

International Association for the Evaluation of Educational Achievement

Trends in International Mathematics and Science Study (TIMSS), 2011

Ontario Report



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I. Key Findings

Mathematics Achievement Results

- In Grade 4, 20 jurisdictions have an average score significantly higher than Ontario's, five jurisdictions have the same average as Ontario's and 31 jurisdictions have a significantly lower average.
- In Grade 8, 10 jurisdictions have an average score significantly higher than Ontario's, 11 jurisdictions have the same average as Ontario's and 34 jurisdictions have a significantly lower average.
- Ontario students have shown significant improvement between 1995 and 2011, but there has been a significant decline in the Grade 8 average scale score since 2003. Quebec's results have dropped significantly since 1995 in both Grade 4 and Grade 8. Alberta's results have remained statistically unchanged in Grade 4 but declined significantly in Grade 8 since 1995.
- The average scale score for Ontario's Grade 4 students has increased significantly, from 489 to 518, between 1995 and 2011, a total of 29 points. The percentage of Grade 4 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 59% to 73%.
- The average scale score for Ontario's Grade 8 students has increased from 501 to 512 between 1995 and 2011, a total of 11 points. The percentage of Grade 8 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 65% to 71%.
- At the international level, there has been little change in the list of jurisdictions outperforming Ontario on the TIMSS mathematics assessments, among those jurisdictions participating in both 2007 and 2011.
- In Grade 4, Ontario achieved higher scale scores for Reasoning and Applying questions than for Knowing questions.
- In Grade 8, 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 2011 difference in achievement between boys and girls is significant, but in Grade 8, the average score for boys and girls is the same.

Science Achievement Results

- In Grade 4, 10 jurisdictions have an average score significantly higher than Ontario's, 13 jurisdictions have the same average as Ontario's and 33 jurisdictions have a significantly lower average.
- In Grade 8, 15 jurisdictions have an average score significantly higher than Ontario's, eight jurisdictions have the same average as Ontario's and 32 jurisdictions have a significantly lower average.
- Ontario students have shown improvement between 1995 and 2011, but in 2011, the average scale scores for Grades 4 and 8 are lower than in 2003. The other participating Canadian provinces have not declined significantly over the years of their participation, except for Quebec in Grade 4.
- The average scale score for Ontario's Grade 4 students has increased from 516 to 528 between 1995 and 2011, a total of 12 points. The percentage of Grade 4 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 71% to 77%.
- There has been a decline in Ontario's international standing in science achievement from 2007 to 2011.
- The average scale score for Ontario's Grade 8 students has increased from 496 to 521 between 1995 and 2011, a total of 25 points. The percentage of Grade 8 students achieving or exceeding the TIMSS Intermediate benchmark has increased from 61% to 76%.
- In Grade 4, Ontario students' scale score in Life Science is the highest among content areas by a significant margin. The results for the three cognitive domains are similar.
- In Grade 8, Ontario students' scale scores are highest in Biology and Earth Science and lowest in Chemistry.
- In Grade 8, Ontario achieved higher scale scores for Reasoning questions than for Knowing and Applying questions.
- In Grade 4 and in Grade 8 the differences in achievement between boys and girls are not significant. In Grade 8, the average score for boys is one point higher than that for girls.

Mathematics Questionnaire Results

- In Grade 4, 35% of Ontario's students indicated liking learning mathematics and 33% indicated a high level of confidence about learning mathematics. These percentages are smaller for Grade 8 students (26% and 32%, respectively). There is a strong positive relationship between enjoyment and confidence about learning mathematics and mathematics achievement.
- A large majority of Ontario students were taught mathematics by teachers who reported feeling "very well" prepared to teach the TIMSS mathematics topics (91% in Grade 4 and 85% in Grade 8).
- Over 60% of students in Grades 4 and 8 were taught mathematics by teachers who reported asking students to explain their answers in every or almost every lesson, which is similar to the international average.

Science Questionnaire Results

- Of Grade 4 Ontario students, 48% indicated liking learning science and 41% indicated a high level of self-confidence about learning science. The corresponding percentages were 29% and 22%, respectively, for Grade 8 students. There is a strong positive relationship between enjoyment and confidence about learning science and achievement in science.
- Fifty-five percent of Grade 4 students and 61% of Grade 8 students were taught science by teachers who reported feeling "very well" prepared to teach the TIMSS science topics.
- In Ontario, 32% of students in Grade 4 and 22% of students in Grade 8 were taught science by teachers who reported emphasizing science investigations in at least half their lessons.

II. Background

TIMSS 2011 was coordinated by the International Association for the Evaluation of Educational Achievement as the fifth assessment in a series measuring the mathematics and science achievement of students in Grades 4 and 8. The first cycle of TIMSS was administered in 1995 in 41 jurisdictions. The second, in 1999, involved 38 jurisdictions. Continuing the regular cycle of studies at four-year intervals, TIMSS 2003 involved more than 50 jurisdictions, approximately 60 jurisdictions participated in TIMSS 2007, and 74 jurisdictions participated in TIMSS 2011 (57 in Grade 4 and 56 in Grade 8; most participated at both grade levels). Ontario has participated in TIMSS since its inception. A total of 4570 students in Ontario participated in the 2011 Grade 4 assessment, and 4756 did in the Grade 8 assessment. Figure 1 below lists the jurisdictions that participated in 2011.

Figure 1: Participating Jurisdictions: Grade 4 and Grade 8

Armenia	Israel (Grade 8 only)	Portugal (Grade 4 only)	Benchmarking participants Alberta – Canada Ontario – Canada Quebec – Canada Abu Dhabi – U.A.E. Dubai – U.A.E. Alabama – U.S.A. (Grade 8 only) California – U.S.A. (Grade 8 only) Colorado – U.S.A. (Grade 8 only) Connecticut – U.S.A. (Grade 8 only) Florida – U.S.A. Indiana – U.S.A. (Grade 8 only) Massachusetts – U.S.A. (Grade 8 only) Minnesota – U.S.A. (Grade 8 only) North Carolina – U.S.A.
Australia	Italy	Qatar	
Austria (Grade 4 only)	Japan	Romania	
Azerbaijan (Grade 4 only)	Jordan (Grade 8 only)	Russian Federation	
Bahrain	Kazakhstan	Saudi Arabia	
Belgium (Flemish)(Grade 4 only)	Korea, Republic of	Serbia (Grade 4 only)	
Chile	Kuwait (Grade 4 only)	Singapore	
Chinese Taipei	Lebanon (Grade 8 only)	Slovak Republic (Grade 4 only)	
Croatia (Grade 4 only)	Lithuania	Slovenia	
Czech Republic (Grade 4 only)	Macedonia, Rep. of (Grade 8 only)	Spain (Grade 4 only)	
Denmark (Grade 4 only)	Malaysia (Grade 8 only)	Sweden	
England	Malta (Grade 4 only)	Syrian Arab Republic (Grade 8 only)	
Finland	Morocco	Thailand	
Georgia	Netherlands (Grade 4 only)	Tunisia	
Germany (Grade 4 only)	New Zealand	Turkey	
Ghana (Grade 8 only)	Northern Ireland (Grade 4 only)	Ukraine (Grade 8 only)	
Hong Kong, S.A.R.	Norway	United Arab Emirates	
Hungary	Oman	United States	
Indonesia (Grade 8 only)	Palestinian National Authority (Grade 8 only)	Yemen (Grade 4 only)	
Iran, Islamic Republic of	Poland (Grade 4 only)		
Ireland (Grade 4 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 centrepoint set at 500 points and a 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 Differences: 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. This report uses the term “significant difference” or language such as “significantly higher” in such cases.

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 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 (i.e., one can be confident that the results would fall within the band 19 times out of 20). The average scale score for Grade 4 students in Ontario is 518. The average scale score for Grade 8 students is 512.

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

Average Grade 4 scale scores range from a low of 248 (Yemen) to a high of 606 (Singapore). Singapore, Korea and Hong Kong were the top-performing jurisdictions, with significantly better achievement than all other jurisdictions. Twenty jurisdictions have an average Grade 4 scale score significantly higher than Ontario's, five jurisdictions have the same score as Ontario's and 31 have lower. Ontario's Grade 4 average scale score (518) is significantly higher than Alberta's (507) and significantly lower than Quebec's (533).

