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ABSTRACT

Information collected as part of the International Assessment of Educational Progress II (IAEP II) about learning in Alberta (Canada) is provided, including information on the educational and cultural factors associated with student achievement and information on student attitudes, backgrounds, and experiences. Results for all participating countries (20 in science and mathematics and 9 in geography) have been distributed. This report indicates what 13-year-olds in Alberta have been able to achieve in science, mathematics, and geography. In Alberta, 119 randomly selected schools participated. Alberta students (n=1,459) did very well in science, scoring in the top one-third in all comparisons. The mathematics achievement of the 1,422 students was not as high, ranking in the middle third both nationally and internationally. Those who took the geography test, a brief assessment, scored in the top third in all comparisons. Results for participating countries are summarized for comparisons with Alberta and other Canadian provinces. Results and score distributions are presented in 27 tables. Appendix 1 gives an overall summary of test administration, and Appendix 2 describes quality control procedures. (SLD)

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Context for Learning

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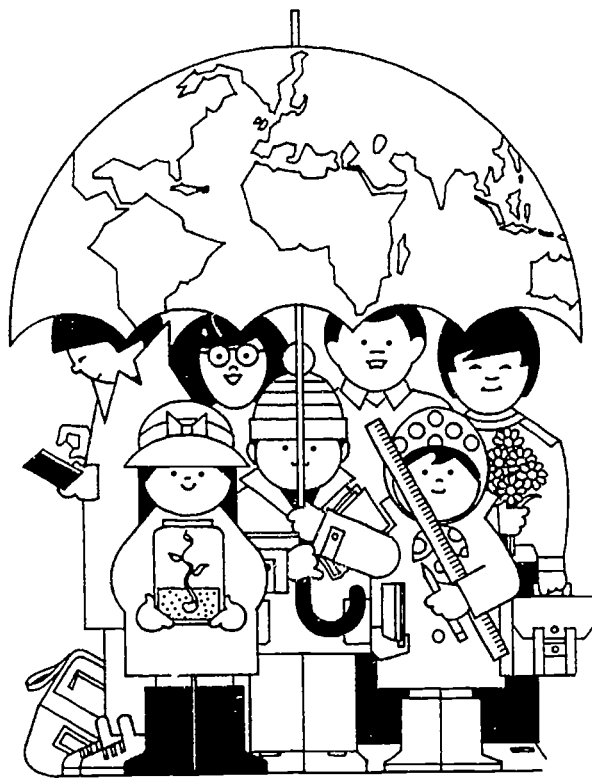
Geography

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IAEP Alberta Report



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This document was written primarily for:

| | |
|------------------|---------------------------------|
| Students | |
| Teachers | ✓ |
| Administrators | ✓ (Superintendents, Principals) |
| Parents | |
| General Public | |
| Others (Specify) | |

Distribution of Reports:

In February 1992 two IAEP reports, *Learning Science* and *Learning Mathematics* were distributed as follows:

- one copy to each school superintendent
- one copy to each participating school
- other copies to organizations and libraries

This report, *Context for Learning: IAEP Alberta Report*, has been distributed as follows:

- one copy to each school superintendent
- one copy to each school that participated in the study
- other copies to organizations and libraries

Acknowledgments

The completion of the IAEP is the result of the contribution and support of many individuals throughout the world. Particular thanks are due to Dr. Nancy Mead at Educational Testing Service, Princeton, who saw IAEP to a successful conclusion. This report draws extensively on the two international reports released in February 1992: *Learning Mathematics* and *Learning Science* by Lapointe, Mead, and Askew.

In Alberta, a special thank-you goes to the teachers, administrators, and students in the 119 schools that participated in IAEP. The support and co-operation of all involved contributed greatly to our successful participation.

Dennis Belyk
Provincial IAEP Coordinator

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SECTION 1: PROJECT OVERVIEW

This report provides additional information, collected as part of the International Assessment of Educational Progress II (IAEP II), about learning in Alberta. It includes information on the educational and cultural factors associated with student achievement, as well as information on student attitudes, backgrounds, and experiences. Results for all participating countries are presented in two IAEP reports: *Learning Mathematics* and *Learning Science*. Copies of these reports have been distributed to all school superintendents and to the schools that participated in the study.

This report identifies what Alberta's 13-year-olds were able to achieve. As well, Alberta results are reported in relation to other Canadian provinces and to some interesting international comparisons. Appendices 1 and 2 summarize test administration procedures.

Overview of IAEP II

In 1990-91, a total of 20 countries, including nine Canadian provinces, surveyed the mathematics and science performance of their 13-year-old students. An optional short probe of geography achievement and an experimental mathematics and science performance-based assessment of 13-year-olds were also administered by some participants. Finally, 14 countries selected the additional option to assess 9-year-olds in the same subjects.

Participants (all Canadian provinces except Prince Edward Island participated):

| | | | |
|---------|---------------|---------|------------------|
| Brazil | Mozambique | Canada: | Alberta |
| China | Portugal | | British Columbia |
| England | Scotland | | Manitoba |
| France | Slovenia | | New Brunswick |
| Hungary | Soviet Union | | Newfoundland |
| Ireland | Spain | | Nova Scotia |
| Israel | Switzerland | | Ontario |
| Italy | Taiwan | | Quebec |
| Jordan | United States | | Saskatchewan |
| Korea | | | |

All participants conducted the mathematics and science assessment of 13-year-olds—the main part of the project. Nine countries, including Alberta and seven other Canadian provinces, participated in the optional assessment of geography at the 13-year-old level.

- As an additional component of the study, 14 countries including four Canadian provinces participated in the optional assessment of mathematics and science at the 9-year-old level: England, Hungary, Ireland, Israel, Italy, Korea, Portugal, Slovenia, Scotland, Spain, Soviet Union, Taiwan, the United States, and British Columbia, New Brunswick, Ontario, and Quebec.
- Four countries (Taiwan, Scotland, England, Soviet Union) and five provinces (Alberta, Ontario, Saskatchewan, British Columbia, Nova Scotia) participated in the performance task (hands-on) assessment of 13-year-olds. The performance assessment report, which will include Alberta's results, is forthcoming.

Each country or province that participated did so for its own reasons. In Alberta, the study provided an opportunity to gauge what our students are able to demonstrate they can do in relation to the skills and knowledge demonstrated by students in other places around the world. This information permits reflection on the expectations described in Alberta's **programs of studies** as we examine the standards that they communicate.

Highlights of Alberta's Participation

In Alberta, 119 randomly selected schools, participated in the project. Students that were 13 years old were randomly sampled from these schools to write either the mathematics or the science test booklet.

- 1422 Alberta students completed the mathematics booklet, plus 12 geography questions.
- 1459 Alberta students completed the science booklet, plus 12 geography questions.

The geography component consisted of 24 questions; 12 were placed along with the mathematics booklet and 12 with the science booklet.

Alberta's Performance

Science (13-year-olds):

Alberta did very well. Not only did Alberta students score in the top one-third in all comparisons, they ranked first in Canada and third internationally.

Mathematics (13-year-olds):

Alberta did not perform as well in mathematics. Results are in the middle third when compared nationally and internationally. In particular, Alberta's scores in Geometry, and Algebra and Functions were the lowest (middle or bottom third in comparisons); scores for Numbers and Operations, Measurement, and Data Analysis and Statistics were higher (mostly in the top third of all scores).

Geography (13-year-olds):

Results show Alberta students in the top third in all comparisons. Results are very good considering there is not a specific geography curriculum in Alberta. Geography knowledge and skills are integrated mostly into social studies and science.

- Caution: The geography component had only 24 questions and was conducted to collect only a minimum of information on geography skills. It should not be interpreted as an extensive assessment of geography knowledge and skills.

"Context for Learning" Highlights

Data that describe the different contexts for learning can contribute to an understanding of achievement results. Of particular interest are patterns that might emerge in relation to high student performance or low student performance. The IAEP II study collected information from students and school principals about some of the characteristics of educational systems, classrooms, homes, and students that might contribute to the thoughtful interpretation of achievement results. Throughout this report, detailed information is presented about the learning contexts for Alberta, for other Canadian provinces, and for some countries with interesting comparisons. This information provides insights that are helpful in understanding the impact of educational and cultural factors on student achievement and learning. A few highlights are listed below.

Amount of Instruction and Class Size

Generally, the highest performing countries also have the most instructional days in their school year. Taiwan, Korea, and Switzerland follow this pattern.

In this study, student achievement does not appear to be related closely to class size. Of particular note are Korea and Taiwan, both of which have very large class sizes and high performance scores.

Home Characteristics

Science and mathematics performance in IAEP II was directly related to the number of books in students' homes. Students with access to a larger number of books achieved higher scores. This is consistent for all countries and provinces that participated.

There seems to be a difference between North America and other countries in the impact on scores when parents show an interest in science. In North America, students score higher when parents show an interest in science. This is not necessarily the case in other parts of the world. Why this difference exists can only be hypothesized, taking into consideration the cultural differences that exist between countries.

How Students Spend Their Time

Children who read more do better; those who watch more television do not do as well. These findings were consistent for both science and mathematics. However, a clear pattern for student performance in relation to the amount of time students spend on homework did not emerge. It is interesting to note that North American results show either no impact or a negative influence on results as students spend more time on all homework. In other countries, there is either no impact or a positive one. This suggests there may be a qualitative difference in the type of homework North American children do compared with children in other countries.

Student Attitudes

In nearly every country or province, students with positive attitudes toward mathematics and science do better than those who are less positive. While this is not surprising, the importance of a positive attitude is reinforced as a key contributor to higher results.

Calculators and Computers

Students in Canada and the United States have or have access to calculators and computers more so than students in most other countries. But, the study shows that this advantage has not generally resulted in North American students achieving higher scores.

SECTION 2: COUNTRIES AND THEIR EDUCATION SYSTEMS

Information about schools and schooling in participating countries follows. The way in which education systems deliver programs varies widely, as does the cultural context within which the programs operate.

Figures 2.1 and 2.2 provide data on class size, amount of instruction and other categories for which information was collected in relation to achievement.

Figure 2.1. Education Systems and Average Percent Correct

| | Average % Correct in Science | Average % Correct in Math | Average Days of Instruction in Year* | Avg. Minutes of Instruction in School Each Day* | Average Class Size for Grade 8* | % of Schools With One or More Serious Problems** |
|---------------------------------|------------------------------|---------------------------|--------------------------------------|---|---------------------------------|--|
| Science Rank Order/IAEP Average | 67 | 58 | | | | |
| Korea | 78 | 73 | 222 | 264 | 49 | 24 |
| Taiwan | 76 | 73 | 222 | 318 | 44 | 10 |
| Switzerland | 74 | 71 | 207 | 305 | 18 | 11 |
| Hungary | 73 | 68 | 177 | 223 | 27 | 32 |
| Soviet Union | 71 | 70 | 198 | 243 | 22 | 72 |
| Slovenia | 70 | 57 | 190 | 248 | 25 | 50 |
| Emilia-Romagna, Italy | 70 | 64 | 204 | 289 | 21 | 18 |
| Israel | 70 | 63 | 215 | 278 | 32 | 46 |
| Caribbean | 69 | 62 | 188 | 304 | 25 | 13 |
| France | 69 | 64 | 174 | 370 | 25 | 29 |
| Scotland | 68 | 61 | 191 | 324 | 24 | 23 |
| Spain | 68 | 55 | 188 | 285 | 29 | 33 |
| United States | 67 | 55 | 178 | 338 | 23 | 5 |
| Ireland | 63 | 61 | 173 | 323 | 27 | 39 |
| Jordan | 57 | 40 | 191 | 260 | 27 | 63 |
| Special Populations | | | | | | |
| England | 69 | 61 | 192 | 300 | 22 | 24 |
| China | 67 | 80 | 251 | 305 | 48 | 43 |
| Portugal | 63 | 48 | 172 | 334 | 25 | 56 |
| Sao Paulo, Brazil | 53 | 37 | 181 | 271 | 38 | 60 |
| Fortaleza, Brazil | 46 | 32 | 183 | 223 | 32 | 62 |
| Mozambique | N/A | 28 | 193 | 272 | 51 | 92 |

* School Questionnaire

** Problems identified in the school questionnaire included overcrowding, shortage of textbooks, shortage of educational materials, student absenteeism, student discipline, vandalism. (See Figure 2.2 for details.)

N/A Information not available.

