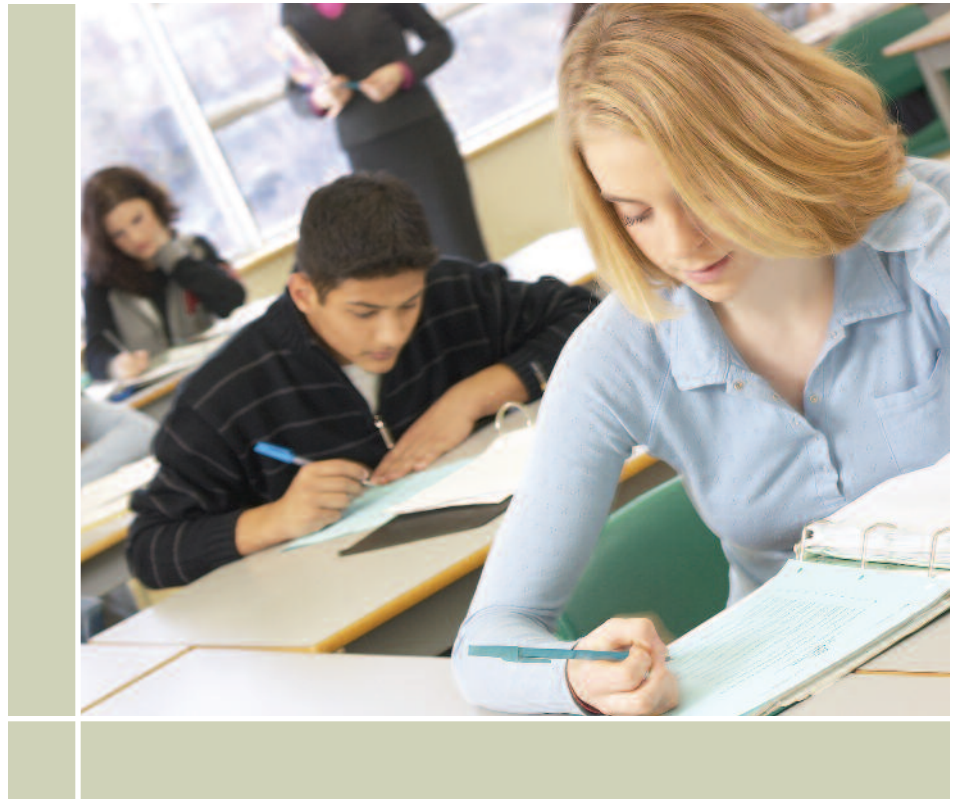


# Trends in International Mathematics and Science Study (TIMSS), 2007

## Ontario Results Report



# **Trends in International Mathematics and Science Study (TIMSS), 2007**

Ontario Results Report

September 2009

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# I. Key Findings

## Mathematics Achievement Results

- In Grade 4, 13 jurisdictions have an average score significantly higher than Ontario's, seven jurisdictions have the same average as Ontario's and 19 jurisdictions have a significantly lower average.
- In Grade 8, six jurisdictions have an average score significantly higher than Ontario's, five jurisdictions have the same average as Ontario's and 40 jurisdictions have a significantly lower average.
- Ontario students have shown significant improvement between 1995 and 2007, but there has been no significant change between 2003 and 2007. The other participating Canadian provinces have shown significant declines over the years of their participation.
- The average scale score for Ontario's Grade 4 students has increased from 489 to 512 between 1995 and 2007, a total of 23 points. The percentage of Grade 4 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 59% to 71%.
- The average scale score for Ontario's Grade 8 students has increased from 501 to 517 between 1995 and 2007, a total of 16 points. The percentage of Grade 4 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 65% to 74%.
- At the international level, there has been little change in the list of countries outperforming Ontario over the four TIMSS mathematics assessments.
- In both grades, Ontario achieved higher scale scores for Reasoning questions than for Knowing and Applying questions.
- In Grade 4, Ontario students' scores in Data Display and Geometric Shapes and Measures are higher than that for Number.
- In Grade 8, Ontario students' scores are highest in Data and Chance and lowest in Algebra.
- In Grade 4, the 2007 difference in achievement between boys and girls is not significant, but the average score for boys in Grade 8 is slightly higher than that for girls.

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## Science Achievement Results

- In Grade 4, four jurisdictions have an average score significantly higher than Ontario's, 12 jurisdictions have the same average as Ontario's and 23 jurisdictions have a significantly lower average.
- In Grade 8, eight jurisdictions have an average score significantly higher than Ontario's, five jurisdictions have the same average as Ontario's and 38 jurisdictions have a significantly lower average.
- Ontario students have shown significant improvement between 1995 and 2007, but there has been no significant change between 2003 and 2007. The other participating Canadian provinces have shown significant declines over the years of their participation.
- The average scale score for Ontario's Grade 4 students has increased from 516 to 536 between 1995 and 2007, a total of 20 points. The percentage of Grade 4 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 71% to 79%.
- At the international level, there has been little change in the list of countries outperforming Ontario over the four TIMSS science assessments.

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## Science Achievement Results (cont'd)

- The average scale score for Ontario's Grade 8 students has increased from 496 to 526 between 1995 and 2007, a total of 30 points. The percentage of Grade 8 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 61% to 77%.
- In both grades, Ontario achieved higher scale scores for Reasoning questions than for Knowing and Applying questions.
- In Grade 4, there are no significant differences in student performance in the content areas of Life Science, Physical Science and Earth Science.
- In Grade 8, Ontario students' scale scores were highest in Biology and lowest in Chemistry.
- In Grade 4, the 2007 difference in achievement between boys and girls is not significant, but the average score for boys in Grade 8 is slightly higher than that for girls.

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## Mathematics Questionnaire Results

- In Grades 4 and 8, over half the girls and just fewer than two-thirds of the boys in Ontario had high levels of self-confidence about learning mathematics.
- A large majority of Ontario students were taught mathematics by teachers who reported feeling "very well" prepared to teach the TIMSS mathematics topics (89% in Grade 4 and 83% in Grade 8).
- Over 80% of students in Grades 4 and 8 were taught mathematics by teachers who reported that they ask students to explain their answers in at least half their mathematics lessons.
- Eighteen percent of Grade 4 students and 35% of Grade 8 students were taught mathematics by teachers who reported that they ask students to memorize formulas and procedures in at least half their mathematics lessons.

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## Science Questionnaire Results

- Approximately two-thirds of the Grade 4 girls and boys and half the Grade 8 boys and girls reported high levels of self-confidence about learning science.
- Fifty-nine percent of Grade 4 students and 54% of Grade 8 students were taught science by teachers who reported feeling "very well" prepared to teach the TIMSS science topics.
- Approximately 20% of students in Grades 4 and 8 were taught science by teachers who reported that they ask students to design or plan experiments or investigations in at least half their science classes.
- Forty-eight percent of Grade 4 students and 38% of Grade 8 students were taught science by teachers who reported that they ask students to conduct experiments or investigations in at least half their lessons.
- About 80% of students in Grades 4 and 8 were taught science by teachers who reported that students spend time memorizing science facts and principles in only some lessons or that they never do this. Approximately a third of the students gave this response.

## II. Background

The Trends in International Mathematics and Science Study (TIMSS) 2007 was coordinated by the International Association for the Evaluation of Educational Achievement. TIMSS 2007 is the fourth assessment in a series and measures the mathematics and science achievement of students in Grades 4 and 8. The first cycle of TIMSS was administered in 1995 in 41 countries. The second cycle, in 1999, involved 38 countries. Continuing the regular cycle of studies at four-year intervals, TIMSS 2003 involved more than 50 countries, and approximately 60 countries participated in TIMSS 2007. Ontario has participated in the TIMSS assessments since their inception. A total of 3496 students in Ontario participated in the TIMSS 2007 Grade 4 assessment, and 3448 did in the Grade 8 assessment.

Figure 1 below lists the countries and Canadian provinces that participated in 2007. Not included in this report are four independently participating parts of countries.

### Figure 1: Participating Countries and Canadian Provinces: Grade 4 and Grade 8

Algeria	Iran, Islamic Republic of	Russian Federation
Armenia	Israel (Grade 8 only)	Saudi Arabia (Grade 8 only)
Australia	Italy	Scotland
Austria (Grade 4 only)	Japan	Serbia (Grade 8 only)
Bahrain (Grade 8 only)	Jordan (Grade 8 only)	Singapore
Bosnia and Herzegovina (Grade 8 only)	Kazakhstan (Grade 4 only)	Slovak Republic (Grade 4 only)
Botswana (Grade 8 only)	Korea, Republic of (Grade 8 only)	Slovenia
Bulgaria (Grade 8 only)	Kuwait	Sweden
Chinese Taipei	Latvia (Grade 4 only)	Syrian Arab Republic (Grade 8 only)
Colombia	Lebanon (Grade 8 only)	Thailand (Grade 8 only)
Cyprus (Grade 8 only)	Lithuania	Tunisia
Czech Republic	Malaysia (Grade 8 only)	Turkey (Grade 8 only)
Denmark (Grade 4 only)	Malta (Grade 8 only)	Ukraine
Egypt (Grade 8 only)	Mongolia	United States
El Salvador	Morocco	Yemen (Grade 4 only)
England	Netherlands (Grade 4 only)	
Georgia	New Zealand (Grade 4 only)	<b>Canadian Participants</b>
Germany (Grade 4 only)	Norway	Alberta (Grade 4 only)
Ghana (Grade 8 only)	Oman (Grade 8 only)	British Columbia
Hong Kong SAR	Palestinian National Authority (Grade 8 only)	<b>Ontario</b>
Hungary	Qatar	Quebec
Indonesia (Grade 8 only)	Romania (Grade 8 only)	

Mathematics and science achievement results for the TIMSS assessment are expressed in two related ways: according to average scale scores and by the percentage of students at four international benchmarks. The TIMSS scale has a mid-point set at 500 points and the standard deviation set at 100. Achievement along the scale is divided by cut scores into four categories, or benchmarks: Low (400 to 474 points), Intermediate (475 to 549 points), High (550 to 624 points) and Advanced (625 points or more). Both scale scores and benchmarks are used to report overall mathematics and science achievement, but only scale scores are used to report achievement in the content and cognitive domains.