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

Average Grade 8 scale scores range from 331 (Ghana) to 613 (Korea). The top performing jurisdictions are Korea, Singapore and Chinese Taipei, with significantly better achievement than all other jurisdictions. Ten jurisdictions have an average Grade 8 scale score significantly higher than Ontario's, 11 jurisdictions have the same score as Ontario's and 34 have lower. Ontario's Grade 8 average (512) is significantly lower than Quebec's (532) and not significantly different from Alberta's (505).

Most of the mathematics items in the TIMSS assessment are covered in *The Ontario Curriculum* by the end of the grade tested (83% of the Grade 4 items and 87% 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.

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

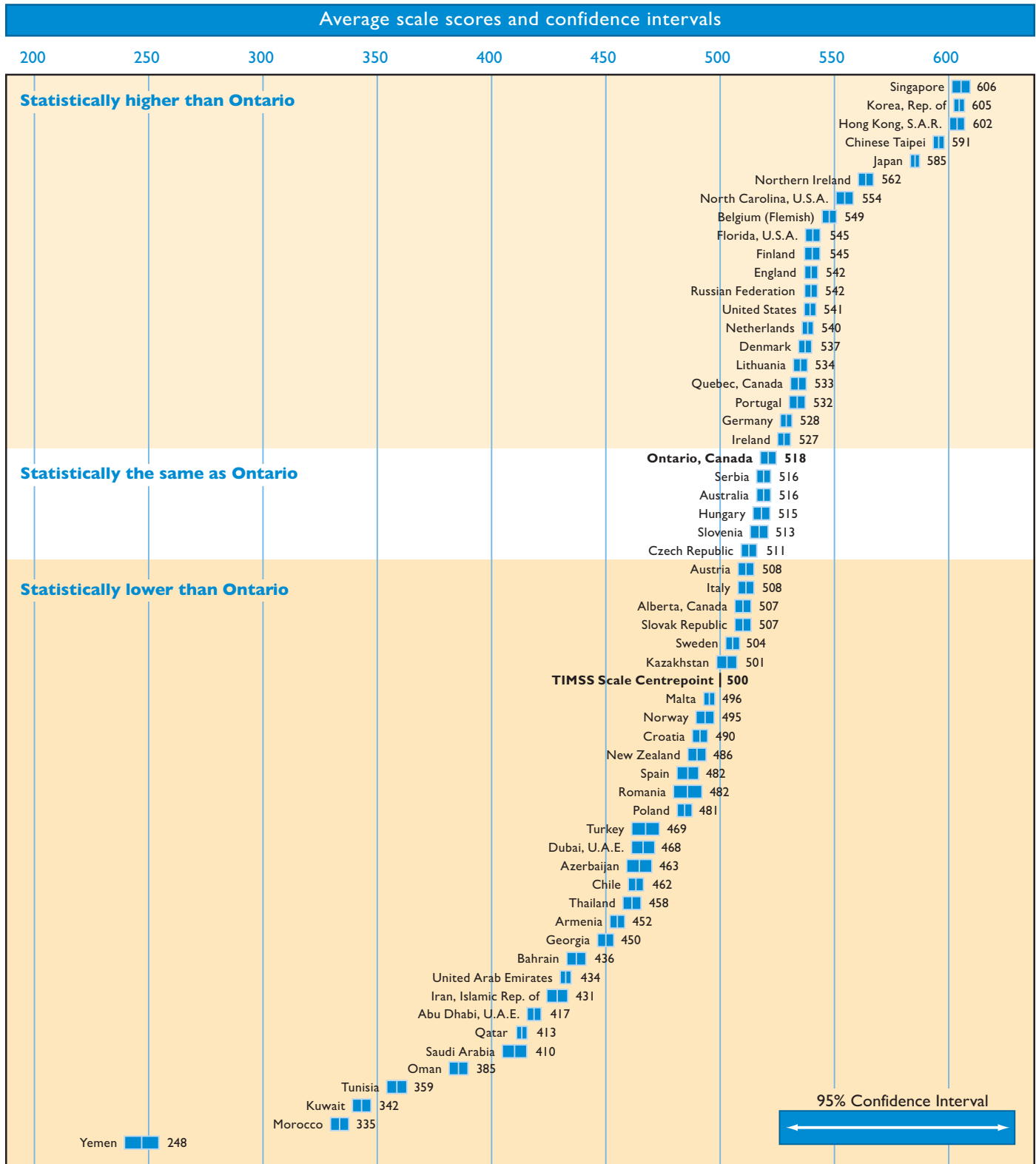
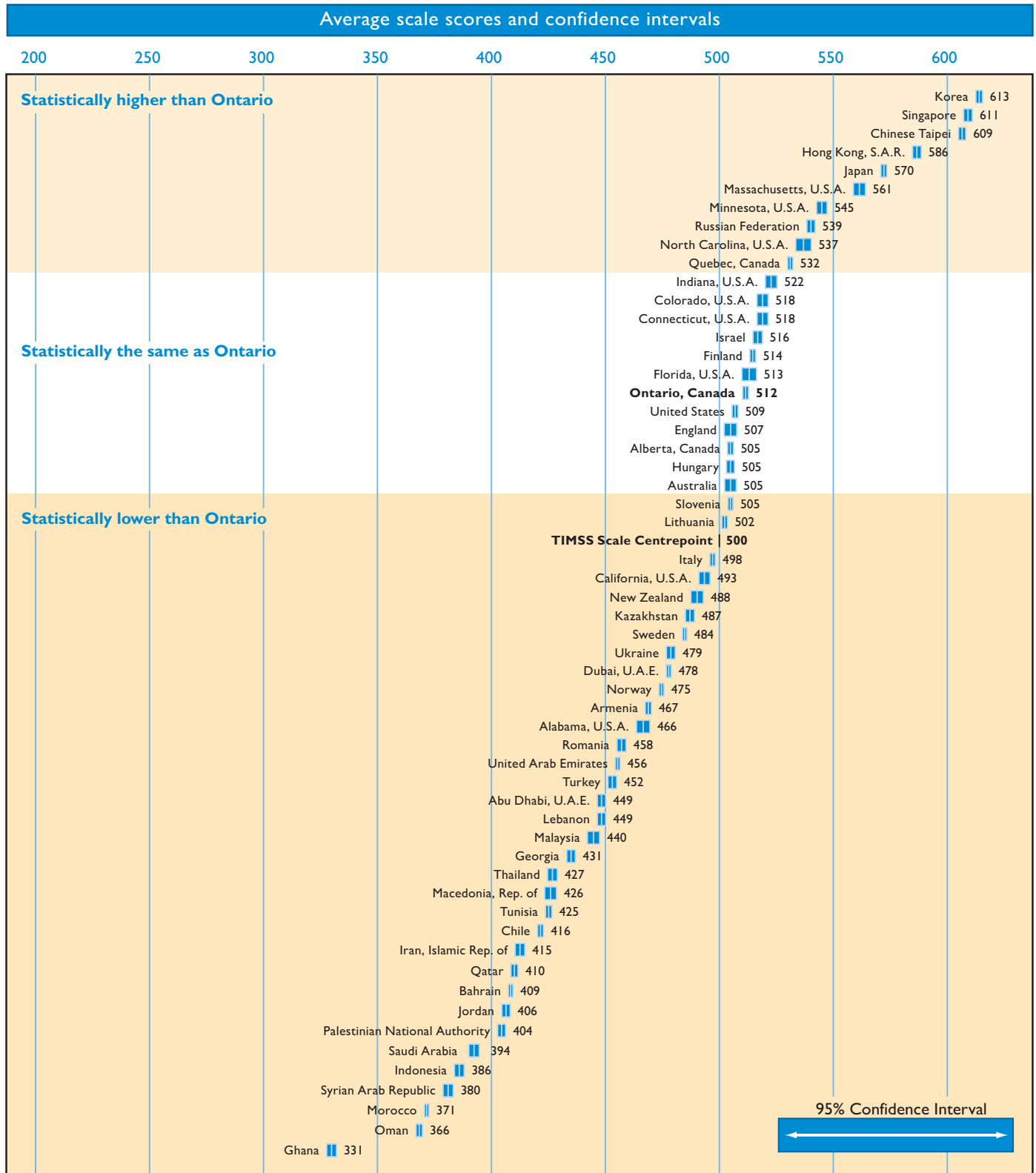


