian Arab
Bahrain	Egypt	Iran	Malta	Russian	Republic
Bosnia &	El Salvador	Italy	Mongolia	Federation	Thailand
Herzegovina	England	Japan	Morocco	Saudi Arabia	Tunisia
Botswana	Georgia	Jordan	Netherlands	Scotland	Turkey
Bulgaria	Germany	Kazakhstan	New Zealand	Serbia	Ukraine
Chinese Taipei	Ghana	Rep. of Korea	Norway	Singapore	United States
Colombia	Hong Kong	Kuwait	Oman	Slovak	Yemen

Benchmarking Participants

Alberta, Canada
Basque Country, Spain
British Colombia, Canada
Dubai, UAE
Massachusetts, US
Minnesota, US
Ontario, Canada

Figure 1 *TIMSS 2007 participating countries*

1 Benchmarking participants: Provinces or regions that participated in TIMSS for their own internal benchmarking. Data from these provinces are not included in the international mean.

The Dubai sample of schools and students

Table 1 summarises the Dubai sample of schools and students at Year 4 and Year 8. Overall, Dubai is as distinctive an educational landscape as exists with over almost 178,000 students, 84 percent of whom are enrolled in private provision, in a mix of 13 curricula ranging from the UK, US, UAE National and Indian to the French, Russian, Japanese and International Baccalaureate.

Table 1 *Dubai sample in TIMSS 2007*

	Number of schools	Number of students
Year 4		
Public	25	618
Private	71	2446
Year 8		
Public	28	1105
Private	60	2090

How does TIMSS assess students?

TIMSS defines a content dimension and a cognitive dimension to frame the mathematics and science assessment for TIMSS 2007. The content dimension of the assessment specifies the domains or subject matter to be assessed within mathematics or science, while the cognitive domain specifies the domains or thinking processes to be assessed. The cognitive domains describe the sets of behaviours expected of students as they engage with the mathematics or science content.

The content domains differ for Year 4 and Year 8 students, reflecting the nature and difficulty of the mathematics and science widely taught at each grade. In mathematics there is more emphasis on *number* at Year 4 than in Year 8, in science there is more emphasis on *Life science* in Year 4 than in Year 8. In mathematics at Year 8, *Geometry* and *Algebra* are assessed, while in Year 4 these content areas are not generally included in the curriculum. Similarly in science in Year 8, *Physics* and *Chemistry* are assessed as separate content domains, and receive more emphasis than in Year 4, where they are assessed as one content domain, *Physical science*. The cognitive framework, however, is the same for both grades, encompassing a range of cognitive processes involved in working mathematically or scientifically and solving problems right through the primary and middle school years.

Content areas in mathematics

The content areas for mathematics at Year 4 are: *number, Geometric shapes and measurement*, and *data display*. At Year 8 the content areas were: *number, Algebra, Geometry*, and *data and chance*.

Content areas in science

At Year 4 the science content areas are: *Life science, Physical science* and *Earth science*. At Year 8 the science content areas were: *Biology, Physics, Chemistry*, and *Earth science*.

Cognitive Domains

To respond correctly to TIMSS test items, students need to be familiar with the mathematics and science content of the items. Just as important, however, the items were designed to elicit the use of particular cognitive skills. The student behaviours used to define both the mathematics and the science framework at Year 4 and Year 8 can be described as follows:

- ***Knowing*** – which covers the facts, procedures, and concepts students need to know;
- ***Applying*** – which focuses on the ability of students to apply knowledge and conceptual understanding to solve problems or answer questions; and
- ***Reasoning*** – which goes beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems.

TIMSS background questionnaires

For a more complete understanding of what the TIMSS achievement results mean and how they may be used to improve student learning in mathematics and science, it is important to understand the contexts in which students learn. After the achievement data were collected from students, each one completed a background questionnaire. The background information collected included demographic data and students' attitudes towards mathematics and science.

Teacher and school questionnaires were also administered to the mathematics and science teacher(s) of the selected class and to the principal of the school. The type of data that was sought in the school questionnaire included information on school organisation, school goals, the role of the school principal, parental involvement, and school climate. A school's social climate comprises the values, cultures, safety practices, and organisational structures that cause it to function and react in particular ways. Respect for individual students and teachers, a safe and orderly environment, constructive interactions among administrators, teachers, parents, and students all contribute to a positive school climate. A supportive school climate helps to build better morale among teachers and students and that leads to higher student achievement. The teacher questionnaire examined a variety of issues related to recruitment, pedagogical practices, teaching styles, use of technology, and assessment and assignment of homework.

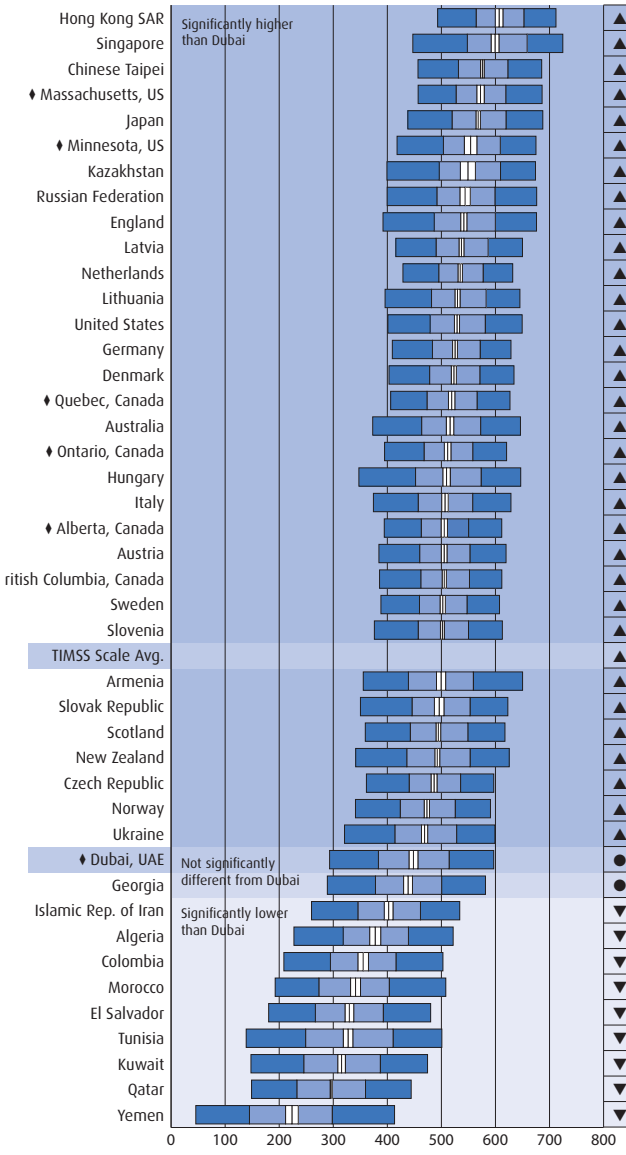
Question types and scoring the responses

Students' knowledge and understanding of mathematics and science are assessed through a range of questions in each subject. Two question formats are used in the TIMSS assessment – multiple-choice and constructed-response. At least half of the total number of points represented by all the questions comes from multiple-choice questions. Each multiple-choice question is worth one score point.

Multiple-Choice Questions: Multiple-choice questions provide four response options, of which only one is correct. These questions can be used to assess any of the behaviours in the cognitive domains. However, because they do not allow for students' explanations or supporting statements, multiple-choice questions may be less suitable for assessing students' ability to make more complex interpretations or evaluations.

Constructed-Response Questions: For this type of test item students are required to construct a written response, rather than select a response from a set of options. Constructed-response questions are particularly well-suited for assessing aspects of knowledge and skills that require students to explain phenomena or interpret data based on their background knowledge and experience.

Achievement internationally – Year 4 mathematics



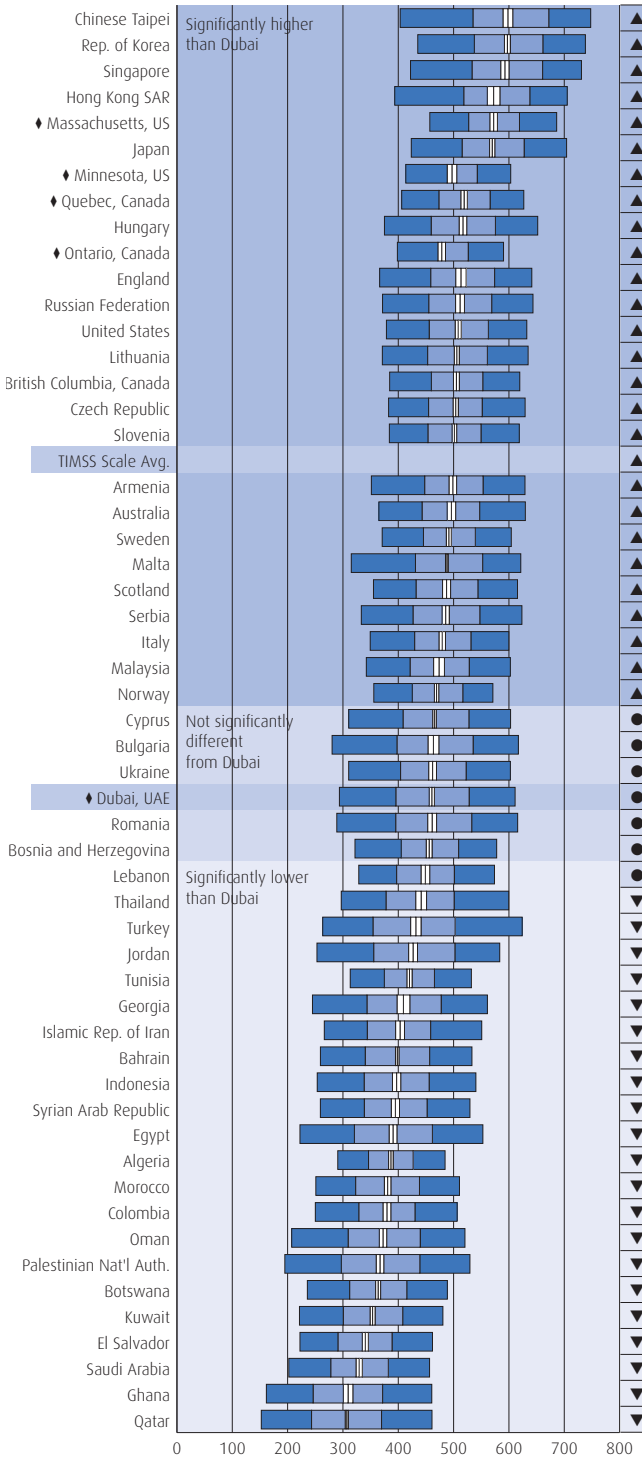
		Average scale score	SE	Years of Formal Schooling*	Average Age at Time of Testing	Human Development Index**
Hong Kong SAR	▲	607	3.6	4	10.2	0.937
Singapore	▲	599	3.7	4	10.4	0.922
Chinese Taipei	▲	576	1.7	4	10.2	0.932
♦ Massachusetts, US	▲	572	3.5	4	10.3	-
Japan	▲	568	2.1	4	10.5	0.953
♦ Minnesota, US	▲	554	5.9	4	10.3	-
Kazakhstan	▲	549	7.1	4	10.6	0.794
Russian Federation	▲	544	4.9	4	10.8	0.813
England	▲	541	2.9	5	10.2	0.946
Latvia	▲	537	2.3	4	11	0.855
Netherlands	▲	535	2.1	4	10.2	0.953
Lithuania	▲	530	2.4	4	10.8	0.862
United States	▲	529	2.4	4	10.3	0.951
Germany	▲	525	2.3	4	10.4	0.935
Denmark	▲	523	2.4	4	11	0.949
♦ Quebec, Canada	▲	519	3.0	4	10.1	-
Australia	▲	516	3.5	4	9.9	0.962
♦ Ontario, Canada	▲	512	3.1	4	9.8	-
Hungary	▲	510	3.5	4	10.7	0.874
Italy	▲	507	3.1	4	9.8	0.941
♦ Alberta, Canada	▲	505	3	4	9.8	-
Austria	▲	505	2	4	10.3	0.948
ritish Columbia, Canada	▲	505	2.7	4	9.8	-
Sweden	▲	503	2.5	4	10.8	0.956
Slovenia	▲	502	1.8	4	9.8	0.917
TIMSS Scale Avg.	▲	500	0		-	0
Armenia	▲	500	4.3	4	10.6	0.775
Slovak Republic	▲	496	4.5	4	10.4	0.863
Scotland	▲	494	2.2	5	9.8	0.946
New Zealand	▲	492	2.3	4.5 - 5.5	10	0.943
Czech Republic	▲	486	2.8	4	10.3	0.891
Norway	▲	473	2.5	4	9.8	0.968
Ukraine	▲	469	2.9	4	10.3	0.788
♦ Dubai, UAE	●	444	(2.1)	4	10.0	-
Georgia	●	438	4.2	4	10.1	0.754
Islamic Rep. of Iran	▼	402	4.1	4	10.2	0.759
Algeria	▼	378	5.2	4	10.2	0.733
Colombia	▼	355	5	4	10.4	0.791
Morocco	▼	341	4.7	4	10.6	0.646
El Salvador	▼	330	4.1	4	11	0.735
Tunisia	▼	327	4.5	4	10.2	0.766
Kuwait	▼	316	3.6	4	10.2	0.891
Qatar	▼	296	1	4	9.7	0.875
Yemen	▼	224	6	4	11.2	0.508

▲: significantly higher than Dubai; ●: not significantly different to Dubai; ▼: significantly lower than Dubai
* Represents years of schooling from the beginning of ISCED 1
** Taken from the UNDP Human Development Report
♦ Benchmarking participants

Figure 2 *International achievement in mathematics – Year 4*

- This figure shows that Hong Kong and Singapore were the highest achievers for TIMSS 2007, with scores one full standard deviation higher than the international scale average.
- Dubai's score of 444 was lower than the international scale average of 500 score points.
- Twenty-six countries outperformed Dubai, Georgia's score was not significantly different to that of Dubai, and Dubai performed significantly better than 9 countries.
- Dubai's score was significantly higher than that of the two GCC countries participating at Year 4, Kuwait and Qatar and other Arab countries Algeria, Morocco, Tunisia and Yemen.

Achievement internationally – Year 8 mathematics



		Average scale score	SE	Years of Formal Schooling*	Average Age at Time of Testing	Human Development Index**
Chinese Taipei	▲	598	4.5	8	14.2	0.932
Rep. of Korea	▲	597	2.7	8	14.3	0.921
Singapore	▲	593	3.8	8	14.4	0.922
Hong Kong SAR	▲	572	5.8	8	14.4	0.937
♦ Massachusetts, US	▲	572	3.5	8	14.2	-
Japan	▲	570	2.4	8	14.5	0.953
♦ Minnesota, US	▲	532	4.4	8	14.3	-
♦ Quebec, Canada	▲	519	3	8	142	-
Hungary	▲	517	3.5	8	14.6	0.874
♦ Ontario, Canada	▲	517	3.5	8	13.8	-
England	▲	513	4.8	9	14.2	0.946
Russian Federation	▲	512	4.1	7 or 8	14.6	0.802
United States	▲	508	2.8	8	14.3	0.951
Lithuania	▲	506	2.3	8	14.9	0.862
British Columbia, Canada	▲	505	2.7	8	13.9	-
Czech Republic	▲	504	2.4	8	14.4	0.891
Slovenia	▲	501	2.1	7 or 8	13.8	0.917
TIMSS Scale Avg.	▲	500	-		-	-
Armenia	▲	499	3.5	8	14.9	0.775
Australia	▲	496	3.9	8	13.9	0.962
Sweden	▲	491	2.3	8	14.8	0.956
Malta	▲	488	1.2	9	14	0.878
Scotland	▲	487	3.7	9	13.7	0.946
Serbia	▲	486	3.3	8	14.9	0.81
Italy	▲	480	3	8	13.9	0.941
Malaysia	▲	474	5	8	14.3	0.811
Norway	▲	469	2	8	13.8	0.968
Cyprus	●	465	1.6	8	13.8	0.903
Bulgaria	●	464	5	8	14.9	0.824
Ukraine	●	462	3.6	8	14.2	0.788
♦ Dubai, UAE	●	461	2.4	8	14.2	-
Romania	●	461	4.1	8	15	0.813
Bosnia and Herzegovina	●	456	(2.7)	8 or 9	14.7	0.803
Lebanon	●	449	4	8	14.4	0.772
Thailand	▼	441	5	8	14.3	0.781
Turkey	▼	432	4.8	8	14	0.775
Jordan	▼	427	4.1	8	14	0.773
Tunisia	▼	420	2.4	8	14.5	0.766
Georgia	▼	410	5.9	8	14.2	0.754
Islamic Rep. of Iran	▼	403	4.1	8	14.2	0.759
Bahrain	▼	398	1.6	8	14.1	0.866
Indonesia	▼	397	3.8	8	14.3	0.728
Syrian Arab Republic	▼	395	3.8	8	13.9	0.724
Egypt	▼	391	3.6	8	14.1	0.708
Algeria	▼	387	2.1	8	14.5	0.733
Morocco	▼	381	3	8	14.8	0.646
Colombia	▼	380	3.6	8	14.5	0.791
Oman	▼	372	3.4	8	14.3	0.814
Palestinian Nat'l Auth.	▼	367	3.5	8	14	0.731
Botswana	▼	364	2.3	8	14.9	0.654
Kuwait	▼	354	2.3	8	14.4	0.891
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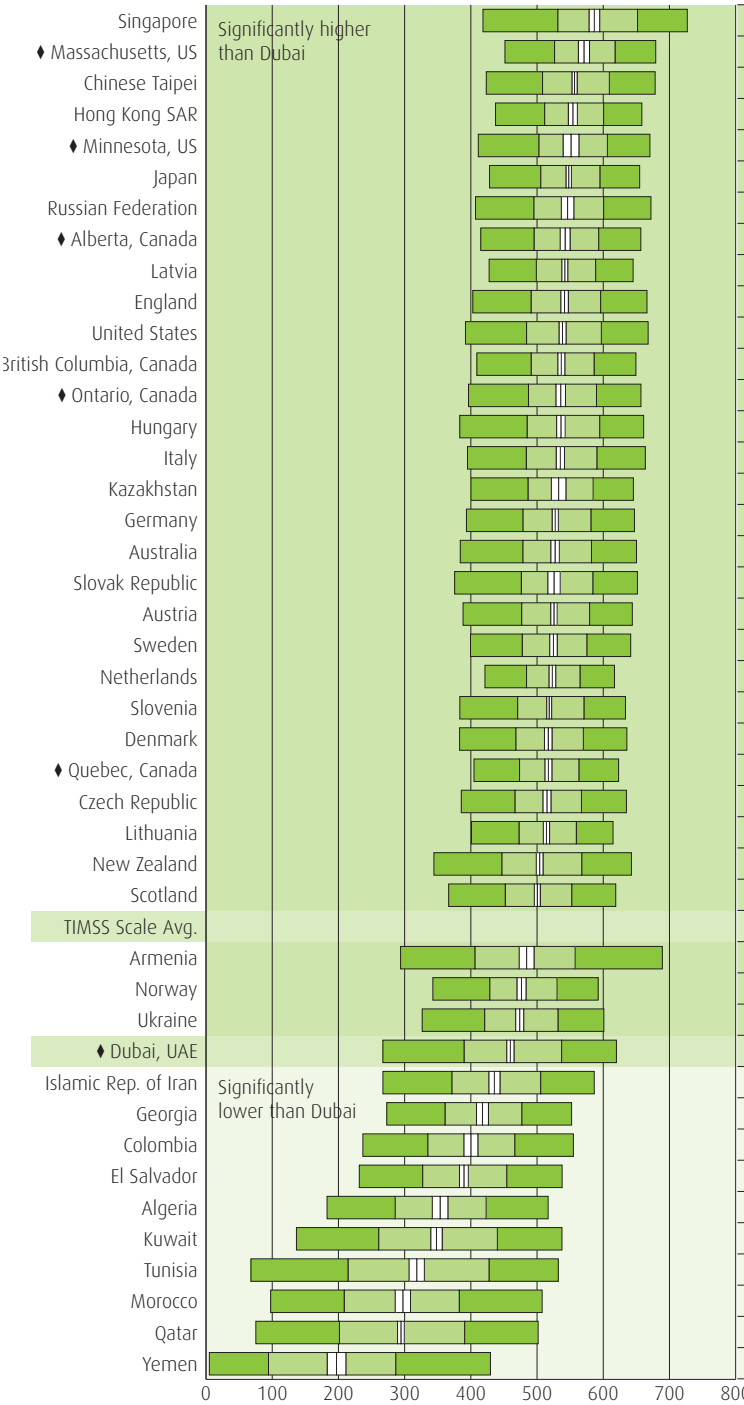
▲: significantly higher than Dubai; ●: not significantly different to Dubai; ▼: significantly lower than Dubai
* Represents years of schooling from the beginning of ISCED 1
** Taken from the UNDP Human Development Report
♦ Benchmarking participants

Figure 3 *International achievement in mathematics – Year 8*

- Chinese Taipei, Korea, and Singapore were the highest scorers for TIMSS 2007 in Year 8 mathematics, with scores almost one standard deviation higher than the international scale average.
- Dubai's score of 461 was lower than the international scale average of 500 score points.
- Dubai's score was statistically similar to that of Cyprus, Bulgaria, Ukraine, Romania, and Bosnia and Herzegovina.
- Dubai's score was significantly higher than all countries below, including the GCC countries Bahrain, Oman, Kuwait, Saudi Arabia and Qatar, and Arab countries Algeria, Egypt, Jordan, Lebanon, Morocco, the Palestinian National Authority, the Syrian Arab Republic and Tunisia.