Figure 2.1 (continued). Education Systems and Average Percent Correct

| | Average % Correct in Science | Average % Correct in Math | Average Days of Instruction in Year* | Avg. Minutes of Instruction in School Each Day* | Average Class Size for Grade 8* | % of Schools With One or More Serious Problems** |
|-----------------------------------|------------------------------|---------------------------|--------------------------------------|---|---------------------------------|--|
| Canadian Populations/LAEP Average | 67 | 58 | | | | |
| Alberta | 74 | 64 | 190 | 315 | 23 | 5 |
| British Columbia | 72 | 66 | 190 | 304 | 25 | 19 |
| Quebec - French | 71 | 69 | 181 | 303 | 28 | 11 |
| Saskatchewan - English | 70 | 62 | 194 | 297 | 21 | 11 |
| Quebec - English | 69 | 66 | 181 | 302 | 26 | 14 |
| Nova Scotia | 69 | 60 | 187 | 293 | 24 | 18 |
| Manitoba - English | 69 | 58 | 192 | 312 | 21 | 10 |
| Ontario - English | 67 | 58 | 187 | 304 | 27 | 11 |
| Manitoba - French | 67 | 63 | 194 | 313 | 20 | 13 |
| New Brunswick - English | 66 | 58 | 185 | 296 | 23 | 11 |
| Newfoundland | 66 | 59 | 187 | 289 | 24 | 35 |
| Saskatchewan - French | 65 | 68 | 195 | 309 | 20 | 21 |
| New Brunswick - French | 64 | 61 | 188 | 303 | 24 | 27 |
| Ontario - French | 60 | 53 | 187 | 300 | 22 | 20 |

* School Questionnaire

** Problems identified in the school questionnaire included overcrowding, shortage of textbooks, shortage of educational materials, student absenteeism, student discipline, vandalism. (See Figure 2.2 for details.)

Observations (Figure 2.1)

Education systems vary from country to country but not necessarily in patterns that explain high and low achievement. For most countries, the average number of days of instruction in a year varies from 175 to 222. In China, the average of 251 days of instruction is dramatically higher than the norm. Korea and Taiwan also show a relatively high number, whereas Ireland and France show the lowest. Alberta shows a higher number than the Canadian average but in general, students across Canada have about the same number of instructional days each year.

The number of minutes spent on instruction each school day must be taken into account when comparing the number of instructional days. For example, the United States shows a slightly lower than average number of instructional days but reports a higher number of minutes of daily instruction compared with the overall average. France has the longest school day, compensating for the fewer number of instructional days each year. Alberta has a higher number of instructional minutes per day compared with other provinces. Similarly, Taiwan, France, Scotland, the United States, Ireland, and Portugal report a high number of instructional minutes per day compared with most other countries.

Student performance in this study does not appear to be related to class size. Of all participating populations, Switzerland has the lowest class size, with 18 students, followed by Italy, England, North America and the Soviet Union. Alberta reports an average of 23 students in each class. China, Korea, Taiwan, and Mozambique report large class sizes.

Figure 2.2 shows the degree to which different school-related problems exist in different countries.

| Figure 2.2. Age 13: Problems in School* | | | | | | | |
|---|---------------------------------------|---|-----------|--------------------------|------------------------|-----------------------|-----------|
| Science Rank Order /IAEP Average | Number of Schools Participating | Percent of Schools Reporting Problems as Moderate or Serious: | | | | | |
| | | Overcrowding | Textbooks | Educational Materials | Student Absenteeism | Student Discipline | Vandalism |
| Korea | 110 | 37 | 1 | 51 | 14 | 45 | 18 |
| Taiwan | 108 | 28 | 0 | 21 | 2 | 8 | 17 |
| Switzerland | 397 | 33 | 6 | 9 | 4 | 16 | 17 |
| Hungary | 144 | 29 | 6 | 31 | 12 | 23 | 31 |
| Soviet Union | 138 | 74 | 32 | 75 | 24 | 20 | 16 |
| Slovenia | 114 | 52 | 13 | 65 | 7 | 20 | 28 |
| Emilia-Romagna, Italy | 90 | 12 | 2 | 39 | 7 | 26 | 27 |
| Israel | 110 | 61 | 13 | 25 | 8 | 22 | 24 |
| Canada | 1373 | 31 | 13 | 22 | 11 | 9 | 4 |
| France | 103 | 46 | 4 | 19 | 12 | 24 | 19 |
| Scotland | 92 | 10 | 24 | 18 | 22 | 12 | 10 |
| Spain | 109 | 36 | 10 | 47 | 20 | 30 | 19 |
| United States | 96 | 16 | 7 | 13 | 18 | 16 | 8 |
| Ireland | 110 | 41 | 14 | 46 | 23 | 13 | 10 |
| Jordan | 106 | 63 | 13 | 48 | 20 | 13 | 18 |
| Special Populations | | | | | | | |
| England | 83 | 28 | 31 | 33 | 9 | 19 | 8 |
| China | 119 | 41 | 4 | 40 | 9 | 12 | 15 |
| Portugal | 89 | 47 | 22 | 75 | 34 | 17 | 16 |
| Sao Paulo, Brazil | 108 | 22 | 41 | 60 | 38 | 51 | 54 |
| Fortaleza, Brazil | 118 | 23 | 58 | 53 | 24 | 38 | 47 |
| Mozambique | 13 | 59 | 85 | 84 | 39 | 38 | 77 |

* School Questionnaire

Figure 2.2 (continued). Age 13: Problems in School*

| | Number of Schools Participating ** | Percent of Schools Reporting Problems as Moderate or Serious: | | | | | |
|----------------------------|------------------------------------|---|-----------|-----------------------|---------------------|--------------------|-----------|
| | | Overcrowding | Textbooks | Educational Materials | Student Absenteeism | Student Discipline | Vandalism |
| Canadian Pops/IAEP Average | | | | | | | |
| Alberta | 119 | 30 | 6 | 17 | 12 | 6 | 1 |
| British Columbia | 105 | 25 | 13 | 23 | 34 | 15 | 12 |
| Quebec - French | 106 | 35 | 2 | 11 | 10 | 15 | 4 |
| Saskatchewan - English | 140 | 27 | 12 | 13 | 15 | 8 | 2 |
| Quebec - English | 83 | 22 | 9 | 18 | 13 | 10 | 8 |
| Nova Scotia | 108 | 38 | 8 | 20 | 14 | 17 | 7 |
| Manitoba - English | 115 | 19 | 8 | 15 | 9 | 10 | 6 |
| Ontario - English | 123 | 34 | 18 | 25 | 5 | 4 | 4 |
| Manitoba - French | 46 | 25 | 22 | 37 | 11 | 11 | 8 |
| New Bruns. - English | 100 | 28 | 11 | 32 | 14 | 28 | 12 |
| Newfoundland | 108 | 33 | 6 | 41 | 32 | 13 | 11 |
| Saskatchewan - French | 30 | 41 | 14 | 41 | 6 | 10 | 6 |
| New Brunswick - French | 70 | 44 | 13 | 31 | 22 | 28 | 5 |
| Ontario - French | 117 | 31 | 17 | 27 | 12 | 12 | 7 |

* School Questionnaire

** The total number of schools for all provinces is 3 less than reported for Canada as a result of 3 schools being dropped due to special circumstances.

Observations (Figure 2.2)

The four lowest performing populations report a high incidence of problems in their schools, as do two higher performing populations, Slovenia and the Soviet Union. Alberta results show that a relatively low percentage of schools perceive the variety of problems surveyed to be of a moderate or serious nature. It is interesting to note that the Soviet Union has an average class size of 22 students, and yet 74% of schools report overcrowding to be a moderate or serious problem. Generally, the most serious problem reported by each population is overcrowding. Student discipline appears to be of less concern when compared with overcrowding and general availability of educational materials. In addition, a high percentage of schools in some countries report a shortage of educational materials as being a moderate to serious issue. For example, 51% of Korean schools report this to be a problem.

SECTION 3: SCIENCE RESULTS

In Alberta, 1459 students were sampled to write the science portion of the study and to answer related background questions. Interesting aspects of curriculum-related information, classroom characteristics, students and their homes, and education systems are presented.

Summary of Science Information

Two areas in which Alberta stands out are Nature of Science, and Integrates Science. Students were required to generalize, hypothesize, and reason by synthesizing specific information. The Alberta results are interesting when considered with the information that shows that Alberta students do experiments on their own more often than students in other participating countries do.

The emphasis that schools place on many of the sub-topics varies dramatically and cannot consistently be linked to performance. Curiously, Alberta schools report a lower emphasis on Nature of Science sub-topics (when compared with the Canadian average), and yet Alberta ranked first overall. The results that show Alberta students conduct experiments fairly often may support Alberta's high overall performance.

The findings that describe classroom factors highlight the variation in practices among countries. The majority of Alberta's 13-year-old students tend to spend one hour on science homework each week, do not have weekly science quizzes, listen to science lessons approximately 45% of the time, and conduct experiments fairly often. Science classes are never based on ability in Alberta, and only 2% of Alberta schools report that they do not have a science laboratory. Approximately one-half of Alberta schools use specialists to teach science, and over 65% of those teaching the course have taken some post-secondary training in science. Alberta spends more time on science instruction each week compared to the Canadian average. All these factors indicate a greater focus on science in Alberta than in most other countries. Perhaps this emphasis helps to explain the high performance of Alberta students.

The information reported about students and their homes shows variation between countries. Nine percent of Alberta's 13-year-olds report receiving instruction in a language different from that spoken at home. This age group is much more likely to spend their time watching television than studying. Overall, science achievement is positively related to the number of books in the home in each population. There is also a positive relationship between leisure reading and science achievement in the majority of populations.

The gender information provides some interesting differences for 13-year-old males and females in Alberta. Approximately 50% of females feel they are good at science compared with approximately 70% of males. A significantly lower percentage of females feel science is useful in their daily lives; however, there is only a 1% difference between male and female responses to the question "Science is more for boys than girls." Obviously, gender differences continue to exist in science. Performance levels show that females continue to perform at lower levels than males.

Only 19% of Alberta students agreed with the statement "Facts and ideas about science cannot be questioned or changed." This is much lower than the overall average and perhaps is a result of Alberta students conducting experiments more often. Having a questioning attitude is a goal that is supported through Alberta's science education programs.

Information about countries and their education systems provides an important context for understanding the relative performance of participants. Performance levels do not seem to be linked directly to class size, as noted from the high performance of students in Korea and Taiwan and the low performance of some participants with relatively lower class sizes.

Although some consistent relationships between certain background characteristics and achievement can be noted, they do not occur often. Factors that impact on academic performance interact in complex ways and appear to operate differently in different cultures and education systems.

Science Performance of 13-Year-Old Students

Figure 3.1 shows the overall results for all participating populations. It reports science performance for males and females as well as average scores for performance on science topics and cognitive processes. Below is a brief description of each topic and cognitive process:

Life Sciences: Students are able to classify plants and animals, know forms of animal adaption, know the basis of animal behavior, and understand interaction/interdependence within ecosystems.

Physical Sciences: Students know and understand concepts such as time, matter, and energy.

Earth and Space Sciences: Students demonstrate knowledge and understanding of concepts such as the solar system, the universe, and the water cycle.

Nature of Science: Students know and can use scientific inquiry skills. Highlighted in the IAEP were observing, classifying and inferring, interpreting data, and conducting inquiries.

Knows (Knowledge): Students have a knowledge base to solve simple problems.

Uses: Students use factual knowledge and apply basic scientific facts and principles in one or two-step processes.

Integrates: Students can bring together a variety of knowledge and skills to solve more complex problems.