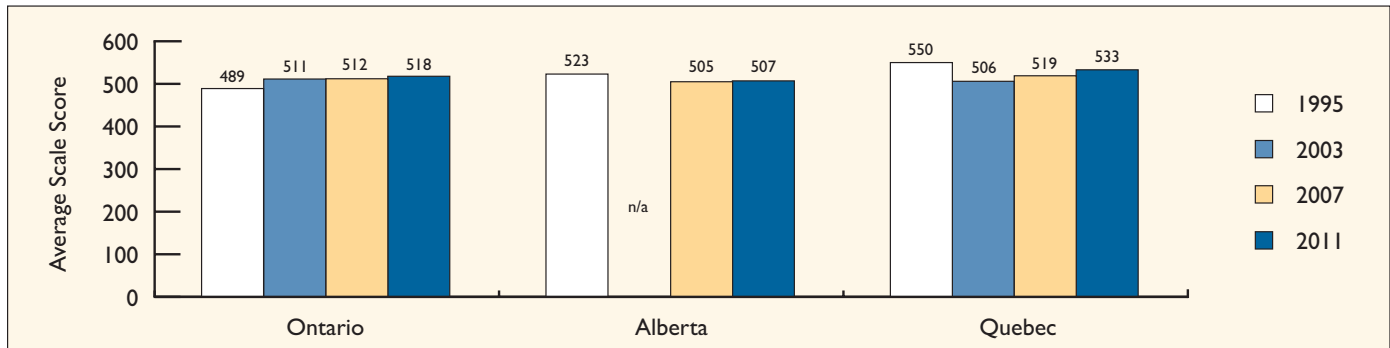
Figure 3: Grade 8 Mathematics Achievement (Average Scale Scores)



Results Over Time

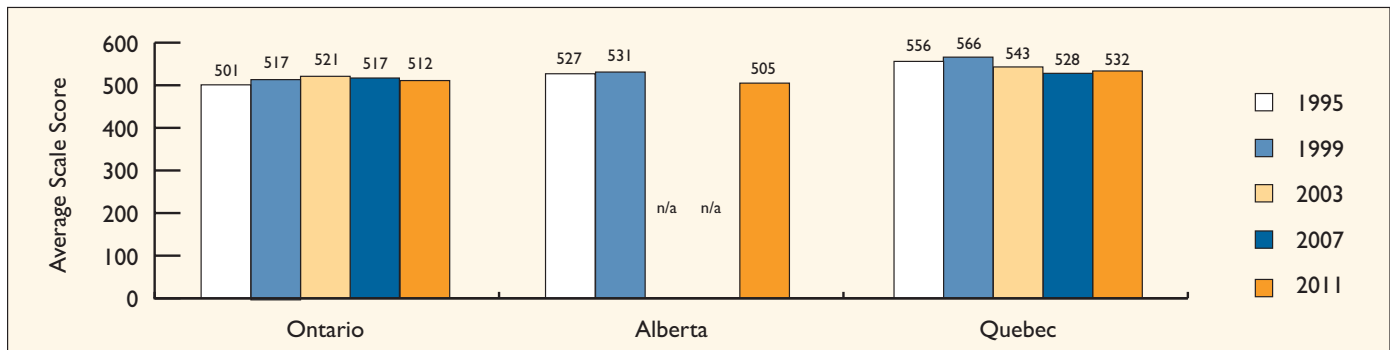
Ontario has participated in all TIMSS assessments (1995, 1999, 2003, 2007 and 2011). Grade 4 results are not available for 1999, because the study did not include Grade 4 students that year. Trends in student achievement in mathematics show significant improvement for Ontario students between 1995 and 2011. 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 significantly improved from an average scale score of 489 to one of 518. Other jurisdictions showing steady improvement over time are Singapore (590 in 1995, 594 in 2003, 599 in 2007 and 606 in 2011), the United States (518, 518, 529, 541), England (484, 531, 541, 542), Slovenia (462, 479, 502, 513) and the Islamic Republic of Iran (387, 389, 402, 431). Results for Alberta have remained statistically unchanged; results for Quebec have declined between 1995 and 2011 but have increased significantly since 2003 and 2007.

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



Since 1995, the Grade 8 results for Ontario have significantly improved from an average scale score of 501 to one of 512. Chinese Taipei has had high and improving results (585 in 1999, 585 in 2003, 598 in 2007 and 609 in 2011), as has Korea (581, 587, 589, 597, 613). Results for Singapore (609, 604, 605, 593, 611) and Hong Kong (569, 582, 586, 572, 586) are generally high but show some increases and some decreases over time. Results for Quebec and Alberta have declined significantly between 1995 and 2011.

Results by Gender

The 2011 mathematics average scale scores for boys and girls are presented in Table 1; the differences between the 2011 scale score averages and those from previous assessments are included.

Table 1: Trends in Ontario Mathematics Achievement by Gender

Grade	Results for Girls					Results for Boys				
	2011 Average Scale Score	2007 to 2011 Change	2003 to 2011 Change	1999 to 2011 Change	1995 to 2011 Change	2011 Average Scale Score	2007 to 2011 Change	2003 to 2011 Change	1999 to 2011 Change	1995 to 2011 Change
Grade 4	515	6	10	n/a	28	521	7	4	n/a	30
Grade 8	512	-1	-8	-2	13	512	-10	-10	-7	8

In Grade 4, the 2011 difference in achievement between boys and girls in Ontario (six points) is significant. The international average for girls (490) is one point lower than that for boys (491). The jurisdiction with the largest difference is Kuwait, where the girls' average score is 35 points higher than that for boys. The gender difference in Ontario among Grade 4 students is most similar to that in Denmark, where boys also do significantly better, by six points.

In Grade 8, the 2011 average score for girls and boys in Ontario is the same (512). The international average for girls is four points higher than that for boys. Oman's Grade 8 girls outperform the boys by an average of 63 points. As in Ontario, there is no difference between girls' and boys' average scale scores in Morocco and the Russian Federation. In Alberta and Quebec, the average scores for boys are two points and one point higher, respectively, than those for girls.

While achievement among Ontario's boys and girls has not always improved from one assessment to the next, both boys and girls have shown significant improvement between 1995 and 2011. During this period, the average score for Grade 4 girls in Ontario has increased by 28 points and that for boys has increased by 30 points. The corresponding increases among Grade 8 students were smaller (13 points among girls and eight points among boys).

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 the students at or above each benchmark. For instance, the percentage of students reaching the Intermediate benchmark includes the 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 (43% Advanced and 78% High), Korea (39% and 80%), Hong Kong (37% and 80%) and Chinese Taipei (34% and 74%). These jurisdictions show similar high 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	7%	34%	73%	94%
Grade 8	4%	31%	71%	94%

The percentage of Grade 4 students achieving each benchmark is slightly larger than the corresponding percentage for Grade 8. The jurisdiction with Grade 4 benchmark achievement results similar to Ontario's is Slovenia (4, 31, 72, 94). In Grade 8, the jurisdiction whose achievement most closely resembles Ontario's is Finland (4, 30, 73, 96).

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 percentage of students reaching each benchmark has increased between 1995 and 2011.

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	2011	1995	2003	2007	2011	1995	2003	2007	2011	1995	2003	2007	2011
Ontario	4%	5%	4%	7%	22%	29%	29%	34%	59%	70%	71%	73%	86%	94%	94%	94%
Alberta	9%	n/a	3%	3%	39%	n/a	25%	25%	74%	n/a	69%	70%	93%	n/a	94%	94%
Quebec	13%	3%	5%	6%	50%	25%	34%	40%	87%	69%	74%	83%	98%	94%	96%	99%

Between 4% and 7% of students in Ontario reached the Advanced benchmark. For this benchmark, the increases since 1995 and since 2007 are statistically significant. The decrease from 9% in 1995 to 3% in 2011 in Alberta is significant. For Quebec, the decrease since 1995 and the increase from 2003 to 2011 are both significant.