Achievement internationally – Year 4 science



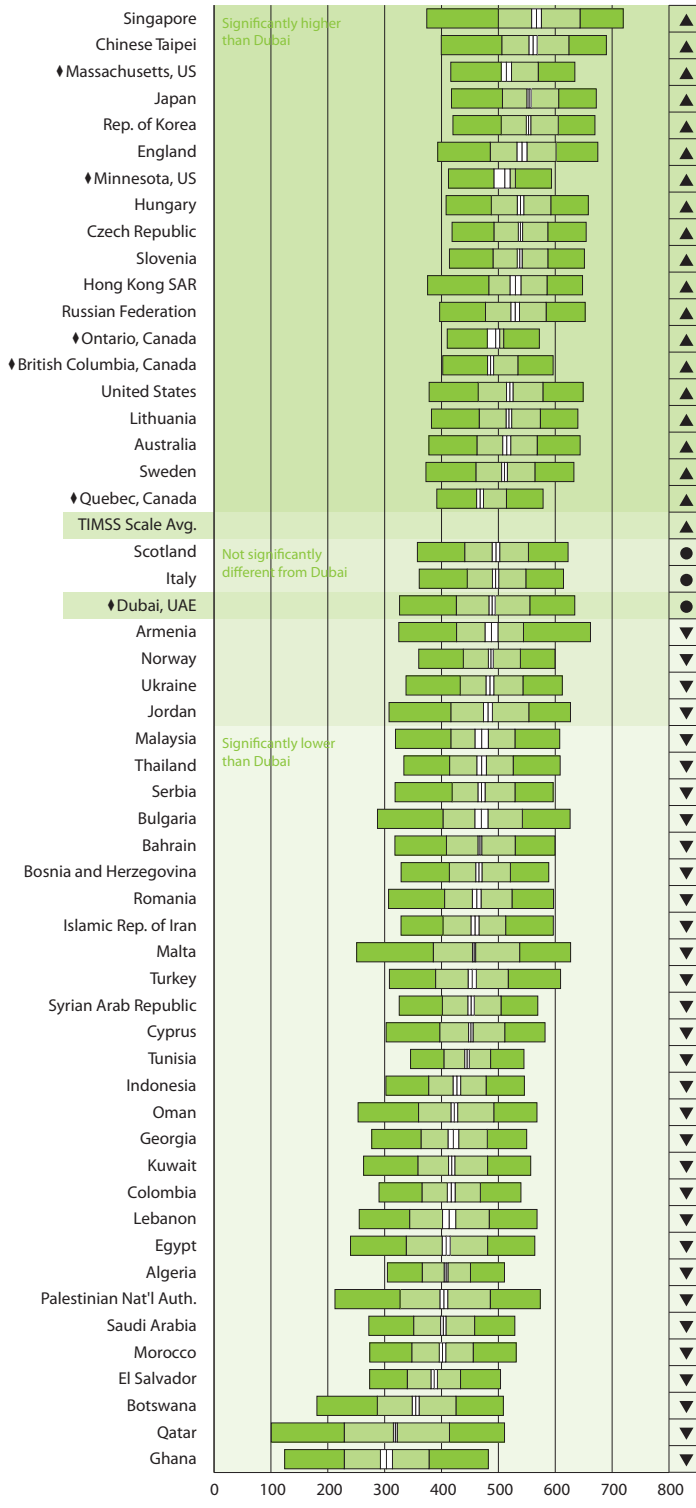
		Average scale score	SE	Years of Formal Schooling*	Average Age at Time of Testing	Human Development Index**
Singapore	▲	587	4.1	4	10.4	0.922
♦ Massachusetts, US	▲	571	4.3	4	10.3	-
Chinese Taipei	▲	557	2	4	10.2	0.932
Hong Kong SAR	▲	554	3.5	4	10.2	0.937
♦ Minnesota, US	▲	551	6.1	4	10.3	-
Japan	▲	548	2.1	4	10.5	0.953
Russian Federation	▲	546	4.8	4	10.8	0.813
♦ Alberta, Canada	▲	543	3.8	4	9.8	-
Latvia	▲	542	2.3	4	11	0.855
England	▲	542	2.9	5	10.2	0.946
United States	▲	539	2.7	4	10.3	0.951
3ritish Columbia, Canada	▲	537	2.7	4	9.8	-
♦ Ontario, Canada	▲	536	3.7	4	9.8	-
Hungary	▲	536	3.3	4	10.7	0.874
Italy	▲	535	3.2	4	9.8	0.941
Kazakhstan	▲	533	5.6	4	10.6	0.794
Germany	▲	528	2.4	4	10.4	0.935
Australia	▲	527	3.3	4	9.9	0.962
Slovak Republic	▲	526	4.8	4	10.4	0.863
Austria	▲	526	2.5	4	10.3	0.948
Sweden	▲	525	2.9	4	10.8	0.956
Netherlands	▲	523	2.6	4	10.2	0.953
Slovenia	▲	518	1.9	4	9.8	0.917
Denmark	▲	517	2.9	4	11	0.949
♦ Quebec, Canada	▲	517	2.7	4	10.1	-
Czech Republic	▲	515	3.1	4	10.3	0.891
Lithuania	▲	514	2.4	4	10.8	0.862
New Zealand	▲	504	2.6	4.5 - 5.5	10	0.943
Scotland	▲	500	2.3	5	9.8	0.946
TIMSS Scale Avg.	▲	500	0		-	
Armenia	▲	484	5.7	4	10.6	0.775
Norway	▲	477	3.5	4	9.8	0.968
Ukraine	▲	474	3.1	4	10.3	0.788
♦ Dubai, UAE	●	460	2.8	4	10	-
Islamic Rep. of Iran	▼	436	(4.3)	4	10.2	0.759
Georgia	▼	418	4.6	4	10.1	0.754
Colombia	▼	400	5.4	4	10.4	0.791
El Salvador	▼	390	3.4	4	11	0.735
Algeria	▼	354	6	4	10.2	0.733
Kuwait	▼	348	4.4	4	10.2	0.891
Tunisia	▼	318	5.9	4	10.2	0.766
Morocco	▼	297	5.9	4	10.6	0.646
Qatar	▼	294	2.6	4	9.7	0.875
Yemen	▼	197	7.2	4	11.2	0.508

▲: significantly higher than Dubai; ●: not significantly different to Dubai; ▼: significantly lower than Dubai
* Represents years of schooling from the beginning of ISCED 1
** Taken from the UNDP Human Development Report
♦ Benchmarking participants

Figure 4 *International achievement in science – Year 4*

- Singapore was the top performing country at Year 4, with an average score 87 points above the 500 scale average. Singapore was followed by Chinese Taipei and Hong Kong, which were outperformed only by Singapore. Next were Japan and the Russian Federation, which were outperformed only by Singapore and Chinese Taipei, and then Latvia and England, which were outperformed only by Singapore, Chinese Taipei, and Hong Kong.
- Dubai's score of 460 was significantly lower than the TIMSS scale mean. The difference of 40 points was not as great as that for mathematics.
- Twenty-six countries outperformed Dubai, while Dubai outperformed 10 countries.
- Dubai's score was significantly higher than that of the two GCC countries participating at Year 4, Kuwait and Qatar, and Arab countries Algeria, Morocco, Tunisia and Yemen.

Achievement internationally – Year 8 science



		Average scale score	SE	Years of Formal Schooling*	Average Age at Time of Testing	Human Development Index**
Singapore	▲	567	4.4	8	14.4	0.922
Chinese Taipei	▲	561	3.7	8	14.2	0.932
♦Massachusetts, US	▲	556	4.6	8	14.2	-
Japan	▲	554	1.9	8	14.5	0.953
Rep. of Korea	▲	553	2	8	14.3	0.921
England	▲	542	4.5	9	14.2	0.946
♦Minnesota, US	▲	539	4.8	8	14.3	-
Hungary	▲	539	2.9	8	14.6	0.874
Czech Republic	▲	539	1.9	8	14.4	0.891
Slovenia	▲	538	2.2	7 or 8	13.8	0.917
Hong Kong SAR	▲	530	4.9	8	14.4	0.937
Russian Federation	▲	530	3.9	7 or 8	14.6	0.802
♦Ontario, Canada	▲	526	3.6	8	13.8	-
♦British Columbia, Canada	▲	526	2.7	8	13.9	-
United States	▲	520	2.9	8	14.3	0.951
Lithuania	▲	519	2.5	8	14.9	0.862
Australia	▲	515	3.6	8	13.9	0.962
Sweden	▲	511	2.6	8	14.8	0.956
♦Quebec, Canada	▲	507	3.1	8	14.2	-
TIMSS Scale Avg.	▲	500	0		-	
Scotland	●	496	3.4	9	13.7	0.946
Italy	●	495	2.8	8	13.9	0.941
♦Dubai, UAE	●	489	2.8	8	14.2	-
Armenia	▼	488	5.8	8	14.9	0.775
Norway	▼	487	2.2	8	13.8	0.968
Ukraine	▼	485	3.5	8	14.2	0.788
Jordan	▼	482	4	8	14	0.773
Malaysia	▼	471	6	8	14.3	0.811
Thailand	▼	471	4.3	8	14.3	0.781
Serbia	▼	470	3.2	8	14.9	0.81
Bulgaria	▼	470	5.9	8	14.9	0.824
Bahrain	▼	467	1.7	8	14.1	0.866
Bosnia and Herzegovina	▼	466	2.8	8 or 9	14.7	0.803
Romania	▼	462	(3.9)	8	15.0	0.813
Islamic Rep. of Iran	▼	459	3.6	8	14.2	0.759
Malta	▼	457	1.4	9	14	0.878
Turkey	▼	454	3.7	8	14	0.775
Syrian Arab Republic	▼	452	2.9	8	13.9	0.724
Cyprus	▼	452	2	8	13.8	0.903
Tunisia	▼	445	2.1	8	14.5	0.766
Indonesia	▼	427	3.4	8	14.3	0.728
Oman	▼	423	3	8	14.3	0.814
Georgia	▼	421	4.8	8	14.2	0.754
Kuwait	▼	418	2.8	8	14.4	0.891
Colombia	▼	417	3.5	8	14.5	0.791
Lebanon	▼	414	5.9	8	14.4	0.772
Egypt	▼	408	3.6	8	14.1	0.708
Algeria	▼	408	1.7	8	14.5	0.733
Palestinian Nat'l Auth.	▼	404	3.5	8	14	0.731
Saudi Arabia	▼	403	2.4	8	14.4	0.812
Morocco	▼	402	2.9	8	14.8	0.646
El Salvador	▼	387	2.9	8	15.0	0.735
Botswana	▼	355	3.1	8	14.9	0.654
Qatar	▼	319	1.7	8	13.9	0.875
Ghana	▼	303	5.4	8	15.8	0.553

▲: significantly higher than Dubai; ●: not significantly different to Dubai; ▼: significantly lower than Dubai
* Represents years of schooling from the beginning of ISCED 1
** Taken from the UNDP Human Development Report
♦ Benchmarking participants

Figure 5 *International achievement in science – Year 8*

- Singapore and Chinese Taipei had the highest average achievement in science at Year 8. These two countries had averages more than 60 points above the TIMSS scale average. Singapore had higher achievement than all of the other countries except Chinese Taipei, which, in turn, outperformed all countries except Singapore, Japan, and Korea.
- Dubai's score of 489 was significantly lower than the international scale average of 500 score points.
- Dubai's score was statistically similar to that of Scotland, Italy, Armenia, Norway, Ukraine and Jordan.
- Dubai's score was significantly higher than Malaysia and all countries below this in the table, including the GCC countries Bahrain, Oman, Kuwait, Saudi Arabia and Qatar, and Arab countries Algeria, Egypt, Lebanon, Morocco, the Palestinian National Authority, the Syrian Arab Republic and Tunisia.

TIMSS Benchmarks

While the achievement scales in mathematics and science summarise student performance on the cognitive processes and content knowledge measured by the TIMSS tests, the international benchmarks help put these scores in context.

Internationally it was decided that performance should be measured at four levels. These four levels summarise the achievement reached by:

- the 'Advanced International Benchmark', which was set at 625;
- the 'High International Benchmark', which was set at 550;
- the 'Intermediate International Benchmark', which was set at 475; and
- the 'Low International Benchmark', which was set at 400.

Benchmarks are only one way of examining student performance. The benchmarks discussed in this report are based solely on student performance in TIMSS 2007, on items that were developed specifically for the purpose of obtaining information on the science domains in the TIMSS framework.

For each benchmark, in both subjects and at both year levels, illustrative items and examples of the answers typically provided by students in Dubai are shown in the Appendix to this report.

In Year 4 mathematics, students at the Advanced International Benchmark were able to apply mathematical understanding and knowledge in a variety of relatively complex problem situations and were able to explain their reasoning, whereas those at the Low International Benchmark demonstrated some basic mathematical knowledge and were able to compute with whole numbers, recognise some geometric shapes, and read simple graphs and tables.

At Year 8, students at the Advanced International Benchmark were able to organise and drew conclusions from information, made generalisations, and solved non-routine problems involving numeric, algebraic, and geometric concepts and relationships. In comparison, those at the Low International Benchmark demonstrated some knowledge of whole numbers and decimals, operations, and basic graphs.

Mathematics	
Year 4	Year 8
Advanced International Benchmark – 625	
Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning.	Students can organise and draw conclusions from information, make generalisations, and solve non-routine problems.
High International Benchmark – 550	
Students can apply their knowledge and understanding to solve problems.	Students can apply their understanding and knowledge in a variety of relatively complex situations.
Intermediate International Benchmark – 475	
Students can apply basic mathematical knowledge in straightforward situations	Students can apply basic mathematical knowledge in straightforward situations.
Low International Benchmark – 400	
Students have some basic mathematical knowledge.	Students have some knowledge of whole numbers and decimals, operations, and basic graphs.

At Year 4 science, students at the Advanced International Benchmark were able to apply their knowledge and understanding of scientific processes and relationships in beginning scientific inquiry, whereas those at the Low International Benchmark displayed just some elementary knowledge of *life science* and *physical science*.

Science	
Year 4	Year 8
Advanced International Benchmark – 625	
Students can apply knowledge and understanding of scientific processes and relationships in beginning scientific inquiry.	Students can demonstrate a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science.
High International Benchmark – 550	
Students can apply knowledge and understanding to explain everyday phenomena.	Students can demonstrate conceptual understanding of some science cycles, systems, and principles.
Intermediate International Benchmark – 475	
Students can apply basic knowledge and understanding to practical situations in the sciences.	Students can recognise and communicate basic scientific knowledge across a range of topics.
Low International Benchmark – 400	
Students have some elementary knowledge of life science and physical science.	Students can recognise some basic facts from the life and physical sciences.

Achievement at the International Benchmarks

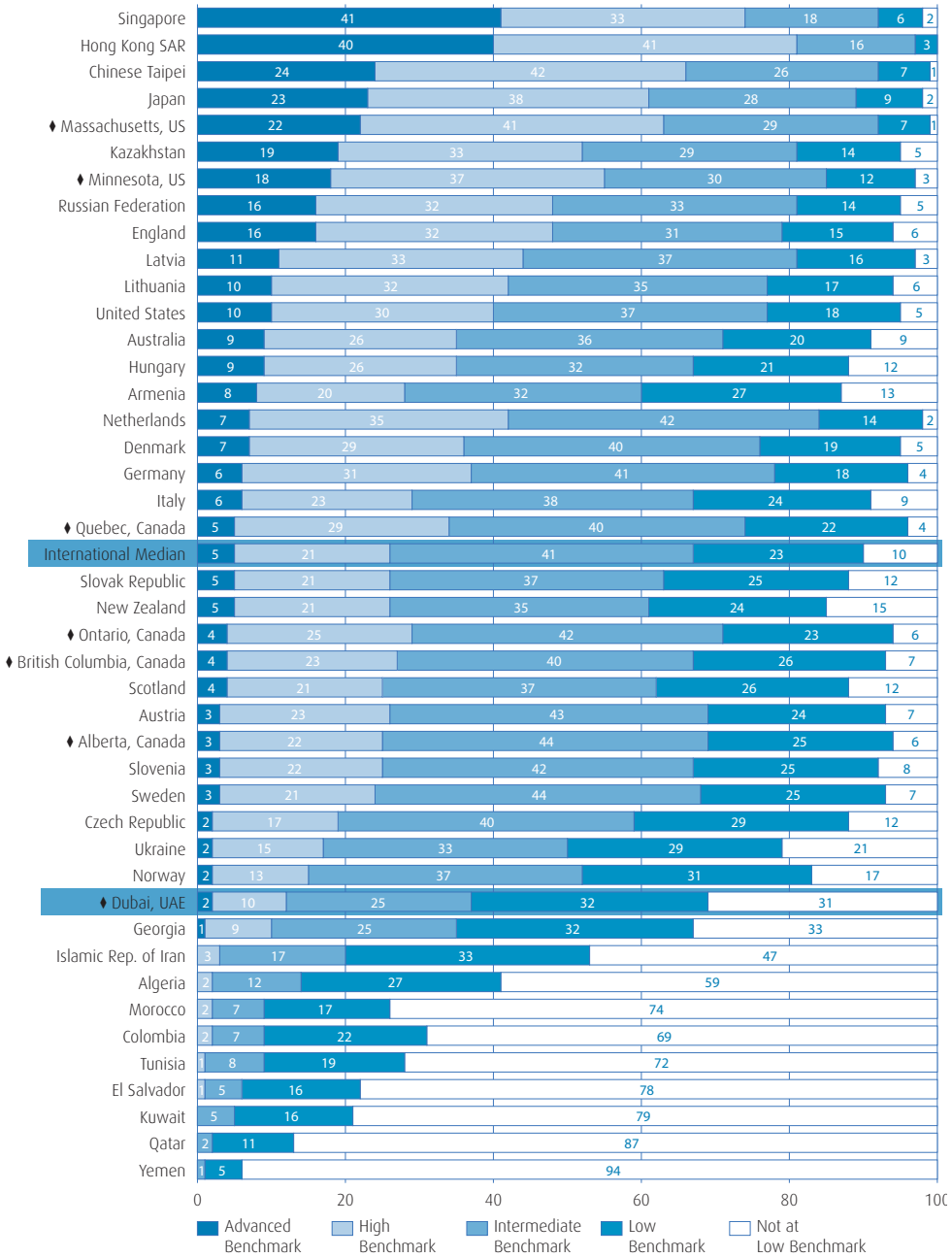


Figure 6 *Percentages of students reaching the International Benchmarks for mathematics achievement by country – Year 4*

- At Year 4, the median for those achieving the low international benchmark was 90 percent, indicating that in at least half the countries most of the Year 4 students had basic knowledge and skills in mathematics.
- In Dubai almost one-third of students (31%) did not achieve the low international benchmark. While this figure is higher than the international median, and of course much higher than that of the highest-achieving countries where only one or two percent of students do not attain this level, it compares very favourably with that of countries such as Kuwait, in which 79 percent of students and Qatar in which 87 percent of students did not reach the low international benchmark.