Figure 3.1. Science, Age 13: Distribution of Percent Correct Scores by Country/Province

| | Overall Average Percent Correct | Average Male/Female Percent | Science Topics (%) | | | | Cognitive Processes (%) | | |
|--------------------------------|---------------------------------|-----------------------------|--------------------|-------------------|----------------------|-------------------|-------------------------|-------|------------|
| | | | Life Sciences | Physical Sciences | Earth/Space Sciences | Nature of Science | Knows | Uses | Integrates |
| Rank Order/IAEP Average | 67 | | 68 | 64 | 67 | 71 | 73 | 66 | 65 |
| Korea | 78 | 80/75 | 82/78 | 78/73 | 78/71 | 80/78 | 86/82 | 80/74 | 74/71 |
| Taiwan | 76 | 76/75 | 79/77 | 75/74 | 75/69 | 75/77 | 82/81 | 76/73 | 72/73 |
| Switzerland | 74 | 76/71 | 76/73 | 74/66 | 78/71 | 80/79 | 79/75 | 76/68 | 76/73 |
| Hungary | 73 | 76/71 | 79/76 | 73/67 | 76/69 | 75/76 | 85/80 | 74/68 | 70/70 |
| Soviet Union | 71 | 73/70 | 73/73 | 74/68 | 76/70 | 68/68 | 79/78 | 72/67 | 69/67 |
| Slovenia | 70 | 73/68 | 75/72 | 71/64 | 73/67 | 72/73 | 82/78 | 71/65 | 67/66 |
| Emilia-Romagna, Italy | 70 | 72/68 | 73/70 | 71/63 | 74/68 | 73/73 | 82/78 | 71/65 | 67/66 |
| Israel | 70 | 72/68 | 68/63 | 72/68 | 71/65 | 78/79 | 73/69 | 71/66 | 71/71 |
| Canada | 69 | 71/67 | 70/67 | 68/62 | 71/65 | 78/80 | 74/70 | 69/63 | 71/71 |
| France | 69 | 71/67 | 69/66 | 70/64 | 70/64 | 76/76 | 75/70 | 68/62 | 66/65 |
| Scotland | 68 | 70/66 | 69/66 | 68/64 | 68/61 | 76/77 | 74/71 | 69/63 | 68/68 |
| Spain | 68 | 69/66 | 72/69 | 66/62 | 72/66 | 70/70 | 78/75 | 68/63 | 64/65 |
| United States | 67 | 69/65 | 72/67 | 65/58 | 70/64 | 76/76 | 75/70 | 68/62 | 66/65 |
| Ireland | 63 | 66/61 | 63/59 | 64/58 | 70/62 | 73/70 | 68/64 | 66/59 | 65/62 |
| Jordan | 57 | 57/56 | 59/58 | 54/53 | 62/58 | 55/57 | 66/65 | 58/55 | 49/50 |
| Special Populations | | | | | | | | | |
| China ¹ | 67 | 69/65 | 66/61 | 70/65 | 73/68 | 70/69 | 71/65 | 70/64 | 68/65 |
| England ¹ | 69 | 70/67 | 69/67 | 69/64 | 69/63 | 76/77 | 74/71 | 69/64 | 69/69 |
| Portugal ¹ | 63 | 65/60 | 68/64 | 62/55 | 65/58 | 69/67 | 72/68 | 64/58 | 61/58 |
| Sao Paulo, Brazil ¹ | 53 | 56/50 | 59/54 | 53/46 | 62/51 | 55/51 | 65/57 | 56/49 | 50/45 |
| Fortaleza, Brazil ¹ | 46 | 49/44 | 54/49 | 45/41 | 53/46 | 46/44 | 59/53 | 48/44 | 43/39 |

¹ This country drew its sample from less than its total student population.

Figure 3.1 (continued). Science, Age 13: Distribution of Percent Correct Scores by Country/Province

| | Overall Average Percent Correct | Average Male/Female Percent | Science Topics (%) | | | | Cognitive Processes (%) | | |
|-----------------------------------|---------------------------------|-----------------------------|--------------------|-------------------|----------------------|-------------------|-------------------------|-------|------------|
| | | | Life Sciences | Physical Sciences | Earth/Space Sciences | Nature of Science | Knows | Uses | Integrates |
| Canadian Populations/IAEP Average | | | 68 | 64 | 67 | 71 | 73 | 66 | 65 |
| Alberta | 74 | 76/72 | 74/71 | 74/68 | 77/70 | 85/84 | 78/74 | 75/69 | 77/75 |
| British Columbia | 72 | 74/71 | 70/70 | 73/68 | 74/70 | 80/82 | 77/76 | 72/67 | 73/75 |
| Manitoba - English | 69 | 70/67 | 70/66 | 68/63 | 74/67 | 76/78 | 74/71 | 69/63 | 72/70 |
| Manitoba - French | 67 | 70/64 | 68/63 | 68/61 | 72/64 | 74/73 | 73/67 | 68/61 | 69/68 |
| New Brunswick - English | 66 | 68/65 | 68/65 | 65/61 | 69/63 | 74/76 | 71/69 | 68/62 | 66/67 |
| New Brunswick - French | 64 | 64/63 | 63/61 | 63/61 | 66/64 | 67/71 | 65/62 | 65/62 | 62/66 |
| Newfoundland | 66 | 69/64 | 67/62 | 66/59 | 72/66 | 75/75 | 73/67 | 68/61 | 66/65 |
| Nova Scotia | 69 | 70/67 | 70/66 | 68/63 | 71/66 | 75/78 | 74/70 | 70/65 | 67/69 |
| Ontario - English | 67 | 69/66 | 68/65 | 66/61 | 68/63 | 77/80 | 72/68 | 67/62 | 69/70 |
| Ontario - French | 60 | 62/59 | 62/59 | 59/54 | 64/58 | 68/68 | 64/60 | 61/56 | 62/61 |
| Quebec - English | 69 | 71/67 | 70/68 | 68/61 | 71/65 | 80/81 | 74/71 | 69/63 | 72/70 |
| Quebec - French | 71 | 73/70 | 74/71 | 70/64 | 73/67 | 80/80 | 76/72 | 72/66 | 73/74 |
| Saskatchewan - English | 70 | 72/68 | 72/69 | 68/62 | 74/69 | 79/80 | 76/72 | 71/65 | 70/70 |
| Saskatchewan - French | 65 | 66/63 | 66/62 | 62/58 | 71/67 | 74/75 | 69/66 | 65/59 | 66/68 |

Observations (Figure 3.1)

The results are presented for four content areas—Life Sciences, Physical Sciences, Earth and Space Sciences, and Nature of Science—and for three levels of cognitive processing—Knows Science, Uses Science, and Integrates Science. Alberta students performed very well in all areas, especially in Nature of Science. Also of note is Alberta's performance in Integrates Science, which is the highest of all project participants.

Finally, results show that significant differences between male and female performance levels continue to exist. A gender difference is evident in all participating populations, with males consistently outperforming females. The smallest gender differences are found in New Brunswick (French), Taiwan, and Jordan. In Alberta, boys scored on average four percentage points higher than girls. An exception to this trend is found in the results for Nature of Science. But for Alberta and Manitoba (French), all Canadian populations show girls scoring equal to or higher than boys in this content area. Similar results are evident in 13 of the participating countries. These results demonstrate that gaps continue to exist between male and female performance levels in spite of the special attention afforded this issue over the years.

Curriculum Emphasis

Figure 3.2 examines the percentage of schools reporting to emphasize on sub-topics in the four content areas.

Figure 3.2. Science, Age 13: Emphasis for All Major Topics*

| | Average Percent Correct | Percent of Schools Reporting to Emphasize: | | | | | | | | | | | | |
|--------------------------------------|-------------------------|--|---------|------------|-------------------------|-----------------------|-----------------|---------------|--------------------------|------------------------|-------------------|-----------------|----------------------|---------------------------|
| | | Life Sciences | | | Physical Sciences | | | | | Earth & Space Sciences | | | Nature of Science | |
| | | Plants | Animals | Human Body | Electricity & Magnetism | Mass Motion & Gravity | Chem Substances | Light & Sound | Solids, Liquids, & Gases | Rocks & Minerals | Weather & Climate | Stars & Planets | Scientific Processes | How to Design Experiments |
| Populations | | | | | | | | | | | | | | |
| Canada | 69 | 21 | 19 | 11 | 17 | 32 | 18 | 9 | 51 | 33 | 26 | 16 | 79 | 65 |
| Alberta | 74 | 26 | 8 | 4 | 7 | 15 | 4 | 4 | 33 | 67 | 30 | 26 | 68 | 48 |
| British Columbia | 72 | 4 | 10 | 31 | 6 | 24 | 17 | 37 | 83 | 36 | 12 | 10 | 71 | 22 |
| Manitoba-English | 69 | 18 | 21 | 62 | 21 | 16 | 34 | 11 | 40 | 32 | 12 | 29 | 62 | 58 |
| Manitoba-French | 67 | 44 | 44 | 56 | 40 | 29 | 47 | 27 | 71 | 20 | 20 | 49 | 78 | 59 |
| N. Bruns.-English | 66 | 33 | 43 | 3 | 46 | 14 | 42 | 8 | 34 | 15 | 11 | 5 | 60 | 34 |
| N. Bruns.-Fr. | 64 | 24 | 27 | 0 | 6 | 26 | 16 | 3 | 66 | 0 | 3 | 0 | 60 | 49 |
| Nfld. | 66 | 6 | 27 | 48 | 42 | 2 | 10 | 1 | 46 | 28 | 3 | 0 | 67 | 58 |
| Nova Scotia | 69 | 20 | 38 | 1 | 55 | 27 | 55 | 2 | 18 | 51 | 12 | 5 | 77 | 55 |
| Ontario-English | 67 | 27 | 25 | 3 | 21 | 45 | 19 | 8 | 55 | 7 | 9 | 8 | 92 | 85 |
| Ontario-Fr. | 60 | 47 | 31 | 16 | 30 | 69 | 34 | 19 | 71 | 6 | 28 | 3 | 94 | 88 |
| Quebec-English | 69 | 6 | 5 | 5 | 2 | 13 | 11 | 9 | 60 | 68 | 71 | 5 | 84 | 39 |
| Quebec-Fr. | 71 | 6 | 6 | 2 | 6 | 27 | 6 | 4 | 83 | 77 | 91 | 16 | 79 | 60 |
| Sask.-Engl. | 70 | 10 | 9 | 5 | 4 | 13 | 4 | 3 | 10 | 73 | 58 | 55 | 52 | 37 |
| Sask.-Fr. | 65 | 11 | 19 | 12 | 21 | 34 | 10 | 21 | 17 | 79 | 45 | 72 | 64 | 52 |
| Other Interesting Comparisons | | | | | | | | | | | | | | |
| China | 67 | 19 | 79 | 11 | 14 | 62 | 5 | 15 | 27 | 8 | 38 | 10 | 22 | 18 |
| Hungary | 73 | 66 | 74 | 74 | 80 | 15 | 24 | 3 | 32 | 31 | 70 | 6 | 44 | 33 |
| Jordan | 57 | 31 | 14 | 29 | 74 | 51 | 62 | 10 | 13 | 20 | 78 | 59 | 16 | 19 |
| Korea | 78 | 47 | 64 | 64 | 84 | 10 | 11 | 2 | 19 | 71 | 13 | 5 | 19 | 30 |
| Soviet Union | 71 | 47 | 95 | 28 | 70 | 32 | 87 | 35 | 63 | 36 | 73 | 9 | 58 | 44 |
| Switzerland | 74 | 36 | 38 | 54 | 16 | 17 | 7 | 7 | 10 | 2 | 25 | 10 | 23 | 10 |
| Taiwan | 76 | 15 | 18 | 11 | 11 | 81 | 20 | 7 | 56 | 1 | 3 | 3 | 61 | 22 |
| United States | 67 | 25 | 25 | 23 | 19 | 40 | 23 | 20 | 39 | 57 | 54 | 52 | 63 | 56 |

* School Questionnaire; information for other countries is reported in *Learning Science: IAEP II*

Observations (Figure 3.2)

There is a substantial variation in what sub-topics are emphasized for the different populations. These differences in emphasis from topic to topic cannot always be consistently related to performance. There are some general trends. For example, Hungary reports a high emphasis on Life Sciences sub-topics and shows high performance scores in this area. Alberta's lower performance corresponds to a lower emphasis on Life Science sub-topics.

The emphasis on the Physical Sciences sub-topics varies considerably from population to population. In Korea and Hungary, for example, a high percentage of schools report emphasis on Electricity and Magnetism, whereas British Columbia and Quebec (French) show a high percentage of schools reporting emphasis on Solids, Liquids and Gases. No consistent pattern emerges when comparing emphasis and performance on the Physical Sciences questions. Manitoba (French) and Ontario (French) both report a relatively high emphasis on the Physical Sciences sub-topics, and yet both populations scored lower on this content area when compared with their overall performance scores. Alberta schools reported a lower emphasis on the Physical Sciences sub-topics compared with the Canadian average, and yet Alberta students scored higher than the Canadian average in Physical Sciences.

As with the other content areas, the patterns are not consistent for Earth and Space Sciences, although some general trends do emerge. For example, Taiwan stands out in the very low emphasis reported for Earth and Space Sciences sub-topics and scored 72% on this content area compared with an overall performance score of 76%. Alberta reported a higher percentage of schools emphasizing this sub-topic compared with the Canadian average and scored 74%, only 1% behind top-performing Korea.