Results for mathematics and science are presented separately in this report. For each subject, the first section provides results according to the TIMSS scale scores, the second section presents results according to the international benchmarks and the third section presents average scale scores for the content and cognitive domains assessed by the test.

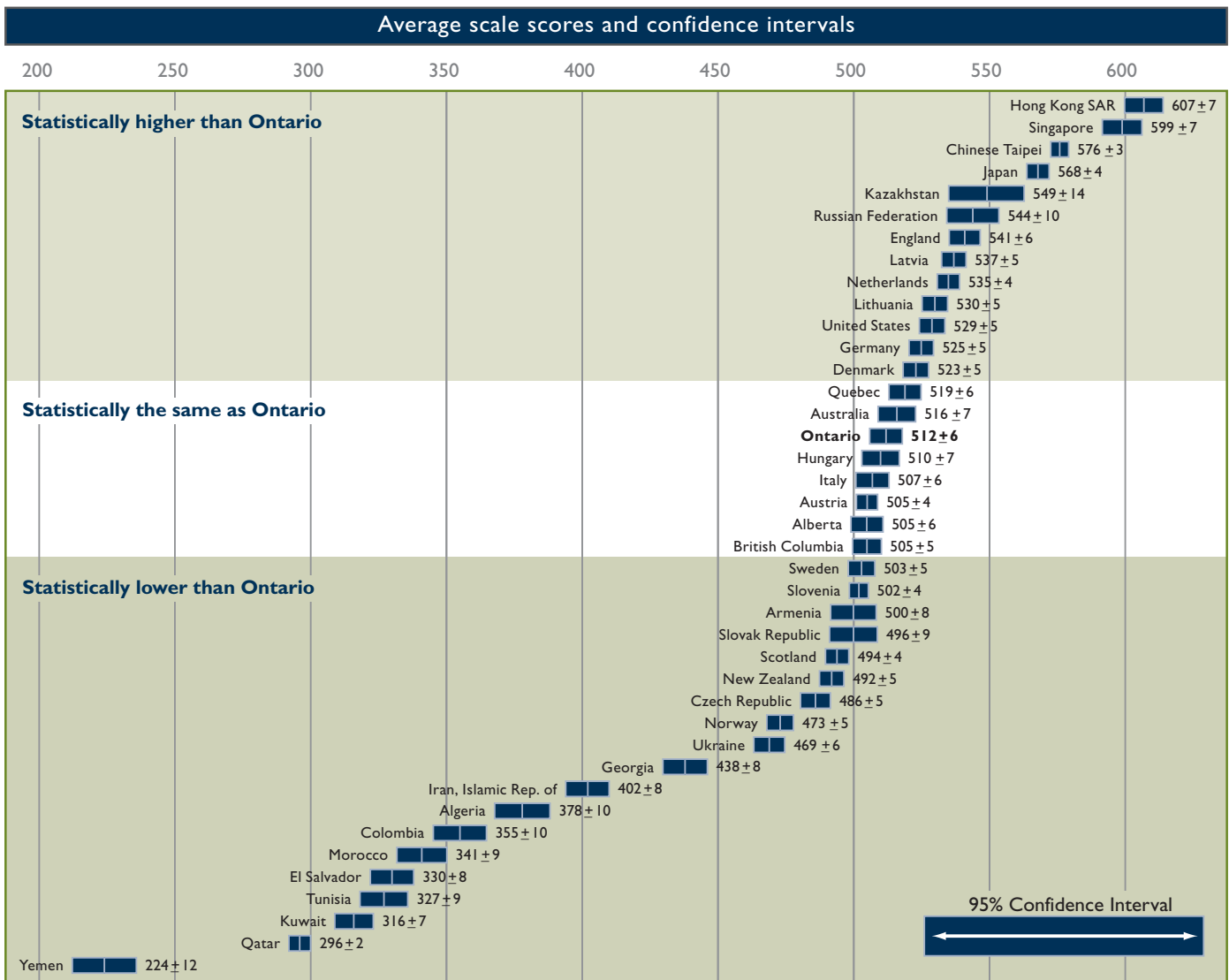
**“Statistically Significant Difference”:** Since the assessments were completed by a sample of students in each jurisdiction, each reported result has a sampling error that must be taken into consideration in claims that the results for one jurisdiction are different from those of another. If the difference between two averages is large enough that it cannot be accounted for by the sampling errors, we say that the difference is statistically significant. These are called “significant differences” in this report.

### III. Mathematics Achievement Results

#### A. Overall Mathematics Achievement: Average Scale Scores

Average mathematics scale scores for participating jurisdictions are presented in three categories in Figures 2 and 3: jurisdictions with an average scale score that is significantly higher than Ontario's, jurisdictions with an average scale score not significantly different from Ontario's and jurisdictions with significantly lower average scale scores than Ontario's. The width of each bar represents the uncertainty due to sampling. There is a 95% probability that the average would be within this band, 19 times out of 20. The average scale score for Grade 4 students in Ontario is 512. The average scale score for Grade 8 students is 517.

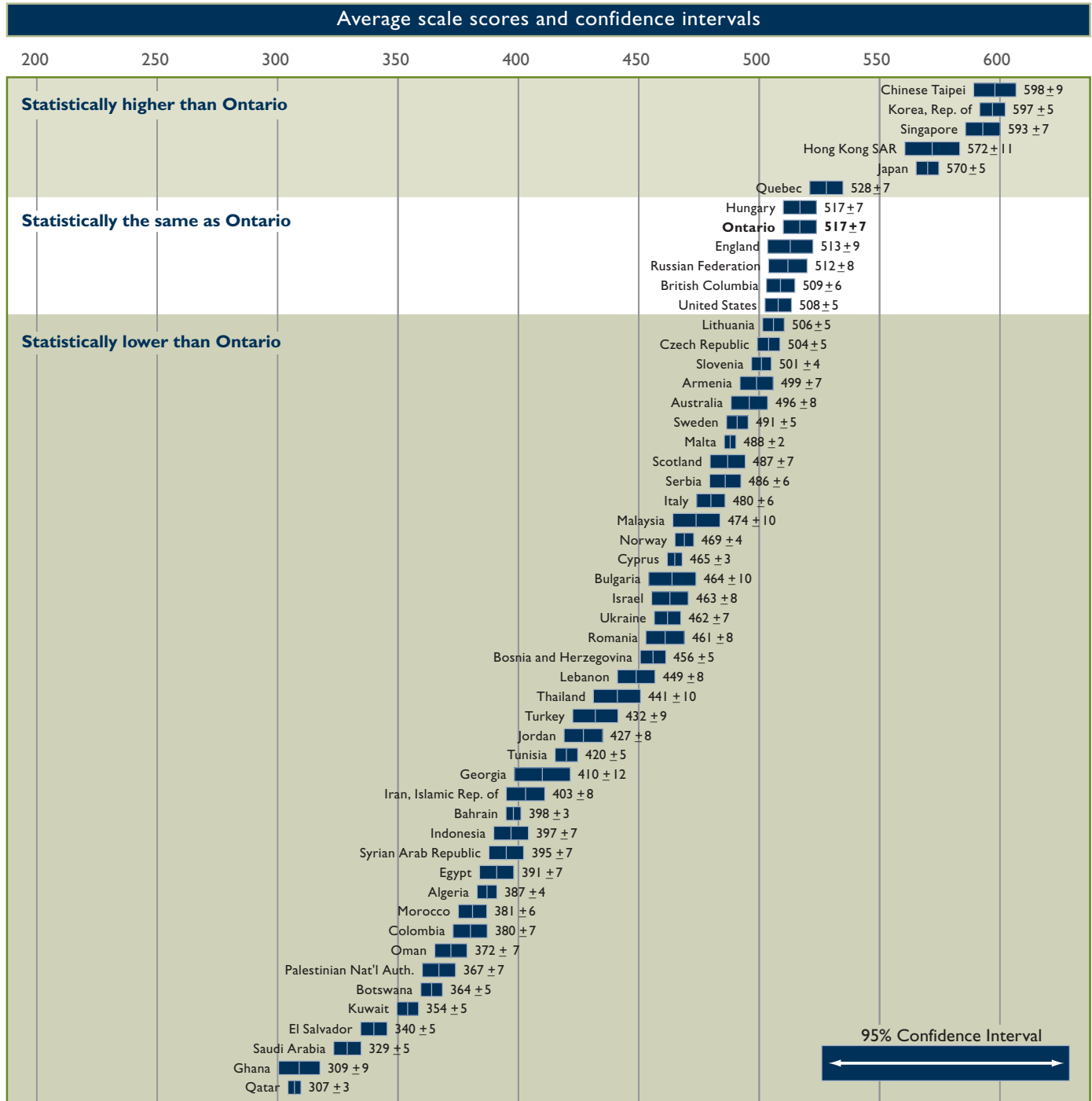
**Figure 2: Grade 4 Mathematics Achievement (Average Scale Scores)**



Average Grade 4 scale scores range from a low of 224 (Yemen) to a high of 607 (Hong Kong). Hong Kong, Singapore, Taipei and Japan are the top-performing jurisdictions, with significantly better achievement than all other jurisdictions. Thirteen jurisdictions have an average Grade 4 scale score significantly higher than Ontario's, seven jurisdictions have the same score as Ontario's and 19 have lower. Ontario's Grade 4 results are not significantly different from those of the other participating Canadian provinces: Alberta, British Columbia and Quebec.