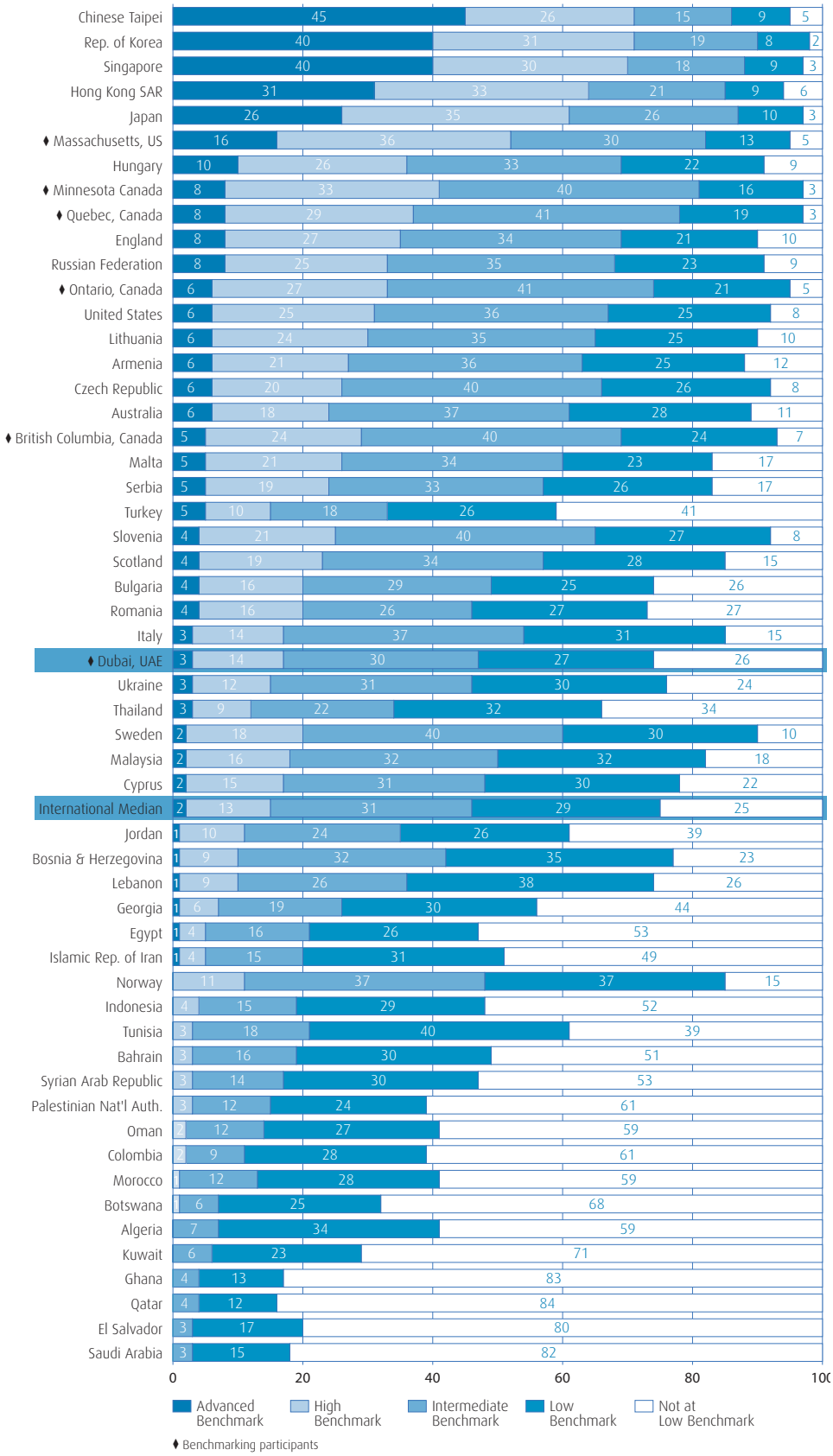


Figure 7 *Percentages of students reaching the International Benchmarks for mathematics achievement by country – Year 8*

- In Dubai at Year 8 the picture is stronger in terms of students' achievement at the benchmarks.
- In Dubai three percent of students, compared to the international median of two percent, achieved the advanced international benchmark, and 14 percent, compared to 13 percent internationally, achieved the high international benchmark.
- In comparison, only a few of the Middle Eastern countries achieved one percent of students at the advanced benchmark, and many had their highest achievement at the high benchmark.
- About one quarter of students in Dubai, which was the same as the international median, did not demonstrate a grasp of the basic mathematical skills required at the low benchmark. As this figure is the same as the international median, this means that half of the countries at Year 8 had a higher proportion of students not achieving this low benchmark.
- In many countries less than half the students did not achieve this basic level, and in several countries less than 20 percent reached the low international benchmark, including Saudi Arabia (18%), Ghana (17%), and Qatar (16%).

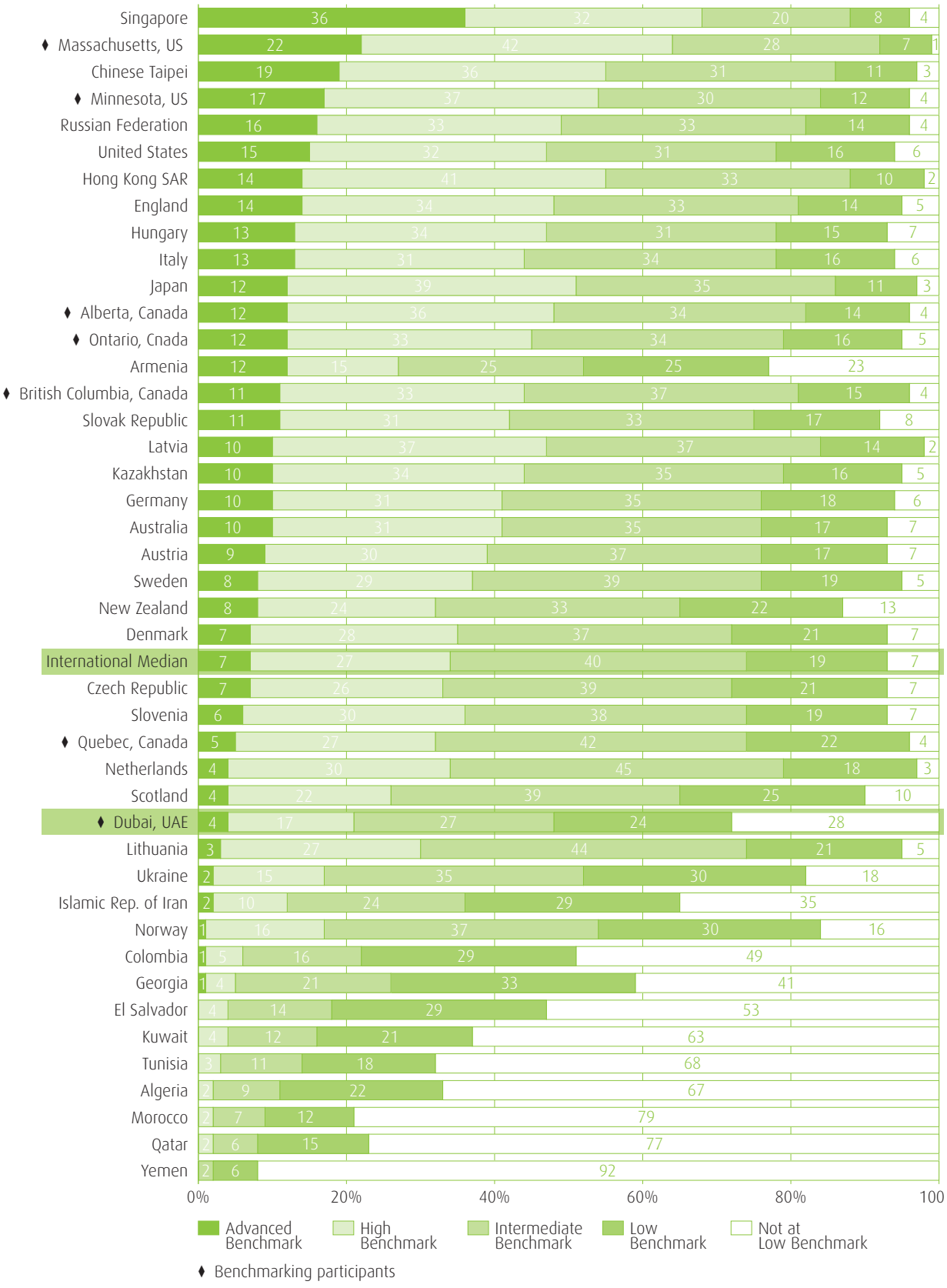


Figure 8 *Percentages of students reaching the International Benchmarks for science achievement by country – Year 4*

- In Dubai at Year 4, four percent of students achieved the advanced international benchmark, and a further 17 percent achieved the high international benchmark. In comparison, the international median for each of these was seven percent and 27 percent respectively.
- At Year 4, the median for those achieving the low international benchmark was 93 percent, indicating that in at least half the countries most of the Year 4 students had basic knowledge and skills in science.
- In Dubai more than one-quarter of students (28%) did not achieve the low international benchmark. While this figure is much higher than the international median, and of course much higher than that of the highest-achieving countries where only one or two percent of students fail to achieve this level, it compares very favourably with that of countries such as Kuwait, in which 63 percent of students and Qatar in which 77 percent of students did not reach the low international benchmark.

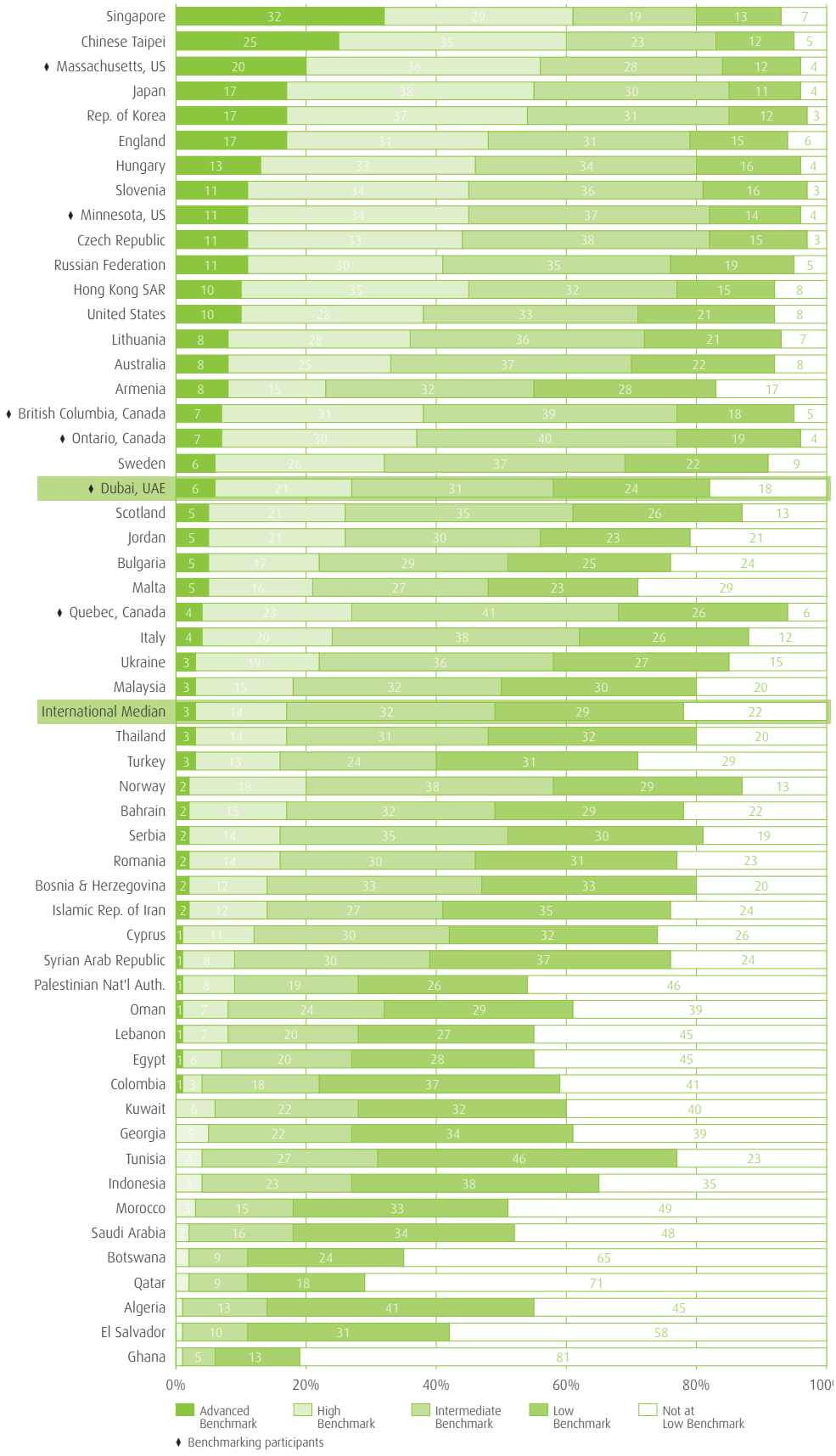


Figure 9 *Percentages of students reaching the International Benchmarks for science achievement by country – Year 8*

- In Dubai six percent of students, compared to the international median of three percent, achieved the advanced international benchmark, and a further 21 percent, compared to 14 percent internationally, achieved the high international benchmark.
- In comparison, only a few of the Middle Eastern countries achieved more than one or two percent of students at the advanced benchmark, and many had their highest achievement at the high benchmark.
- Eighteen percent of students in Dubai, which was lower than the international median, did not demonstrate a grasp of the basic scientific skills required at the low benchmark.
- In many countries less than half the students did not achieve this basic level, and in Ghana 81 percent and Qatar 71 percent of students did not achieve the low international benchmark.

Achievement and gender

Year 4 mathematics

- Internationally there were no differences in the average scale scores for boys and girls at Year 4.
- This was also the case for 16 of the countries, and for Dubai. Although the gender difference is 14 score points in favour of girls, the standard error is quite large, and so precludes significance.

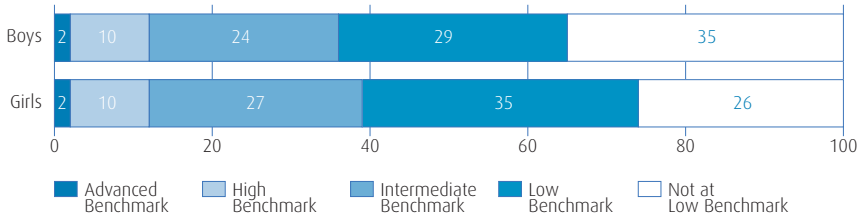


Figure 10 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by gender – Year 4*

- Clearly from this figure, achievement at the higher benchmarks is the same for girls and boys.
- At Year 4, about 12 percent of boys and girls are achieving at the advanced and high benchmarks.
- At the lower end of the benchmarking scale, about one-quarter of girls (26%) but more than one-third of boys (35%) are failing to achieve the low international benchmark.

Year 8 mathematics

- On average across the TIMSS 2007 countries at this year level, girls had higher average achievement than boys.
- Girls had higher achievement than boys in 16 of the participating countries and in many, but not all, of the countries situated geographically in the Middle East, including Egypt, Jordan, Kuwait, Saudi Arabia, Bahrain, Qatar, and Oman.
- Boys had higher achievement than girls in eight countries, including Algeria, Lebanon, the Syrian Arab Republic and Tunisia.

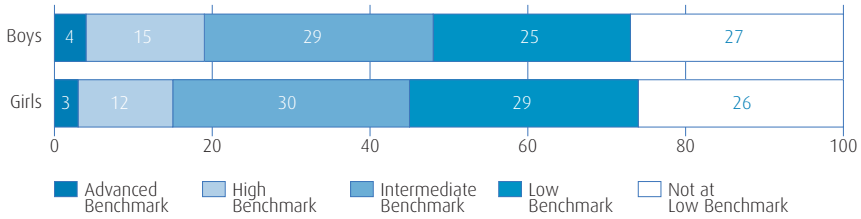


Figure 11 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by gender – Year 8*

- At Year 8 level, boys slightly outperformed girls at the higher benchmarks, with about four percent more boys than girls achieving the advanced and high benchmarks.
- The performance of boys at the lower levels pulls down their overall score. While more than one-quarter of the boys and girls in Dubai did not achieve the low international benchmark, this was slightly higher for boys.

Year 4 science

- On average across the TIMSS 2007 countries at this year level, girls had higher average achievement (6 score points) than boys.
- Girls had higher achievement than boys in 16 of the participating countries and in many, but not all, of the countries situated geographically in the Middle East, including Bahrain, Saudi Arabia, Oman, Kuwait and Qatar, but the difference was not significant in Dubai.
- Boys had higher achievement than girls in 11 countries, including Korea, Italy, the Czech Republic, the Syrian Arab Republic, the United States, Hungary, Australia, Tunisia, El Salvador, Ghana, and Colombia.

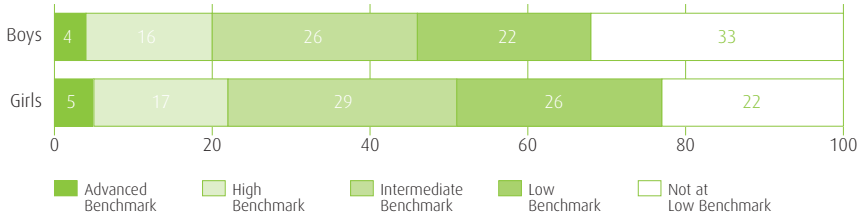


Figure 12 *Percentages of Dubai students reaching the International Benchmarks for science achievement by gender – Year 4*

- Clearly from this figure, achievement at the higher benchmarks is very similar for girls and boys. At Year 4, about 20 percent of boys and 22 percent of girls are achieving at the advanced and high benchmarks.
- At the lower end of the benchmarking scale, 22 percent of girls but 33 percent of boys are failing to achieve the low international benchmark.

Year 8 science

- Internationally, science achievement for girls was a little higher than for boys across the participating countries, on average (by three points), although the situation varied from country to country.
- Girls had significantly higher levels of achievement in 6 countries, including Qatar and Kuwait, and in Dubai.
- In more than half the countries, there was no significant gender difference in science.

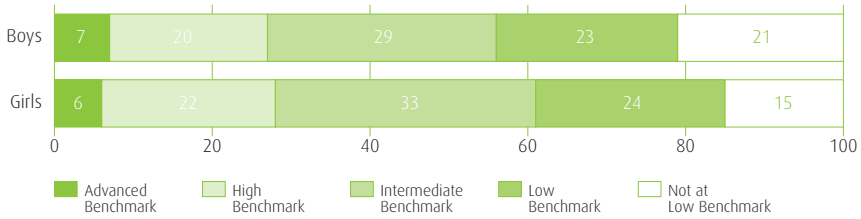


Figure 13 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by gender – Year 8*

- At Year 8 level, achievement at the higher benchmarks is very similar for boys and girls, with more than one-quarter of both boys and girls achieving the advanced and high benchmarks.
- Again, the performance of boys at the lower levels pulls down their overall score. While 21 percent of the boys in Dubai did not achieve the low international benchmark, only 15 percent of girls did not do so.

Achievement by school type

Figure 14 shows the level of mathematics and science achievement in public and private schools in Dubai. The TIMSS score is a scaled score, with the mean set arbitrarily at 500, so the scale does not have a zero. The scores for each school type are expressed in these graphs by the amount the score deviates from this scale average of 500. Figure 14 shows that the gap between the scores of students in public and private schools is greater for mathematics than science and larger at Year 8 than at Year 4.

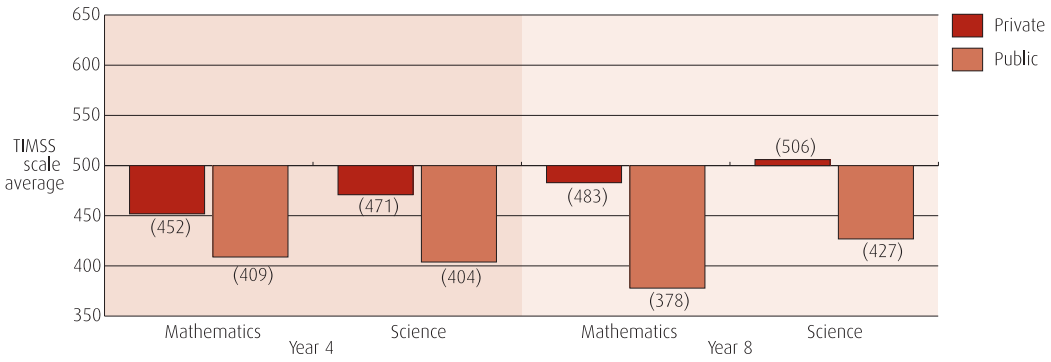


Figure 14 *Differences in mathematics and science scores by type of school*

Further to this, Table 2 shows the proportions of students and the level of mathematics and science achievement in public and private schools in Dubai.

Table 2 *Proportion of students and average mathematics and science scores in public and private schools*

School type	Percentage of students	Mathematics		Science	
		Mean	SE	Mean	SE
Year 4					
Private	84	452	(2.3)	471	(3.1)
Public	16	409	(3.5)	404	(4.8)
Year 8					
Private	78	483	(2.8)	506	(3.4)
Public	22	378	(2.6)	427	(2.4)

- At Year 4, students in private schools scored about 40 score points higher in mathematics than students in public schools, but both were lower than the international average scale scores.
- At Year 8 level the score differential widens, with more than one hundred points difference in mathematics scores between students in private schools and those in public schools.
- At Year 4, students in private schools score, on average, about 70 score points higher in science than students in public schools, although both are significantly lower than the international average scale scores.
- At Year 8 level the score differential widens slightly, with 80 score points in science separating students in private schools and those in public schools.
- Students at Year 8 in science in Dubai private schools achieved a score similar to the TIMSS scale average.

Year 4 mathematics

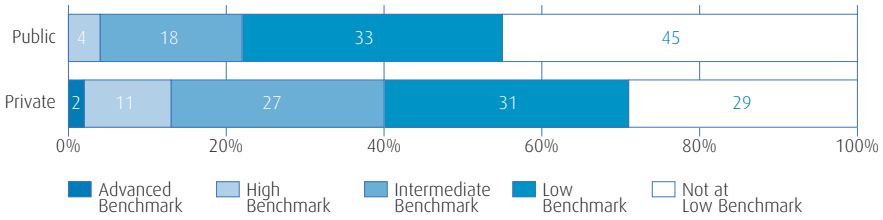


Figure 15 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by school type – Year 4*

- At Year 4, two percent of students in private schools achieve the advanced international benchmark; however, for public schools this proportion was very low. Even at the high international benchmark there were substantial differences, with a total of 13 percent of students in private schools achieving at least the high international benchmark compared to four percent of students in public schools. The international median for Year 4 was 26 percent achieving at least the high international benchmark.
- At the lower end of the distribution the differences are quite stark, with almost half (45%) of the students in public schools not achieving the low benchmark compared to 29 percent of students in private schools. The international median was 10 percent at this level.