Alberta reported a lower percentage of schools emphasizing Nature of Science sub-topics compared with the Canadian average. Yet Alberta students scored 84% on this content area—ranking first overall. The Nature of Science questions compare favorably with Alberta's "process skill" approach in the teaching of science. The low curriculum emphasis reported by schools may not have reflected this aspect of curriculum emphasis. High performance in science would seem to be related to factors other than just curricular emphasis in schools.

Classroom Characteristics

The information reported in this section was collected from students and school administrators. It highlights the variation in teaching practices and classroom factors across various populations.

Figure 3.3. Science, Age 13: Teaching Practices and Average Percent Correct

| Populations | Average Percent Correct | Average Minutes of Science Instruction Each Week** | Percent of Students Who: | | | |
|-------------------------------|-------------------------|--|-------------------------------------|------------------------------------|---|--|
| | | | Listen to Science Lessons Each Day* | Never Do Experiments on Their Own* | Take a Science Test or Quiz at Least Once a Week* | Spend 4 Hrs or More on Science Homework Each Week* |
| Canada | 69 | 156 | 21 | 13 | 26 | 4 |
| Alberta | 74 | 194 | 44 | 14 | 24 | 6 |
| British Columbia | 72 | 188 | 29 | 14 | 33 | 7 |
| Manitoba - English | 69 | 201 | 45 | 23 | 27 | 4 |
| Manitoba - French | 67 | 205 | 19 | 10 | 55 | 7 |
| N. Bruns. - English | 66 | 180 | 37 | 24 | 27 | 3 |
| N. Bruns. - French | 64 | 180 | 24 | 14 | 44 | 4 |
| Newfoundland | 66 | 198 | 38 | 13 | 17 | 7 |
| Nova Scotia | 69 | 204 | 47 | 18 | 19 | 6 |
| Ontario - English | 67 | 123 | 22 | 14 | 14 | 3 |
| Ontario - French | 60 | 141 | 14 | 5 | 38 | 4 |
| Quebec - English | 69 | 178 | 36 | 21 | 34 | 6 |
| Quebec - French | 71 | 176 | 12 | 10 | 51 | 4 |
| Sask. - English | 70 | 166 | 22 | 34 | 14 | 3 |
| Sask. - French | 65 | 133 | 14 | 12 | 30 | 4 |
| Other Interesting Comparisons | | | | | | |
| China | 67 | 331 | 23 | 29 | 42 | 16 |
| Hungary | 73 | 207 | 40 | 31 | 27 | 13 |
| Jordan | 57 | 180 | 60 | 26 | 73 | 12 |
| Korea | 78 | 144 | 21 | 35 | 21 | 9 |
| Soviet Union | 71 | 387 | 80 | 13 | 88 | 59 |
| Switzerland | 74 | 152 | 28 | 36 | 18 | 1 |
| Taiwan | 76 | 245 | 25 | 25 | 67 | 10 |
| United States | 67 | 233 | 66 | 25 | 69 | 7 |

* Student Questionnaire

** School Questionnaire

Observations (Figure 3.3)

Alberta and British Columbia, the two top-performing provinces, spend more time on science instruction each week compared with the Canadian average. The majority of populations report an average of 150 to 200 minutes spent on science instruction each week. The average is higher in Taiwan, Hungary, and the United States (between 200 and 250 minutes each week), and very high in China and the Soviet Union (between 330 and 390 minutes each week). Korea, Saskatchewan (French), Ontario (French), and Ontario (English) show a relatively shorter length of time spent on science instruction (less than 145 minutes each week).

The United States, Jordan, and especially the Soviet Union all report a relatively high percentage of students who spend their instructional time listening to their teachers explain science lessons every day. Nova Scotia, Manitoba (English), and Alberta are well above the Canadian average for the number of students reporting that they listen to science lessons daily.

Taking tests and quizzes at least once a week is common in some places. The results from the Soviet Union and Taiwan (both high-performing populations) and Jordan and the United States (both lower performing populations) indicate that weekly quizzes are used extensively to evaluate student performance in science. The relationship between frequent testing and overall performance is not consistent for the school-administered or teacher-administered tests that were reported in this study. In general, most populations do not report a majority of schools administering science tests on a weekly basis.

A consistent relationship between the amount of time spent on homework and science achievement is not evident. The majority of students from most populations spend between 0 and 1 hour on science homework each week. The Soviet Union is an exception, with 59% of students reporting that they spend four hours or more on science homework each week.

The information about teaching practices and the relationship to science achievement is examined in Figure 3.4.

| Figure 3.4. Science, Age 13: Relationship of Teaching Practices and Average Percent Correct Within Populations | | | | |
|--|---|--|----------------------------|---|
| | Amount of Listening to Science Lessons* | Amount of Student Conducted Experiments* | Amount of Science Testing* | Amount of Time Spent on Science Homework* |
| Populations | | | | |
| Canada | 0 | + | + | 0 |
| Alberta | + | 0 | 0 | 0 |
| British Columbia | + | 0 | + | 0 |
| Manitoba - English | + | - | 0 | 0 |
| Manitoba - French | - | - | 0 | - |
| N. Bruns. - English | + | - | 0 | 0 |
| N. Bruns. - French | 0 | - | 0 | - |
| Newfoundland | + | 0 | - | 0 |
| Nova Scotia | + | 0 | - | 0 |
| Ontario - English | + | 0 | 0 | 0 |
| Ontario - French | - | 0 | 0 | 0 |
| Quebec - English | + | + | 0 | + |
| Quebec - French | - | + | + | 0 |
| Sask. - English | + | 0 | 0 | 0 |
| Sask. - French | - | 0 | 0 | 0 |
| Other Interesting Comparisons | | | | |
| China | + | 0 | 0 | 0 |
| Hungary | 0 | - | 0 | + |
| Jordan | + | - | 0 | 0 |
| Korea | + | - | - | - |
| Soviet Union | + | 0 | + | + |
| Switzerland | 0 | 0 | 0 | - |
| Taiwan | + | 0 | + | + |
| United States | 0 | - | 0 | 0 |

* Student Questionnaire

+ Statistically significant positive relationship

- Statistically significant negative relationship

0 No statistically significant linear relationship

IAEP II results indicate that science instruction with frequent teacher presentations is positively associated with performance. Canada is the only population where students using hands-on activities was positively related to science performance.

The use of computers and hands-on activities, such as work in science laboratories, is increasingly being advocated by science educators as a central part of learning and developing scientific skills. The information reported in Figure 3.5 shows that access to laboratories and computers varies from country to country.

| Figure 3.5. Science, Age 13: Teaching Materials and Average Percent Correct | | | | |
|---|-------------------------|---|---|---|
| | Average Percent Correct | Percent of Schools With No Science Laboratories** | Percent of Schools With General or Specialized Science Labs in One or More Classrooms** | Average Number of Computers in School** |
| Populations | | | | |
| Canada | 69 | 25 | 62 | 17 |
| Alberta | 74 | 2 | 88 | 26 |
| British Columbia | 72 | 4 | 96 | 37 |
| Manitoba - English | 69 | 9 | 77 | 15 |
| Manitoba - French | 67 | 5 | 90 | 18 |
| N. Bruns. - English | 66 | 24 | 68 | 13 |
| N. Bruns. - French | 64 | 8 | 71 | 8 |
| Newfoundland | 66 | 7 | 83 | 7 |
| Nova Scotia | 69 | 9 | 75 | 12 |
| Ontario - English | 67 | 47 | 37 | 15 |
| Ontario - French | 60 | 15 | 49 | 14 |
| Quebec - English | 69 | 18 | 81 | 15 |
| Quebec - French | 71 | 0 | 85 | 18 |
| Sask. - English | 70 | 11 | 81 | 14 |
| Sask. - French | 65 | 13 | 52 | 10 |
| Other Interesting Comparisons | | | | |
| China | 67 | 31 | 68 | 2 |
| Hungary | 73 | 32 | 34 | 6 |
| Jordan | 57 | 22 | 65 | 1 |
| Korea | 78 | 0 | 87 | 15 |
| Soviet Union | 71 | 3 | 94 | 2 |
| Switzerland | 74 | 45 | 48 | 4 |
| Taiwan | 76 | 1 | 99 | 15 |
| United States | 67 | 14 | 76 | 24 |

** School Questionnaire

Observations (Figure 3.4 and 3.5)

The relationship between the variables examined and achievement are consistent across the participating countries. Some students have fewer opportunities to conduct experiments as access to laboratories varies significantly from population to population. Still, the majority of schools in most populations indicate that students have access to a general or specialized laboratory.

Few schools in the Canadian provinces are without the benefit of having a lab. Ontario (English) is an exception, with almost one-half of schools reporting that they do not have a science laboratory. Although Korea and Taiwan report almost universal access to labs, both countries have a relatively high percentage of students reporting that they never do experiments (see Figure 3.3). Perhaps this is a result of the large class sizes. Alberta has the lowest percentage of schools in Canada that report not having a science laboratory—2% compared to the Canadian average of 25%. The commitment in Alberta to the development of science process skills through hands-on experimentation seems to be supported through facilities that include laboratories for student use.

Access to computers also varies vastly among the participants. Very few populations indicate that they have enough computers that would allow students to use them for school work. Alberta, the United States, and British Columbia report having from 24 to 37 computers in each school that students can use for school work. This is high compared to other participants in the study.

Figure 3.6 reports information on the academic background of the teachers responsible for teaching science. It also shows the percentage of schools that report assigning students to science classes based on ability.

| Figure 3.6. Science, Age 13: Teacher Background, Classroom Organization, and Average Percent Correct | | | | |
|--|-------------------------|--|---|--|
| | Average Percent Correct | Percent of Schools Where: | | |
| | | Teacher Teaches Science Most or All the Time** | All Science Teachers Have Taken Some Post-Secondary Science Courses** | Science Classes Are Based on Ability** |
| Populations | | | | |
| Canada | 69 | 37 | 50 | 5 |
| Alberta | 74 | 51 | 66 | 0 |
| British Columbia | 72 | 78 | 84 | 8 |
| Manitoba - English | 69 | 45 | 65 | 1 |
| Manitoba - French | 67 | 47 | 51 | 0 |
| N. Bruns. - English | 66 | 28 | 38 | 0 |
| N. Bruns. - French | 64 | 21 | 52 | 18 |
| Newfoundland | 66 | 49 | 61 | 2 |
| Nova Scotia | 69 | 77 | 60 | 8 |
| Ontario - English | 67 | 21 | 40 | 2 |
| Ontario - French | 60 | 9 | 10 | 6 |
| Quebec - English | 69 | 61 | 86 | 7 |
| Quebec - French | 71 | 81 | 49 | 21 |
| Sask. - English | 70 | 19 | 58 | 4 |
| Sask. - French | 65 | 14 | 43 | 17 |
| Other Interesting Comparisons | | | | |
| China | 67 | 74 | 28 | 1 |
| Hungary | 73 | 59 | 79 | 0 |
| Jordan | 57 | 87 | 72 | 10 |
| Korea | 78 | 89 | 10 | 1 |
| Soviet Union | 71 | 85 | 66 | 13 |
| Switzerland | 74 | 29 | 25 | 17 |
| Taiwan | 76 | 100 | 38 | 57 |
| United States | 67 | 79 | 62 | 29 |

** School Questionnaire

Observations (Figure 3.6)

In Canada, teachers of science also teach other courses of study more often than science teachers in other countries do. It is also interesting to note that in Korea and Ontario (French), only 10% of teachers teaching science have taken post-secondary science courses. The Canadian provinces report large differences in their responses. Quebec (English) and British Columbia report the highest percentage of science teachers with post-secondary courses in science. Taiwan reports that 100% of teachers teach science most or all of the time. Approximately one-half of Alberta schools use specialists to teach science, and over 65% of those teaching science have taken some post-secondary training in science.

Only Taiwan reports a high percentage of schools that organize science classes on the basis of ability. Alberta schools report that they never do this. The highest achieving populations, with the exception of Taiwan, do not assign students to science classes on the basis of ability.