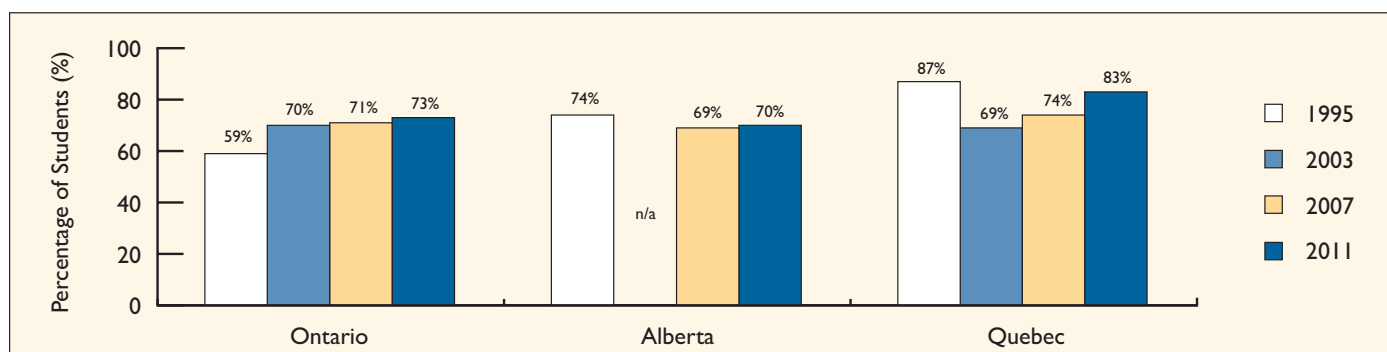
There was significant improvement in Ontario students reaching the high benchmark from 2007 to 2011 (five points) and between 1995 and 2011 (12 points). The percentage in Alberta has fallen significantly, from 39% to 25%, between 1995 and 2011. The fluctuations in the percentages in Quebec, which fell from 50% to 25% from 1995 to 2003 and then rose again in 2007 to 34%, and in 2011 to 40%, are significant.

The percentage of students in Ontario reaching the Intermediate benchmark has increased significantly from 59% in 1995 to 73% in 2011. In Quebec, the percentage has decreased significantly, from 87% to 83%.

The vast majority (94%) of students in Ontario are at the Low benchmark or higher in 2011. This percentage has been stable since 2003 and is consistent with that in Alberta.

The strongest improvement among Ontario students between 1995 and 2011 has been in the Intermediate benchmark, which rose by 14 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	2011	1995	1999	2003	2007	2011	1995	1999	2003	2007	2011	1995	1999	2003	2007	2011
Ontario	3%	6%	6%	6%	4%	26%	32%	34%	33%	31%	65%	72%	75%	74%	71%	91%	96%	97%	95%	94%
Alberta	6%	7%	n/a	n/a	3%	39%	40%	n/a	n/a	24%	79%	81%	n/a	n/a	69%	97%	97%	n/a	n/a	95%
Quebec	14%	18%	8%	8%	6%	54%	60%	45%	37%	40%	90%	93%	88%	78%	82%	99%	99%	99%	97%	98%

Since 1995, between 3% and 6% of Ontario students have reached the Advanced benchmark in Grade 8 mathematics. Results in Alberta have declined significantly in 2011, as did Quebec's results in 2003.

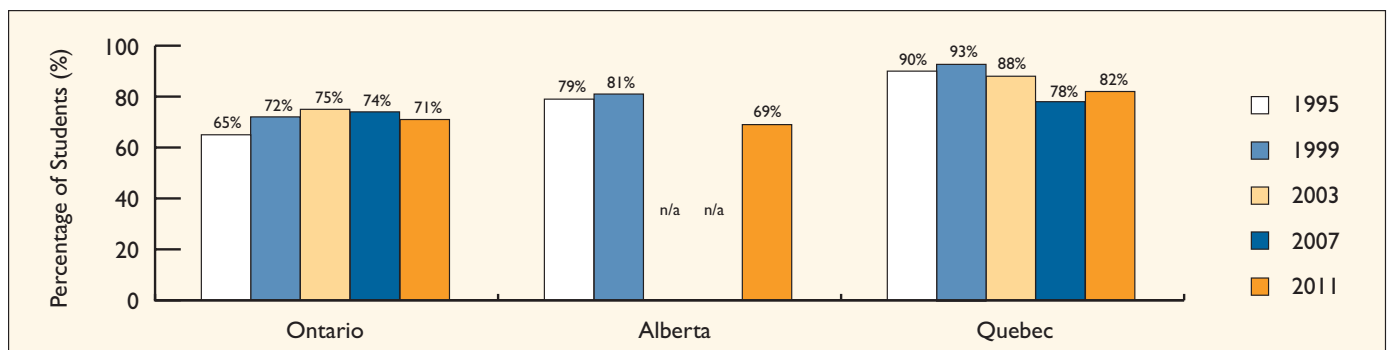
Since 1995, the percentage of Ontario students reaching the High benchmark in Grade 8 mathematics has increased significantly. Approximately one-third of Ontario students have reached this benchmark since 1999. Results for Alberta and Quebec have declined significantly since 1995.

The percentage of Ontario students reaching the Intermediate benchmark in 2011 is significantly larger than the percentage in 1995, but it is significantly smaller than the percentage in 2003. Results for Alberta and Quebec have declined significantly since 1995.

The vast majority (94%) of students in Ontario are at the Low benchmark or higher in 2011. This percentage has increased since the 1995 administration and is consistent with that in Alberta.

The strongest improvement among Ontario Grade 8 students between 1995 and 2011 has been in the Intermediate benchmark, which has risen by six percentage points. The results for the Intermediate benchmark are presented in Figure 7.

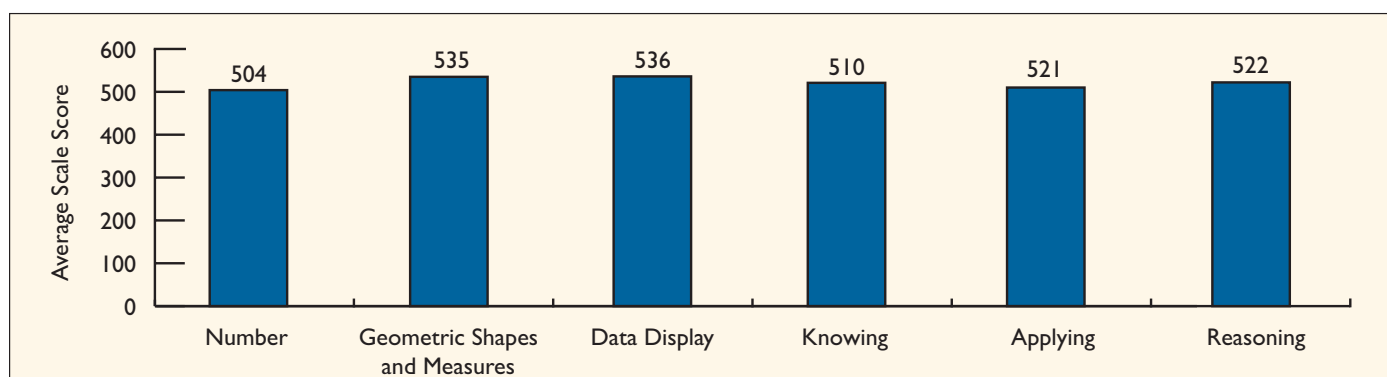
Figure 7: Trends in Percentages of Grade 8 Students in Canadian Provinces Reaching or Exceeding the Intermediate Mathematics Benchmark



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.

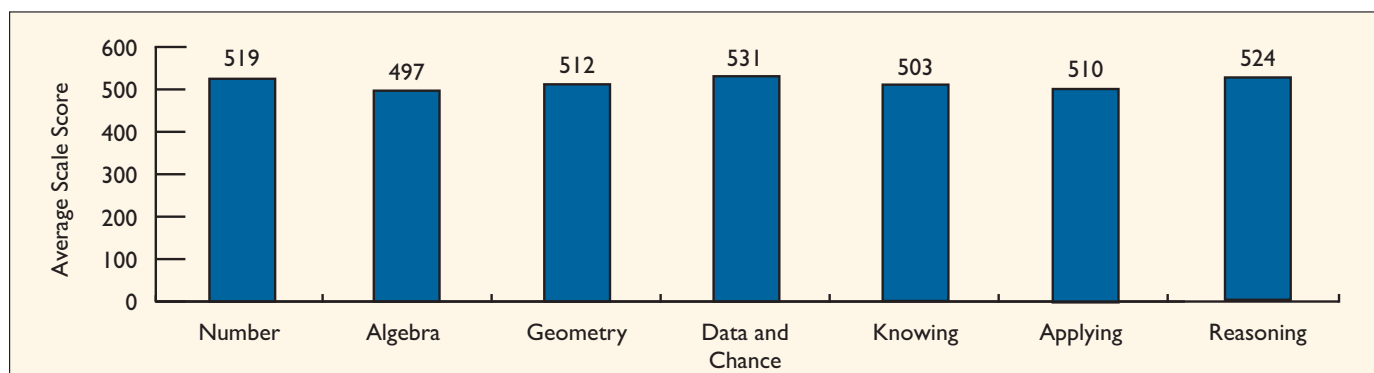
Figure 8: Average Achievement of Grade 4 Ontario Students in the Mathematics Content and Cognitive Domains



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

A possible reason for the lower average for Number is that the test contained 18 items in this domain that were not covered by *The Ontario Curriculum* by the end of Grade 4. Although 83% of the Grade 4 mathematics items on the TIMSS assessment were covered by *The Ontario Curriculum*, 18 out of the 29 items not covered were in Number.