Year 8 mathematics

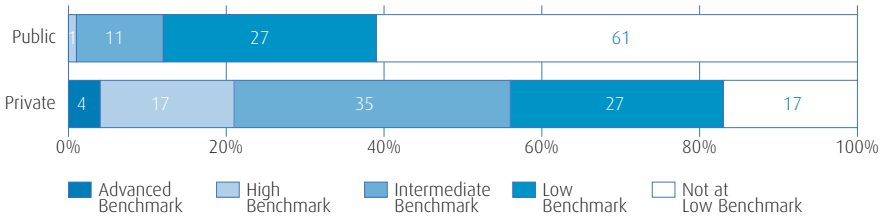


Figure 16 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by school type – Year 8*

- At Year 8, the international median was two percent of students achieving at the advanced international benchmark and a further 13 percent at the high international benchmark. The proportion of students in Dubai private schools bettered this, with four percent of students achieving the advanced benchmark and a further 17 percent achieving the high international benchmark. The proportion of students in Dubai public schools was also not largely different to this, with less than one percent at the advanced international benchmark and a further 11 percent at the high benchmark.

Year 4 science

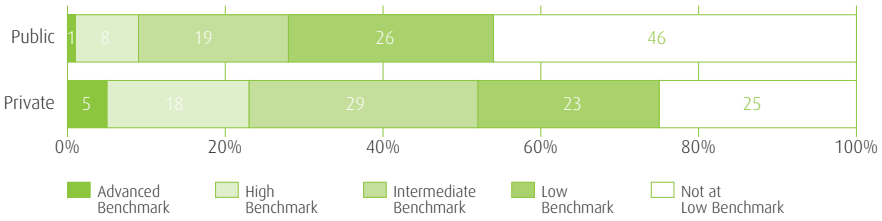


Figure 17 *Percentages of Dubai students reaching the International Benchmarks for science achievement by school type – Year 4*

- At Year 4, five percent of students in private schools achieved the advanced international benchmark; however for public schools this proportion was only around one percent. At the high international benchmark there were substantial differences, with a total of 23 percent of students in private schools achieving at least the high international benchmark compared to nine percent of students in public schools. The international median for Year 4 was 34 percent achieving at least the high international benchmark.
- At the lower end of the distribution the differences are quite marked, with almost half (46%) of the students in public schools not achieving the low benchmark compared to 25 percent of students in private schools. The international median was seven percent at this level.

Year 8 science

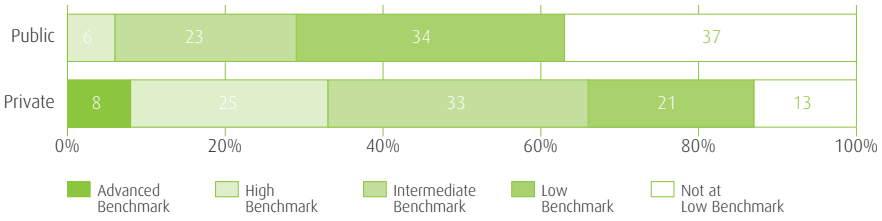


Figure 18 *Percentages of Dubai students reaching the International Benchmarks for science achievement by school type – Year 8*

- At Year 8, the international median was three percent of students achieving at the advanced international benchmark and a further 14 percent at the high international benchmark. The proportion of students in Dubai private schools bettered this, with eight percent of students achieving the advanced benchmark and a further 25 percent achieving the high international benchmark. The proportion of students in Dubai public schools was very much lower than this, with less than one percent at the advanced international benchmark and just six percent at the high benchmark.

Achievement by type of school curriculum

Another feature of the education system in Dubai is that there are many different curricula in the schools. While public schools all follow the National Curriculum, private schools follow different curricula, the main ones being the CBSE or Indian curriculum, the UK curriculum and the US curriculum, as well as some following the National Curriculum. Figure 19 and Figure 20 show the differences in scores from the TIMSS Scale average for mathematics and science at Year 4 and Year 8 respectively, by curriculum type.

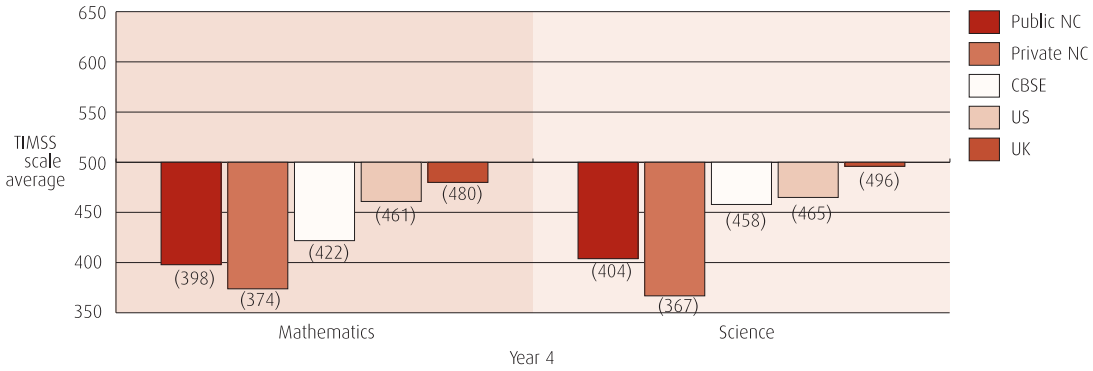


Figure 19 *Differences in mathematics and science achievement by curriculum type, Year 4*

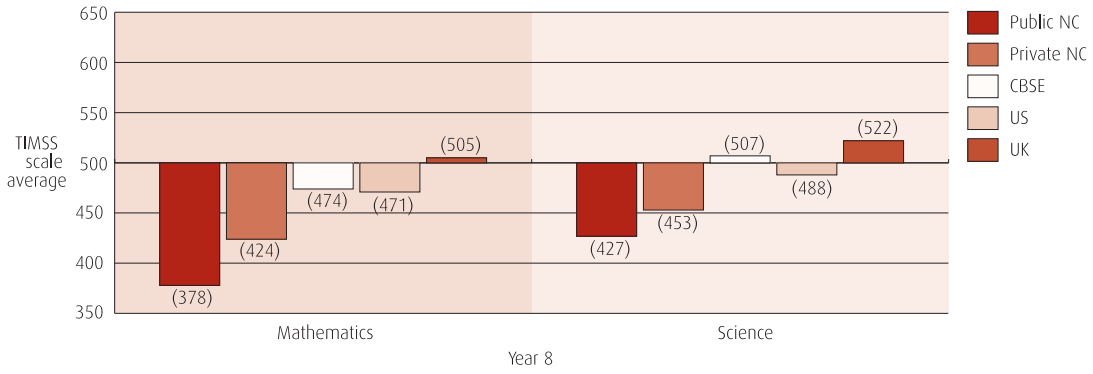


Figure 20 *Differences in mathematics and science achievement by curriculum type, Year 8*

- At Year 4, students in private schools studying the National Curriculum performed at a significantly lower level than students studying any other type of curriculum, including those studying the National Curriculum at public schools.
- At Year 4, students in schools with the UK curriculum were achieving at the highest level, although this was still lower than the TIMSS scale average.
- At Year 8, students studying the National Curriculum in public schools were achieving at a significantly lower level than any other group, almost 130 score points lower than the TIMSS scale average in mathematics and 73 points in science.
- At Year 8, students in schools following the UK curriculum were the highest achievers in both mathematics and science, with a score significantly higher than the TIMSS scale average in science and the same as the TIMSS scale average in mathematics. CBSE schools also scored at around the same as the TIMSS scale average in science.

Table 3 provides the data behind the previous two figures, and also shows the percentage of students studying each type of curriculum.

Table 3 *Proportion of students and average mathematics and science scores by school curriculum*

Type of curriculum	Percentage of students	Mathematics		Science	
		Mean	SE	Mean	SE
Year 4					
Public schools					
National Curriculum	16	398	(3.7)	404	(4.8)
Private schools					
National Curriculum	7	374	(7.2)	367	(9.4)
CBSE	27	422	(6.3)	458	(7.2)
US curriculum	9	461	(6.7)	465	(7.0)
UK curriculum	41	480	(2.8)	496	(4.4)
Year 8					
Public schools					
National Curriculum	22	378	(2.6)	427	(2.4)
Private schools					
National Curriculum	8	424	(7.6)	453	(8.9)
CBSE	26	474	(3.9)	507	(4.1)
US curriculum	9	471	(8.7)	488	(9.4)
UK curriculum	35	505	(4.5)	522	(5.7)

Year 4 mathematics

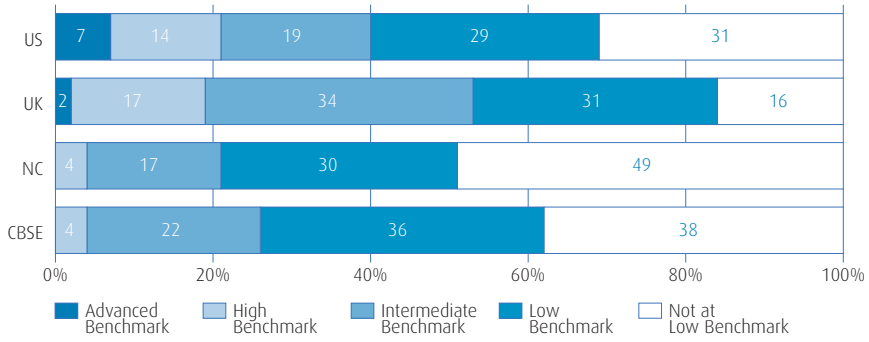


Figure 21 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by curriculum type – Year 4*

- Seven percent of Year 4 students studying the US curriculum and two percent of students studying the UK curriculum achieved the advanced international benchmark. Fewer than one percent of students studying the National Curriculum or the CBSE curriculum achieved this highest level.
- Only four percent of students in the national or CBSE curriculum schools achieved the high international benchmark, while in the US and UK curricula schools around 20 percent of students attained at least this performance level (including high and advanced benchmarks).
- Almost half of the students following the National Curriculum failed to reach the low international benchmark.

Year 8 mathematics

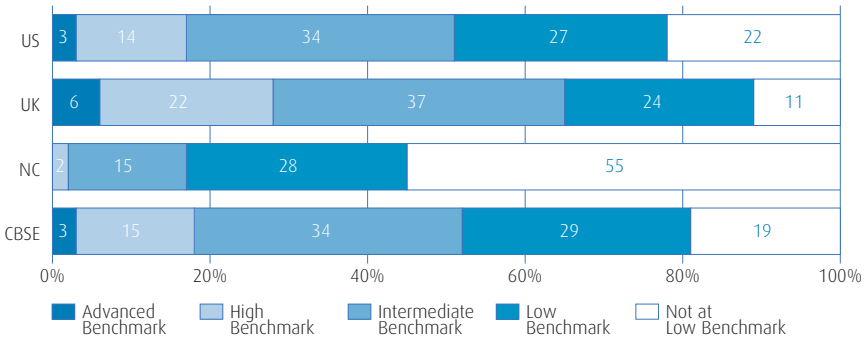


Figure 22 *Percentages of Dubai students reaching the International Benchmarks for mathematics achievement by curriculum type – Year 8*

- The gap between schools following the National Curriculum and schools following the other types of curricula widens at Year 8 level. More than half of the students in the National Curriculum schools did not achieve the low international benchmark, compared to around 11 percent of students in UK curriculum schools and around 20 percent of students in US and CBSE curriculum schools.
- The schools following the UK curriculum also do well in having six percent of their students attaining the advanced international benchmark, compared to three percent of students in US and CBSE curriculum schools and fewer than one percent of students in National Curriculum schools (thus this is not shown on the graph).

Year 4 science

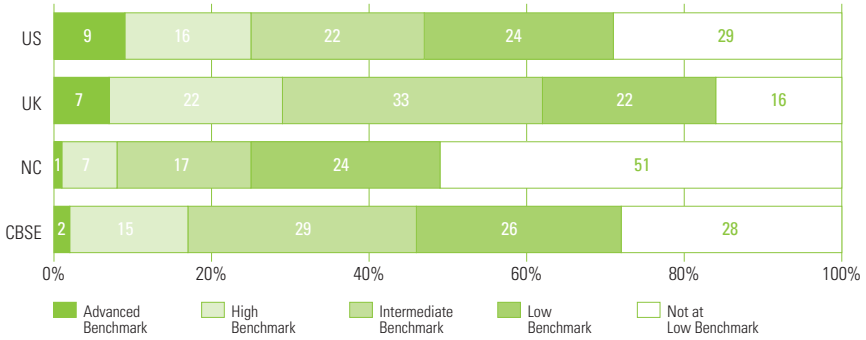


Figure 23 *Percentages of Dubai students reaching the International Benchmarks for science achievement by curriculum type – Year 4*

- Nine percent of Year 4 students studying the US curriculum, seven percent of students studying the UK curriculum and two percent of students studying the CBSE curriculum achieved the advanced international benchmark. Just one percent of students studying the National Curriculum achieved this highest level.
- Only a further seven percent of students in the National Curriculum schools achieved the high international benchmark, while in the US schools a total of 25 percent of students, in the CBSE schools 17 percent and in the UK schools 29 percent attained at least this performance level.
- A little more than half of the students following the National Curriculum failed to reach the low international benchmark. Only UK curriculum schools had a level of students achieving the low international benchmark that was close to the international median, but even this was 16 percent compared to 7 percent of students.

Year 8 science

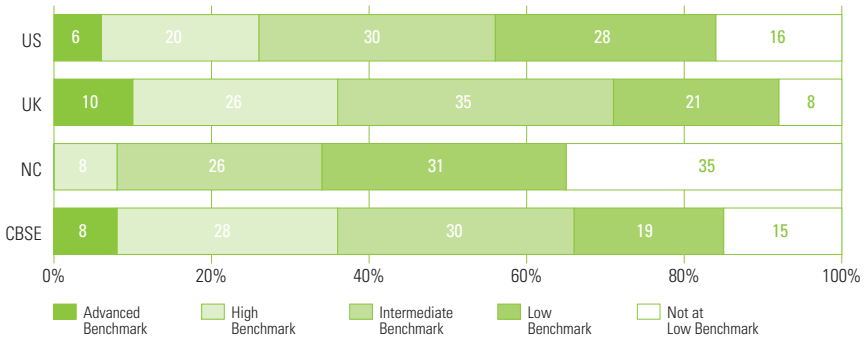


Figure 24 *Percentages of Dubai students reaching the International Benchmarks for science achievement by curriculum type – Year 8*

- The gap between schools following the National Curriculum and schools following the other types of curricula is smaller at Year 8 level. Thirty-five percent of students in the National Curriculum schools did not achieve the low international benchmark, compared to around 8 percent of students in UK curriculum schools, 16 percent of students in US schools and 15 percent in CBSE curriculum schools, the international median was 22 percent.
- The schools following the UK curriculum also did well in having 10 percent of their students attain the advanced international benchmark, compared to six percent of students in US and 8 percent in CBSE curriculum schools and fewer than one percent of students in National Curriculum schools.

As outlined previously, the TIMSS mathematics assessment can be described in terms of content and cognitive domains. The content domain outlines the subject matter to be assessed: at Year 4, *number, Geometric shapes and measures,* and *data display;* and at Year 8, *number, Algebra, Geometry*, and *data and chance*. The cognitive dimension details the thinking processes that students will need to use. At both year levels the cognitive domains are *knowing, applying* and *reasoning*. Each item is associated with a single content domain and a single cognitive domain. This allows student performance to be described in terms of achievement in each of the domains.

To simplify comparisons of student achievement across the domains, the content and cognitive achievement scales at each year level were constructed to have the same average difficulty (see the Reader's Guide).

Content domains

Mathematics – Year 4

At Year 4, half (50%) of the assessment items were devoted to assessing the *number* content domain, including understanding place value, ways of representing numbers, and the relationships between numbers. According to the TIMSS 2007 Mathematics Framework, students should have developed number sense and computational fluency, be able to use numbers and operations to solve problems, and be familiar with a range of number patterns.

Within the *Geometric shapes and measures* domain (35% of the assessment), students should be able to identify and analyse the properties and characteristics of lines, angles, and a variety of Geometric figures, including two- and three-dimensional shapes, and to provide explanations based on Geometric relationships. This domain also included understanding informal coordinate systems and using spatial visualisation skills.

The *data display* content domain (15% of the assessment) included understanding how to organise data that have been collected and how to display it in graphs, as well as reading and interpreting various data displays. Students at Year 4 should be able to compare characteristics of data and to draw conclusions based on data displays. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

Mathematics – Year 8

At Year 8, TIMSS 2007 assessed four content domains with each given similar weight – *number* (30%), *Algebra* (30%), *Geometry* (20%), and *data and chance* (20%). According to the TIMSS 2007 Mathematics Framework, within the number *domain*, students should have developed computational fluency with fractions and decimals, understand how operations relate to one another, and extended their understanding to operations with integers. By Year 8 students should be able to move flexibly among equivalent fractions, decimals, and percents and use proportional reasoning to solve problems.

In *Algebra*, students should have developed an understanding of linear relationships and the concept of variable. They are expected to use and simplify algebraic formulas, solve linear equations, inequalities, pairs of simultaneous equations involving two variables, and use a range of functions. They should be able to solve problems using algebraic models and to explain relationships involving algebraic concepts.

In *Geometry*, the focus is on using geometric properties and their relationships to solve problems. It also includes understanding coordinate representations and using spatial visualisation skills to move between two- and three-dimensional shapes and their representations.

The *data and chance* domain includes describing and comparing characteristics of data (shape, spread, and central tendency). Students should be able to use data to draw conclusions and make predications, and understand issues related to misinterpretation of data. Year 8 students should understand elementary probability in terms of the likelihood of familiar events and use data from experiments to predict the chance of a given outcome.

Table 4 and Table 5 present the average achievement in each of the mathematics content domains, for Years 4 and 8 respectively, for Dubai.

Internationally at Year 4 level Singapore was the highest achieving country in *number* (611), while Hong Kong was the highest achieving country in *geometric shapes and measures* (599) and *data display* (583). At the lower ends of the scale Tunisia was the lowest achieving country in *data display* (307) while Qatar achieved the lowest in both *Geometric shapes and measures* (296) and *number* (292). Students in Dubai scored lower than the TIMSS scale average in all three content areas; however, relatively their best area was *Geometric shapes and measures*.

At Year 8, in the content area of *number*, Singapore again had the highest average achievement. In *Algebra*, Chinese Taipei had the highest achievement and in *Geometry*, Chinese Taipei and Korea had the highest average achievement. In *data and chance*, the highest performing countries were Korea and Singapore. Dubai students' performance was lower than the TIMSS scale average in all four content domains, but was relatively strongest in the area of *Algebra*.

Table 4 *Achievement in the mathematics content domains, Dubai Year 4 students*

	Average Scale Scores for Mathematics Content Domains					
	Data display		Geometric shapes and measures		Number	
	Mean	SE	Mean	SE	Mean	SE
All students	451	(3.4)	475	(2.4)	458	(3.2)
Males	452	(5.9)	430	(4.9)	441	(4.8)
Females	**471**	**(5.2)**	**452**	**(5.4)**	448	(3.8)
Type of school						
Private	**464**	**(3.4)**	**447**	**(2.8)**	**453**	**(2.1)**
Public	453	(4.4)	412	(5.1)	399	(4.5)
Curriculum type						
NC*	438	(3.5)	400	(4.5)	395	(3.5)
CBSE	428	(7.2)	**418**	**(6.0)**	**425**	**(5.4)**
US	**477**	**(5.6)**	**454**	**(6.3)**	**465**	**(5.9)**
UK	**492**	**(3.8)**	**474**	**(3.4)**	**478**	**(2.8)**

* Other curricula compared to National Curriculum
Significant differences shown in bold

- All scores are significantly lower than the TIMSS scale average.

Dubai students scored at a significantly higher level in *geometric shapes and measures* than in either *data display* or *number*.

Girls scored at a significantly higher level than boys in *Geometric shapes and measures* and in *data display*. Scores in *number* were not statistically different.

- Students in private schools outscored those in public schools in each domain.
- Students in schools offering the CBSE, UK and US curriculum outperformed those in schools offering the National Curriculum in almost all areas.