**Figure 3: Grade 8 Mathematics Achievement (Average Scale Scores)**



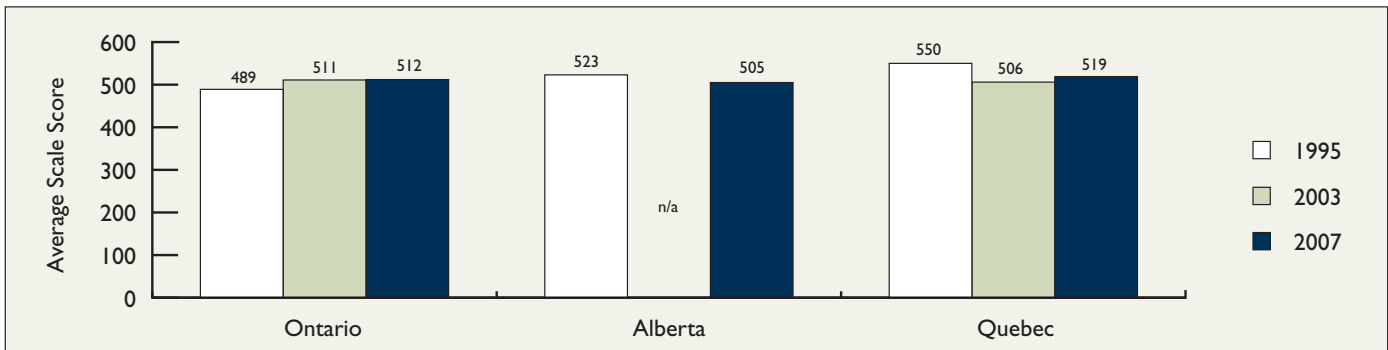
Average Grade 8 scale scores range from 307 (Qatar) to 598 (Taipei). The top performing jurisdictions are Taipei, Korea and Singapore, with significantly better achievement than all other jurisdictions. Six jurisdictions have an average Grade 8 scale score significantly higher than that Ontario's, five jurisdictions have the same score as Ontario's and 40 have lower. Ontario's Grade 8 average (517) is significantly lower than Quebec's (528) and not significantly different from British Columbia's (509).

Most of the mathematics items in the TIMSS assessment are covered in *The Ontario Curriculum* to the end of the grade tested (83% of the Grade 4 items and 89% of the Grade 8 items). When the Ontario averages are computed excluding the items that are not covered, there is no significant difference in the average. Among the top performing jurisdictions are some with curricula that cover more assessed items than Ontario's does and some with curricula that cover fewer.

## Results over Time

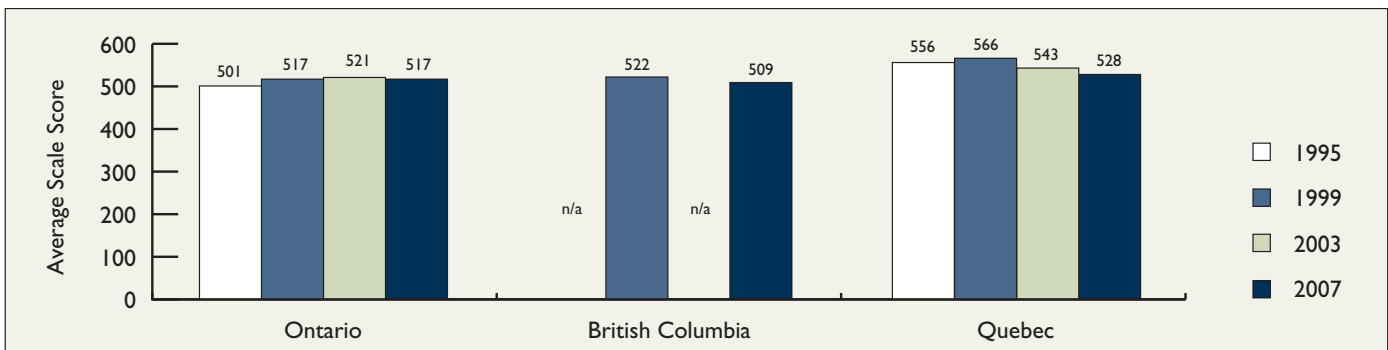
Ontario participated in all TIMSS assessments (1995, 1999, 2003 and 2007), but Grade 4 results are not available for 1999, because the study did not include Grade 4 students that year. Over time, trends in student achievement in mathematics show significant improvement for Ontario students between 1995 and 2007. The Grade 4 and Grade 8 mathematics results over time for Ontario and the other participating Canadian provinces are presented in Figures 4 and 5.

**Figure 4: Trends in Canadian Provinces' Grade 4 Mathematics Achievement**



Since 1995, the Grade 4 results for Ontario have improved from an average scale score of 489 to one of 512. Other jurisdictions showing steady improvement over time are Hong Kong (557 in 1995, 575 in 2003 and 607 in 2007), Singapore (590, 594, 599), the United States (518, 518, 529) and Australia (495, 499, 516). Results for Quebec and Alberta declined between 1995 and 2007.

**Figure 5: Trends in Canadian Provinces' Grade 8 Mathematics Achievement**



Since 1995, the Grade 8 results for Ontario have improved from an average scale score of 501 to one of 517. Taipei has had consistently high and improving results (585 in 1999, 585 in 2003 and 598 in 2007), as has Korea (581 in 1995, 587 in 1999, 589 in 2003 and 597 in 2007). Results for Singapore (609, 604, 605, 593) and Hong Kong (569, 582, 586, 572) are generally high but show some increases and some decreases over time. Results for Quebec declined between 1995 and 2007, and those for British Columbia declined between 1999 and 2007.

At the international level, there has been little change in the list of countries outperforming Ontario over the four TIMSS mathematics assessments.

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## Results by Gender

The 2007 mathematics average scale scores for boys and girls are presented in Table I; the differences between the 2007 scale score averages and those from previous assessments are included.

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**Table I: Trends in Ontario Mathematics Achievement by Gender**

Grade	Results for Girls				Results for Boys			
	2007 Average Scale Score	2003 to 2007 Change	1999 to 2007 Change	1995 to 2007 Change	2007 Average Scale Score	2003 to 2007 Change	1999 to 2007 Change	1995 to 2007 Change
Grade 4	509	3	n/a	22	514	-2	n/a	24
Grade 8	513	-7	-1	13	522	0	2	18

In Grade 4, the 2007 difference in achievement between boys and girls in Ontario and internationally is not statistically significant. The country with the largest difference is Kuwait, where the girls' average score is 37 points higher than that for boys. The gender difference in Ontario among Grade 4 students is most similar to those of Australia and Denmark, where boys also do better, but not significantly so.

The 2007 average score for Grade 8 boys in Ontario is significantly higher (by nine points) than that for girls. The international average for girls is five points higher than that for boys. Oman's Grade 8 girls outperform the boys by an average of 54 points. The small but significant difference in Ontario most resembles that of British Columbia (six points for boys), Algeria (five), Lebanon (13) and Australia (15).

While achievement among Ontario's boys and girls has not always improved from one year to the next, both boys and girls showed significant improvement between 1995 and 2007. During this period, the average score for Grade 4 girls in Ontario increased by 22 points and the average score for boys increased by 24 points. The corresponding increases among Grade 8 students were slightly smaller (13 points among girls and 18 points among boys).

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## B. Overall Mathematics Achievement: Benchmarks

TIMSS has established four international descriptive benchmarks for reporting mathematics achievement in Grades 4 and 8: Advanced, High, Intermediate and Low. These benchmarks are described in Appendix A. The percentages reported for students reaching these benchmarks are not mutually exclusive and are not intended to sum to 100. The reported percentages include students at or above each benchmark. For instance, the percentage of students reaching the Intermediate benchmark includes students reaching the High and Advanced benchmarks.

In general, jurisdictions with high average scale scores have larger percentages of students reaching the High and Advanced benchmarks. Among jurisdictions with the highest achievement on the Grade 4 benchmarks are Singapore (41% Advanced and 74% High), Hong Kong (40% and 81%) and Taipei (24% and 66%). These jurisdictions showed similar results for Grade 8.

Table 2 shows the percentages of Ontario students in Grades 4 and 8 reaching or exceeding each benchmark.

**Table 2: Percentages of Ontario Students Reaching or Exceeding the Mathematics Benchmarks**

Grade	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Grade 4	4%	29%	71%	94%
Grade 8	6%	33%	74%	95%

The percentage of Grade 8 students achieving each benchmark is slightly larger than the corresponding percentage for Grade 4. The jurisdictions with Grade 4 benchmark achievement results similar to Ontario's are British Columbia, Alberta, Italy, New Zealand, the Slovak Republic, Scotland, Slovenia, Austria and Sweden. In Grade 8, the jurisdictions whose achievement closely resembles that of Ontario are Quebec, Lithuania, the United States, Australia, Armenia and the Czech Republic.

Descriptors for the benchmarks have changed slightly over administrations, but the cut scores have remained constant so that comparisons can be made across administrations. Tables 3 and 4 present the percentage of students in each participating Canadian province reaching or exceeding each benchmark on each administration. In Ontario, the percentages of students reaching the High, Intermediate and Low benchmarks have increased between 1995 and 2007.

**Table 3: Trends in Percentages of Grade 4 Students in Canadian Provinces Reaching or Exceeding the Mathematics Benchmarks**

Province	Advanced International Benchmark (625)			High International Benchmark (550)			Intermediate International Benchmark (475)			Low International Benchmark (400)		
	1995	2003	2007	1995	2003	2007	1995	2003	2007	1995	2003	2007
Ontario	4%	5%	4%	22%	29%	29%	59%	70%	71%	86%	94%	94%
Alberta	9%	n/a	3%	39%	n/a	25%	74%	n/a	69%	93%	n/a	94%
Quebec	13%	3%	5%	50%	25%	34%	87%	69%	74%	98%	94%	96%

Between 4% and 5% of students in Ontario reached the Advanced benchmark. For this benchmark, the differences from one year to the next are not statistically significant. The decrease from 9% in 1995 to 3% in 2007 in Alberta is significant. For Quebec, the decrease from 1995 to 2003 and the increase from 2003 to 2007 are both significant.