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



The strongest performance among Grade 8 students is in Data and Chance. Among the cognitive domains, the highest average is in Reasoning. A possible reason for the lower average for Algebra is that the test contained 24 Algebra items that are not covered by *The Ontario Curriculum* by the end of Grade 8. Although 87% of the Grade 8 mathematics items on the TIMSS assessment were covered by *The Ontario Curriculum*, 24 out of the 28 items not covered were in Algebra.

There are some significant differences between girls and boys. In Grade 4, the average for boys in Number (508) is significantly higher than that for girls (500). In Knowing, the average for boys (515) is significantly higher than that for girls (505). In Grade 8, the average for boys is significantly higher in Number (523, as opposed to 515 for girls), and the average for girls is significantly higher in Algebra (501, as opposed to 492 for boys).

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 Content and Cognitive Domains

Province	Number	Geometric Shapes and Measures	Data Display	Knowing	Applying	Reasoning
Ontario	504	535	536	510	521	522
Alberta	505	496	524	498	508	514
Quebec	531	536	538	536	529	534

Students in Quebec have higher average scores than those in other Canadian provinces in the content area Number and in all three cognitive domains.

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

Province	Number	Algebra	Geometry	Data and Chance	Knowing	Applying	Reasoning
Ontario	519	497	512	531	503	510	524
Alberta	523	485	485	529	500	505	512
Quebec	543	516	529	549	528	536	529

Students in Quebec outperformed students in the other two provinces in all four content domains and in all three cognitive domains.

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 according to *The Ontario Curriculum*, 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.

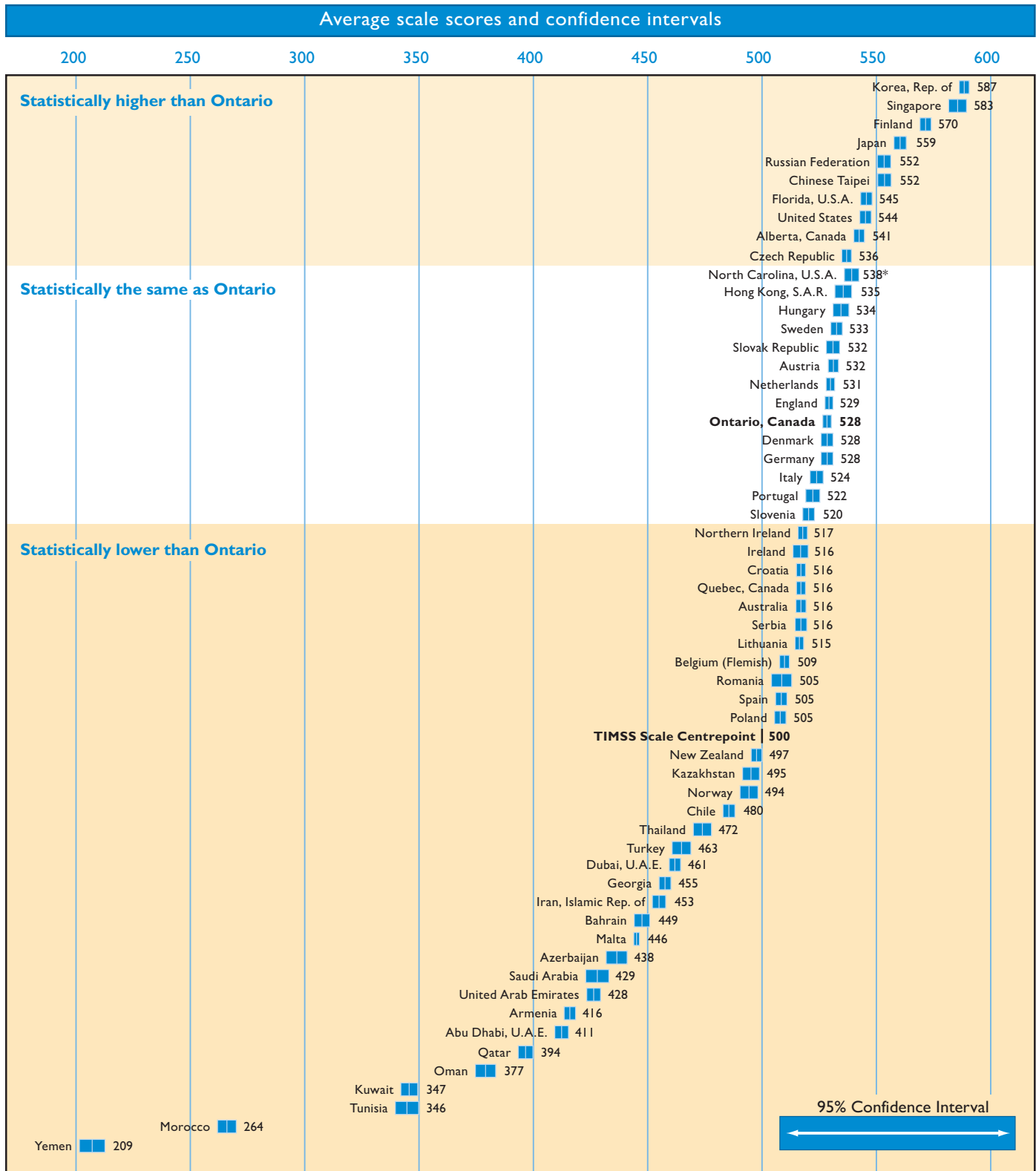
The substantial improvements in student achievement on the Grade 4 TIMSS mathematics assessment since 1995 are similar to the improvements in student achievement tracked by EQAO's Grade 3 assessment over a similar period; however, in recent years the improvements in the EQAO assessment results have been greater.

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 (i.e., one can be confident that the results would fall within this band 19 times out of 20). The average scale score for Grade 4 students in Ontario is 528, and it is 521 for Grade 8 students.

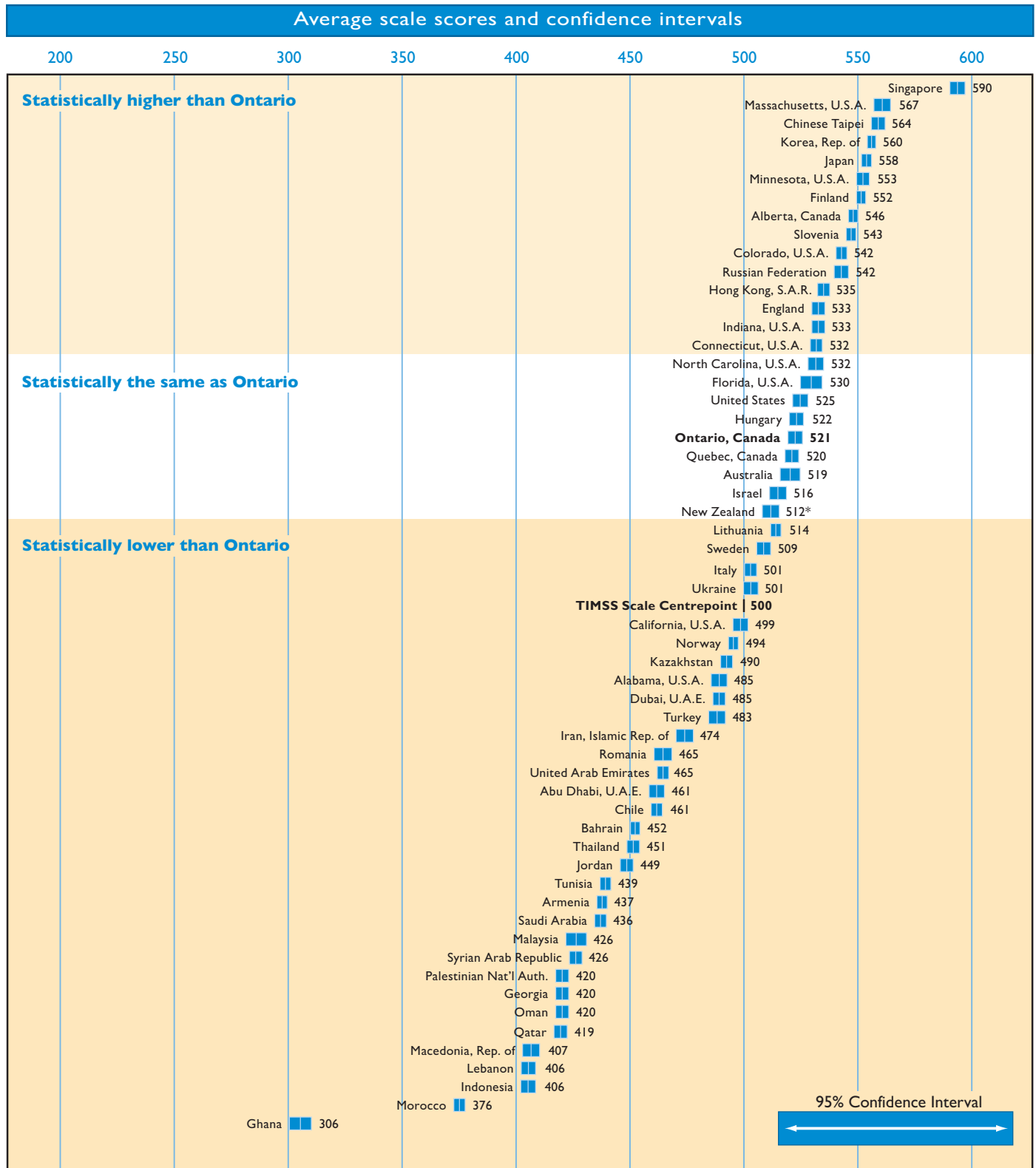
Figure 10: Grade 4 Science Achievement (Average Scale Scores)