Table 5 *Achievement in the mathematics content domains, Year 8 students*

	Average Scale Scores for Mathematics Content Domains							
	Algebra		Data & chance		Number		Geometry	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
All students	475	(2.4)	457	(3.2)	458	(3.2)	451	(3.4)
Males	474	(5.8)	457	(5.7)	463	(6.8)	447	(5.6)
Females	475	(5.1)	457	(6.3)	453	(5.3)	455	(5.7)
Type of school								
Private	**498**	**(3.1)**	**478**	**(4.0)**	**482**	**(3.4)**	**465**	**(3.9)**
Public	390	(3.7)	381	(3.3)	374	(4.1)	400	(4.0)
Curriculum type								
NC*	406	(3.5)	389	(2.8)	388	(4.5)	405	(4.0)
CBSE	**491**	**(4.3)**	**467**	**(5.1)**	**464**	**(3.4)**	**457**	**(4.1)**
US	**487**	**(6.2)**	**470**	**(9.7)**	**473**	**(8.8)**	**451**	**(9.0)**
UK	**515**	**(4.9)**	**500**	**(5.6)**	**507**	**(5.7)**	**483**	**(5.7)**

* Other curricula compared to National Curriculum
Significant differences shown in bold

- All scores are significantly lower than the TIMSS scale average.
- The scores for girls and boys were not significantly different in any of the content domains.
- Students in private schools significantly outscored those in public schools in each content domain.
- Students in CBSE, UK and US curriculum schools outperformed those in National Curriculum schools in all content areas.

Science – Year 4

At Year 4, almost half the assessment items (45%) were devoted to assessing the *Life science* content domain. According to the TIMSS 2007 Science Framework, students should be able to demonstrate knowledge of the characteristics and life processes of living things, know and be able to compare the life cycles of common organisms such as the butterfly and frog, describe relationships between plants and animals in common ecosystems, and have a rudimentary knowledge of human health, nutrition, and disease.

Within the *Physical science* domain (35% of the assessment), students should be able to compare or classify objects and materials on the basis of physical properties, identify common energy sources and have some understanding of heat flow, relate familiar physical phenomena to the behaviour of light and sound, have some notion of a complete electrical circuit and some practical knowledge of magnets and their uses, and have some grasp of the idea of forces as they relate to movement.

In the *Earth science* content domain (20% of the assessment), Year 4 students were expected to demonstrate some general knowledge about the structure and physical characteristics of Earth; Earth's processes, cycles, and history; and some understandings about Earth's place in the solar system. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

Science – Year 8

At Year 8, TIMSS 2007 assessed four content domains with each given similar weight – *biology* (35%), *Chemistry* (20%), *Physics* (25%), and *Earth science* (20%). According to the TIMSS 2007 Science Framework, in *Biology*, students should be able to classify organisms into the major taxonomic groups, identify cell structures and their function, distinguish between growth and development in different organisms, and show some understanding of diversity, adaptation, and natural selection among organisms. By Year 8, students are expected to have an understanding of the interdependence of living organisms and their relationship to the physical environment, and demonstrate knowledge of human health, nutrition, and disease.

In *Chemistry*, students should be able to classify substances on the basis of characteristic physical properties and have a clear understanding of the properties of matter. Students should recognise the differences between physical and chemical changes and recognise the conservation of matter during these changes.

In *Physics*, students are expected to be able to describe processes involved in changes of state and apply knowledge of energy transformations, heat, and temperature. They should know basic properties of light and sound, understand the relationship between current and voltage in electrical circuits, and describe properties and forces of permanent magnets and electromagnets. Students are expected to have a quantitative knowledge of mechanics, as well as a commonsense understanding of density and pressure as they relate to familiar physical phenomena.

In the *Earth science* domain, Year 8 students are expected to demonstrate knowledge of the structure and physical characteristics of Earth's crust, mantle, and core, and apply the concept of cycles and patterns to describe Earth's processes, including the rock and water cycles. Students should have an understanding of Earth's resources and their use and conservation, and demonstrate knowledge of the solar system in terms of the relative distances, sizes, and motions of the sun, the planets, and their moons, and of how phenomena on Earth relate to the motion of bodies in the solar system. Within each content domain, students needed to draw on a range of cognitive skills and go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems.

Table 6 presents the average achievement in each of the science content domains, for Year 4 for Dubai.

This table shows that at Year 4 Singapore, Japan, Chinese Taipei, and Hong Kong had the highest average achievement in *Physical science,* but only Singapore maintained this level in *Life science* and in *Earth science* also. Italy and Hungary followed Singapore in having the highest performance in *Life science*. In *Earth science,* Hong Kong, Singapore, and Chinese Taipei had the highest average achievement. The lowest performing countries in all three content areas were Qatar and Morocco.

At Year 8 as with Year 4, Singapore, Japan, Chinese Taipei and Hong Kong, along with Korea, were among the highest achieving countries in *Physics,* but again only Singapore maintained this level in all four content domains.

In *Biology,* in addition to Singapore, Japan, Chinese Taipei, and Korea were the highest performers. In *Chemistry,* top-performing Chinese Taipei was followed by Singapore and by Japan, and in *Earth science,* the top performers were Chinese Taipei, Slovenia, Singapore and Korea.

While the scores for Dubai Year 8 students were all significantly below the TIMSS scale average, they were substantially closer than for Year 4. In *Chemistry* in particular, scores were only just lower than the TIMSS scale average. Dubai students also did well in *Earth science* and *Physics*.

Table 6 *Achievement in the science content domains, Dubai Year 4 students*

	Average Scale Scores for Science Content Domains					
	Life Science		Physical Science		Earth Science	
	Mean	SE	Mean	SE	Mean	SE
All students	457	2.8	467	2.8	471	2.6
Gender						
Males	446	5.5	455	5.8	462	5.3
Females	**471**	**4.3**	**480**	**4.6**	**481**	**4.4**
Type of school						
Private	**468**	**3.2**	**477**	**2.8**	**484**	**3.7**
Public	411	6.5	417	5.8	405	7.4
Curriculum type						
NC	400	5.4	407	6.2	400	5.5
CBSE	**459**	**6.8**	**458**	**6.2**	**477**	**5.6**
US	**460**	**8.8**	**474**	**6.4**	**479**	**8.0**
UK	**488**	**4.2**	**504**	**3.3**	**503**	**4.4**

*Other curricula compared to National Curriculum
Significant differences shown in bold

- Most scores are significantly lower than the TIMSS scale average.
- Dubai students scored significantly lower than the TIMSS scale average in all three content domains, but performed slightly more strongly in *Earth science*.
- Girls scored at a significantly higher level than boys in all three content domains.
- Students in private schools significantly outscored those in public schools in each domain.
- Students in schools offering the CBSE, UK and US curriculum outperformed those in schools offering the National Curriculum in all areas.

The average scores for the different groups in Dubai in the science content domains for Year 8 students are shown in Table 7.

Table 7 *Achievement in the science content domains, Year 8 students*

	Average Scale Scores for Science Content Domains							
	Biology		Chemistry		Physics		Earth science	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
All students	485	3.4	493	3.5	489	3.4	490	3.2
Gender								
Males	477	6.7	485	6.0	488	6.0	485	6.2
Females	493	5.3	501	5.3	491	4.5	495	5.4
Type of school								
Private	**502**	**4.3**	**511**	**4.1**	**503**	**3.6**	**505**	**4.2**
Public	424	2.5	430	5.1	437	8.8	438	4.1
Curriculum type								
NC	431	2.7	440	4.1	445	4.8	442	3.1
CBSE	**505**	**7.2**	**516**	**6.9**	**504**	**4.6**	**511**	**6.0**
US	**486**	**9.0**	**495**	**9.0**	**484**	**8.4**	**486**	**11.7**
UK	**515**	**7.3**	**520**	**7.1**	**516**	**7.1**	**516**	**7.4**

*Other curricula compared to National Curriculum
Significant differences shown in bold

- All scores are significantly lower than the TIMSS scale average.
- The scores for girls and boys were not significantly different in any of the content domains.
- Students in private schools significantly outscored those in public schools in each content domain.
- Students in CBSE, UK and US curriculum schools outperformed those in National Curriculum schools in all content areas.

Students, teachers and schools

One of the major components in understanding student achievement is understanding the contexts in which students learn. In addition to the achievement tests, TIMSS included student, teacher and school questionnaires. Some of the findings from these questionnaires are presented in this section of the report.

Books in the home

Earlier cycles of TIMSS have shown that students from homes with abundant literacy resources have higher achievement, on average, in mathematics, science, and reading than students from less well-endowed homes. Figure 25, which displays Year 4 students' reports about the number of books in their homes together with mathematics achievement, shows that this continues to be true for mathematics achievement. The figure presents for Dubai and the international mean the percentage of students in five categories of book ownership, i.e. more than 200 books, 101 – 200 books, 26 – 100 books, 11 – 25 books, and 0 – 10 books, together with average mathematics achievement in each category.

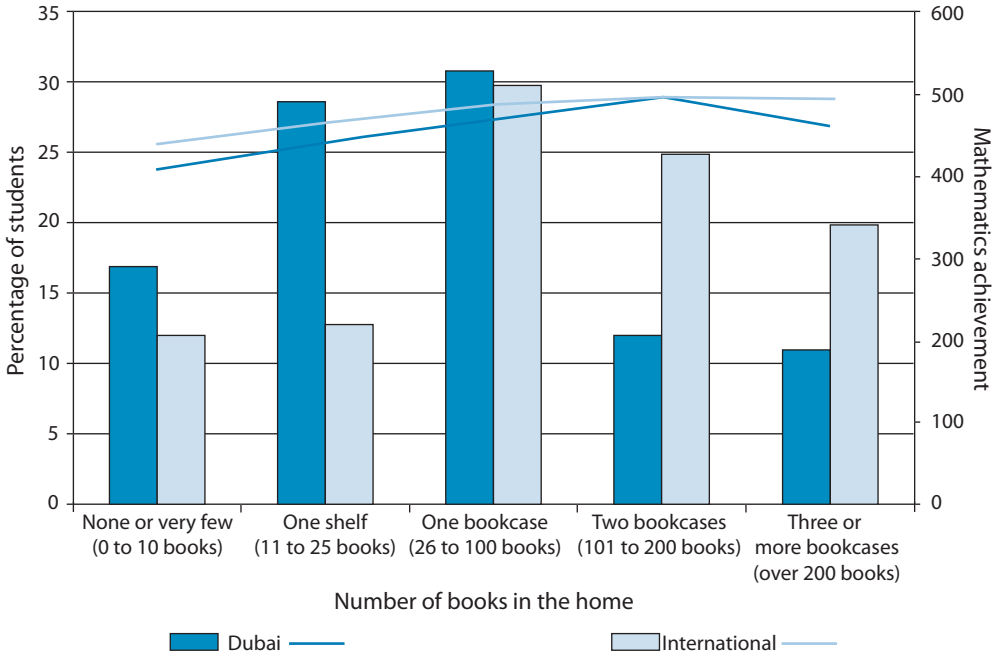


Figure 25 *Books in the home*

In this figure the bars represent the proportion of students at each category while the line represents student achievement.

- A little more than fifty percent of students in Dubai have at least one bookcase of books in their home.
- On average, however, students in Dubai have a lower level of book ownership than students internationally. A larger proportion of Dubai students report that they have less than 25 books in their home, and a much lower proportion reports having more than 100 books.
- The relationship between achievement and book ownership in Dubai is similar to the relationship internationally; achievement is generally higher for students with a higher number of books in their homes.
- At Year 8 also there was an association between average mathematics achievement and number of books in the home. Internationally 12 percent of students reported having more than 200 books at home and 12 percent reported having 101 – 200 books, and these students had average achievement of 486 and 480 score points, respectively. These averages were higher than the 464-point average of the 27 percent of students with 26 – 100 books, the 436-point average of the 29 percent of students with 11 – 25 books, and the 413-point average of the 20 percent of students with 10 books or fewer.
- In Dubai the same pattern of book ownership seen at Year 4 was evident. Only 11 percent of students reported more than 200 books in the home, and a further 14 percent between 101 and 200 books, and these students achieved a score that was not significantly different to the TIMSS scale average.
- The 17 percent of students with very few books in the home achieved about 85 score points lower than the TIMSS scale average. This was the same as the average for the same group of students internationally.

Computers and the internet

- At Year 4, 89 percent of Dubai students had a computer at home (compared to 70% internationally) and 78 percent had access to the Internet (compared to 56% internationally). These students had significantly higher levels of achievement than students without access to a computer or the Internet at home. Some caution should be exercised when interpreting these results, as it is likely that having a computer and Internet connection is a factor of socioeconomic status, and that it is the separate influence of socioeconomic status that effects achievement.
- At Year 8 there were similar findings: 95 percent of students in Dubai had a computer at home and 84 percent access to the Internet, and these students had significantly higher achievement in mathematics and science than students without such access.
- Internationally, 38 percent of Year 4 students reported using a computer both at home and at school; in Dubai 63 percent of students reported this level of computer use.
- Twenty-nine percent of Year 4 Dubai students, almost the same as the international average of 31 percent, use a computer at home but not at school.
- Achievement was highest amongst those students who said that they used a computer at home and at school, and lowest among those who reported using a computer at school but not at home.
- The findings are very similar at Year 8. Two-thirds of students in Dubai used a computer both at home and school, and the average achievement levels for these students was significantly higher than for students who only used a computer in one setting.

Attitudes towards mathematics and science

- Year 4 students generally had positive attitudes towards mathematics, with a little more than 80 percent of Dubai students reporting high levels on this index. In contrast only nine percent of students responded negatively to all three items.
- There were no significant gender differences and no differences in the proportion of public and private school students reporting positive attitudes.
- Across countries at Year 4, students with a high positive attitude towards mathematics had higher average achievement than students at the medium or low level. This was not as clear in Dubai, where there were no significant differences.
- At Year 8, both in Dubai and internationally, students are less positive about mathematics. A little more than half report high levels of positive attitudes towards mathematics, and about one-quarter report low levels, indicating, as before, that they find mathematics boring and they don't enjoy learning it.
- Students who scored at the high levels of positive attitudes towards mathematics scored significantly higher than students in the medium or low categories, and significantly higher than the international average for the same group of students.
- Significantly more boys than girls reported high levels of positive attitudes towards mathematics, and the scores for girls and boys reporting positive attitudes were almost the same.
- There was a significantly higher proportion of students attending private schools who reported strong positive attitudes, and these students scored 100 score points more than those students in public schools having similar attitudes.
- Students at Year 4 are also very positive about science, with 84 percent reporting high levels of positive attitudes towards science. This is higher than the international average.
- Average science achievement was highest among students with high positive attitudes towards science, followed by those at the medium level, and lowest among those at the low level.

- There was little difference in positive attitudes to science between Year 4 students in private and public schools.
- As with mathematics, Year 8 students are less positive about science than Year 4 students; however, more than two-thirds of the students in Dubai maintain high levels of positive attitude.
- Students in Dubai with a strong positive attitude towards science scored significantly higher than the international average for the same group of students.
- Both girls and boys with strong positive attitudes also scored higher than those students with medium or low levels of positive attitude.
- The proportion of students in private and public schools reporting strong positive attitudes towards science were similar, and the proportion of students at the low level was the same.

TIMSS 2007 asked the students' teachers of mathematics and science how prepared they felt to teach a subset of the mathematics and science topics included in the TIMSS 2007 frameworks.

- At Year 4, the international average across all mathematics topics was 72 percent, meaning that 72 percent of students had teachers who reported feeling 'very well' prepared to teach all topics. In Dubai this was 94 percent.
- The average for *number* was highest, with 97 percent of students in Dubai having teachers who reported they were 'well prepared' to teach the topics.
- The average for *Geometric shapes and measures* and *data display* were lowest both internationally and in Dubai. However, there were still more than 90 percent of students that had teachers who felt 'well prepared' to teach the topics in these content areas.
- At Year 8, the international average across all mathematics topics was 79 percent. In Dubai this was 88 percent.
- The average for *number* was again highest, followed by *Algebra,* with 95 percent and 94 percent of students respectively in Dubai having teachers who reported they were 'well prepared' to teach the topics.
- The averages for *Geometry* and *data and chance* were again the weakest areas, both internationally and in Dubai. However there were still more than 80 percent of students that had teachers who felt 'well prepared' to teach the topics in these content areas.
- The international average across all science topics was 71 percent. In Dubai this was 79 percent.
- The only averages available for Dubai are for *Chemistry* and *Physics*. In *Chemistry* 85 percent of students and in *Physics* 80 percent of students had teachers who felt 'well prepared' to teach the topics in these content areas. These are again substantially higher than the international average.
- Year 8 teachers in Dubai were also very confident of teaching all aspects of mathematics and science.

Mathematics problem-solving in the classroom

Because of the high interest in improving students' capacity for mathematics problem-solving, the TIMSS questionnaire asked students and teachers about how often students were asked to do certain activities related to problem-solving.

- At Year 4, the activities queried provided a comparison between an emphasis on memorising how to solve problems versus working on problems independently and explaining answers. Internationally, students reported much more emphasis than teachers on memorisation, with 72 percent reporting that they memorised how to solve problems in at least half their mathematics lessons compared to 38 percent reported by teachers.
- This was the same situation in Dubai, with 76 percent reporting that they used memorisation strategies to solve problems in at least half their lessons compared to the 44 percent reported by teachers.

- Internationally, students and teachers were in close agreement about students working on problems on their own (76 compared to 74 percent), and about students explaining answers (61 compared to 66 percent) in at least half the lessons.
- In Dubai there was also very close agreement about these activities at Year 4.
- At Year 8, students again reported more memorisation than teachers. Internationally 63 percent reported memorising how to work on problems in at least half their mathematics lessons compared to 49 percent by teachers.
- In Dubai 72 percent of students reported using memorisation compared to the 61 percent indicated by teachers.
- There was closer agreement about doing problem-solving, even though somewhat smaller Percentages of students reported doing several of the activities in at least half the lessons than reported by teachers. For routine problem-solving in Dubai, students reported 72 percent and teachers reported 83 percent; for explaining answers, the results were 75 percent and 84 percent; and for emphasis on having to decide on procedures for solving complex problems, 50 percent and 49 percent, respectively.
- While not different internationally, in Dubai there were differences in students' and teachers' perceptions about the frequency of relating mathematics to students' daily lives in the classroom, with 54 percent of students and 72 percent of teachers reporting the activity in at least half their lessons.
- Finally, only teachers were asked about the emphasis on asking students to work on problems for which there is no immediately obvious solution, and Dubai teachers reported that only 19 percent of students were asked to do so in at least half the lessons. This was slightly lower than the international average.

How is scientific inquiry emphasised in science lessons?

Because of the high level of interest in incorporating scientific inquiry into science class, TIMSS asked students and their teachers about the frequency with which they engage in a range of inquiry-related instructional activities. The science activities were similar at both grades but were tailored to the differences in ability level between grades. Activities included making an observation and describing what was seen, giving an explanation about what was being studied, watching the teacher demonstrate an experiment or investigation, design or plan an experiment or investigation, conduct an experiment or investigation, work in small groups, and, at Year 8 only, relate what is being learned in science to daily life.

- Internationally amongst Year 4 students, the most frequent science investigation activities were writing or giving an explanation for something being studied and watching the teacher do a science experiment, with, respectively, an average of 69 percent and 67 percent of students reporting that they devoted time to these activities at least once or twice a month. These were also the most common science investigation activities in Dubai, with 76 percent and 77 percent of students participating regularly in these activities.
- Working with other students in small groups (56% internationally and 64% in Dubai) and doing a science experiment or investigation (49% internationally and 64% in Dubai) were the next most frequent, followed by designing or planning a science experiment or investigation (47% internationally and 60% in Dubai) and making observations and recording what was seen (52% internationally and 50% in Dubai).
- Teachers internationally generally reported less engagement in the scientific inquiry activities than students; however, in Dubai the opposite was generally the case. At Year 4, the most frequent teacher-reported activity was relating what students are learning in science to their daily lives – an activity not included in the student questionnaire.

- The next most frequent activity was asking for explanations about something students are studying. On average, 69 percent of students internationally and 88 percent of students in Dubai had teachers who ask them for explanations in at least half of their science lessons, a percentage that was substantially higher than the percentage reported by students.
- The only activity that more students than teachers reported engaging in was watching the teacher do a science experiment, where 60 percent of teachers reported regularly getting students to watch them carry out an experiment but 77 percent of students reported doing this regularly.
- Internationally and in Dubai at Year 8, making observations, giving explanations, and watching the teacher demonstrate an experiment or investigation were equally frequent activities, with 70 to 74 percent of students in Dubai reporting devoting time to them in at least half the science lessons.
- Relating what is being learned in science to daily life was the next most frequent in Dubai (65%). Less frequent were designing or conducting an experiment or working in groups on an experiment or investigation.
- Teacher reports at Year 8 resembled those at Year 4 internationally and as with Year 4, Year 8 science teachers internationally and in Dubai most frequently reported asking students to give explanations for something they are studying and to relate what they are studying to their daily lives. A similar proportion of teachers (88%) reported asking students to give explanations about what they were studying.
- As with Year 4, teachers internationally generally reported less engagement in the scientific inquiry activities than students, but in Dubai this was not so clear cut. Students again reported more frequently watching teachers carry out investigations than teachers reported asking students to do so.

What school resources are available to support school learning?

To provide information about the level of school resources available to schools for mathematics instruction and in particular about the impact of shortages of important resources, principals were asked about shortages affecting schools' general capacity to provide instruction, and to provide mathematics and science instruction in particular.