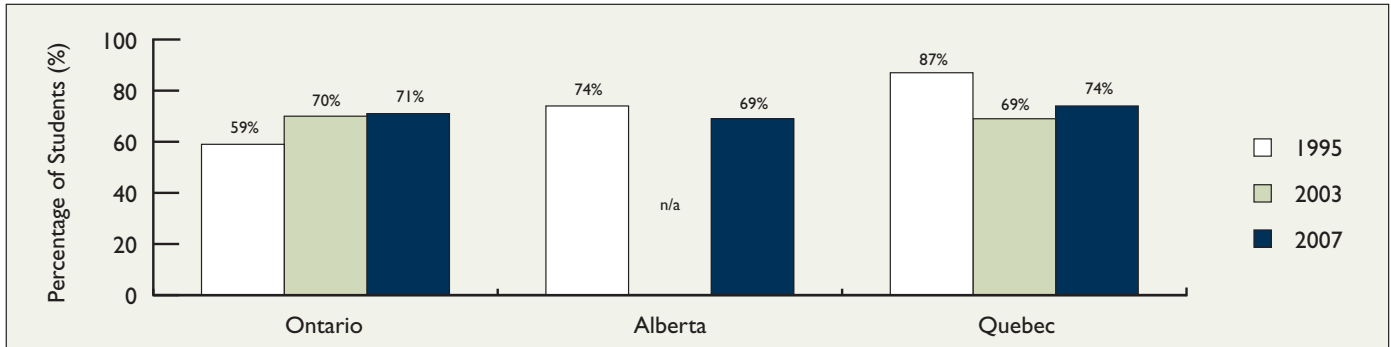
Between 1995 and 2003, there was significant improvement (seven percentage points) in Ontario students reaching the High benchmark. Results for 2007 were the same. The percentage in Alberta fell significantly from 39% to 25%. The fluctuations in the percentages in Quebec, which fell from 50% to 25% between 1995 and 2003 and then rose again in 2007 to 34%, are significant.

The percentage of students in Ontario reaching the Intermediate benchmark increased from 59% in 1995 to 71% in 2007. Results in the other Canadian provinces decreased between 1995 and 2007.

The vast majority (94%) of students in Ontario reached the Low benchmark in 2007. This percentage has been stable since 2003 and is consistent with those in the other provinces.

The strongest improvement among Ontario students between 1995 and 2007 is in the Intermediate benchmark, which changed by 12 percentage points. The results for the Intermediate benchmark are presented in Figure 6.

**Figure 6: Trends in Percentages of Grade 4 Students in Canadian Provinces Reaching or Exceeding the Intermediate Mathematics Benchmark**



Benchmark results for Grade 8 are presented in Table 4.

**Table 4: Trends in Percentages of Grade 8 Students in Canadian Provinces Reaching or Exceeding the Mathematics Benchmarks**

Province	Advanced International Benchmark (625)				High International Benchmark (550)				Intermediate International Benchmark (475)				Low International Benchmark (400)			
	1995	1999	2003	2007	1995	1999	2003	2007	1995	1999	2003	2007	1995	1999	2003	2007
Ontario	3%	6%	6%	6%	26%	32%	34%	33%	65%	72%	75%	74%	91%	96%	97%	95%
BC	n/a	7%	n/a	5%	n/a	35%	n/a	29%	n/a	75%	n/a	69%	n/a	94%	n/a	93%
Quebec	14%	18%	8%	8%	54%	60%	45%	37%	90%	93%	88%	78%	99%	99%	99%	97%

Since 1995, Ontario results have improved from 3% to 6% of students reaching the Advanced benchmark in Grade 8 mathematics. Results in British Columbia are between 7% and 5%. Quebec's results declined substantially in 2003.

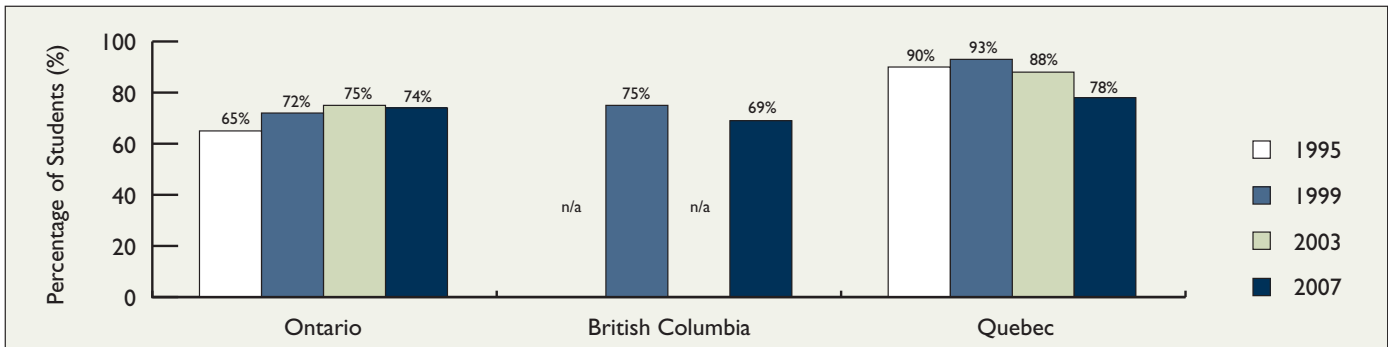
Since 1999, the changes in the percentage of Ontario students reaching the High benchmark in Grade 8 mathematics are not significant. Approximately one-third of Ontario students reached this benchmark in 2003 and 2007. Results for British Columbia and Quebec declined from 1999 to 2007.

The percentage of Ontario students reaching the Intermediate benchmark in 2007 is significantly larger than the percentage in 1995. Results for British Columbia and Quebec declined between 1999 and 2007.

The vast majority (95%) of students in Ontario reached the Low benchmark in 2007. This percentage has been stable since the 1995 administration and is consistent with those in the other provinces.

The strongest improvement among Ontario students between 1995 and 2007 is in the Intermediate benchmark, which changed by nine percentage points. The results for the Intermediate benchmark are presented in Figure 7.

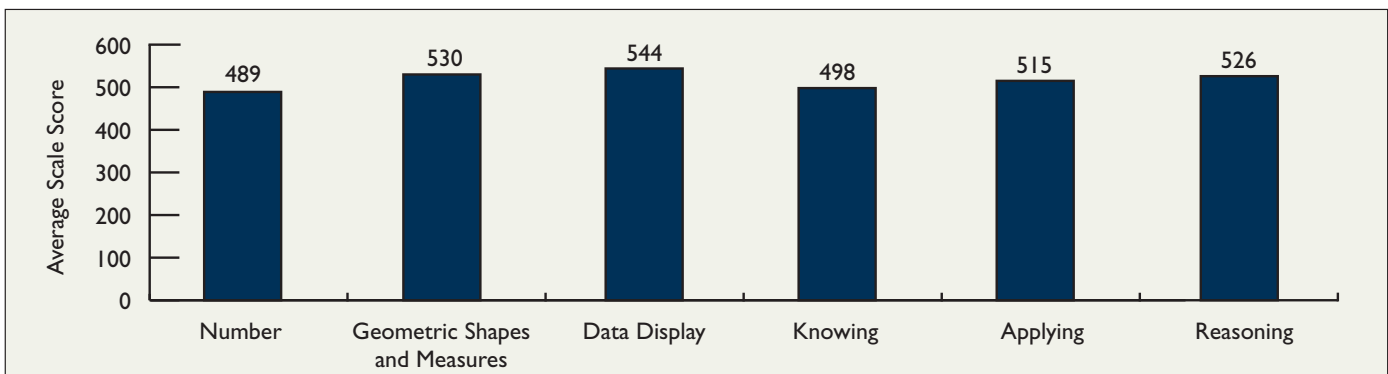
**Figure 7: Trends in Percentages of Grade 8 Students in Canadian Provinces Reaching or Exceeding the Intermediate Mathematics Benchmark**



## C. Mathematics Content and Cognitive Domains

In Grade 4, the content domains are Number; Geometric Shapes and Measures, and Data Display, and in Grade 8 they are Number, Algebra, Geometry, and Data and Chance. The cognitive domains tested are the same in both grades: Knowing, Applying and Reasoning. The average scale scores in these content and cognitive domains are presented in Figures 8 and 9.

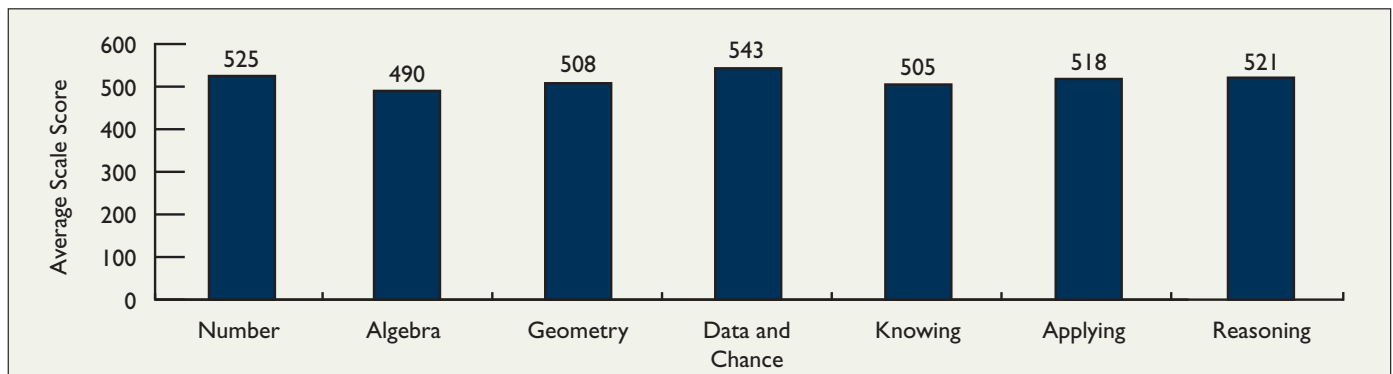
**Figure 8: Average Achievement of Grade 4 Ontario Students in the Mathematics Cognitive and Content Domains**



Ontario's strongest results in Grade 4 are in the areas of Data Display and Geometric Shapes and Measures. The average scale score in Reasoning is higher than those in Knowing and Applying.

A possible reason for the lower average for Number is that the test contained 21 items on Number that are not covered by *The Ontario Curriculum* to the end of Grade 4. Although 83% of the Grade 4 mathematics items on the TIMSS assessment are covered by *The Ontario Curriculum*, 21 out of the 30 items not covered are in Number.

**Figure 9: Average Achievement of Grade 8 Ontario Students in the Mathematics Cognitive and Content Domains**



The strongest performance among Grade 8 students was in Data and Chance and Number. Among the cognitive domains, the highest average is in Reasoning.

A possible reason for the lower average for Algebra is that the test contained 16 Algebra items that are not covered by *The Ontario Curriculum* to the end of Grade 8. Although 89% of the Grade 8 mathematics items on the TIMSS assessment are covered by *The Ontario Curriculum*, 16 out of the 24 items not covered are in Algebra.