Students and Their Homes

The IAEP study collected descriptive information about the students themselves and their families. Figures 3.7, 3.8, 3.9, and 3.10 report this information.

| Figure 3.7. Science, Age 13: Home Characteristics* and Average Percent Correct | | | | | | | |
|--|-------------------------|--|-------------------------------------|----------------------------------|--|---|--|
| | Average Percent Correct | Percent of Students Who: | | | | | |
| | | Speak the Same Language at Home as at School | Have 4 or More Brothers and Sisters | Have Fewer than 25 Books at Home | Have Parents Who are Interested in Science | Talk with Someone at Home about Science Class | Receive Help at Home with Science Homework |
| Populations | | | | | | | |
| Canada | 69 | 88 | 7 | 14 | 36 | 47 | 47 |
| Alberta | 74 | 91 | 11 | 11 | 39 | 52 | 59 |
| British Columbia | 72 | 88 | 9 | 9 | 39 | 57 | 56 |
| Manitoba - English | 69 | 89 | 10 | 12 | 33 | 44 | 47 |
| Manitoba - French | 67 | 19 | 9 | 15 | 33 | 50 | 42 |
| N. Bruns. - English | 66 | 96 | 10 | 14 | 34 | 44 | 51 |
| N. Br. s. - French | 64 | 89 | 7 | 31 | 28 | 45 | 49 |
| Newfoundland | 66 | 98 | 11 | 18 | 39 | 53 | 62 |
| Nova Scotia | 69 | 98 | 9 | 12 | 39 | 48 | 60 |
| Ontario - English | 67 | 86 | 8 | 10 | 38 | 45 | 50 |
| Ontario - French | 60 | 52 | 5 | 26 | 36 | 44 | 49 |
| Quebec - English | 69 | 79 | 7 | 7 | 41 | 46 | 38 |
| Quebec - French | 71 | 92 | 5 | 21 | 31 | 47 | 40 |
| Sask. - English | 70 | 95 | 11 | 12 | 34 | 43 | 51 |
| Sask. - French | 65 | 11 | 12 | 12 | 37 | 53 | 52 |
| Other Interesting Comparisons | | | | | | | |
| China | 67 | 97 | 12 | 30 | 62 | 80 | 40 |
| Hungary | 73 | 99 | 3 | 10 | 54 | 75 | 61 |
| Jordan | 57 | 98 | 88 | 48 | 55 | 79 | 40 |
| Korea | 78 | 98 | 21 | 25 | 28 | 53 | 44 |
| Soviet Union | 71 | 87 | 11 | 11 | 31 | 67 | 26 |
| Switzerland | 74 | 79 | 4 | 16 | 49 | 54 | 26 |
| Taiwan | 76 | N/A | 12 | 35 | 19 | 59 | 45 |
| United States | 67 | 94 | 15 | 18 | 35 | 50 | 53 |

*Student Questionnaire

Figure 3.8. Science, Age 13: Relationship of Home Characteristics and Average Percent Correct Within Populations

| | Number of Brothers and Sisters* | Number of Books in the Home* | Parents are Interested in Science* |
|--------------------------------------|---------------------------------|------------------------------|------------------------------------|
| Populations | | | |
| Canada | - | + | + |
| Alberta | 0 | + | + |
| British Columbia | - | + | + |
| Manitoba - English | - | + | + |
| Manitoba - French | 0 | + | + |
| N. Bruns. - English | - | + | + |
| N. Bruns. - French | - | + | + |
| Newfoundland | - | + | + |
| Nova Scotia | 0 | + | + |
| Ontario - English | - | + | + |
| Ontario - French | 0 | + | + |
| Quebec - English | - | + | + |
| Quebec - French | 0 | + | + |
| Sask. - English | - | + | + |
| Sask. - French | 0 | + | + |
| Other Interesting Comparisons | | | |
| China | - | + | 0 |
| Hungary | - | + | 0 |
| Jordan | 0 | + | 0 |
| Korea | - | + | + |
| Soviet Union | - | + | 0 |
| Switzerland | - | + | 0 |
| Taiwan | 0 | + | 0 |
| United States | - | + | + |

* Student Questionnaire

+ Statistically significant positive relationship

- Statistically significant negative relationship

0 No statistically significant linear relationship

Observations (Figure 3.7 and 3.8)

More than 12% of students living in Canada, Switzerland, and the Soviet Union report that they receive instruction at school in a language different from the one spoken at home. In Saskatchewan (French), almost 90% of students report that a different language from the one used in school was spoken at home.

Family size is generally smallest in industrialized nations. For example, only 7% of 13-year-olds in Canada report that they have four or more brothers and sisters. In Jordan, 88% of students indicate that they come from families where there are four or more children. In general, science performance is higher for students from smaller families.

The role of language and the opportunity to read by having material at home is important in learning and is positively related to performance in science (Figures 3.7 and 3.8). In Alberta, parental interest in science is also positively linked to student performance in science. In this case, a North American cultural effect exists which is not generally consistent in other countries. With the exception of North America and Korea (Figure 3.8), a significant relationship between parental interest in science and student achievement does not exist.

Figures in 3.9 and 3.10 examine some out-of-school activities that may be related to science achievement.

Figure 3.9. Science, Age 13: Home Activities* and Average Percent Correct

| | Average Percent Correct | Percent of Students Who: | | | |
|--------------------------------------|-------------------------|-------------------------------|---|--|--|
| | | Read for Fun Almost Every Day | Spend 2 Hrs or More on all Homework Every Day | Watch Television 5 Hrs or More Every Day | Have Positive Attitudes Toward Science** |
| Populations | | | | | |
| Canada | 69 | 36 | 26 | 15 | 62 |
| Alberta | 74 | 37 | 20 | 14 | 62 |
| British Columbia | 72 | 38 | 27 | 13 | 60 |
| Manitoba - English | 69 | 37 | 16 | 19 | 55 |
| Manitoba - French | 67 | 43 | 21 | 14 | 58 |
| N. Bruns. - English | 66 | 38 | 19 | 22 | 56 |
| N. Bruns. - French | 64 | 28 | 19 | 16 | 63 |
| Newfoundland | 66 | 39 | 27 | 23 | 67 |
| Nova Scotia | 69 | 36 | 20 | 22 | 59 |
| Ontario - English | 67 | 37 | 27 | 17 | 62 |
| Ontario - French | 60 | 33 | 22 | 18 | 71 |
| Quebec - English | 69 | 40 | 33 | 15 | 56 |
| Quebec - French | 71 | 32 | 25 | 12 | 61 |
| Sask. - English | 70 | 36 | 13 | 17 | 55 |
| Sask. - French | 65 | 45 | 17 | 10 | 57 |
| Other Interesting Comparisons | | | | | |
| China | 67 | 28 | 35 | 2 | 74 |
| Hungary | 73 | 44 | 61 | 16 | 69 |
| Jordan | 57 | 22 | 54 | 10 | 82 |
| Korea | 78 | 11 | 38 | 10 | 27 |
| Soviet Union | 71 | 48 | 52 | 19 | 66 |
| Switzerland | 74 | 49 | 21 | 7 | 59 |
| Taiwan | 76 | 17 | 44 | 7 | 51 |
| United States | 67 | 29 | 31 | 22 | 57 |

* Student Questionnaire

** Students were asked to what extent they agreed with the following statements: Much of what is learned in science is useful in everyday life; It is important to know some science to get a good job; I am good at science; My parents are interested in science. Their responses were combined to form an index of attitudes toward science.

Figure 3.10. Science, Age 13: Relationship of Home Activities and Average Percent Correct Within Populations

| | Amount of Leisure Reading* | Amount of Time Spent on All Homework* | Amount of Time Spent Watching Television* | Students' Attitudes Toward Science* |
|--------------------------------------|----------------------------|---------------------------------------|---|-------------------------------------|
| Populations | | | | |
| Canada | + | - | - | + |
| Alberta | + | - | - | + |
| British Columbia | + | 0 | - | + |
| Manitoba - English | + | - | - | + |
| Manitoba - French | + | - | - | + |
| N. Bruns. - English | + | - | - | + |
| N. Bruns. - French | + | - | - | + |
| Newfoundland | + | - | 0 | + |
| Nova Scotia | + | 0 | - | + |
| Ontario - English | + | - | - | + |
| Ontario - French | + | - | - | + |
| Quebec - English | + | 0 | - | + |
| Quebec - French | + | 0 | - | + |
| Sask. - English | + | - | - | + |
| Sask. - French | 0 | 0 | 0 | + |
| Other Interesting Comparisons | | | | |
| China | + | 0 | - | + |
| Hungary | + | + | - | + |
| Jordan | 0 | + | 0 | + |
| Korea | + | 0 | - | + |
| Soviet Union | + | + | 0 | 0 |
| Switzerland | + | 0 | - | + |
| Taiwan | + | + | - | + |
| United States | + | 0 | - | + |

* Student Questionnaire

+ Statistically significant positive relationship

- Statistically significant negative relationship

0 No statistically significant linear relationship

Observations (Figures 3.9 and 3.10)

How students spend their time outside of school hours provides interesting information and comparisons. Consistent reading is positively related to achievement in the majority of populations; however, the lowest percentage of daily readers reported was in Korea (11%) and Taiwan (17%), two countries that achieved the highest overall science scores. Alberta reports that 37% of their 13-year-olds read for fun almost every day.

In Canada, many provinces showed a negative relationship between time spent on all homework and science achievement. All other participating populations show either no relationship or a positive one. In Jordan, Hungary, and the Soviet Union, a higher percentage of students report that they spend two hours or more on all homework every day. Generally, students in Canada and Switzerland report spending the least time overall on homework. In Alberta, students who spend the most time doing homework perform at lower levels.

The amount of time students spend watching television is related to performance. With very few exceptions, the more television students watch the lower their performance scores. In the United States, slightly more than one-fifth of 13-year-olds report watching five hours or more of television every day compared to 14% of Alberta students.

Finally, a positive attitude toward science is likely to result in better performance. This trend existed for nearly all populations.

Figure 3.11 probes students attitude toward science. The percentage of males and females agreeing with the statements is reported for Alberta's students.

| Figure 3.11. Science, Age 13: Attitudes Towards Science* and Average Percent Correct | | | | | | |
|--|-------------------------|--|--------------------------------------|---|---|--|
| | Average Percent Correct | Percent of Students Agreeing With Statement: | | | | |
| | | I am Good At Science. | Science is More for Boys than Girls. | What I Learn in Science is Useful in Everyday Life. | It is Important to Know Some Science to Get a Good Job. | Facts & Ideas About Science Cannot be Questioned or Changed. |
| Populations | | | | | | |
| Canada | 69 | 65 | 3 | 57 | 76 | 26 |
| Alberta** | 74 76/72 | 60 69/51 | 5 5/4 | 55 60/51 | 83 85/81 | 19 23/15 |
| British Columbia | 72 | 57 | 5 | 51 | 82 | 18 |
| Manitoba - English | 69 | 55 | 6 | 47 | 79 | 21 |
| Manitoba - French | 67 | 72 | 4 | 53 | 69 | 39 |
| N. Bruns. - Engl. | 66 | 55 | 4 | 53 | 79 | 26 |
| N. Bruns. - French | 64 | 69 | 4 | 66 | 71 | 41 |
| Newfoundland | 66 | 58 | 5 | 63 | 88 | 25 |
| Nova Scotia | 69 | 55 | 4 | 54 | 86 | 25 |
| Ontario - English | 67 | 63 | 4 | 54 | 83 | 25 |
| Ontario - French | 60 | 78 | 4 | 68 | 79 | 42 |
| Quebec - English | 69 | 55 | 4 | 48 | 70 | 26 |
| Quebec - French | 71 | 72 | 2 | 65 | 58 | 33 |
| Sask. - English | 70 | 56 | 5 | 46 | 80 | 23 |
| Sask. - French | 65 | 71 | 5 | 54 | 71 | 36 |
| Other Interesting Comparisons | | | | | | |
| China | 69 | 46 | 0 | 81 | 71 | 46 |
| Hungary | 73 | 39 | 4 | 79 | 72 | 57 |
| Jordan | 57 | 84 | 18 | 89 | 79 | 64 |
| Korea | 78 | 25 | 32 | 61 | 35 | 36 |
| Soviet Union | 71 | 40 | 14 | 70 | 82 | 22 |
| Switzerland | 74 | 49 | 4 | 73 | 45 | 41 |
| Taiwan | 76 | 19 | 20 | 77 | 70 | 34 |
| United States | 67 | 62 | 7 | 52 | 77 | 21 |

* Student Questionnaire

** Male/Female percentages

Observations (Figure 3.11)

Having a positive attitude toward science is positively related to science achievement in the majority of populations. In some cases, though, strong beliefs about being good at science did not relate to higher performance. In Ontario (French), for example, almost 80% of students feel they are good at science. In Taiwan and Korea, both high performers, only 19% and 25% respectively perceived themselves as being good at science. Alberta students responded in a manner similar to most other students in Canada, with slightly more than half of them indicating they believe they are good in science.