Principals were asked the degree to which shortages or inadequacies in five areas affected their school's general capacity to provide instruction – instructional materials (e.g. textbooks); budget for supplies (e.g. paper, pencils, etc.); school buildings and grounds; heating/cooling and lighting systems; and instructional space (e.g. classrooms).

For mathematics they also responded to five questions about shortages affecting mathematics instruction specifically – computers for mathematics instruction; computer software for mathematics instruction; calculators for mathematics instruction; library materials relevant to mathematics instruction; and audio-visual resources.

For science principals responded to six questions about shortages affecting science instruction specifically – science laboratory equipment and supplies; computers for science instruction; computer software for science instruction; calculators for science instruction; library materials relevant to science instruction; and audio-visual resources.

- At Year 4, the principals of 36 percent of students internationally and 79 percent of students in Dubai were at the high level of the index reported that resource shortages essentially were not a problem. The principals of a further 55 percent of students internationally and 21 percent of students in Dubai reported that these were somewhat of an issue while the principals of 9 percent internationally and 1 percent of Dubai students reported that such shortages were a serious problem.
- In Dubai, average mathematics achievement was highest among students in schools where there were few shortages (445 points).

- At Year 8 the situation was similar, with the principals of 27 percent of students internationally and 72 percent of students in Dubai reporting that resource shortages essentially were not a problem, 62 percent internationally and 25 percent of Dubai students in schools with some shortages, and 10 percent internationally and three percent in Dubai in schools with more serious shortages of resources.
- Students in schools in Dubai with few resource problems had the highest average mathematics achievement (477 points), followed by students in schools with some resource problems (432 points) and then by students in schools where resourcing is a serious problem (399 points).

Final words

In 2007 Dubai students, teachers and their schools participated for the first time in an international study of student achievement, managed by the Dubai School Agency. It is hoped that the findings presented in this report provide food for thought for all involved in education in Dubai: schools, teachers, parents and students as well as those involved in educational administration at all levels.

These findings are one step forward in establishing a baseline for our efforts in improving the education we offer our children, strengthening our accountability to the public in our responsibility to deliver world class education to all communities within Dubai. The schools, teachers and students who gave their time to participate in this study are to be commended for their assistance in this study, which enables education authorities with facts and evidence on which to base their decisions about education in Dubai.

Appendix

TIMSS benchmarks – Examples

While the achievement scales in mathematics and science summarise student performance on the cognitive processes and content knowledge measured by the TIMSS tests, the international benchmarks help put these scores in context. The benchmarks were developed using scale anchoring techniques and student achievement data from all countries that participated in TIMSS 2007. A similar exercise was carried out for the TIMSS 1999 study, and six factors seemed to differentiate between student performance at each level:

- the depth and breadth of content area knowledge
- the level of understanding and use of technical vocabulary
- the context of the problem (progressing from practical to more abstract)
- the level of scientific investigation skills
- the complexity of diagrams, graphs, tables, and textual information used
- the completeness of written responses.

The TIMSS benchmarks are a way of describing students' performance on the TIMSS 2007 achievement scales at both year levels in terms of the types of items that students at the particular year level answered correctly. It has both empirical and qualitative components. For the empirical component, the results of all students taking part in TIMSS 2007 were pooled so that the levels describe what the best students can do, irrespective of which country they come from. For the qualitative component, subject matter specialists examined the content of the items and generalised to the students' knowledge and understanding. The descriptions of the levels are cumulative, so that a student who reached the high international benchmark can typically demonstrate the knowledge and skills both of the intermediate and low benchmark levels. These are shown in Figures A1, A7, A15 and A20.

Internationally it was decided that performance should be measured at four levels. These four levels summarise the achievement reached by:

- the 'Advanced International Benchmark', which was set at 625;
- the 'High International Benchmark', which was set at 550;
- the 'Intermediate International Benchmark', which was set at 475; and
- the 'Low International Benchmark', which was set at 400.

Benchmarks are only one way of examining student performance. The benchmarks discussed in this report are based solely on student performance in TIMSS 2007, on items that were developed specifically for the purpose of obtaining information on the science domains in the TIMSS framework. There are undoubtedly other curricular elements on which students at the various benchmarks would have been successful if they had been included in the assessment. The remainder of this appendix provides more detail and examples of the benchmarks.

For each benchmark, in both subjects at each year level, illustrative items and examples of the answers typically provided by students in Dubai follow. After each example is a table providing the percentage of students in various countries answering the item correctly, to gain an idea of how Dubai students performed. The countries that make up this table are: the two countries with the highest proportion of students answering correctly; the other GCC countries: Saudi Arabia, Kuwait, Bahrain, Qatar and Oman (at the grade levels at which they participated); Dubai and the international average percent correct; and finally the country with the lowest percentage of students answering the item correctly.

Year 4: Performance at the Advanced International Benchmark – Mathematics

Figure A1 provides descriptors for each level of the benchmarks for Year 4 mathematics. More detailed descriptions of the benchmarks can be found in the TIMSS international mathematics and science reports. As can be seen in Figure A1, students at the Advanced International Benchmark applied mathematical understanding and knowledge in a variety of relatively complex problem situations and were able to explain their reasoning, whereas those at the Low International Benchmark demonstrated some basic mathematical knowledge and were able to compute with whole numbers, recognise some geometric shapes, and read simple graphs and tables.

At Year 4, half of the assessment items were devoted to assessing the *number* content domain, including understanding place value, ways of representing numbers, and the relationships between numbers. According to the *TIMSS 2007 Mathematics Framework,* students should have developed number sense and computational fluency, be able to use numbers and operations to solve problems, and be familiar with a range of number patterns.

Within the *Geometric shapes and measures* domain (35% of the assessment), students should be able to identify and analyze the properties and characteristics of lines, angles, and a variety of geometric figures, including two– and three-dimensional shapes, and to provide explanations based on geometric relationships. This domain also included understanding informal coordinate systems and using spatial visualisation skills.

The *data display* content domain (15%) included understanding how to organise data that have been collected and how to display it in graphs as well as reading and interpreting various data displays. Students at Year 4 should be able to compare characteristics of data and to draw conclusions based on data displays. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

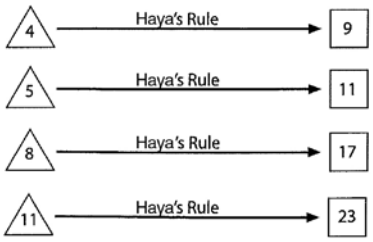
Year 4	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	Students have some basic mathematical knowledge. Students demonstrate an understanding of adding and subtracting with whole numbers. They demonstrate familiarity with triangles and informal coordinate systems. They can read information from simple bar graphs and tables.	*Students can apply basic mathematical knowledge in straightforward situations.* Students at this level demonstrate an understanding of whole numbers. They can extend simple numeric and geometric patterns. They are familiar with a range of two-dimensional shapes. They can read and interpret different representations of the same data.	*Students can apply their knowledge and understanding to solve problems.* Students can solve multi-step word problems involving operations with whole numbers. They can use division in a variety of problem situations. They demonstrate understanding of place value and simple fractions. Students can extend patterns to find a later specified term and identify the relationship between ordered pairs. Students show some basic geometric knowledge. They can interpret and use data in tables and graphs to solve problems.	*Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning.* They can apply proportional reasoning in a variety of contexts. They demonstrate a developing understanding of fractions and decimals. They can select appropriate information to solve multi-step word problems. They can formulate or select a rule for a relationship. Students can apply geometric knowledge of a range of two–and three-dimensional shapes in a variety of situations. They can organise, interpret, and represent data to solve problems.

Figure A1 *Descriptors of performance at the international benchmarks, Year 4 mathematics*

Year 4 students achieving at the advanced international benchmark demonstrated their ability to apply their understanding and knowledge in a wide variety of relatively complex situations. They typically demonstrated success on the knowledge and skills represented by this benchmark, as well as those demonstrated at the high, intermediate and low benchmarks.

At Year 4 level, pre-algebraic concepts and skills are a part of the TIMSS framework and assessment. Students at this age typically explore number patterns, investigate the relationships between the terms and find or use the rules that generate them. As an example of this, Figure A2 shows a number pattern item likely to be answered correctly by students who are performing at the advanced benchmark.

In this item students were shown a linear relationship between pairs of numbers and asked to write the two-step rule that described how to get the second number from the first. Internationally, 15 percent of students were able to provide a correct response to this item. In Hong Kong and Japan (and Singapore, not shown) the proportion of students answering this item correctly was between 36 and 39 percent. In Dubai 14 percent answered correctly, and this was higher than any of the other participating GCC countries and not significantly different from the international average.



Haya used the same rule to get the number in the □ from the number in the △.
What was the rule?

Answer: double the number and add 1

Country	Percent full correct
Hong Kong	39 (2.7)
Japan	38 (2.1)
International average	15 (0.3)
Dubai	**14 (1.7) ***
Kuwait	1 (0.4)
Qatar	1 (0.2)
Yemen	0 (0.2)
El Salvador	0 (0.0)

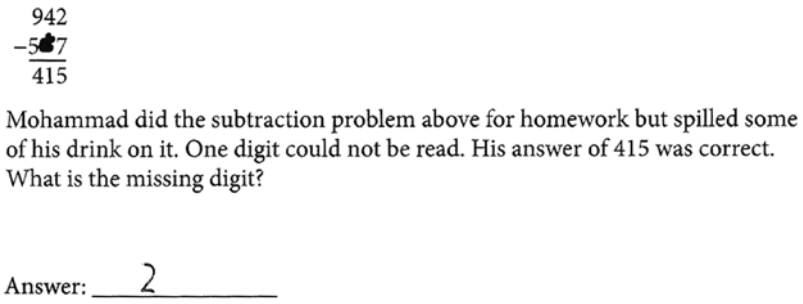
** Not significantly different to the International average*

Figure A2 *Mathematics Year 4 example item 1*

Year 4: Performance at the High International Benchmark – Mathematics

Students reaching the high international benchmark in mathematics demonstrated some competency with many of the topics in the framework. For example, in the number domain they applied their knowledge and understanding to solve problems involving whole numbers, including division. They also demonstrated understanding of place value, simple fractions, and how to extend a pattern to find a later specified term. They had some geometric knowledge about angles and triangles as well as distances, perimeters, and areas, and displayed some spatial visualisation skills. They could interpret and use data in tables and graphs to solve problems. Figure A3 provides an example of a constructed-response item that was typically answered correctly by students achieving at the high benchmark.

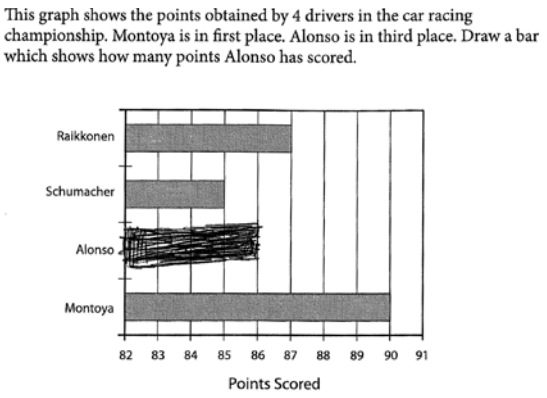
This item, involving subtraction with three digits, was answered correctly by 42 percent of students internationally, and by 88 percent of students in Chinese Taipei. In ten countries internationally (Chinese Taipei, Hong Kong, Singapore, Russian Federation, Kazakhstan, Japan, Lithuania, Latvia, Ukraine and Armenia), two-thirds or more students answered this item correctly, while in Dubai one-third of students (32%) did so.



Country	Percent full correct
Chinese Taipei	88 (1.6)
Hong Kong	85 (1.9)
International average	42 (0.4)
Dubai	**32 (2.9)**
Kuwait	10 (1.4)
Yemen	7 (1.3)
Qatar	5 (0.8)

Figure A3 *Mathematics Year 4 example item 2*

The next example shows an example of a data display problem likely to be answered correctly by students at the high benchmark. Students were asked to use data interpretation and representation skills to complete the bar graph provided. Internationally on average, 38 percent of the students drew the bar that correctly completed the graph. In Dubai, 31 percent of students answered this item correctly.



Country	Percent full correct
Hong Kong	77 (1.9)
Chinese Taipei	72 (1.8)
International average	38 (0.4)
Dubai	**31 (2.2)**
Kuwait	9 (1.4)
Qatar	4 (0.6)
Yemen	1 (0.4)

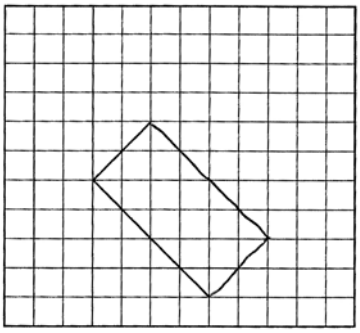
Figure A4 *Mathematics Year 4 example item 3*

Year 4: Performance at the Intermediate International Benchmark – Mathematics

Students reaching the intermediate international benchmark are able to apply basic mathematical knowledge to straightforward situations. They are able to order, add, subtract and multiply whole numbers, can identify basic fractions and extend patterns from the first few terms to next terms. They demonstrate familiarity with a range of two-dimensional shapes and can read and interpret different representations of the same data.

In this example, from the domain of *Geometric shapes and measures,* students were given two adjacent sides of a rectangle on a grid and asked to draw the other two sides. On average internationally more than half of the students completed the rectangle correctly. In Hong Kong 90 percent of students answered correctly, and 37 percent of students in Dubai also completed the rectangle correctly.

Here are two sides of a rectangle. Draw the other two sides.



Country	Percent full correct
Hong Kong	90 (1.4)
Japan	78 (1.8)
International average	54 (0.4)
Dubai	**37 (2.5)**
Kuwait	24 (2.0)
Qatar	16 (1.2)
Yemen	5 (1.0)

Figure A5 *Mathematics Year 4 example item 4*

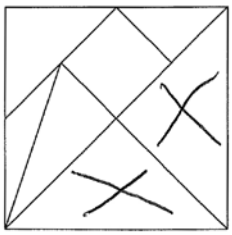
Year 4: Performance at the Low International Benchmark – Mathematics

Students performing at the low international benchmark demonstrate some mathematical knowledge, including adding and subtracting whole numbers. They show familiarity with simple number sentences, have some knowledge of triangles and informal coordinate systems and can read information from simple bar graphs and tables.

In this example, students were asked to use their knowledge of shape and size to classify and identify which of the triangles in the diagram were the same size and shape. This is an example of the type of item likely to be answered correctly by students reaching the low international benchmark.

Internationally, 72 percent of students correctly identified the two triangles, however this was as high as 91 percent in Hong Kong and Slovenia. In Dubai, 67 percent of students answered correctly, statistically the same as the international average.

The square is cut into 7 pieces. Put an X on each of the 2 triangles that are the same size and shape.



Country	Percent full correct
Hong Kong	91 (1.2)
Slovenia	91 (1.3)
International average	72 (0.3)
Dubai	**67 (2.6) ***
Kuwait	40 (2.5)
Qatar	32 (1.5)
Yemen	13 (1.5)

** Not significantly different to the International average*

Figure A6 *Mathematics Year 4 example item 5*

Year 8: Performance at the Advanced International Benchmark – Mathematics

At Year 8, students at the Advanced International Benchmark organised and drew conclusions from information, made generalisations, and solved non-routine problems involving numeric, algebraic, and geometric concepts and relationships. In comparison, those at the Low International Benchmark demonstrated some knowledge of whole numbers and decimals, operations, and basic graphs.

At Year 8, TIMSS 2007 assessed four content domains with each given similar weight – *number* (30%), *Algebra* (30%), *Geometry* (20%), and *data and chance* (20%).

According to the *TIMSS 2007 Mathematics Framework*, within the number domain, students should have developed computational fluency with fractions and decimals, understand how operations relate to one another, and extended their understanding to operations with integers. By Year 8, students should be able to move flexibly among equivalent fractions, decimals, and Percentages and use proportional reasoning to solve problems.

In *Algebra,* students should have developed an understanding of linear relationships and the concept of variable. They are expected to use and simplify algebraic formulas, solve linear equations, inequalities, pairs of simultaneous equations involving two variables, and use a range of functions. They should be able to solve problems using algebraic models and to explain relationships involving algebraic concepts.

In *Geometry,* the focus is on using geometric properties and their relationships to solve problems. It also includes understanding coordinate representations and using spatial visualisation skills to move between two–and three-dimensional shapes and their representations.

The *data and chance* domain includes describing and comparing characteristics of data (shape, spread, and central tendency). Students should be able to use data to draw conclusions and make predications, and understand issues related to misinterpretation of data. Year 8 students should understand elementary probability in terms of the likelihood of familiar events and use data from experiments to predict the chance of a given outcome.

Within each content domain, students needed to draw on a range of cognitive skills and go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems. At Year 8, calculator use was permitted but not required. If students usually used calculators in the classroom then countries were encouraged to allow calculator use; however, if this was not the norm then countries could not permit their use. In Dubai, students were allowed to use calculators, reflecting general practice in schools.

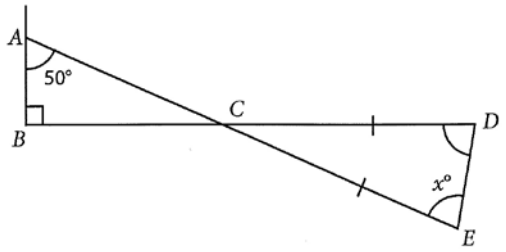
Figure A7 provides the brief descriptors of achievement at the international benchmarks for Year 8 mathematics.

Year 8	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	Students have some knowledge of whole numbers and decimals, operations, and basic graphs.	*Students can apply basic mathematical knowledge in straightforward situations.* They can add and multiply to solve one-step word problems involving whole numbers and decimals. They can work with familiar fractions. They understand simple algebraic relationships. They demonstrate understanding of properties of triangles and basic geometric concepts. They can read and interpret graphs and tables. They recognise basic notions of likelihood.	*Students can apply their understanding and knowledge in a variety of relatively complex situations.* They can relate and compute with fractions, decimals, and Percents, operate with negative integers, and solve word problems involving proportions. Students can work with algebraic expressions and linear equations. Students use knowledge of geometric properties to solve problems, including area, volume, and angles. They can interpret data in a variety of graphs and table and solve simple problems involving probability.	*Students can organise and draw conclusions from information, make generalisations, and solve non-routine problems.* They can solve a variety of ratio, proportion, and percent problems. They can apply their knowledge of numeric and algebraic concepts and relationships. Students can express generalisations algebraically and model situations. They can apply their knowledge of geometry in complex problem situations. Students can derive and use data from several sources to solve multi-step problems.

Figure A7 *Descriptors of performance at the international benchmarks, Year 8 mathematics*

This item is from the *Geometry* domain, and asks students to use the properties of isosceles and right-angled triangles to find the size of an angle.

Around three-quarters of the students in Singapore and Chinese Taipei responded correctly to this item, but only around one-fifth (22%) of students in Dubai answered it correctly. This was significantly lower than the international average.



In this diagram, $CD = CE$.
What is the value of x?

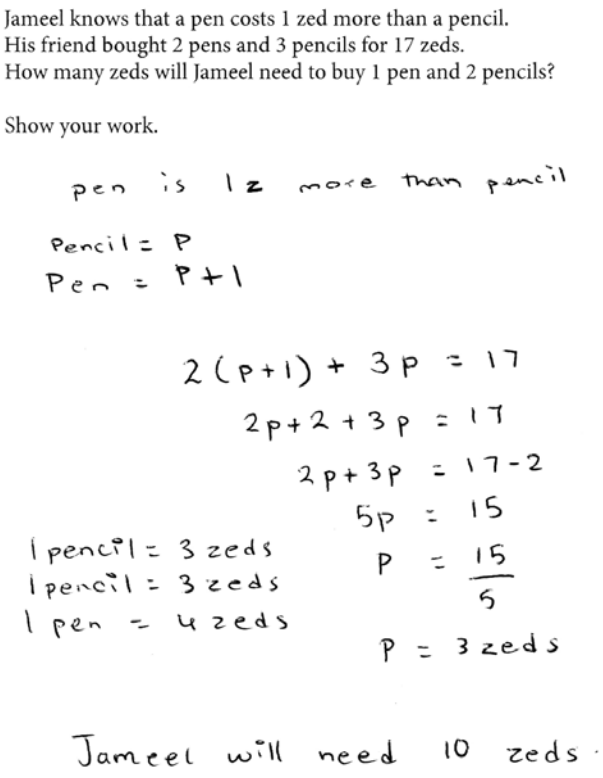
Ⓐ 40
Ⓑ 50
Ⓒ 60
● 70

Country	Percent full correct
Singapore	75 (1.7)
Chinese Taipei	73 (2.2)
International average	32 (0.3)
Dubai	**22 (2.4)**
Kuwait	17 (1.5)
Qatar	17 (1.2)
Saudi Arabia	18 (1.9)
Bahrain	17 (1.4)
Oman	19 (1.7)
Ghana	14 (1.5)

Figure A8 *Mathematics Year 8 example item 1*

Figure A9 provides a good example of one of the most difficult items in the Year 8 assessment. The example is a word problem that can be expressed as a linear equation with two variables, with students asked to show their work. While the aim of this item was for students to solve the item algebraically, alternative methods were also acceptable. Most of the remaining students who answered this item correctly used a 'guess and check' method, which was fairly straightforward for this particular item.