There are some significant differences between girls and boys. In Grade 4, the average for boys in Number (495) is significantly higher than that for girls (483). In Knowing, the average for boys (502) is significantly higher than that for girls (493). In Grade 8, the average for boys is significantly higher in Number (532, as opposed to 517 for girls), as it is in Applying (524 vs. 513) and Reasoning (526 vs. 517).

Tables 5 and 6 show Ontario's Grade 4 and Grade 8 content and cognitive domain average scale scores with the results of the other participating Canadian provinces for comparison.

**Table 5: Average Achievement of Grade 4 Students in Canadian Provinces in the Mathematics Cognitive and Content Domains**

Province	Number	Geometric Shapes and Measures	Data Display	Knowing	Applying	Reasoning
Ontario	489	530	544	498	515	526
Alberta	489	512	537	494	505	519
British Columbia	493	510	531	498	505	516
Quebec	511	525	527	517	517	523

Grade 4 students in Ontario perform best in the content areas Data Display and Geometric Shapes and Measures and in the cognitive domain Reasoning. Students in Quebec have higher average scores than those in other Canadian provinces in the content area Number and in the cognitive domains Knowing and Applying, although the difference between the Ontario and Quebec results in Applying are not significant.

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**Table 6: Average Achievement of Grade 8 Students in Canadian Provinces in the Mathematics Cognitive and Content Domains**

Province	Number	Algebra	Geometry	Data and Chance	Knowing	Applying	Reasoning
Ontario	525	490	508	543	505	518	521
British Columbia	520	489	487	529	504	509	510
Quebec	534	505	523	533	520	529	524

Ontario's average for Data and Chance is higher than all others'. Students from Quebec outperformed students in the other two provinces in Number, Algebra and Geometry and in all three cognitive domains.

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## **D. Comparison with EQAO Mathematics Assessment Results**

It is not possible to make direct comparisons between percentages of students at the four performance levels used to report EQAO assessment results and percentages at the four international TIMSS benchmarks. The TIMSS benchmarks were set in 1995 by selecting cut points that yielded a predetermined percentage of students at each benchmark. Descriptions of each benchmark, based on the questions that students at each benchmark were able to answer correctly, were then written.

The EQAO performance levels were set with the curriculum documents, with Level 3 as the provincial standard. The EQAO performance levels are based on expectations, while the TIMSS benchmarks were defined according to the distribution of student scores on the first administration.

The substantial improvements in student achievement on the TIMSS Grade 4 mathematics assessment since 1995 are similar to the improvements in student achievement tracked by EQAO's Grade 3 assessment over a similar period.

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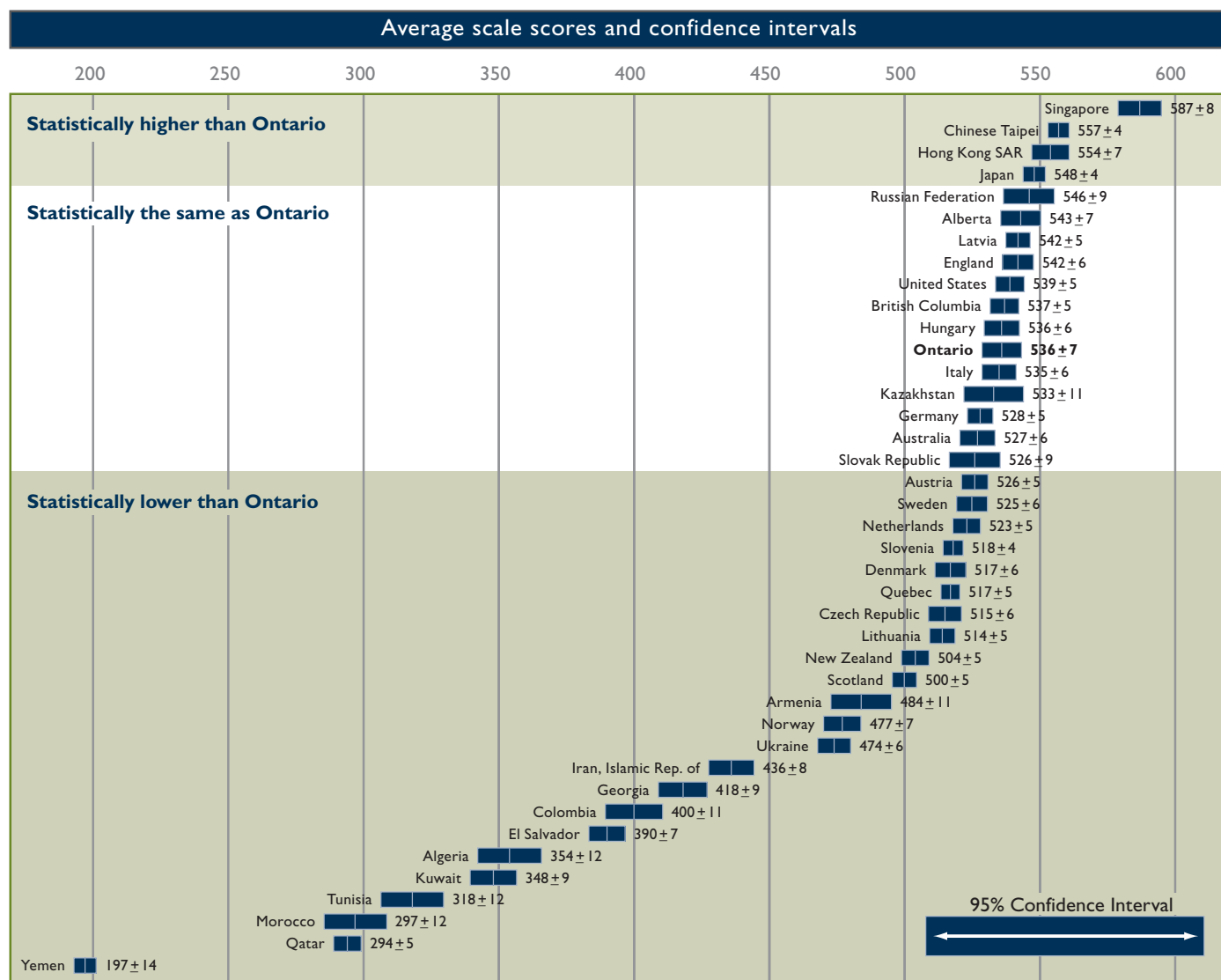


# IV. Science Achievement Results

## A. Overall Science Achievement: Average Scale Scores

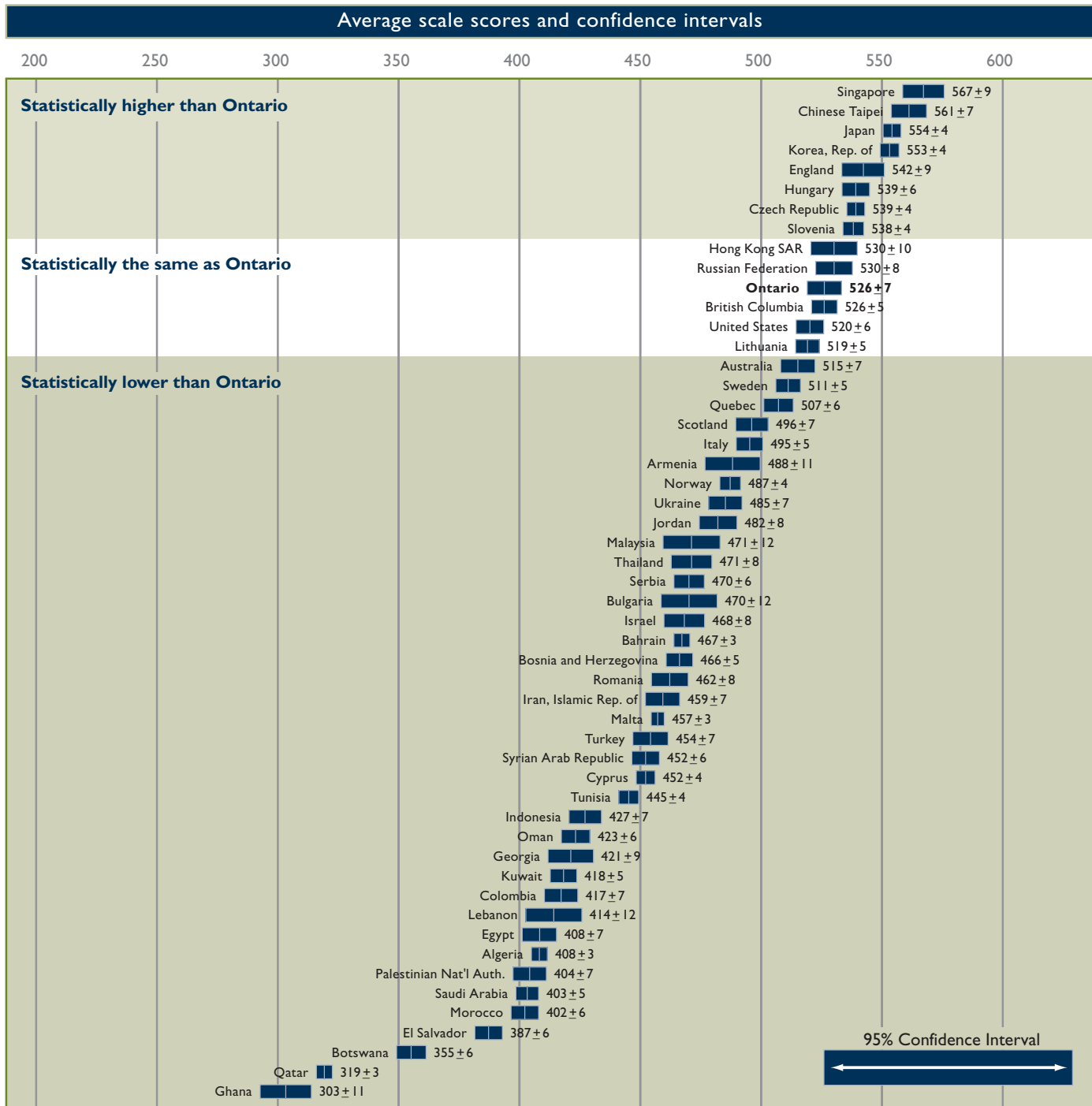
The average science scale scores of participating jurisdictions are presented in Figures 10 and 11 according to three categories: jurisdictions with an average scale score significantly higher than Ontario's, jurisdictions with an average scale score not significantly different from Ontario's and jurisdictions with average scale scores significantly lower than Ontario's. The width of each bar represents the uncertainty due to sampling. There is a 95% probability that the average would be within this band, 19 times out of 20. The average scale score for Grade 4 students in Ontario is 536 and it is 526 for Grade 8 students.