*Although the mean score for North Carolina is higher than that for the Czech Republic, it is not significantly higher than the mean score for Ontario.

Average scale scores in Grade 4 range from a low of 209 (Yemen) to a high of 587 (Korea). Korea and Singapore are the top-performing jurisdictions, with significantly better achievement than all other jurisdictions. Ten jurisdictions have a Grade 4 average scale score significantly higher than Ontario's, 13 jurisdictions have a score the same as Ontario's and 33 have lower. The Ontario average in Grade 4 is lower than Alberta's and higher than Quebec's.

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



*Although the mean score for New Zealand is lower than that for Lithuania, it is not significantly lower than the mean score for Ontario.

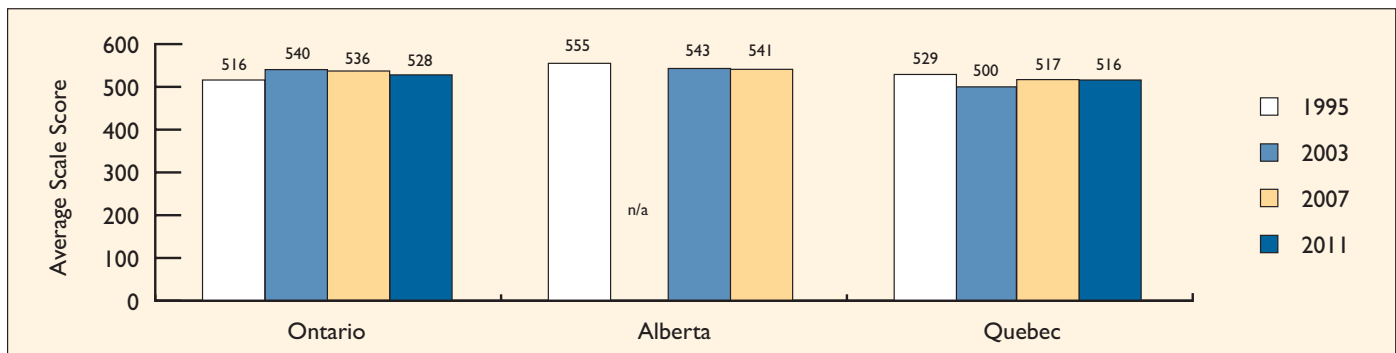
Grade 8 average scale scores range from 306 (Ghana) to 590 (Singapore). Singapore is the top-performing jurisdiction, with significantly better achievement than all others. Fifteen jurisdictions have an average Grade 8 scale score significantly higher than Ontario's, eight jurisdictions have a score the same as Ontario's and 32 have lower. Ontario's Grade 8 results were significantly lower than Alberta's and the same as Quebec's.

Most of the science items in the TIMSS assessment are covered in *The Ontario Curriculum* by the end of the grade tested (51% of the Grade 4 items and 63% 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

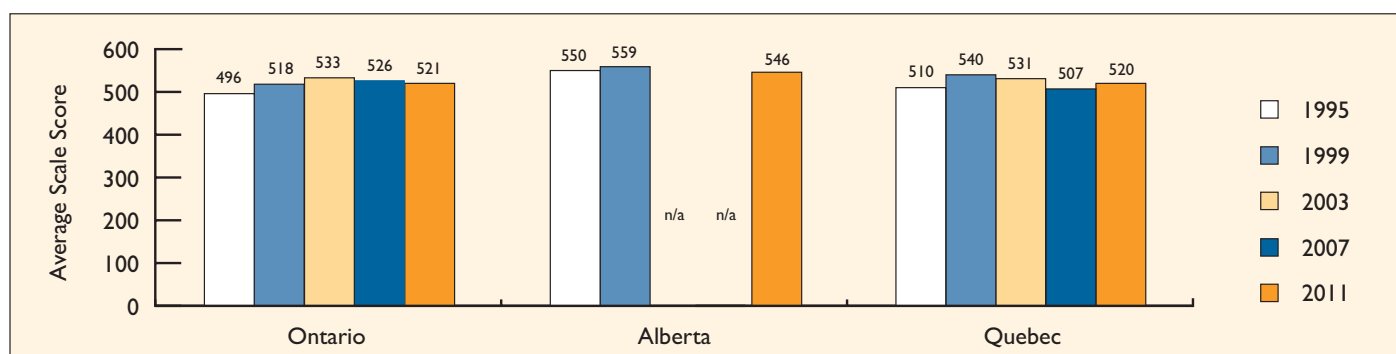
Ontario has participated in all TIMSS assessments (1995, 1999, 2003, 2007 and 2011), but Grade 4 results are not available for 1999, because the study did not include Grade 4 students that year. Trends in student achievement in science show significant improvement for Ontario students since 1995. The 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 have improved significantly between 1995 and 2011. The 2011 average scale score is significantly higher than in 1995, but significantly lower than in 2003. Jurisdictions showing steady improvement over time are Slovenia (464 in 1995, 490 in 2003, 518 in 2007 and 520 in 2011) and the Islamic Republic of Iran (380, 414, 436, 453). In Quebec, the average scale score is significantly lower than in 1995, but it has increased significantly since 2003. Results for Singapore and Hong Kong are generally high but have decreased since 2007.

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



Ontario's Grade 8 results improved steadily until 2003. They have declined slightly since 2003 but the 2011 average is significantly higher than the 1995 average. Singapore's (580 in 1995, 568 in 1999, 578 in 2003, 567 in 2007, and 590 in 2011), Korea's (546, 549, 558, 553, 560) and Chinese Taipei's (569 in 1999, 571 in 2003, 561 in 2007, and 564 in 2011) results are consistently high but variable, with some improvement and some decline from assessment to assessment. The average for Quebec has increased significantly since 2007, and Alberta's has declined slightly since 1995.

There has been a decline in Ontario's international standing in science achievement from 2007 to 2011.

Results by Gender

The 2011 average mathematics scale scores for boys and girls are presented in Table 7; the differences between the 2011 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				
	2011 Average Scale Score	2007 to 2011 Change	2003 to 2011 Change	1999 to 2011 Change	1995 to 2011 Change	2011 Average Scale Score	2007 to 2011 Change	2003 to 2011 Change	1999 to 2011 Change	1995 to 2011 Change
Grade 4	525	-7	-12	n/a	12	530	-9	-13	n/a	12
Grade 8	521	0	-5	12	33	522	-9	-18	-5	16

In Grade 4, the 2011 difference in achievement between boys and girls in Ontario is not statistically significant. The international average for girls is two points higher than that for boys. The jurisdiction with the largest gender difference is Kuwait, where the average score among girls is higher by 53 points. Ontario's Grade 4 gender difference is most similar to those of Hungary and Japan, where the average for boys is five points higher but the difference in favour of boys is not significant. In Ontario, girls and boys showed the same improvement between 1995 and 2011.