On average across countries, only 18 percent of students gained full credit for their response to this item, but in Chinese Taipei and Korea more than two-thirds (68%) of students and in Singapore (59%) and Hong Kong (53%) did so. Students in Dubai performed at a level similar to the international average, with 16 percent answering correctly.



Country	Percent full correct
Chinese Taipei	68 (2.3)
Korea	68 (2.1)
International average	18 (0.2)
Dubai	**16 (2.0) ***
Bahrain	4 (0.8)
Oman	4 (0.8)
Saudi Arabia	3 (0.8)
Kuwait	2 (0.6)
Qatar	2 (0.4)
Palestinian Nat. Auth.	1 (0.7)

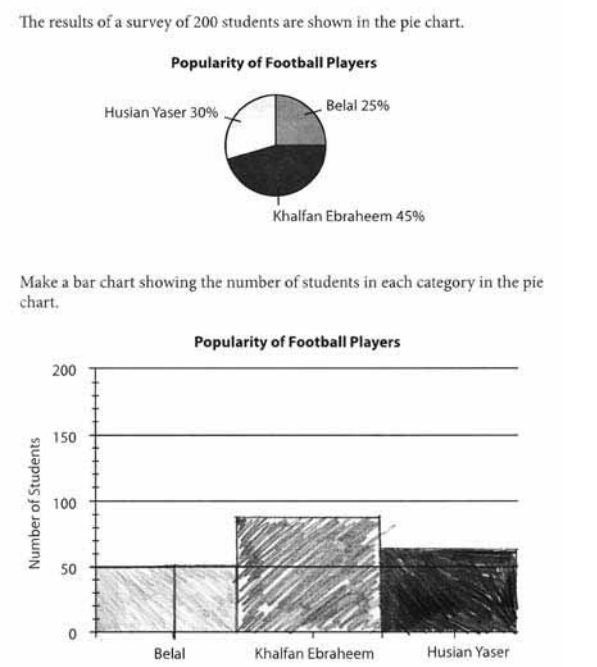
** Not significantly different to the International average*

Figure A9 *Mathematics Year 8 example item 2*

Year 8: Performance at the High International Benchmark – Mathematics

Students reaching the High International benchmark level were able to apply their understanding and knowledge to a variety of relatively complex situations. They were able to relate fractions, decimals, and percents and operate with negative integers. They demonstrated the ability to work with algebraic expressions and linear equations, and used their knowledge of geometric properties to solve problems. They were able to compare and integrate several sets of data, and to solve simple problems involving outcomes and probabilities.

Figure A10 presents an item from the *data and chance* domain that assesses students' ability to read, organise and display data using various types of graphs, in this case a bar graph and a pie chart. Students needed to draw the bar graph in its entirety to receive full credit, and 27 percent of students internationally received full credit for this item. In the Asian countries of Korea, Singapore, Chinese Taipei, Japan and Hong Kong, at least two-thirds of students gained full credit on this item, while in Dubai the 21 percent who answered correctly was not significantly different to the international average.



Country	Percent full correct
Korea	76 (2.0)
Singapore	75 (1.7)
International average	27 (0.3)
Dubai	**21 (3.1) ***
Bahrain	9 (1.2)
Oman	6 (1.0)
Qatar	4 (0.6)
Saudi Arabia	3 (0.9)
Kuwait	3 (0.8)
Ghana	2 (0.6)

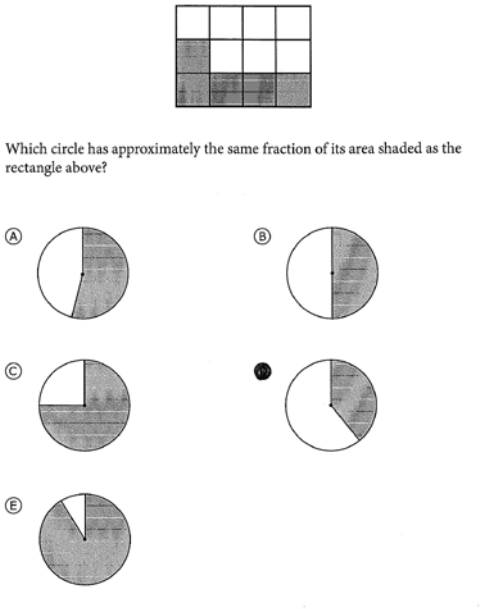
** Not significantly different to the International average*

Figure A10 *Mathematics Year 8 example item 3*

Year 8: Performance at the Intermediate International Benchmark – Mathematics

Students reaching the Intermediate International Benchmark were able to apply basic mathematical knowledge in relatively straightforward situations. For example, they solved one-step word problems involving addition and multiplication of decimals, and worked with familiar fractions. They demonstrated understanding of simple algebraic relationships, properties of triangles, and basic geometric concepts. They read and interpreted graphs and tables, and recognised basic notions of likelihood.

Figure A11 shows an example of the type of item that was typically answered correctly by students at the intermediate benchmark. This item called on students' understanding of representations of fractions. Students needed to recognise that of the circular models presented, the only one showing less than ½ best represents the fractional part shown in a rectangle as 5/12. On average internationally, 63 percent of the Year 8 students answered correctly. The Korean students were the top-performers with 89 percent answering correctly. Students in Dubai also performed well on this item, with 60 percent answering correctly.



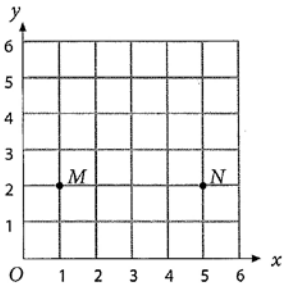
Country	Percent full correct
Korea	89 (1.3)
Japan	85 (1.8)
International average	**63 (0.3)**
Bahrain	61 (2.0)
Dubai	**60 (2.0) ***
Kuwait	56 (2.0)
Oman	46 (2.1)
Qatar	44 (1.8)
Saudi Arabia	41 (2.3)
Ghana	34 (2.3)

** Not significantly different to the International average*

Figure A11 *Mathematics Year 8 example item 4*

Example Item 5 presented in Figure A12 also illustrates the type of item likely to be answered correctly by students reaching the intermediate benchmark. Students were asked to use the properties of an isosceles triangle to identify the point on the grid that completes the triangle. On average internationally, more than half (57%) did so, and in Chinese Taipei and Korea at least 80 percent of students answered correctly.

In Dubai half the students answered this item correctly.



Two points M and N are shown in the figure above. John is looking for a point P such that MNP is an isosceles triangle. Which of these points could be point P?

● (3,5)
Ⓑ (3,2)
Ⓒ (1,5)
Ⓓ (5,1)

Country	Percent full correct
Chinese Taipei	86 (1.5)
Korea	82 (1.6)
Kuwait	63 (2.6)
Bahrain	59 (2.1)
Oman	59 (2.0)
International average	57 (0.3)
Dubai	**50 (2.6)**
Saudi Arabia	46 (2.3)
Qatar	38 (1.5)
Palestinian Nat. Auth.	1 (0.7)

Figure A12 *Mathematics Year 8 example item 5*

Year 8: Performance at the Low International Benchmark – Mathematics

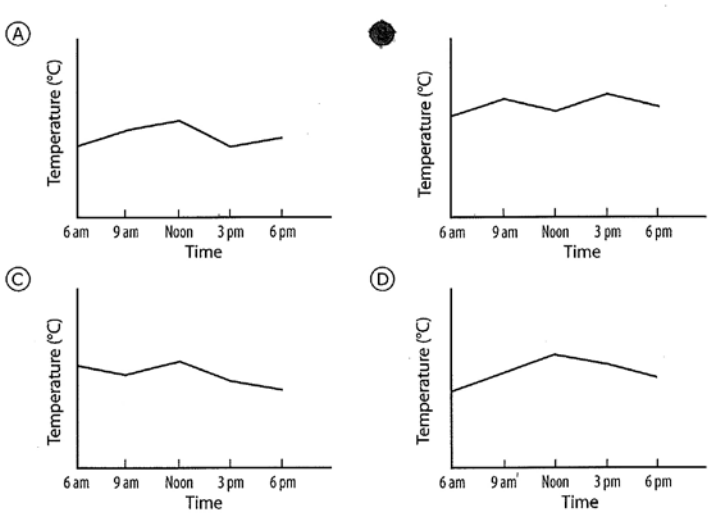
The few items that anchored at this level provided some evidence that students have an elementary knowledge of whole numbers and decimals, operations, and basic graphs.

In the example provided in Figure A13, example 6, students are expected to be able to draw on their knowledge in the data and chance domain to match the data in a line graph with the data in a table. The temperatures in the table rise and fall from day to day, and students needed to recognise that only one graph has this up and down pattern. Seventy-two percent of students internationally answered this item correctly. At least 90 percent of students in Korea and Japan also answered correctly, and 72 percent of Dubai students also answered correctly, which was the same as the international average.

The table shows the temperatures at various times on a certain day.

Time	6 am	9 am	Noon	3 pm	6 pm
Temperature °C	12	17	14	18	15

A graph, without a temperature scale, is drawn. Of the following, which could be the graph that shows the information given in the table?



Country	Percent full correct
Korea	97 (0.7)
Japan	96 (0.8)
International average	72 (0.3)
Dubai	**72 (2.9) ***
Bahrain	62 (2.2)
Oman	57 (2.1)
Kuwait	47 (2.2)
Saudi Arabia	45 (2.3)
Qatar	40 (1.6)
Ghana	34 (2.3)

** Not significantly different to the International average*

Figure A13 *Mathematics Year 8 example item 6*

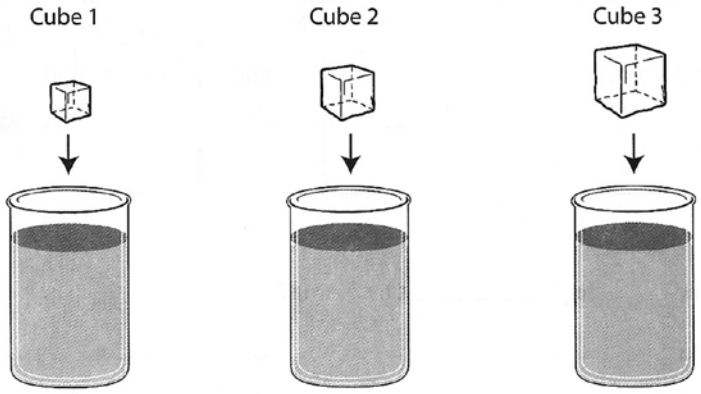
Year 4: Performance at the Advanced International Benchmark – Science

Students achieving at or above this benchmark at Year 4 demonstrated fluency with most framework topics. They typically demonstrated success on the knowledge and skills represented by this benchmark, as well as those demonstrated at the high, intermediate and low benchmarks.

Figure A14 provides an example of an item that students achieving at this benchmark would be expected to have answered correctly. While not expecting students to have mastered the concept of density, students at Year 4 are expected to understand that an object's capacity to sink or float is not determined by its size. In this example students are presented with a diagram showing three beakers the same size and containing the same amount of water, and three ice cubes of varying size.

On average across countries 39 percent of students recognised that all three ice cubes would float, regardless of their size. Sixty percent of the students in Chinese Taipei answered this item correctly, closely followed by Japan. In Dubai, 29 percent of students answered this item correctly.

Suhair has three ice cubes of different sizes. She places each ice cube into an identical beaker containing the same volume of water, as shown in the diagram.



What happens to the ice cubes when they are placed in the water?

Ⓐ Cubes 1, 2, and 3 will sink.

● Cubes 1, 2, and 3 will float.

Ⓒ Cube 1 will float, and cubes 2 and 3 will sink.

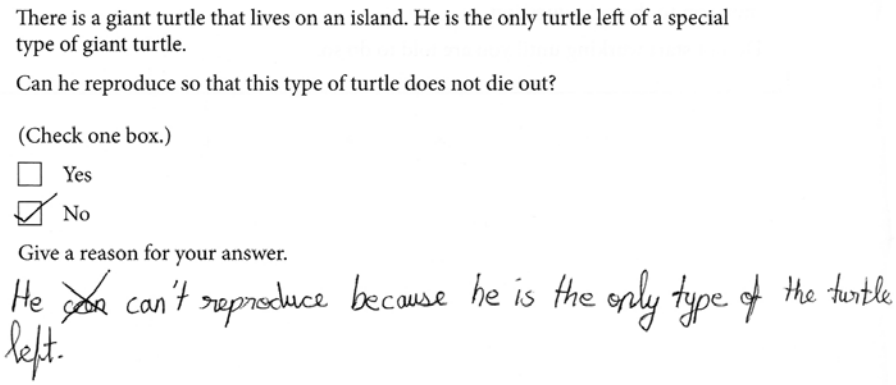
Ⓓ Cubes 1 and 2 will float, and cube 3 will sink.

Country	Percent full correct
Chinese Taipei	60 (2.1)
Japan	58 (2.3)
International average	**39 (0.4)**
Kuwait	31 (2.0)
Dubai	**29 (2.1)**
Qatar	1 (0.2)
Yemen	0 (0.2)
El Salvador	0 (0.0)

Figure A14 *Science Year 4 example item 1*

A further example of a constructed-response item that demonstrates a student's understanding of basic principles of heredity and reproduction is shown in Figure A15. This example is likely to be correctly answered by students reaching the advanced level in science. The question asks students to explain whether the last remaining member of a species, the giant turtle, can reproduce so the species does not die out. To gain credit on this item, students were required to explain that turtles cannot reproduce by themselves, and that a male turtle needed a female turtle in order to reproduce.

Internationally just 30 percent of students gained credit for this item. Students in Lithuania and Latvia achieved the highest proportion of students answering correctly, and 12 percent of students in Dubai also answered correctly.


There is a giant turtle that lives on an island. He is the only turtle left of a special type of giant turtle.

Can he reproduce so that this type of turtle does not die out?

(Check one box.)

☐ Yes

☑ No

Give a reason for your answer.

He ~~can~~ can't reproduce because he is the only type of the turtle left.

Country	Percent full correct
Lithuania	58 (2.4)
Latvia	55 (2.4)
International average	30 (0.3)
Dubai	**12 (1.7)**
Kuwait	9 (1.4)
Qatar	2 (0.5)
Yemen	1 (0.4)

Figure A15 *Science Year 4 example item 2*

Year 4: Performance at the High International Benchmark – Science

At this year level, almost half (45%) of the assessment items were devoted to assessing the *Life science* content domain. A further 35 percent were devoted to assessing *Physical science* and the remaining 20 percent to *Earth science*. As can be seen in Figure A16, students at the Advanced International Benchmark applied knowledge and understanding of scientific processes and relationships in beginning scientific inquiry, whereas those at the Low International Benchmark displayed some elementary knowledge of *Life science* and *Physical science*.

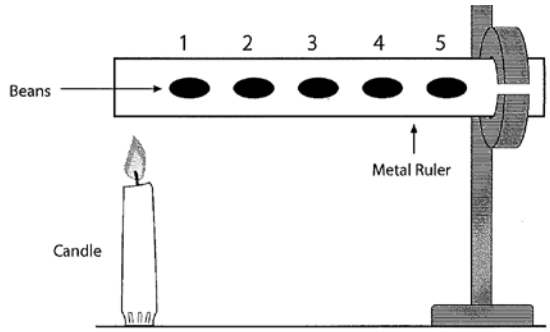
According to the *TIMSS 2007 Science Framework*, Year 4, in the *Life science* domain, students should be able to demonstrate knowledge of the characteristics and life processes of living things, know and be able to compare the life cycles of common organisms such as the butterfly and frog, describe relationships between plants and animals in common ecosystems, and have a rudimentary knowledge of human health, nutrition, and disease. Within the *Physical science* domain Year 4 students should be able to compare or classify objects and materials on the basis of physical properties, identify common energy sources and have some understanding of heat flow, relate familiar physical phenomena to the behaviour of light and sound, have some notion of a complete electrical circuit and some practical knowledge of magnets and their uses, and have some grasp of the idea of forces as they relate to movement. In the *Earth science* content domain Year 4 students were expected to demonstrate some general knowledge about the structure and physical characteristics of Earth; Earth's processes, cycles, and history; and some understanding about Earth's place in the solar system. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

Year 4	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	Students have some elementary knowledge of life science and physical science. Students can demonstrate knowledge of some simple facts related to human health and the behavioural and physical characteristics of animals. They recognise some properties of matter, and demonstrate a beginning understanding of forces. Students interpret labelled pictures and simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.	*Students can apply basic knowledge and understanding to practical situations in the sciences.* Students recognise some basic information related to characteristics of living things and their interaction with the environment, and show some understanding of human biology and health. They also show some understanding of familiar physical phenomena. Students know some basic facts about the solar system and have a developing understanding of Earth's resources. They demonstrate some ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.	*Students can apply knowledge and understanding to explain everyday phenomena.* Students demonstrate some understanding of plant and animal structure, life processes, and the environment and some knowledge of properties of matter and physical phenomena. They show some knowledge of the solar system, and of Earth's structure, processes, and resources. Students demonstrate beginning scientific inquiry knowledge and skills, and provide brief descriptive responses combining knowledge of science concepts with information from everyday experience of physical and life processes.	*Students can apply knowledge and understanding of scientific processes and relationships in beginning scientific inquiry.* Students communicate their understanding of characteristics and life processes of organisms as well as of factors relating to human health. They demonstrate understanding of relationships among various physical properties of common materials and have some practical knowledge of electricity. Students demonstrate some understanding of the solar system and Earth's physical features and processes. They show a developing ability to interpret the results of investigations and draw conclusions as well as a beginning ability to evaluate and support an argument.

Figure A16 *Descriptors of performance at the international benchmarks, Year 4 science*

The following examples provide examples of types of items that are typically answered correctly by students reaching the high benchmark. In the first example, Figure A17, students are required to recognise that when heat is applied to one end of a metal ruler, that heat will be conducted to the other end.

On average internationally this was answered correctly by 57 percent of Year 4 students. In Japan 92 percent of students were able to answer correctly, and in Singapore 88 percent of students answered correctly. In Dubai more than half (52%) of the students answered correctly. This was statistically the same as the international average.



Beans are fixed on a metal ruler with butter as shown in the figure above. The ruler is heated at one end. In which order will the beans fall off?

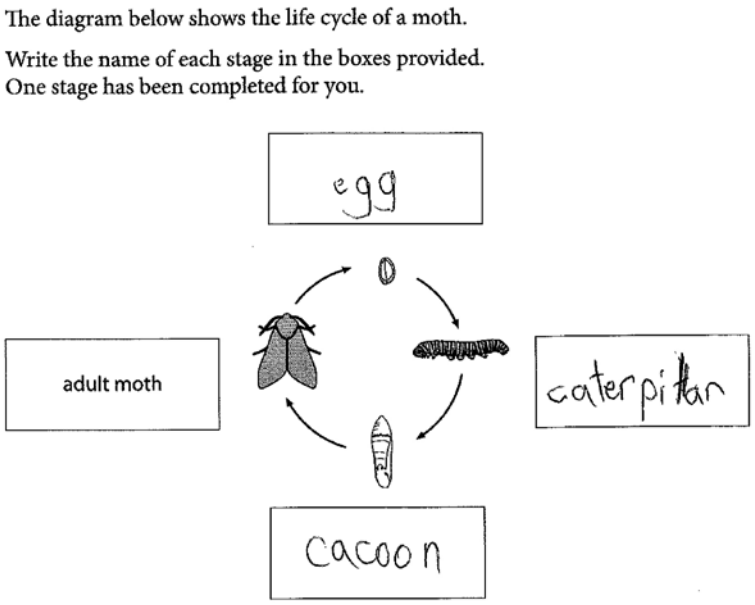
- ● 1, 2, 3, 4, 5
- Ⓑ 5, 4, 3, 2, 1
- Ⓒ 1, 3, 5, 4, 2
- Ⓓ All at the same time

Country	Percent full correct
Japan	92 (1.2)
Singapore	88 (1.4)
International average	57 (0.4)
Dubai	**52 (2.3) ***
Qatar	40 (1.5)
Kuwait	35 (2.3)
Yemen	20 (1.6)

** Not significantly different to the International average*

Figure A17 *Science Year 4 example item 3*

Figure A18 is an example of a *Life science* item likely to be completed by students reaching the high benchmark. This constructed-response item shows the life cycle of a moth and students are asked to label three of the four stages. Internationally on average 33 percent of students correctly labelled the egg, caterpillar and pupa stages of the cycle. Ninety-three percent of Japanese students, 66 percent of Slovak students and 17 percent of Dubai students answered this item correctly.



Country	Percent full correct
Japan	93 (1.3)
Slovak Republic	66 (2.3)
International average	**33 (0.4)**
Kuwait	32 (2.5)
Dubai	**17 (2.1)**
Qatar	7 (0.8)
Yemen	0 (0.0)

Figure A18 *Science Year 4 example item 4*

Year 4: Performance at the Intermediate International Benchmark – Science

Students achieving at the intermediate international benchmark were able to apply basic knowledge and understanding to practical situations in the sciences. For example they can recognise some basic information about characteristics of living things.