**Figure 10: Grade 4 Science Achievement (Average Scale Scores)**



Average scale scores in Grade 4 range from a low of 197 (Yemen) to a high of 587 (Singapore). Singapore is the top-performing jurisdiction, with significantly better achievement than all other jurisdictions. Four jurisdictions have a Grade 4 average scale score significantly higher than Ontario's, 12 jurisdictions have a score the same as Ontario's and 23 have lower. The Ontario average in Grade 4 is the same as Alberta's and British Columbia's and higher than Quebec's.

**Figure II: Grade 8 Science Achievement (Average Scale Scores)**



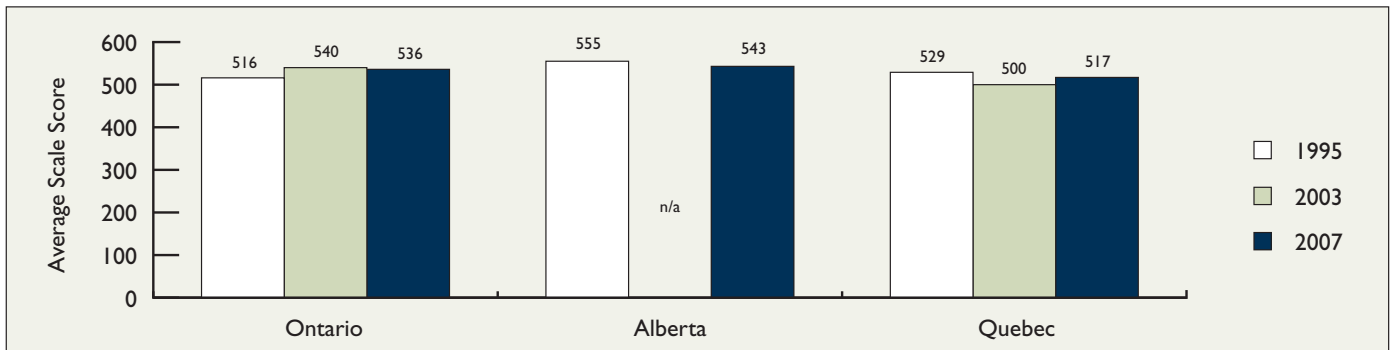
Grade 8 average scale scores range from 303 (Ghana) to 567 (Singapore). The top performing jurisdictions along with Singapore are Taipei, Japan and Korea. Eight jurisdictions have an average Grade 8 scale score significantly higher than Ontario's, five jurisdictions have a score the same as Ontario's and 38 have lower. Ontario's Grade 8 results were significantly higher than Quebec's and the same as British Columbia's.

Most of the science items in the TIMSS assessment are covered in *The Ontario Curriculum* to the end of the grade tested (82% of the Grade 4 items and 85% of the Grade 8 items). When the Ontario averages are computed excluding the items that are not covered, there is no significant difference in the average. The curricula of many of the top performing countries cover fewer items than Ontario's does.

## Results over Time

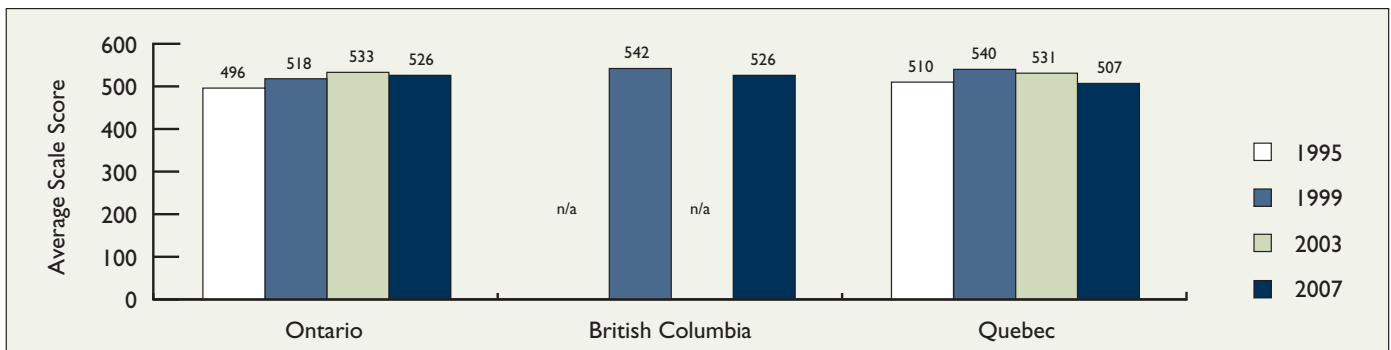
Ontario participated in all TIMSS assessments (1995, 1999, 2003 and 2007), but Grade 4 results are not available for 1999, because the study did not include Grade 4 students that year. Over time, trends in student achievement in mathematics show significant improvement for Ontario students between 1995 and 2007. The Grade 4 and Grade 8 science results over time for Ontario and the other participating provinces are presented in Figures 12 and 13.

**Figure 12: Trends in Canadian Provinces' Grade 4 Science Achievement**



In Grade 4, Ontario results improved between 1995 and 2007. Jurisdictions showing steady improvement over time are Singapore (523 in 1995, 565 in 2003 and 587 in 2007) and Hong Kong (508, 542, 554). The results for Quebec and Alberta declined between 1995 and 2007.

**Figure 13: Trends in Canadian Provinces' Grade 8 Science Achievement**



Ontario's Grade 8 results improved steadily until 2003. There was a slight decline between 2003 and 2007, but the 2007 average is higher than the 1995 average. Korea's (546 in 1995, 549 in 1999, 558 in 2003 and 553 in 2007), Singapore's (580, 568, 578, 567) and Taipei's (569 in 1999, 571 in 2003 and 561 in 2007) results are consistently high but variable, with some improvement and some decline from assessment to assessment. The averages for Quebec and British Columbia declined between 1999 and 2007.

At the international level, there has been little change in the list of countries outperforming Ontario over the four TIMSS science assessments.

## Results by Gender

The 2007 average mathematics scale scores for boys and girls are presented in Table 7; the differences between the 2007 scale score averages and those from previous assessments are included.

**Table 7: Trends in Ontario Science Achievement by Gender**

Grade	Results for Girls				Results for Boys			
	2007 Average Scale Score	2003 to 2007 Change	1999 to 2007 Change	1995 to 2007 Change	2007 Average Scale Score	2003 to 2007 Change	1999 to 2007 Change	1995 to 2007 Change
Grade 4	532	-5	n/a	19	539	-4	n/a	21
Grade 8	521	-4	13	33	531	-10	3	25

In Grade 4, the 2007 difference in achievement between boys and girls in Ontario is not statistically significant, but the international average for girls is three points higher than that for boys. The country with the largest gender difference is Kuwait, where the average score among girls is higher by 64 points. Ontario's Grade 4 gender difference is most similar to those of Alberta, Australia and Denmark, where the average for boys is higher but the difference between the averages for boys and girls is not significant. In Ontario, boys showed greater improvement between 1995 and 2007.

In Ontario, the Grade 8 boys' average scale score is 10 points higher than the girls'. This small but significant difference most resembles those of British Columbia (seven points for boys), Korea and Italy (eight), the Czech Republic and Syria (nine), and the United States (12). In Ontario, girls showed greater improvement between 1995 and 2007. The international average for girls is six points higher than that for boys. Qatar's Grade 8 girls have outperformed the country's boys by an average of 70 points.

## B. Overall Science Achievement: Benchmarks

TIMSS has established four international descriptive benchmarks for reporting science achievement in Grades 4 and 8: Advanced, High, Intermediate and Low. These benchmarks are described in Appendix B. The percentages reported for students reaching these benchmarks are not mutually exclusive and are not intended to sum to 100. The reported percentages include students at or above each benchmark. For instance, the percentage of students reaching the Intermediate benchmark includes students reaching the High and Advanced benchmarks.

In general, jurisdictions with high average scale scores have larger percentages of students reaching the High and Advanced benchmarks. Among jurisdictions with the highest achievement of the Grade 4 benchmarks are Singapore (36% Advanced and 68% High), Taipei (19% and 55%), Russia (16% and 49%) and the United States (15% and 47%). The highest Advanced and High benchmark results in Grade 8 are in Singapore (32% and 61%), Taipei (25% and 60%), Japan (17% and 55%) and England (17% and 48%).

Table 8 shows the percentages of Ontario students in Grade 4 and Grade 8 reaching or exceeding each benchmark.

**Table 8: Percentages of Ontario Students Reaching or Exceeding the Science Benchmarks**

Grade	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Grade 4	12%	45%	79%	95%
Grade 8	7%	37%	77%	96%

The Grade 4 results are slightly more positive than the Grade 8 results, which are consistent with the scale score results reported in Figures 10 and 11. In Grade 4 and Grade 8, 79% and 77% of students, respectively, reached the Intermediate benchmark. The corresponding values for the High benchmark are 45% and 37%. The jurisdictions with Grade 4 benchmark achievement similar to Ontario's are British Columbia, Alberta, Hungary and Italy. In Grade 8, the jurisdiction with achievement most resembling Ontario's is British Columbia.

Descriptors for the benchmarks have changed slightly over administrations, but the cut scores have remained constant so that comparisons can be made across administrations. In Ontario, the percentage of students reaching each benchmark has increased between 1995 and 2007. Tables 9 and 10 present the percentage of students in each participating Canadian province reaching each benchmark on each administration.