The majority of students feel that what they learn in science is useful in their everyday life. Curiously, North American students were less likely to see science as being useful. The majority of students report that it is important to know some science to get a good job. Korea and Switzerland are the exceptions; only 35% of Korean 13-year-olds and 45% of Swiss students feel that they need some science to get a good job. Students in Alberta believe science is important.

Alberta's results indicate that our students have a healthy, questioning attitude; only 19% of students feel that they cannot question or change science facts and ideas. The curriculum in Alberta encourages students to question ideas and to apply scientific skills in order to understand the world they live in. In Alberta, 85% of females feel they can question science ideas compared to 77% of males. British Columbia, the Soviet Union, and the United States display similar results. A majority of students in Hungary and Jordan feel science ideas are not to be questioned.

SECTION 4: MATHEMATICS RESULTS

The information in this section shows the results for mathematics. In Alberta 1422 students were sampled to write the mathematics portion of the study and to answer related background questions.

The information is displayed according to categories that were used in the overall study report: mathematics performance of 13-year-olds, curriculum-related information, classroom characteristics, students and their homes, and education systems.

Summary of Mathematics Information

This study provides information on the context for learning mathematics. Alberta's 13-year-old students report that they spend 0 to 1 hour on mathematics homework each week, do not have weekly mathematics quizzes, listen to mathematics lessons approximately 60% of the time, and seldom or never use mathematics tools, but they do use calculators and computers.

In Alberta, mathematics classes are not based on ability. As well, about one-half of students report completing exercises on their own every day and slightly over one-third work in small groups to solve problems at least once a week. Slightly more than one-half of the teachers teaching mathematics to 13-year-olds are specialists.

It is interesting to note that although China, Korea, and Taiwan report a very high percentage of specialists teaching mathematics, a relatively low percentage of teachers have post-secondary courses in mathematics. An interesting research question would be the amount of inservice training in instructing mathematics that these teachers are receiving.

Alberta's performance in mathematics varied; Alberta students performed well in some areas and not so well in others. One area where Alberta students did do well was in, "Data Analysis, Probability, and Statistics." The two areas that Alberta performed lowest in were "Geometry" and "Algebra and Functions."

Fifteen percent of the assessment was devoted to Geometry. Four questions dealt directly with knowing the measures of an angle when given other information to permit calculations. Alberta students performed poorly when calculating the measure of an angle from supplementary angles, the angles of a triangle, or in right angles. According to the Alberta programs of study, students should know how to do these calculations.

In Algebra and Functions, students were required to express relationships in equations, to substitute numbers for variables, and to solve equations for one variable. According to Alberta's programs of study, students should be able to solve expressions such as $[16+3y, y=-2]$, $[2x+4=10, \text{ solve for } x]$, and $[n(n+2), \text{ when } n=4]$. Alberta's performance was well below the performance levels of most other participants in the study. Students were able to match algebraic expressions to written statements, showing that Alberta students have a good conceptual understanding of writing number sentences. Many top-performing countries, with the exception of Switzerland, tend to place a heavy emphasis on algebra at this age.

Finally, there is room for improvement in certain areas of mathematics. This study clearly points out at least two areas where performance was below what was expected: "Geometry" and "Algebra and Functions."

Mathematics Performance of 13-Year-Old Students

Figure 7 shows the overall results for participating populations. It reports mathematics performance for males and females, as well as average scores for performance on mathematics topics and cognitive processes. Below is a brief description of each topic and cognitive process.

Numbers and Operations: Students show they know numbers, can compute (+, -, x, ÷), and can apply ratios and percentages.

Measurement: Students show they know and can use measurements of length, time, money, temperature, mass/weight, area, and angles.

Geometry: Students show they can describe, compare, and classify geometric figures; visualize, draw, and construct geometric figures; and apply this knowledge in solving problems.

Data Analysis, Probability, and Statistics: Students show they can read, interpret, and make predictions using tables and graphs, and they can calculate averages and create graphs (bar, line, etc.)

Algebra and Functions: Students can write symbolic expressions and verbal statements (e.g., number sentences with one or two variables), solve simple equations (e.g. $y=x+2$, find y when x is 9, etc.), and solve problems that require setting up equations and solving for one variable.

Conceptual Understanding: Students show an understanding of mathematics principles (e.g., division), and can recognize, interpret, and apply the signs, symbols, and terms used in mathematics.

Procedural Knowledge: Students know what to do to solve a problem and can use basic knowledge and skills to complete tasks.

Problem Solving: Students show skill in using reasoning and analytic abilities, and can judge the reasonableness of answers.

Figure 4.1 shows the overall results for all populations.

Figure 4.1. Mathematics, Age 13: Distribution of Percent Correct Scores by Country/Province

| | Overall Average Percent Correct | Average Male/Female Percent | Topics (%) | | | | | Cognitive Processes (%) | | |
|----------------------------|---------------------------------|-----------------------------|--------------|-------|-----------|-------------------------|---------------|-------------------------|---------------|-----------------|
| | | | Num. & Oper. | Meas. | Geo-metry | Data Anal./Prob./Stats. | Algebra/Func. | Concept Underst. | Proced. Know. | Problem Solving |
| Rank Order/IAEP Average | 58 | | 61 | 47 | 62 | 69 | 54 | 61 | 58 | 56 |
| Korea | 73 | 74/72 | 77 | 60 | 77 | 81 | 71 | 78 | 73 | 68 |
| Taiwan | 73 | 73/72 | 75 | 64 | 77 | 81 | 69 | 75 | 75 | 69 |
| Switzerland | 71 | 73/69 | 74 | 62 | 77 | 82 | 63 | 72 | 69 | 72 |
| Soviet Union | 70 | 70/70 | 69 | 60 | 78 | 76 | 72 | 70 | 73 | 67 |
| Hungary | 68 | 68/68 | 69 | 55 | 73 | 76 | 70 | 68 | 71 | 64 |
| France | 64 | 66/63 | 65 | 53 | 73 | 79 | 57 | 67 | 66 | 59 |
| Emilia-Romagna, Italy | 64 | 66/62 | 64 | 63 | 75 | 72 | 53 | 67 | 62 | 63 |
| Israel | 63 | 64/62 | 65 | 47 | 66 | 75 | 65 | 64 | 65 | 60 |
| Canada | 62 | 63/61 | 66 | 50 | 68 | 76 | 53 | 65 | 62 | 59 |
| Scotland | 61 | 60/61 | 60 | 51 | 70 | 79 | 53 | 62 | 62 | 58 |
| Ireland | 61 | 63/58 | 65 | 49 | 60 | 72 | 56 | 62 | 59 | 61 |
| Slovenia | 57 | 58/56 | 62 | 43 | 63 | 64 | 52 | 58 | 59 | 54 |
| Spain | 55 | 57/54 | 60 | 38 | 60 | 68 | 52 | 58 | 56 | 52 |
| United States | 55 | 56/55 | 61 | 40 | 54 | 72 | 49 | 57 | 56 | 52 |
| Jordan | 40 | 41/39 | 43 | 32 | 44 | 46 | 38 | 45 | 38 | 38 |
| Special Populations | | | | | | | | | | |
| China | 80 | 82/79 | 85 | 71 | 80 | 75 | 82 | 82 | 83 | 76 |
| England | 61 | 61/60 | 59 | 51 | 70 | 80 | 54 | 62 | 59 | 61 |
| Portugal | 48 | 50/48 | 52 | 32 | 49 | 69 | 43 | 52 | 47 | 46 |
| Sao Paulo, Brazil | 37 | 38/36 | 41 | 24 | 34 | 50 | 36 | 38 | 36 | 36 |
| Fortaleza, Brazil | 32 | 35/30 | 36 | 20 | 29 | 44 | 32 | 35 | 31 | 31 |
| Maputo & Beira, Mozambique | 28 | 29/28 | 34 | 20 | 29 | 35 | 20 | 34 | 23 | 28 |

Figure 4.1, continued. Mathematics, Age 13: Distribution of Percent Correct Scores by Country/Province

| | Overall Average Percent Correct | Average Male/Female Percent | Topics (%) | | | | | Cognitive Processes (%) | | |
|-----------------------------------|---------------------------------|-----------------------------|--------------|-------|-----------|---------------------------|----------------|-------------------------|---------------|-----------------|
| | | | Num. & Oper. | Meas. | Geo-metry | Data Anal./ Prob./ Stats. | Algebra/ Func. | Concept Underst. | Proced. Know. | Problem Solving |
| Canadian Populations/IAEP Average | 58 | | 61 | 47 | 62 | 69 | 54 | 61 | 58 | 56 |
| Quebec - French | 69 | 70/68 | 72 | 56 | 78 | 81 | 58 | 73 | 68 | 65 |
| Saskatchewan - French | 68 | 70/66 | 74 | 54 | 69 | 76 | 62 | 70 | 69 | 63 |
| British Columbia | 66 | 67/65 | 69 | 54 | 70 | 80 | 60 | 69 | 68 | 62 |
| Quebec - English | 66 | 66/66 | 69 | 54 | 71 | 78 | 60 | 68 | 67 | 62 |
| Alberta | 64 | 64/63 | 69 | 54 | 67 | 80 | 52 | 68 | 63 | 61 |
| Manitoba - French | 63 | 64/62 | 67 | 49 | 67 | 75 | 59 | 65 | 66 | 58 |
| Saskatchewan - English | 62 | 63/61 | 66 | 50 | 63 | 78 | 55 | 64 | 64 | 57 |
| New Brunswick - French | 61 | 60/61 | 65 | 47 | 65 | 72 | 54 | 64 | 63 | 55 |
| Nova Scotia | 60 | 61/59 | 63 | 47 | 64 | 74 | 54 | 62 | 60 | 57 |
| Newfoundland | 59 | 58/60 | 62 | 45 | 65 | 72 | 53 | 62 | 60 | 54 |
| Ontario - English | 58 | 59/57 | 62 | 46 | 63 | 74 | 50 | 61 | 59 | 56 |
| Manitoba - English | 58 | 58/58 | 63 | 46 | 58 | 74 | 51 | 61 | 59 | 54 |
| New Brunswick - English | 58 | 58/57 | 62 | 51 | 62 | 71 | 43 | 61 | 55 | 56 |
| Ontario - French | 53 | 54/54 | 58 | 39 | 59 | 69 | 45 | 57 | 54 | 50 |

Observations (Figure 4.1)

The average score across all populations was 58%. Students in Alberta, with an overall average of 64%, were outperformed by students in Quebec (French and English), British Columbia, and Saskatchewan (French). Alberta's performance is in the middle compared with the performance of other participants; this does not meet the provincial expectation of performance that compares favorably with the best in the world.

The results are presented for five content areas—Numbers and Operations, Measurement; Geometry; Data Analysis, Probability, and Statistics; and Algebra and Functions—and three levels of cognitive processing—Conceptual Understanding, Procedural Knowledge, and Problem Solving. The content area of Measurement received the lowest overall IAEP score, only 47%. Alberta students scored an average of 54% on measurement questions. They did well in most content areas with the exception of Algebra and Functions and some aspects of Geometry. Alberta's results in Algebra and Functions and in Geometry were its lowest of the five content areas assessed.

Curriculum Emphasis

Figure 4.2 examines the percentage of schools reporting to emphasize sub-topics within the content areas.