In Ontario, the Grade 8 boys' average scale score is one point higher than the girls'. This small difference most resembles that in Singapore. In Ontario, girls have shown much greater improvement than boys between 1995 and 2011. The international average for girls is six points higher than that for boys. Oman's Grade 8 girls have outperformed the country's boys by an average of 78 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 the students at or above each benchmark. For instance, the percentage of students reaching the Intermediate benchmark includes the 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 (33% Advanced and 68% High), Korea (29% and 73%), Finland (20% and 65%), Russia (16% and 52%) and Chinese Taipei (15% and 53%). The highest Advanced and High benchmark results in Grade 8 are in Singapore (40% and 69%), Chinese Taipei (24% and 60%), Korea (20% and 57%) and Japan (18% and 57%).

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	9%	40%	77%	94%
Grade 8	6%	35%	76%	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, 77% and 76% of students, respectively, reached the Intermediate benchmark. The corresponding values for the High benchmark are 40% and 35%. The jurisdictions with Grade 4 benchmark achievement similar to Ontario's are Germany, Austria, Denmark and Italy. In Grade 8, the jurisdiction with achievement most resembling Ontario's is Quebec.

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 2011, except in the case of the Advanced benchmark in Grade 4, which decreased by one point. 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

Province	Advanced International Benchmark (625)				High International Benchmark (550)				Intermediate International Benchmark (475)				Low International Benchmark (400)			
	1995	2003	2007	2011	1995	2003	2007	2011	1995	2003	2007	2011	1995	2003	2007	2011
Ontario	10%	13%	12%	9%	37%	47%	45%	40%	71%	81%	79%	77%	90%	96%	95%	94%
Alberta	21%	n/a	12%	11%	57%	n/a	48%	47%	84%	n/a	82%	83%	94%	n/a	96%	97%
Quebec	9%	3	5%	3%	40%	25%	32%	29%	77%	66%	74%	76%	94%	91%	96%	97%

The proportion of Grade 4 students reaching the Advanced benchmark is almost the same in 2011 as it was in 1995. Since 2003, however, the proportion of students reaching this benchmark has decreased significantly, from 13% to 9%.

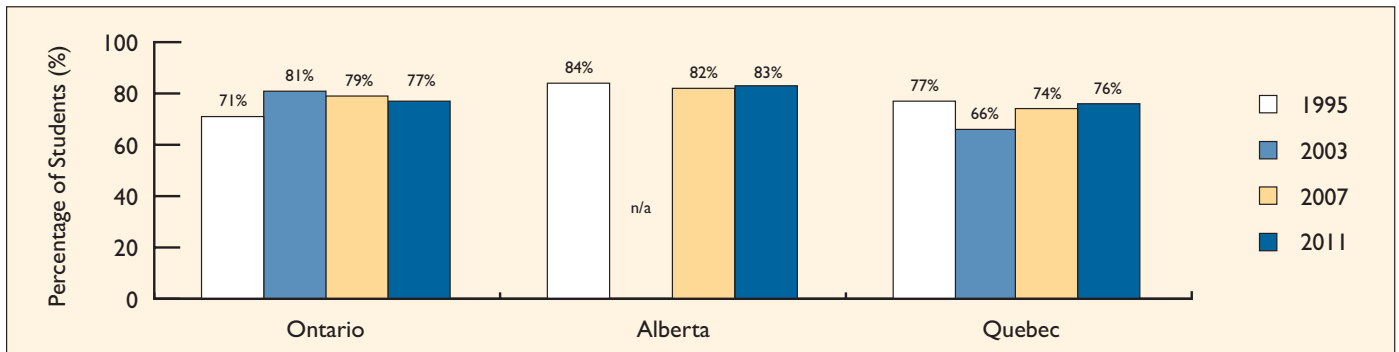
From 1995 to 2003, there was a significant increase in the percentage of Ontario students in Grade 4 reaching the High international benchmark. Since 2003, the percentage of students at this benchmark has declined significantly. The percentages in Alberta and Quebec have declined significantly between 1995 and 2011.

The percentage of Ontario students reaching the Intermediate benchmark has risen significantly from 71% in 1995 to 77% in 2011. Results for Alberta have remained relatively 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 relatively stable since 1995 and is consistent with those of the other participating Canadian provinces.

The strongest improvement among Ontario students between 1995 and 2011 has been in the Intermediate benchmark, which changed by six 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, 6% of students in Ontario reached the Advanced benchmark in Grade 8 science in 2011. These results have been steady since 1999. Results in Alberta and Quebec have declined significantly between 1999 and 2011.

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	2011	1995	1999	2003	2007	2011	1995	1999	2003	2007	2011	1995	1999	2003	2007	2011
Ontario	5%	7%	7%	7%	6%	26%	34%	41%	37%	35%	61%	72%	81%	77%	76%	88%	95%	97%	96%	96%
Alberta	17%	17%	n/a	n/a	12%	51%	57%	n/a	n/a	48%	83%	87%	n/a	n/a	85%	97%	98%	n/a	n/a	98%
Quebec	7%	10%	6%	4%	5%	30%	43%	39%	27%	34%	69%	83%	82%	68%	76%	92%	98%	98%	94%	96%

Ontario results show a statistical improvement in the percentages of students reaching the High benchmark between 1995 and 2011, but since 2003, the percentage of students at this benchmark has decreased significantly. Results in Alberta and Quebec have remained relatively stable since 1995, but in Quebec, they have increased significantly since 2007.

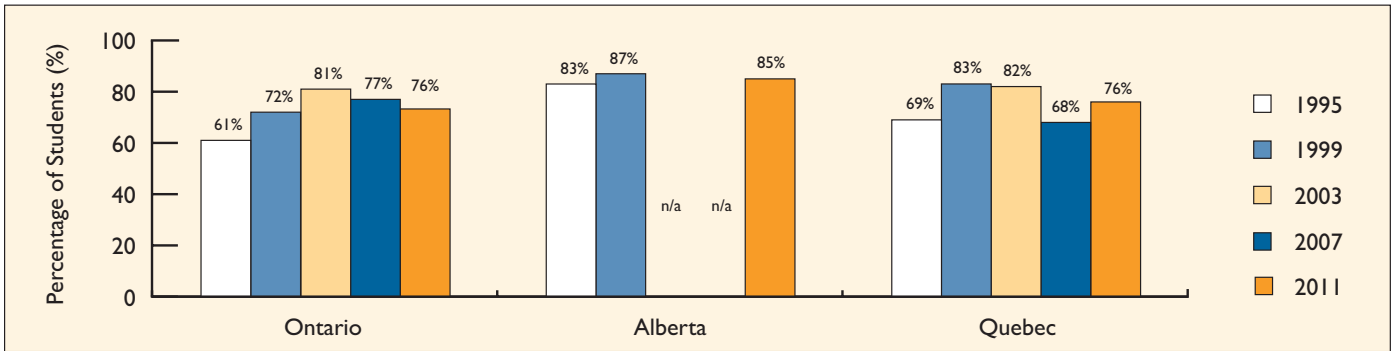
The percentages of students in Ontario reaching the Intermediate benchmark are significantly larger than on the first administration, in 1995. Results for Alberta have been steady at around 85%. Results for Quebec have been variable over time; they fell significantly from 2003 to 2007, but increased significantly from 2007 to 2011, even if they remain statistically lower than in 2003.

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%. Results in Alberta have remained stable at around 98%. Quebec's 2011 results are significantly lower than those in 1999 and 2003.

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 2011 has been in the Intermediate benchmark, which rose by 15 percentage points. The results for the Intermediate benchmark are presented in Figure 15.