**Table 9: Trends in Percentages of Grade 4 Students in Canadian Provinces Reaching or Exceeding the Science Benchmarks**

	Advanced International Benchmark (625)			High International Benchmark (550)			Intermediate International Benchmark (475)			Low International Benchmark (400)		
	1995	2003	2007	1995	2003	2007	1995	2003	2007	1995	2003	2007
Ontario	10%	13%	12%	37%	47%	45%	71%	81%	79%	90%	96%	95%
Alberta	21%	n/a	12%	57%	n/a	48%	84%	n/a	82%	94%	n/a	96%
Quebec	9%	3%	5%	40%	25%	32%	77%	66%	74%	94%	91%	96%

Steady proportions (between 10% and 13%) of students in Ontario reached the Advanced international benchmark. This percentage declined significantly in Alberta and Quebec between 1995 and 2007.

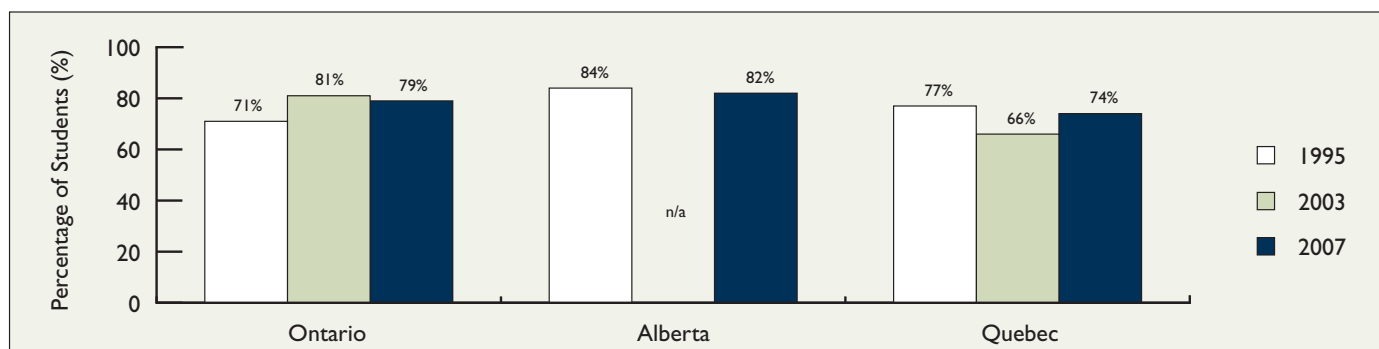
Between 1995 and 2003, there was a significant increase in the percentage of Ontarians in Grade 4 reaching the High international benchmark. The results for 2007 remain consistent. The percentages in Alberta and Quebec declined significantly between 1995 and 2007.

The percentage of Ontario students reaching the Intermediate benchmark has risen from 71% in 1995 to approximately 79% in 2007. Results for Alberta remained steady. The percentages in Quebec have fluctuated between a high of 77% in 1995 and a low of 66% in 2003.

The vast majority (between 90% and 96%) of Grade 4 students in Ontario reach or exceed the Low benchmark. This percentage has been stable since 1995 and is consistent with those of the other participating Canadian provinces.

The strongest improvement among Ontario students between 1995 and 2007 is in the Intermediate benchmark, which changed by eight percentage points. The results for the Intermediate benchmark are presented in Figure 14.

**Figure 14: Trends in Percentages of Grade 4 Students in Canadian Provinces Reaching or Exceeding the Intermediate Science Benchmark**



As shown in Table 10, seven percent of students in Ontario reached the Advanced benchmark in Grade 8 science in 2007. These results are steady since 1999. Results in British Columbia and Quebec declined between 1999 and 2007.

**Table 10: Trends in Percentages of Grade 8 Students in Canadian Provinces Reaching or Exceeding the Science Benchmarks**

Province	Advanced International Benchmark (625)				High International Benchmark (550)				Intermediate International Benchmark (475)				Low International Benchmark (400)			
	1995	1999	2003	2007	1995	1999	2003	2007	1995	1999	2003	2007	1995	1999	2003	2007
Ontario	5%	7%	7%	7%	26%	34%	41%	37%	61%	72%	81%	77%	88%	95%	97%	96%
BC	n/a	14%	n/a	7%	n/a	47%	n/a	38%	n/a	81%	n/a	77%	n/a	96%	n/a	95%
Quebec	7%	10%	6%	4%	30%	43%	39%	27%	69%	83%	82%	68%	92%	98%	98%	92%

Ontario results show a statistical improvement in the percentages of students reaching the High benchmark between 1995 and 2003 and no significant change between 2003 and 2007. Results in British Columbia and Quebec declined between 1999 and 2007.

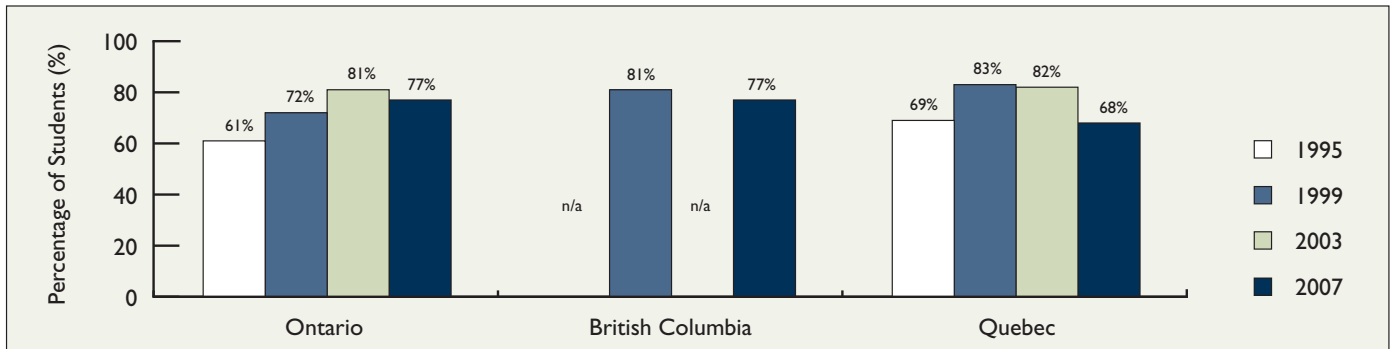
The percentages of students in Ontario reaching the Intermediate benchmark are the same in 2003 and 2007 and are significantly larger than on the first administration, in 1995. Results for British Columbia are steady at around 80%. Results for Quebec are variable over time and fell significantly between the 2003 and 2007 administrations.

The percentage of Ontario students reaching the Low benchmark increased significantly from 88% in 1995 to 95% in 1999, and has remained stable at around 95%. These results are consistent with British Columbia's. Quebec's 2007 results are significantly lower than those in 1999 and 2003.

An increasing proportion of students are reaching the higher benchmarks, and the percentages of Ontario students in both grades at the High and Advanced levels in science are generally holding steady or growing. Ontario's Grade 8 benchmark trends appear to be improving more steadily than those of both other participating Canadian provinces.

The strongest improvement among Ontario students between 1995 and 2007 is in the Intermediate benchmark, which changed by 16 percentage points. The results for the Intermediate benchmark are presented in Figure 15.

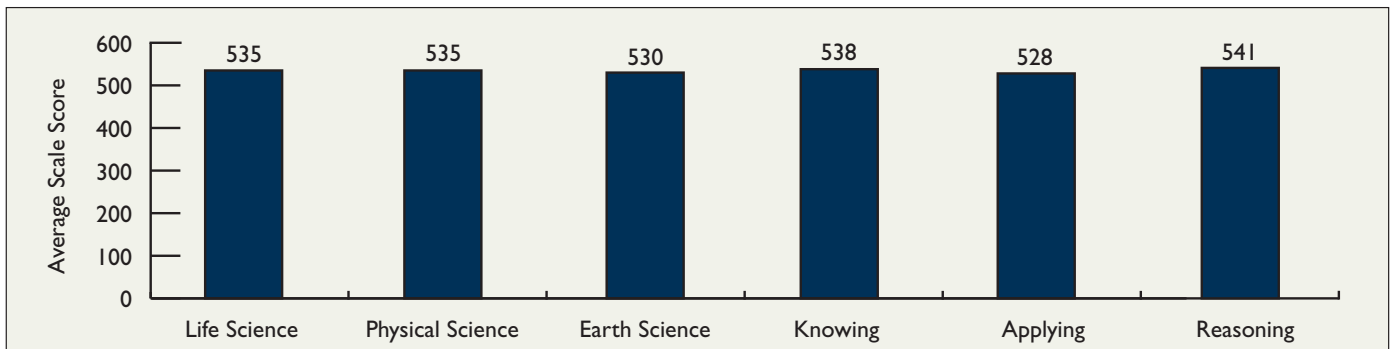
**Figure 15: Trends in Percentages of Grade 8 Students in Canadian Provinces Reaching or Exceeding the Intermediate Science Benchmark**



## C. Science Content and Cognitive Domains

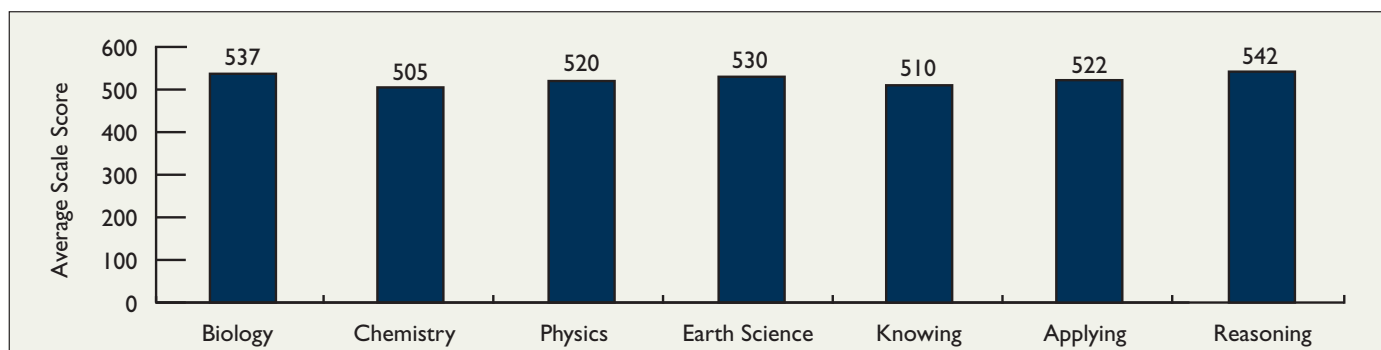
The TIMSS assessments of science focus on curriculum- and grade-specific content areas, or domains. In Grade 4, the content domains are Life Science, Physical Science and Earth Science, and in Grade 8 they are Biology, Chemistry, Physics and Earth Science. The cognitive domains tested are the same in both grades: Knowing, Applying and Reasoning. The 2007 average scale score in each content and cognitive domain among Ontario Grade 4 and Grade 8 students is presented in Figures 16 and 17.