Figure 4.2. Mathematics, Age 13: Emphasis For All Major Topics*

| | Percent of Schools Reporting to Emphasize: | | | | | | | | | | | |
|-------------------------------|--|------------------------|-----------|----------|--------|---------|-------------|----------|--|-------------|------------|---------|
| | Average Percent Correct | Numbers and Operations | | | | | Measurement | Geometry | Data Analysis, Probability, & Statistics | | | Algebra |
| | | Numbers | Fractions | Decimals | Ratios | Percent | | | Tables/Graphs | Probability | Statistics | |
| Populations | | | | | | | | | | | | |
| Canada | 62 | 72 | 52 | 63 | 48 | 57 | 53 | 41 | 18 | 5 | 8 | 41 |
| Alberta | 64 | 72 | 66 | 66 | 69 | 58 | 64 | 34 | 19 | 3 | 9 | 31 |
| British Columbia | 66 | 67 | 57 | 61 | 43 | 45 | 44 | 38 | 12 | 2 | 4 | 45 |
| Manitoba - English | 58 | 68 | 58 | 73 | 36 | 48 | 47 | 34 | 20 | 3 | 5 | 44 |
| Manitoba - French | 63 | 84 | 73 | 84 | 56 | 58 | 67 | 49 | 27 | 9 | 11 | 64 |
| N. Brunswick - English | 58 | 62 | 36 | 48 | 40 | 48 | 58 | 31 | 9 | 0 | 6 | 18 |
| N. Brunswick - French | 61 | 92 | 44 | 44 | 49 | 41 | 49 | 48 | 3 | 2 | 3 | 69 |
| Newfoundland | 59 | 55 | 36 | 44 | 32 | 42 | 43 | 41 | 11 | 0 | 4 | 18 |
| Nova Scotia | 60 | 64 | 58 | 64 | 58 | 64 | 60 | 36 | 24 | 4 | 14 | 28 |
| Ontario - English | 58 | 79 | 47 | 66 | 42 | 61 | 53 | 40 | 18 | 3 | 7 | 39 |
| Ontario - French | 53 | 89 | 79 | 92 | 55 | 72 | 72 | 70 | 38 | 10 | 20 | 64 |
| Quebec - English | 66 | 37 | 43 | 43 | 36 | 39 | 45 | 44 | 24 | 8 | 10 | 42 |
| Quebec - French | 53 | 54 | 44 | 41 | 61 | 58 | 45 | 53 | 16 | 14 | 16 | 90 |
| Saskatchewan - English | 62 | 75 | 62 | 70 | 56 | 58 | 53 | 31 | 14 | 4 | 5 | 15 |
| Saskatchewan - French | 68 | 66 | 72 | 79 | 79 | 79 | 55 | 38 | 17 | 14 | 14 | 34 |
| Other Interesting Comparisons | | | | | | | | | | | | |
| China | 80 | 23 | 24 | 21 | 20 | 22 | 22 | 80 | 15 | 9 | 9 | 94 |
| Hungary | 68 | 71 | 90 | 88 | 13 | 60 | 32 | 79 | 44 | 0 | 2 | 90 |
| Jordan | 40 | 61 | 21 | 25 | 75 | 61 | 23 | 43 | 6 | 0 | 0 | 59 |
| Korea | 73 | 47 | 19 | 30 | 10 | 3 | 15 | 67 | 37 | 53 | 11 | 86 |
| Soviet Union | 70 | 46 | 54 | 60 | 27 | 17 | 40 | 83 | 67 | 0 | 3 | 96 |
| Switzerland | 71 | 75 | 72 | 81 | 43 | 41 | 70 | 58 | 20 | 0 | 0 | 23 |
| Taiwan | 73 | 33 | 24 | 15 | 52 | 7 | 9 | 14 | 35 | 0 | 15 | 74 |
| United States | 55 | 49 | 54 | 52 | 38 | 42 | 38 | 27 | 18 | 9 | 13 | 51 |

* School Questionnaire

Observations (Figure 4.2)

Patterns of instruction and emphasis on the sub-topics vary from population to population. Most countries still emphasize Numbers and Operations at age 13. Korea, Taiwan, and China are all high-performing populations that do not emphasize the various Numbers and Operations sub-topics as much as other populations do.

Some general patterns are noted in these results. For example, Alberta students scored an average of 54% on Measurement, above the overall IAEP II average of 47%. This correlates with our relatively high emphasis on Measurement. With the exception of Switzerland, the higher performing populations do not emphasize Measurement at this age.

The emphasis on Geometry varies considerably from population to population. China, Hungary, Korea, the Soviet Union, and Ontario (French) report a high emphasis on Geometry. With the exception of Ontario (French), all of these populations performed very well in Geometry. Taiwan does not emphasize Geometry at this age, and yet they performed very well in this area. Alberta schools report a lower emphasis on Geometry (34%) compared with high-performing countries like Hungary (79%).

There is substantial variation in emphasis on the three sub-topics in Data Analysis, Probability, and Statistics. There is heavier emphasis on tables and graphs than on probability or statistics. Korea and, to some extent, Taiwan and Ontario (French) stand out in the higher emphasis reported on this content area. With the exception of China, every population scored higher on this content area compared with their overall performance scores. Although not reporting a high emphasis on this area, Alberta performed at 80% on Data Analysis, Probability, and Statistics.

Alberta schools report a lower emphasis on Algebra compared with other populations. Alberta students scored 52% on Algebra compared with the overall IAEP average of 54%. With the exception of Switzerland, high-performing populations report a high emphasis on Algebra: China 94%, Hungary 90%, Korea 86%, Taiwan 74%, and the Soviet Union 96%. The four Canadian populations that report a higher emphasis on Algebra compared with other Canadian populations are Quebec (French), New Brunswick (French), Manitoba (French), and Ontario (French). These populations did not perform at correspondingly high levels.

Classroom Characteristics

The information reported in this section was collected from students and school administrators. It highlights the variation in teaching practices and classroom factors across various populations.

Figure 4.3. Mathematics, Age 13: Teaching Practices and Average Percent Correct

| | Average Percent Correct | Average Minutes of Math Instruction Each Week** | Percent of Students Who: | | | | Spend 4 Hrs or More on Math Homework Each Week* |
|--------------------------------------|-------------------------|---|----------------------------------|--|--|--|---|
| | | | Listen to Math Lessons Each Day* | Do Math Exercises on Their Own Each Day* | Solve Problems in Groups at Least Once a Week* | Take a Math Test or Quiz at Least Once a Week* | |
| Populations | | | | | | | |
| Canada | 62 | 225 | 51 | 50 | 40 | 53 | 15 |
| Alberta | 64 | 214 | 62 | 50 | 41 | 38 | 15 |
| British Columbia | 66 | 199 | 37 | 34 | 44 | 54 | 12 |
| Manitoba - English | 58 | 216 | 60 | 49 | 42 | 37 | 10 |
| Manitoba - French | 63 | 238 | 16 | 31 | 41 | 59 | 17 |
| N. Bruns. - English | 58 | 256 | 63 | 54 | 44 | 41 | 10 |
| N. Bruns. - French | 61 | 304 | 26 | 47 | 24 | 48 | 17 |
| Newfoundland | 59 | 318 | 76 | 60 | 47 | 23 | 19 |
| Nova Scotia | 60 | 260 | 70 | 55 | 44 | 32 | 14 |
| Ontario - English | 58 | 211 | 67 | 55 | 48 | 32 | 16 |
| Ontario - French | 54 | 217 | 22 | 32 | 38 | 54 | 14 |
| Quebec - English | 66 | 273 | 19 | 40 | 43 | 49 | 14 |
| Quebec - French | 69 | 270 | 73 | 62 | 21 | 99 | 15 |
| Sask. - English | 62 | 221 | 55 | 44 | 43 | 20 | 11 |
| Sask. - French | 68 | 226 | 14 | 38 | 38 | 40 | 16 |
| Other Interesting Comparisons | | | | | | | |
| China | 80 | 307 | 74 | 78 | 68 | 63 | 37 |
| Hungary | 68 | 186 | 40 | 37 | 55 | 17 | 11 |
| Jordan | 40 | 180 | 62 | 34 | 83 | 68 | 14 |
| Korea | 73 | 179 | 32 | 17 | 28 | 28 | 33 |
| Soviet Union | 70 | 258 | 62 | 40 | 54 | 52 | 33 |
| Switzerland | 71 | 251 | 60 | 47 | 47 | 40 | 15 |
| Taiwan | 73 | 204 | 64 | 32 | 38 | 87 | 24 |
| United States | 55 | 228 | 78 | 50 | 49 | 68 | 15 |

* Student Questionnaire

** School Questionnaire

Figure 4.4 presents information about the relationship between teaching practices and mathematics performance.

| Figure 4.4. Mathematics, Age 13: Relationship of Teaching Practices and Average Percent Correct Within Populations | | | | | |
|--|---|--|--------------------------------------|--------------------------------|---|
| | Amount of Listening to Mathematics Lessons* | Amount of Doing Math Exercises on Own* | Amount of Problem Solving in Groups* | Amount of Mathematics Testing* | Amount of Time Spent on Mathematics Homework* |
| Populations | | | | | |
| Canada | - | + | - | + | 0 |
| Alberta | + | + | - | 0 | 0 |
| British Columbia | + | + | - | 0 | 0 |
| Manitoba - English | + | + | - | 0 | 0 |
| Manitoba - French | - | + | 0 | 0 | - |
| N. Bruns. - English | + | + | - | 0 | 0 |
| N. Bruns. - French | - | + | - | 0 | 0 |
| Newfoundland | + | + | - | 0 | 0 |
| Nova Scotia | + | + | - | 0 | + |
| Ontario - English | 0 | + | - | 0 | 0 |
| Ontario - French | - | + | - | + | 0 |
| Quebec - English | 0 | 0 | 0 | - | 0 |
| Quebec - French | - | + | 0 | + | 0 |
| Sask. - English | 0 | + | - | 0 | - |
| Sask. - French | - | 0 | 0 | 0 | 0 |
| Other Interesting Comparisons | | | | | |
| China | + | 0 | 0 | 0 | + |
| Hungary | + | + | - | - | + |
| Jordan | + | 0 | 0 | - | + |
| Korea | + | + | - | - | + |
| Soviet Union | + | + | - | + | + |
| Switzerland | 0 | 0 | - | 0 | 0 |
| Taiwan | + | + | + | + | + |
| United States | + | + | - | + | + |

* Student Questionnaire

+ Statistically significant positive relationship

- Statistically significant negative relationship

0 No statistically significant linear relationship

Observations (Figure 4.3 and 4.4)

The different features of educational programs help to describe the learning context in various places. The majority of populations report an average of 200 to 250 minutes being spent on mathematics instruction each week. The average is slightly higher in the Soviet Union and Switzerland and is especially high in China (307 minutes each week). Korea, Hungary, and Jordan show a relatively shorter length of time spent on math instruction (between 179 and 186 minutes each week). Quebec (French and English), Newfoundland, and New Brunswick (French) report the largest amount of time for mathematics instruction; Alberta schools spend on average of 214 minutes on mathematics instruction each week.

Reported classroom activities provide interesting comparisons. For example, 78% of students in China report that they do mathematics exercises on their own every day compared with 62% in Quebec (French) and 50% in Alberta. Independent work is positively related to mathematics achievement in the majority of populations. Also interesting is the negative relationship between solving problems in small groups and achievement. This may be because paper and pencil tests cannot measure important skills that are developed in small-group learning experiences.

The relationship between testing and performance is not consistent. The majority of participants do not use mathematics tests or quizzes on a weekly basis. Thirty-eight percent of Alberta students report taking a math quiz on a weekly basis. Quebec (French) reports regular use of weekly quizzes or tests.

The majority of students spend between 0 and 1 hour on mathematics homework each week. China is an exception, where 37% of students reporting that they spend four hours or more on math homework each week. The Soviet Union, Korea, and Taiwan, where 24% to 33% of students report spending more than four hours on math homework each week, are higher than the norm. Results from China, the Soviet Union, Korea, and Taiwan show a positive relationship between the amount of time spent on mathematics homework and performance. Curiously, Nova Scotia is the only Canadian population where there is a positive relationship between mathematics performance and time spent on mathematics homework. In Alberta, 15% of students report that they spend four hours or more each week on mathematics homework. This was not found to have either a positive or a negative effect on their performance in Mathematics.

The information reported in Figure 4.5 indicates the extent to which manipulatives and new technologies have been integrated into schools.