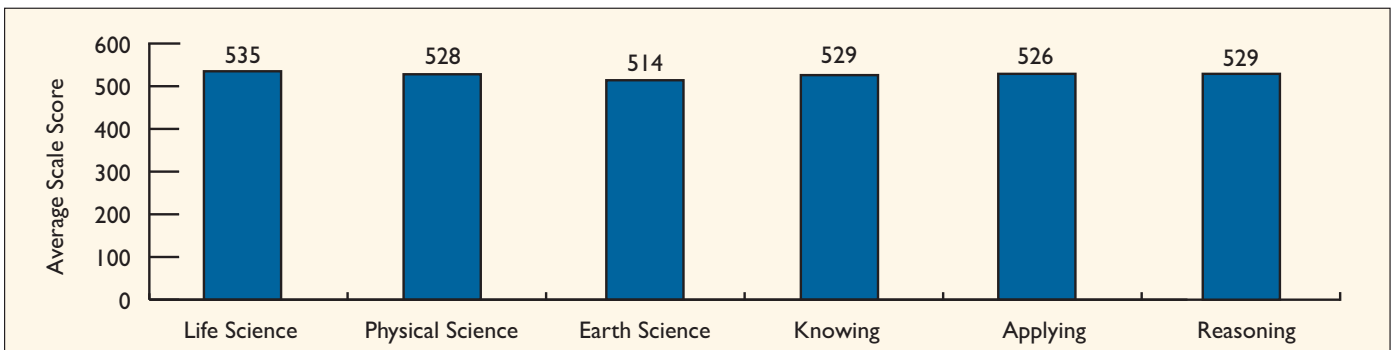
Figure 15: Trends in Percentages of Grade 8 Students in Canadian Provinces Reaching or Exceeding the Intermediate Science Benchmark



C. Science Content and Cognitive Domains

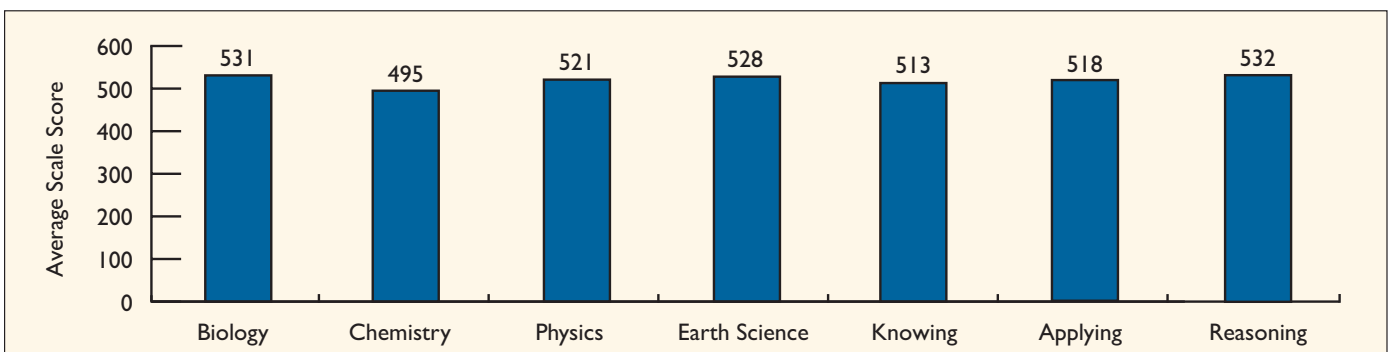
The TIMSS assessments of science focus on curriculum- and grade-specific content areas, or domains. In Grade 4, the content domains are Life Science, Physical Science and Earth Science, and in Grade 8 they are Biology, Chemistry, Physics and Earth Science. The cognitive domains tested are the same in both grades: Knowing, Applying and Reasoning. The 2011 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: 2011 Average Achievement of Grade 4 Students in the Science Content and Cognitive Domains



In Grade 4, Ontario students' scale score in Life Science is the highest among content areas by a significant margin. The results for the three cognitive domains are similar.

Figure 17: 2011 Average Achievement of Grade 8 Students in the Science Content and Cognitive Domains



In Grade 8, the average scores for Biology and Earth Science are higher than those for Physics and Chemistry. The average for Chemistry is substantially lower than those for 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, boys' average scores in Physical Science, Earth Science, Knowing and Applying are significantly higher than girls'. Girls' average scores in Life Science and Reasoning are slightly higher than boys'.

In Grade 8, boys do better than girls in Chemistry, Physics and Earth Science, but the difference is significant only in the last. Girls do better than boys in Biology, but not significantly. In the cognitive domains, boys' average score is significantly higher than girls' in Knowing, and girls' average score is significantly higher in Reasoning. Both genders perform the same in Applying.

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

Table 11: 2011 Average Achievement of Grade 4 Students in Canadian Provinces in the Science Content and Cognitive Domains

Province	Life Science	Physical Science	Earth Science	Knowing	Applying	Reasoning
Ontario	535	528	514	529	526	529
Alberta	542	542	539	543	541	540
Quebec	524	507	516	519	514	520

In Grade 4, Alberta has the highest score of participating Canadian provinces in all content and cognitive domains. Quebec has the lowest ones in all domains except Earth Science.

Table 12: 2011 Average Achievement of Grade 8 Students in Canadian Provinces in the Science Content and Cognitive Domains

Province	Biology	Chemistry	Physics	Earth Science	Knowing	Applying	Reasoning
Ontario	531	495	521	528	513	518	532
Alberta	554	521	545	559	542	543	552
Quebec	525	515	502	536	519	518	522

In Grade 8, Alberta has the highest scores in all domains (Content and Cognitive). Ontario has higher scores than Quebec in Biology, Physics and Reasoning.

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. Of Grade 8 students, 89% reported speaking the language of the TIMSS tests at home always or almost always. The average scale score for these students was lower than that for the students who reported sometimes speaking the language of the test at home (there was a 16-point difference in favour of those speaking the language of the test sometimes at home in Grade 8).

In Grade 4, 35% of Ontario's students indicated liking learning mathematics and 33% indicated a high level of confidence about learning mathematics. These percentages are smaller for Grade 8 students (26% and 32%, respectively). There is a strong positive relationship between enjoyment and confidence about learning mathematics and mathematics achievement.

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 7%, a slightly smaller percentage than those in the other Canadian provinces, but much smaller than the international average (approximately 38%).

The percentage of Grade 8 students in Ontario taught by a teacher who had mathematics as a major area of study at university (12%) is smaller than those in the other Canadian provinces (35% in Alberta and 47% in Quebec) and much smaller than the international average (73%).

In Grade 4, 91% of the students were taught mathematics by teachers who indicated that they considered themselves "very well" prepared to teach the topics covered by the TIMSS mathematics assessment. This is similar to the percentages in Alberta and Quebec and larger than the international average (83%). In Grade 8, the corresponding percentages were 85% in Ontario, 84% internationally (average), 92% in Alberta and 90% in Quebec.

Over 60% of Ontario students in Grades 4 and 8 were taught mathematics by teachers who reported asking students to explain their answers in every or almost every lesson, which is similar to the international average and to Alberta and 10 to 20 points more than in Quebec. Approximately 10% of Ontario Grade 4 and Grade 8 students were taught mathematics by teachers who reported asking their students to memorize formulas and procedures in every or almost every lesson. The corresponding international averages are 37% in Grade 4 and 45% 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 8, the average score (521) of the 89% of students always or almost always speaking the language of the test at home is the same as that of the 10% of students who reported sometimes speaking the language of the test at home.

Of Grade 4 Ontario students, 48% indicated liking learning science and 41% indicated a high level of self-confidence about learning science. There is a strong positive relationship between confidence in learning science and achievement in science.

Of Grade 8 students, 34% in Ontario, 38% in Alberta and 27% in Quebec reported valuing science highly, compared to the 41% internationally. The percentages of Grade 8 students who indicated liking learning science are smaller (29% in Ontario, 30% in Alberta and 24% in Quebec, compared to the 35% internationally). In all the Canadian provinces and internationally, about 20% of Grade 8 students expressed a high level of self-confidence about learning science.

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 percentage of Grade 8 students in Ontario taught by a teacher who had science as a major area of study at university (38%) is considerably smaller than those in the other Canadian provinces (56% in Alberta and 69% in Quebec) and the international average (79%).

In Grade 4, 55% of the Ontario students were taught science by teachers who indicated that they considered themselves “very well” prepared to teach the topics covered by the TIMSS science assessment. This is smaller than the percentage in Alberta (66%) and the international average (62%), and larger than the percentage in Quebec (41%). In Grade 8, smaller percentages of students were taught science by teachers who reported feeling “very well” prepared to teach the TIMSS science topics: there were 61% in Ontario, compared to the 72% internationally and in Alberta, and the 71% in Quebec.

In Ontario, 32% of students in Grade 4 and 22% of students in Grade 8 were taught science by teachers who reported emphasizing science investigations in at least half their lessons. In Ontario, 25% and 29% of Grade 4 students were taught science by teachers who reported having their students use computers at least monthly to do scientific procedures or experiments and to practise skills and procedures, respectively. In Grade 8, their percentages are 36% and 33%, respectively. For both grades, the percentages are similar to the International averages but much smaller than those in Alberta.

Appendix A: TIMSS 2011 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.

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.

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.

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.

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.

Low International Benchmark (400)

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

Appendix B: TIMSS 2011 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 behavioural 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.

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.

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.

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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