**Figure 16: 2007 Average Achievement of Grade 4 Students in the Science Cognitive and Content Domains**



The Grade 4 results are similar across the three content domains. Among the cognitive domains, the strongest performance is in Reasoning and the weakest in Applying.

**Figure 17: 2007 Average Achievement of Grade 8 Students in the Science Cognitive and Content Domains**



In Grade 8, the average scores in Biology and Earth Science are considerably higher than those in Physics and Chemistry. The average in Chemistry is substantially lower than those in the other three content domains. The strongest performance among the cognitive domains is in Reasoning and the weakest is in Knowing.

There are some differences between girls and boys. In Grade 4, the boys' average score of 543 in Knowing is significantly higher than the girls' (533). In Grade 8, boys do better in Physics (530 vs. 511), Earth Science (536 vs. 523) and Knowing (520 vs. 500).

Tables 11 and 12 present Ontario's Grade 4 and Grade 8 content and cognitive domain average scale scores with the results of the other participating Canadian provinces.

**Table 11: 2007 Average Achievement of Grade 4 Students in Canadian Provinces in the Science Cognitive and Content Domains**

Province	Life Science	Physical Science	Earth Science	Knowing	Applying	Reasoning
Ontario	535	535	530	538	528	541
Alberta	541	535	544	549	535	537
British Columbia	538	531	537	539	533	536
Quebec	522	513	523	516	515	528

In Grade 4, Ontario and Alberta share top results in Physical Science (535). Ontario has the highest score of participating Canadian provinces in Reasoning (541). Alberta's and British Columbia's averages are slightly higher than Ontario's in Life Science, Earth Science, Knowing and Applying.



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**Table 12: 2007 Average Achievement of Grade 8 Students in Canadian Provinces in the Science Cognitive and Content Domains**

Province	Biology	Chemistry	Physics	Earth Science	Knowing	Applying	Reasoning
Ontario	537	505	520	530	510	522	542
British Columbia	535	505	517	530	516	521	535
Quebec	513	497	492	513	495	500	523

In Grade 8, Ontario has the highest scores in Biology, Physics, Applying and Reasoning. Ontario and British Columbia share the highest results in Chemistry (505) and Earth Science (530).

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## V. Questionnaire Results

### Mathematics

#### Students' Backgrounds and Attitudes Toward Mathematics

The language spoken at home has little impact on Ontario students' achievement on the TIMSS mathematics assessments. Eighty-five percent of Grade 4 students and 90% of Grade 8 students reported speaking the language of the TIMSS tests at home always or almost always. The average scale score for these students was similar to that for the students who reported sometimes speaking the language of the test at home (there was a six-point difference in favour of those speaking the language of the test more frequently at home in Grade 4 and a three-point difference in Grade 8).

In Grade 4, 59% of Ontario's students expressed a highly positive attitude toward mathematics and 63% indicated a high level of self-confidence about learning mathematics. These percentages are smaller for Grade 8 students (47% and 59%, respectively). There was a strong positive relationship between confidence about learning mathematics and mathematics achievement.

While the percentage of Grade 4 students who expressed a highly positive attitude toward mathematics is smaller in Ontario than in the other Canadian provinces and is smaller than the international average, the average scores among Ontario students reporting highly positive attitudes toward mathematics and a high level of self-confidence about learning mathematics are higher.

Both in Ontario and internationally, in Grades 4 and 8, the percentage of boys who expressed a high level of self-confidence about learning mathematics is larger than that of girls. In Ontario, 66% of Grade 4 boys and 65% of Grade 8 boys reported a high level of confidence compared with 59% and 54% of girls, respectively.

---

#### Teachers of Mathematics and Mathematics Instruction

All Ontario-certified teachers receive specific preparation to teach the mathematics curriculum as part of their pre-service education. The percentage of Grade 4 students in Ontario taught mathematics by a teacher with a specialization in mathematics is just under 10%, a similar percentage to those in the other Canadian provinces, but much smaller than the international average (approximately 35%). Sixty-four percent of these students' mathematics teachers have neither a specialization in mathematics nor one in science, a smaller percentage than those in the other Canadian provinces (70% in Alberta, 72% in British Columbia and 84% in Quebec), but much larger than the international average (43%).

The percentage of Grade 8 students in Ontario taught by a teacher who had mathematics as a major area of study at university (11%) is smaller than those in the other Canadian provinces (25% in British Columbia and 33% in Quebec) and much smaller than the international average (70%).

In Grade 4, 89% of the students were taught mathematics by teachers who indicated that they were well prepared to teach the topics covered by the TIMSS mathematics assessment. This is similar to the percentages in British Columbia and Quebec and larger than the international average (72%). In Grade 8, the corresponding percentages were 83% in Ontario, 79% internationally (average), 91% in British Columbia and 87% in Quebec.

Over 80% of Ontario students in Grades 4 and 8 were taught mathematics by teachers who reported that they ask students to explain their answers in at least half their lessons, which is slightly more than the international average and approximately 10 points more than in the other Canadian provinces. Fewer than 20% of Ontario Grade 4 students were taught mathematics by teachers who reported that they ask their students to memorize formulas and procedures in at least half their lessons. The corresponding proportion in Grade 8 was just under two-thirds. The corresponding international averages are 38% in Grade 4 and almost 50% in Grade 8.

---

## Science

### Students' Backgrounds and Attitudes Toward Science

Among Ontario students, the language spoken at home had a greater impact on science achievement than on mathematics achievement. In Grade 4, 85% of students reported always or almost always speaking the language of the test at home. The average scale score in science for these students is 541. For those who reported sometimes speaking the language of the test at home, the average is 517, a difference of 19 scale points. In Grade 8, 90% of students always or almost always speak the language of the test at home; their average score is 539, compared with 505 for the 9% of students who reported sometimes speaking the language of the test at home, a difference of 24 points.

Seventy-one percent of Grade 4 Ontario students expressed a highly positive attitude toward science and 67% indicated a high level of self-confidence about learning science. There was a strong positive relationship between confidence in learning science and achievement in science.

Just over 50% of Grade 8 students in Ontario and British Columbia and only 35% in Quebec reported valuing science highly, compared to 66% internationally. The percentage with a highly positive attitude toward science is marginally larger (about 55% in Ontario and British Columbia and 53% in Quebec, compared to 65% internationally). In all the Canadian provinces and internationally, about 50% of Grade 8 students expressed a high level of self-confidence about learning science.

There were no significant gender differences among Ontario Grade 4 and Grade 8 students with respect to self-confidence about learning science. This is consistent with international results.

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### Teachers of Science and Science Instruction

All Ontario-certified teachers receive specific preparation to teach the science curriculum as part of their pre-service education. The results for teachers with a specialization in science are very similar to those for teachers with a specialization in mathematics, presented above under "Teachers of Mathematics and Mathematics Instruction."

The percentage of Grade 8 students in Ontario taught by a teacher who had science as a major area of study at university (44%) is considerably smaller than those in the other Canadian provinces (74% in British Columbia and 69% in Quebec) and the international average (81%).

In Grade 4, 59% of the Ontario students were taught science by teachers who indicated that they were well prepared to teach the topics covered by the TIMSS science assessment. This is similar to the percentage in Alberta, British Columbia and Quebec (54%) and the international average (54%). In Grade 8, smaller percentages of students were taught science by teachers who reported feeling very well prepared to teach the TIMSS science topics: 54% in Ontario compared to 70% internationally, 69% in British Columbia and 61% in Quebec.

In Ontario, 49% of students in Grade 4 and 38% of students in Grade 8 were taught science by teachers who reported that they required their students to conduct experiments or investigations in at least half their lessons. Twenty percent of Grade 4 students and 21% of Grade 8 students were taught science by teachers who reported that their students designed or planned experiments or investigations in at least half their lessons. More than two-thirds of the students in Grades 4 and 8 were taught science by teachers who reported that they ask students to give explanations about what they are studying in at least half their lessons.

About 80% of Ontario students in Grades 4 and 8 were taught science by teachers who reported that they ask their students to memorize science facts and principles in only some lessons or that they never do this. Approximately a third of the students gave this response.

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# Appendix A: TIMSS 2007 International Benchmarks of Mathematics Achievement

## Grade 4

### Advanced International Benchmark (625)

*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 organize, interpret, and represent data to solve problems.

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### High International Benchmark (550)

*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.

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### Intermediate International Benchmark (475)

*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.

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### Low International Benchmark (400)

*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.

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## Grade 8

### Advanced International Benchmark (625)

*Students can organize and draw conclusions from information, make generalizations, 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 generalizations 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.*

---

### High International Benchmark (550)

*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 tables and solve simple problems involving probability.*

---

### Intermediate International Benchmark (475)

*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 recognize basic notions of likelihood.*

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### Low International Benchmark (400)

*Students have some knowledge of whole numbers and decimals, operations, and basic graphs.*

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# Appendix B: TIMSS 2007 International Benchmarks of Science Achievement

## Grade 4

### Advanced International Benchmark (625)

*Students can apply their 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.*

---

### High International Benchmark (550)

*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.*

---

### Intermediate International Benchmark (475)

*Students can apply basic knowledge and understanding to practical situations in the sciences. Students recognize 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.*

---

### Low International Benchmark (400)

*Students have some elementary knowledge of life science and physical science. Students can demonstrate some knowledge of simple facts related to human health and the behavioral and physical characteristics of animals. They recognize some properties of matter, and demonstrate a beginning understanding of forces. Students interpret labeled pictures and simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.*

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## Grade 8

### Advanced International Benchmark (625)

*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 structural 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.*

---

### High International Benchmark (550)

*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.*

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### Intermediate International Benchmark (475)

*Students can recognize 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.*

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### Low International Benchmark (400)

*Students can recognize 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.*

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## Notes



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Accountability Office**



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