In the following example, students were shown a picture of two sunflower plants grown in similar pots of soil from seeds from the same plant. One plant was clearly larger and healthier looking than the other, and to earn full credit on this item students had to describe one way in which the larger plant may have been treated differently from the smaller one.

On average across countries 63 percent of students answered correctly, explaining, for example, that the larger plant may have been given more light and water. Students in Singapore and Lithuania did very well on this item, with 85 percent answering correctly. More than half (56%) of students in Dubai also answered this item correctly.

Fadi and Fadwa each had a sunflower seed taken from the same plant. They took two identical pots and put potting soil in each. They then planted one seed in each pot. Fadi looked after one pot in his home, and Fadwa looked after the other pot in her home.

After some time, they compared the plants and saw that there was a large difference in their growth, as shown in the pictures below.

Fadi's plant Fadwa's plant

Describe one way in which Fadi may have treated his plant differently from the way Fadwa treated hers.

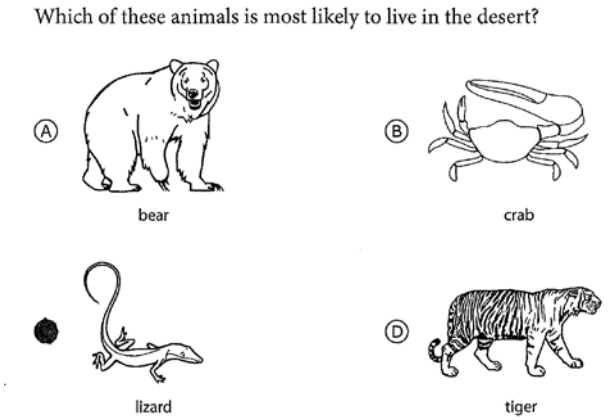
Fadi treated his plant more carefully because Fadi fed his plant better put in were there was alot of sun, changed it's pot. Fadwa treated her plant not carefully she didn't give it alot of water didn't were there was alot sunlight.

Country	Percent full correct
Singapore	85 (1.8)
Lithuania	85 (1.7)
International average	63 (0.4)
Dubai	**56 (3.2)**
Kuwait	22 (1.8)
Qatar	16 (1.0)
Yemen	7 (1.2)

Figure A19 *Science Year 4 example item 5*

Year 4: Performance at the Low International Benchmark – Science

Figure A20 presents an example of student achievement at the low international benchmark. At this level students demonstrated some elementary knowledge of the life and physical sciences. This included simple facts related to human health and the behavioural and physical characteristics of animals and humans. In this example students are presented with a pictorial representation of four animals and asked to identify the animal most likely to live in the desert. On average internationally 68 percent of Year 4 students were able to identify the lizard as the most likely desert dweller. More than 90 percent of students in the United States and 89 percent of students in the Russian Federation correctly answered this item, and 74 percent of Dubai students also identified the correct animal. This was significantly higher than the international average.



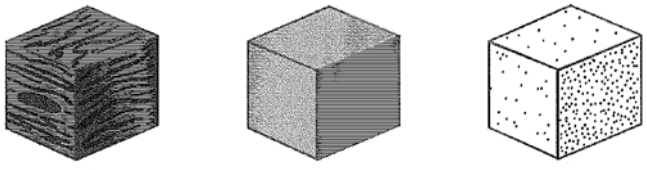
Country	Percent full correct
United States	92 (0.8)
Russian Federation	89 (2.2)
Kuwait	80 (1.8)
Dubai	**74 (2.4) ▲**
International average	68 (0.4)
Qatar	64 (1.5)
Yemen	28 (2.1)

▲ Significantly higher than the International average

Figure A20 *Science Year 4 example item 6*

In Figure A21 another example of an item that students at the low international benchmark would be expected to answer correctly, students were presented with three objects of the same size and shape and students were required to recognise that the object made of iron is the heaviest. More than 90 percent of students in Japan and the Russian Federation answered this item correctly, and around two-thirds (68%) of Dubai students also answered correctly.

The three objects below are the same shape and size.



Which statement about the weight of the objects is most likely to be correct?

Ⓐ The wood object is the heaviest.
● The iron object is the heaviest.
Ⓒ The styrofoam object is the heaviest.
Ⓓ All three objects weigh the same.

Country	Percent full correct
Japan	94 (1.2)
Russian Federation	92 (1.3)
International average	80 (0.3)
Kuwait	69 (2.3)
Dubai	**68 (1.9)**
Yemen	48 (2.6)
Qatar	47 (1.6)

Figure A21 *Science Year 4 example item 7*

Year 8: Performance at the Advanced International Benchmark – Science

At Year 8, TIMSS assessed four content domains, which were allotted varying weights: *Biology* (35%), *Chemistry* (20%), *Physics* (25%) and *Earth science* (20%).

According to the TIMSS 2007 Science Framework, in *Biology,* Year 8 students should be able to classify organisms into the major taxonomic groups, identify cell structures and their function, distinguish between growth and development in different organisms, and show some understanding of diversity, adaptation, and natural selection among organisms. By Year 8, students are expected to have an understanding of the interdependence of living organisms and their relationship to the physical environment, and demonstrate knowledge of human health, nutrition, and disease.

In *Chemistry,* students should be able to classify substances on the basis of characteristic physical properties and have a clear understanding of the properties of matter. Students should recognise the differences between physical and chemical changes and recognise the conservation of matter during these changes.

In *Physics,* students are expected to be able to describe processes involved in changes of state and apply knowledge of energy transformations, heat, and temperature. They should know basic properties of light and sound, understand the relationship between current and voltage in electrical circuits, and describe properties and forces of permanent magnets and electromagnets. Students are expected to have a quantitative knowledge of mechanics, as well as a commonsense understanding of density and pressure as they relate to familiar physical phenomena.

In the *Earth science* domain, Year 8 students are expected to demonstrate knowledge of the structure and physical characteristics of Earth's crust, mantle, and core, and apply the concept of cycles and patterns to describe Earth's processes, including the rock and water cycles. Students should have an understanding of Earth's resources and their use and conservation, and demonstrate knowledge of the solar system in terms of the relative distances, sizes, and motions of the sun, the planets, and their moons, and of how phenomena on Earth relate to the motion of bodies in the solar system.

Within each content domain, students needed to draw on a range of cognitive skills and go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems.

Figure A22 provides the brief descriptors for the International Benchmarks at Year 8. As the figure shows, students at the Advanced International Benchmark in Year 8 demonstrated a grasp of some complex and abstract concepts in biology, chemistry, physics, and *Earth science*. In comparison, those at the Low International Benchmark simply recognised some basic facts from the life and physical sciences.

Year 8	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	Students can recognise some basic facts from the life and physical sciences. They have some knowledge of the human body, and demonstrate some familiarity with everyday physical phenomena. Students can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.	*Students can recognise and communicate basic scientific knowledge across a range of topics.* They demonstrate some understanding of characteristics of animals, food webs, and the effect of population changes in ecosystems. They are acquainted with some aspects of sound and force and have elementary knowledge of chemical change. They demonstrate elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students extract information from tables and interpret pictorial diagrams. They can apply knowledge to practical situations and communicate their knowledge through brief descriptive responses	*Students can demonstrate conceptual understanding of some science cycles, systems, and principles.* They have some understanding of biological concepts including cell processes, human biology and health, and the interrelationship of plants and animals in ecosystems. They apply knowledge to situations related to light and sound, demonstrate elementary knowledge of heat and forces, and show some evidence of understanding the structure of matter, and chemical and physical properties and changes. They demonstrate some understanding of the solar system, Earth's processes and resources, and some basic understanding of major environmental issues. Students demonstrate some scientific inquiry skills. They combine information to draw conclusions, interpret tabular and graphical information, and provide short explanations conveying scientific knowledge.	*Students can demonstrate a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science.* They have an understanding of the complexity of living organisms and how they relate to their environment. They show understanding of the properties of magnets, sound, and light, as well as demonstrating understanding of structure of matter and physical and chemical properties and changes. Students apply knowledge of the solar system and of Earth's features and processes, and apply understanding of major environmental issues. They understand some fundamentals of scientific investigation and can apply basic physical principles to solve some quantitative problems. They can provide written explanations to communicate scientific knowledge.

Figure A22 *Descriptors of performance at the international benchmarks, Year 8 science*

Students achieving at or above the advanced benchmark demonstrated a grasp of some complex and abstract science concepts. For example, they have an understanding of the complexity of living organisms and how they relate to their environment, and show knowledge of the structure of matter and of physical and chemical properties and changes. They show understanding of the properties of magnets, sound, and light. Students apply knowledge and understanding of the solar system and Earth's features and processes, and of major environmental issues. They understand some fundamentals of scientific investigation, can apply basic physical principles to solve quantitative problems, and can provide written explanations to communicate scientific knowledge.

Example 1 in Figure A23 provides an example of the type of item a student performing at the advanced international benchmark is likely to answer correctly. Students were told that two substances together had a mass of 110 grams, and were asked to predict the mass of a new substance formed by combining the two original substances and explain their reasoning.

On average across countries only 23 percent of students obtained full credit for their answer. In Japan and Korea more than half of the students answered correctly, while in Dubai the proportion answering correctly was 19 percent, which was essentially the same as the international average.

The mass of substances A and B are measured on a balance, as shown in Figure 1. Substance B is put into the beaker and substance C is formed. The empty beaker is put back on the balance, as shown in Figure 2.

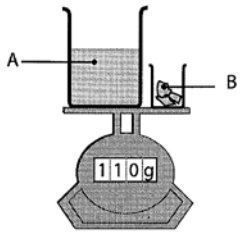


Figure 1

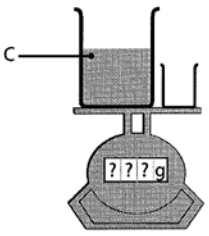


Figure 2

The scale in Figure 1 shows a mass of 110 grams.

What will it show in Figure 2?

(Tick one box.)

- ☐ More than 110 grams
- ☑ 110 grams
- ☐ Less than 110 grams

Explain your answer.

The two substances are still on the scales, one has just dissolved in the other. As both substances are still there it will still weigh the same.

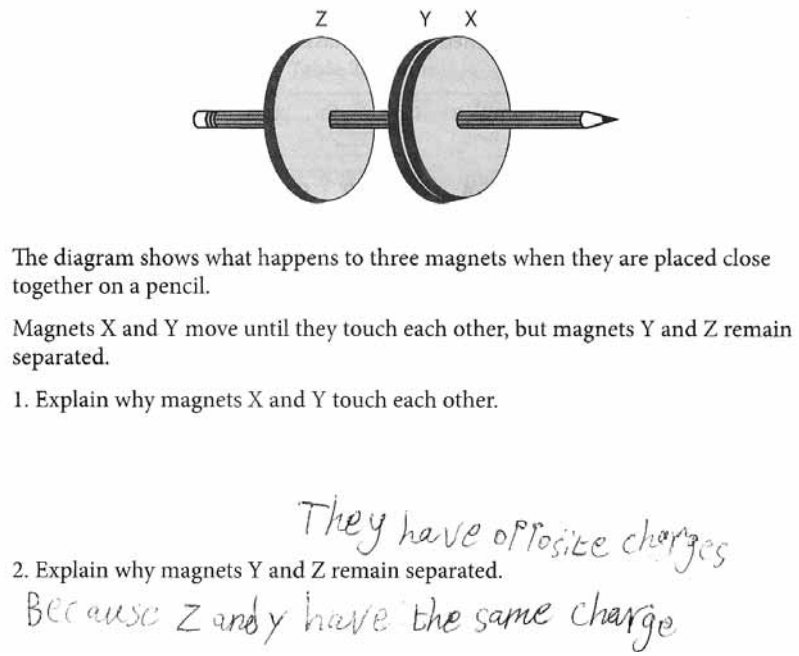
Country	Percent full correct
Japan	65 (2.1)
Korea	51 (2.0)
International average	23 (0.3)
Dubai	**19 (2.3)** *
Bahrain	18 (1.6)
Oman	9 (1.4)
Kuwait	7 (1.2)
Saudi Arabia	5 (1.0)
Qatar	3 (0.6)
Botswana	1 (0.4)

** Not significantly different to the International average*

Figure A23 *Science Year 8 example item 1*

Figure A24 is set in the *Physics* domain, and assesses students understanding of the properties of magnets, and in particular magnetic polarity. Given the diagram depicting three magnets, two of which are touching and a third is separated from the touching pair, students were asked to provide two explanations: firstly why the touching magnets touch and secondly why the separated magnets stay separated. To earn full credit students had to apply knowledge of the polarity of magnets to explain that the touching magnets had facing north and south poles while the separated magnets had either facing north poles or facing south poles.

This was a very difficult question for students, with just 23 percent on average internationally getting full credit for their answer on this item. The percentage answering correctly in Dubai was 26 percent, which was not significantly different to the international average.



Country	Percent full correct
Japan	71 (2.0)
Singapore	61 (1.8)
Dubai	**26 (2.5) ***
Bahrain	26 (2.1)
International average	**23 (0.3)**
Kuwait	19 (1.8)
Oman	16 (1.7)
Qatar	9 (0.9)
Saudi Arabia	8(1.0)
Algeria	2 (0.6)

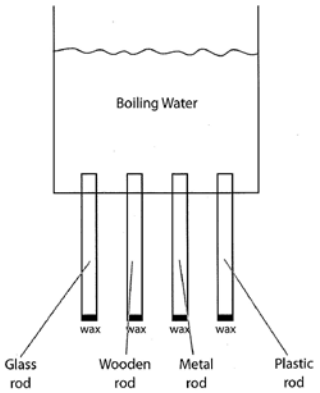
** Not significantly different to the International average*

Figure A24 *Science Year 8 example item 2*

Year 8: Performance at the High International Benchmark – Science

Students reaching this benchmark were able to recognise and communicate basic scientific knowledge across a range of topics. They demonstrated some understanding of characteristics of animals, and are acquainted with some aspects of sound, force, and chemical change. They demonstrated elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students extract information from tables and diagrams, apply knowledge to practical situations, and communicate their knowledge through brief descriptive responses.

Figure A25 shows the type of *Physics* item likely to be answered correctly by students reaching the high benchmark. In the context of an investigation into thermal conductivity, this multiple-choice question asks students to choose among glass, wood, metal, and plastic for the best conductor of heat. On average, internationally, 47 percent of students correctly chose metal as the best conductor. More than 70 percent of students answered correctly in Singapore (79%) and in Chinese Taipei (75%). Students in Dubai (61%) performed on average significantly higher than the international average.



The diagram shows four identical size rods each of a different material sealed into the bottom of a container. The same amount of wax is placed on the end of each rod and then the container is filled with boiling water. On which rod will the wax melt first?

Ⓐ Glass rod
Ⓑ Wooden rod
● Metal rod
Ⓓ Plastic rod

Country	Percent full correct
Singapore	79 (1.7)
Chinese Taipei	75 (1.8)
Dubai	**61 (2.0) ▲**
Bahrain	47 (2.0)
International average	**47 (0.3)**
Kuwait	43 (2.4)
Oman	40 (2.2)
Qatar	36 (1.4)
Saudi Arabia	31 (2.7)
Indonesia	21 (2.1)

▲ *Significantly higher proportion than the international average*

Figure A25 *Science Year 8 example item 3*

Year 8: Performance at the Intermediate International Benchmark – Science

Students reaching this benchmark were able to recognise and communicate basic scientific knowledge across a range of topics. They demonstrated some understanding of characteristics of animals, and are acquainted with some aspects of sound, force, and chemical change. They demonstrated elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students could extract information from tables and diagrams, apply knowledge to practical situations, and communicate their knowledge through brief descriptive responses.

Figure A26 presents example item 4, from the *Biology* domain. This multiple-choice item requires students to identify an animal characteristic found only in mammals. On average internationally, 63 percent of Year 8 students recognised *glands that make milk* as the correct answer. More than 80 percent of students in Chinese Taipei (91%) and Hong Kong (86%) answered correctly. Students in Dubai performed at a level significantly lower then the international average, however 57 percent answered this item correctly.

Which characteristic is found ONLY in mammals?

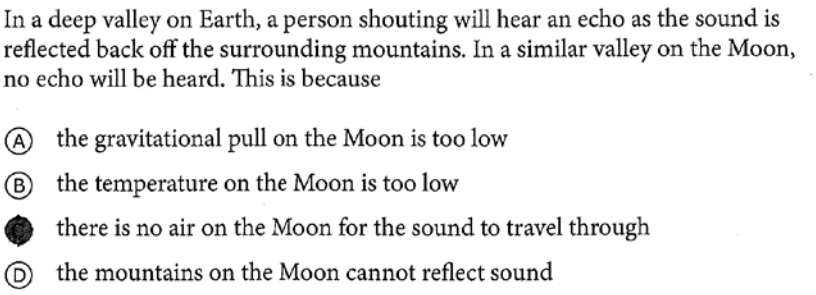
Ⓐ eyes that detect colour
● glands that make milk
Ⓒ skin that absorbs oxygen
Ⓓ bodies that are protected by scales

Country	Percent full correct
Chinese Taipei	91 (1.3)
Hong Kong	86 (1.8)
Saudi Arabia	72 (1.8)
Kuwait	70 (2.1)
Bahrain	66 (2.1)
International average	63 (0.3)
Dubai	**57 (2.5)**
Oman	49 (2.0)
Qatar	49 (1.5)
Ghana	31 (2.1)

Figure A26 *Science Year 8 example item 4*

In Figure A27, students are asked to draw on their knowledge of *Physics* to recognise the reason that a sound can cause an echo on the Earth but not on the moon. Almost two-thirds (65%) of students internationally recognised that there would be no echo on the moon because there is no air for the sound to travel through.

In Korea (90%) and Chinese Taipei (89%) at least 80 percent of students answered this item correctly. In Dubai 78 percent of students answered correctly, significantly higher than the international average.



In a deep valley on Earth, a person shouting will hear an echo as the sound is reflected back off the surrounding mountains. In a similar valley on the Moon, no echo will be heard. This is because

Ⓐ the gravitational pull on the Moon is too low

Ⓑ the temperature on the Moon is too low

● there is no air on the Moon for the sound to travel through

Ⓓ the mountains on the Moon cannot reflect sound

Country	Percent full correct
Korea	90 (1.3)
Chinese Taipei	89 (1.3)
Dubai	**78 (2.4) ▲**
Bahrain	72 (2.2)
Kuwait	69 (2.1)
International average	**65 (0.3)**
Oman	64 (2.5)
Saudi Arabia	58 (2.5)
Qatar	44 (1.5)
Ghana	34 (1.9)

▲ *Significantly higher proportion than the international average*

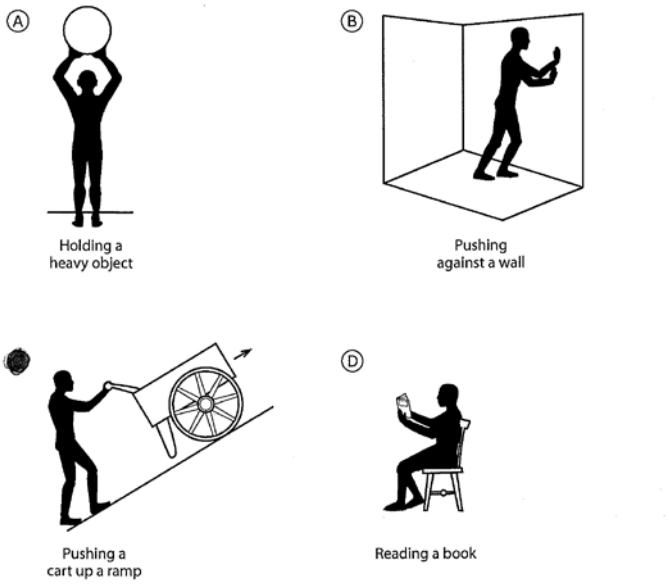
Figure A27 *Science Year 8 example item 5*

Year 8: Performance at the Low International Benchmark – Science

Students performing at this level recognised some basic facts from the *Life* and *Physical sciences*. They have some knowledge of the human body and demonstrate some familiarity with everyday physical phenomena. They can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.

The multiple-choice item shown as example item 6 (Figure A28) illustrates the type of item likely to be answered correctly by students reaching the low benchmark. In example item 6 from the *Physics* domain, students are given a definition of work (work is done when an object is moved in the direction of an applied force) and asked to identify a diagram depicting a person doing work. On average internationally, this item was answered correctly by 78 percent of students, who recognised that a person pushing a cart up a ramp was doing work. Every country except Tunisia had more than half their students answer correctly. Eighty-four percent of Dubai students answered this item correctly, significantly higher than the international average.

Work is done when an object is moved in the direction of an applied force. A person performed different tasks as shown in the diagrams below. In which diagram is the person doing work?



Country	Percent full correct
Singapore	96 (0.9)
United States	91 (1.0)
Dubai	**84 (2.0) ▲**
International average	78 (0.3)
Bahrain	70 (1.8)
Kuwait	67 (2.1)
Saudi Arabia	61 (2.8)
Oman	58 (2.1)
Qatar	55 (1.7)
Tunisia	49 (2.1)

▲ *Significantly higher proportion than the international average*

Figure A28 *Science Year 8 example item 6*