Figure 4.5. Teaching Materials and Average Percent Correct

| | Average Percent Correct | Percent of Students Who: | | | | Average Number of Computers in School** |
|--------------------------------------|-------------------------|--|--------------------|---------------------------------|---|---|
| | | Work With Math Tools at Least Once a Week* | Have a Calculator* | Ever Use Calculators in School* | Ever Use Computers for School Work or Homework* | |
| Populations | | | | | | |
| Canada | 62 | 14 | 91 | 75 | 42 | 17 |
| Alberta | 64 | 13 | 92 | 85 | 52 | 26 |
| British Columbia | 66 | 11 | 92 | 83 | 51 | 37 |
| Manitoba - English | 58 | 13 | 84 | 53 | 42 | 15 |
| Manitoba - French | 63 | 10 | 88 | 55 | 35 | 18 |
| N. Bruns. - Engl. | 58 | 19 | 89 | 87 | 29 | 13 |
| N. Bruns. - French | 61 | 12 | 87 | 72 | 11 | 8 |
| Newfoundland | 59 | 25 | 93 | 89 | 35 | 7 |
| Nova Scotia | 60 | 18 | 86 | 60 | 41 | 12 |
| Ontario - English | 58 | 16 | 91 | 74 | 53 | 15 |
| Ontario - French | 54 | 16 | 90 | 75 | 46 | 14 |
| Quebec - English | 66 | 20 | 92 | 73 | 16 | 15 |
| Quebec - French | 69 | 10 | 92 | 76 | 43 | 18 |
| Sask. - English | 62 | 15 | 86 | 67 | 49 | 14 |
| Sask. - French | 68 | 13 | 83 | 73 | 40 | 10 |
| Other Interesting Comparisons | | | | | | |
| China | 80 | 40 | 21 | 7 | 6 | 2 |
| Hungary | 68 | 43 | 87 | 71 | 31 | 6 |
| Jordan | 40 | 39 | 53 | 5 | 5 | 1 |
| Korea | 73 | 17 | 20 | 4 | 10 | 15 |
| Soviet Union | 70 | 32 | 47 | 19 | 6 | 2 |
| Switzerland | 71 | 36 | 85 | 51 | 25 | 4 |
| Taiwan | 73 | 38 | 58 | 62 | 6 | 15 |
| United States | 55 | 18 | 89 | 54 | 37 | 24 |

* Student Questionnaire

** School Questionnaire

Observations (Figure 4.5)

The use of math manipulatives, calculators, and computers is not yet a part of mathematics instruction in most populations. Alberta, other Canadian provinces, Korea, and the United States report a relatively low percentage of students that work with concrete mathematics materials. Students in China, Hungary, Jordan, and Taiwan are higher than the norm; approximately 40% of students from these countries indicate working with mathematics tools at least once a week. Overall, results show that most students do not use manipulatives when learning mathematics.

Ownership of calculators is common except in Korea, China and to some extent, the Soviet Union, Taiwan, and Jordan. Although the use of calculators in school is common in Hungary, in the Canadian provinces and, to some extent, in Taiwan, students in most countries report using calculators in school infrequently.

Overall, computer use is even more infrequent than calculator use. The majority of students report that they never use a computer for school work or homework. Alberta, British Columbia, and Ontario (English) are the only places where over one-half of students report using a computer for school work or homework. Very few populations indicate that they have enough computers for students to use on a regular basis for school work. Alberta, British Columbia, and the United States do have this benefit, as they report having from 24 to 37 computers in each school.

Figure 4.6 reports information about teachers and about the percentage of schools reporting to assign students to mathematics classes based on ability.

| Figure 4.6. Mathematics, Age 13: Teacher Background, Classroom Organization, and Average Percent Correct | | | | |
|---|-------------------------|---|---|-------------------------------------|
| | Average Percent Correct | Percent of Schools Where: | | |
| | | Teacher Teaches Math Most or All the Time** | All Math Teachers Have Taken Some Post-Secondary Math Courses** | Math Classes are Based on Ability** |
| Populations | | | | |
| Canada | 62 | 31 | 44 | 10 |
| Alberta | 64 | 53 | 58 | 2 |
| British Columbia | 66 | 58 | 58 | 26 |
| Manitoba - English | 58 | 39 | 46 | 5 |
| Manitoba - French | 63 | 36 | 51 | 0 |
| N. Bruns. - English | 58 | 41 | 32 | 3 |
| N. Bruns. - French | 61 | 49 | 58 | 19 |
| Newfoundland | 59 | 29 | 65 | 6 |
| Nova Scotia | 60 | 78 | 60 | 10 |
| Ontario - English | 58 | 7 | 31 | 6 |
| Ontario - French | 54 | 10 | 17 | 8 |
| Quebec - English | 66 | 64 | 57 | 32 |
| Quebec - French | 69 | 98 | 58 | 34 |
| Sask. - English | 62 | 19 | 62 | 9 |
| Sask. - French | 68 | 7 | 39 | 14 |
| Other Interesting Comparisons | | | | |
| China | 80 | 91 | 45 | 3 |
| Hungary | 68 | 53 | 100 | 0 |
| Jordan | 40 | 99 | 81 | 5 |
| Korea | 73 | 88 | 12 | 0 |
| Soviet Union | 70 | 92 | 79 | 18 |
| Switzerland | 71 | 25 | 18 | 18 |
| Taiwan | 73 | 99 | 37 | 63 |
| United States | 55 | 95 | 76 | 56 |

** School Questionnaire

Observations (Figure 4.6)

In Alberta, 53% of teachers who teach 13-year-olds mathematics teach mathematics most or all of the time. China, Korea, the Soviet Union, Taiwan, the United States, and Jordan report that approximately 90% of teachers teaching mathematics teach mathematics most of the time.

In Hungary, mathematics teachers universally have post-secondary courses in mathematics. China, Korea, and Taiwan, other high-performing populations, report a low percentage of teachers with post-secondary courses in mathematics. Alberta and British Columbia results show that more than one-half of teachers teaching mathematics have post-secondary courses. This figure is above the Canadian average.

The highest achieving populations, with the exception of Taiwan, do not group by ability. In British Columbia, 26% of schools report using ability to group students in mathematics classes. In Taiwan, 63% of schools report organizing their mathematics classes on the basis of ability. In Alberta, only 2% of schools report using the practice.

Students and Their Homes

Figures 4.7, 4.8, 4.9, and 4.10 report information about students themselves and their homes. A number of questions examined how students spend some of their time outside of school in ways that may enhance their in-school performance.

Figure 4.7. Mathematics, Age 13: Home Characteristics* and Average Percent Correct

| | Average Percent Correct | Percent of Students Who: | | | | | |
|--------------------------------------|-------------------------|--|-------------------------------------|----------------------------------|---|--|---|
| | | Speak the Same Language at Home as at School | Have 4 or more Brothers and Sisters | Have Fewer than 25 Books at Home | Have Parents Who Want them to Do Well in Math | Talk with Someone at Home about Math Class | Receive Help at Home with Math Homework |
| Populations | | | | | | | |
| Canada | 62 | 88 | 8 | 13 | 96 | 64 | 69 |
| Alberta | 64 | 91 | 10 | 10 | 97 | 63 | 74 |
| British Columbia | 66 | 89 | 9 | 10 | 95 | 61 | 70 |
| Manitoba - English | 58 | 90 | 11 | 12 | 95 | 54 | 65 |
| Manitoba - French | 63 | 17 | 9 | 14 | 89 | 56 | 60 |
| N. Bruns. - English | 58 | 95 | 10 | 13 | 95 | 57 | 66 |
| N. Bruns. - French | 61 | 90 | 7 | 31 | 96 | 67 | 65 |
| Newfoundland | 59 | 98 | 12 | 17 | 97 | 67 | 73 |
| Nova Scotia | 60 | 98 | 10 | 12 | 97 | 63 | 69 |
| Ontario - English | 58 | 87 | 9 | 11 | 97 | 63 | 72 |
| Ontario - French | 54 | 55 | 6 | 26 | 95 | 68 | 67 |
| Quebec - English | 66 | 92 | 5 | 19 | 95 | 67 | 63 |
| Quebec - French | 69 | 76 | 10 | 10 | 97 | 69 | 62 |
| Sask. - English | 62 | 95 | 10 | 13 | 95 | 58 | 72 |
| Sask. - French | 68 | 12 | 9 | 14 | 89 | 55 | 66 |
| Other Interesting Comparisons | | | | | | | |
| China | 80 | 97 | 11 | 26 | 81 | 85 | 37 |
| Hungary | 68 | 99 | 3 | 10 | 93 | 85 | 80 |
| Jordan | 40 | 99 | 88 | 51 | 91 | 79 | 43 |
| Korea | 73 | 97 | 19 | 24 | 92 | 52 | 53 |
| Soviet Union | 70 | 89 | 13 | 12 | 84 | 61 | 32 |
| Switzerland | 71 | 80 | 4 | 16 | 85 | 67 | 42 |
| Taiwan | 73 | N/A | 12 | 35 | 90 | 74 | 51 |
| United States | 55 | 94 | 18 | 17 | 96 | 67 | 74 |

* Student Questionnaire

N/A Information is not available.

Figure 4.8. Mathematics, Age 13: Relationship of Home Characteristics and Average Percent Correct Within Populations

| | Number of Brothers and Sisters* | Number of Books in the Home* | Parents Wanting Student to Do Well in Mathematics* |
|--------------------------------------|---------------------------------|------------------------------|--|
| Populations | | | |
| Canada | - | + | + |
| Alberta | 0 | + | + |
| British Columbia | - | + | + |
| Manitoba - English | - | + | 0 |
| Manitoba - French | 0 | + | 0 |
| N. Bruns. - English | - | + | + |
| N. Bruns. - French | - | + | 0 |
| Newfoundland | 0 | + | 0 |
| Nova Scotia | 0 | + | + |
| Ontario - English | - | + | + |
| Ontario - French | 0 | + | 0 |
| Quebec - English | 0 | + | + |
| Quebec - French | 0 | + | 0 |
| Sask. - English | 0 | + | 0 |
| Sask. - French | 0 | + | 0 |
| Other Interesting Comparisons | | | |
| China | - | + | + |
| Hungary | - | + | 0 |
| Jordan | 0 | + | + |
| Korea | - | + | + |
| Soviet Union | - | + | 0 |
| Switzerland | - | + | 0 |
| Taiwan | - | + | + |
| United States | 0 | + | + |

* Student Questionnaire

+ Statistically significant positive relationship

- Statistically significant negative relationship

0 No statistically significant linear relationship

The amount of time students spend in various out-of-school activities provides for some interesting comparisons.

| Figure 4.9. Mathematics, Age 13: Home Activities* and Average Percent Correct | | | | | |
|---|-------------------------|-------------------------------|---|--|---------------------------------------|
| | Average Percent Correct | Percent of Students Who: | | | |
| | | Read for Fun Almost Every Day | Spend 2 Hrs or More on all Homework Every Day | Watch Television for 5 Hrs or More Every Day | Have Positive Attitudes Toward Math** |
| Populations | | | | | |
| Canada | 62 | 38 | 27 | 14 | 94 |
| Alberta | 64 | 40 | 20 | 12 | 91 |
| British Columbia | 66 | 40 | 25 | 13 | 89 |
| Manitoba - English | 58 | 35 | 16 | 18 | 88 |
| Manitoba - French | 63 | 42 | 19 | 15 | 90 |
| N. Bruns. - English | 58 | 37 | 16 | 19 | 88 |
| N. Bruns. - French | 61 | 31 | 17 | 16 | 93 |
| Newfoundland | 59 | 37 | 26 | 23 | 94 |
| Nova Scotia | 60 | 35 | 23 | 21 | 93 |
| Ontario - English | 58 | 40 | 28 | 16 | 94 |
| Ontario - French | 54 | 35 | 23 | 17 | 96 |
| Quebec - English | 66 | 33 | 29 | 11 | 95 |
| Quebec - French | 69 | 37 | 33 | 14 | 92 |
| Sask. - English | 62 | 40 | 13 | 13 | 91 |
| Sask. - French | 68 | 45 | 15 | 9 | 93 |
| Other Interesting Comparisons | | | | | |
| China | 80 | 28 | 44 | 7 | 79 |
| Hungary | 68 | 44 | 58 | 13 | 85 |
| Jordan | 40 | 24 | 56 | 7 | 77 |
| Korea | 73 | 11 | 41 | 11 | 71 |
| Soviet Union | 70 | 47 | 52 | 17 | 76 |
| Switzerland | 71 | 51 | 20 | 7 | 85 |
| Taiwan | 73 | 19 | 41 | 10 | 79 |
| United States | 55 | 28 | 29 | 20 | 90 |

* Student Questionnaire

** Students in the assessment were asked to what extent they agreed with the following statements:

Mathematics is useful in solving everyday problems; It is important to know some math to get a good job; I am good at mathematics; My parents want me to do well in mathematics.

Their responses were combined to form an index of attitudes toward mathematics.

Figure 4.10 shows whether the relationship between achievement and increasing levels of a particular home-activity variable is positive, negative, or not related for each population. A study of the association between home activities and mathematics performance within populations relates the importance of how students spend their time away from school.

| Figure 4.10. Mathematics, Age 13: Relationship of Home Activities and Average Percent Correct Within Populations | | | | |
|--|----------------------------|---------------------------------------|---|---|
| | Amount of Leisure Reading* | Amount of Time Spent on All Homework* | Amount of Time Spent Watching Television* | Students' Attitudes Toward Mathematics* |
| Populations | | | | |
| Canada | + | - | - | + |
| Alberta | + | 0 | - | + |
| British Columbia | + | 0 | - | + |
| Manitoba - English | + | - | - | + |
| Manitoba - French | + | - | - | 0 |
| N. Bruns. - English | + | 0 | - | + |
| N. Bruns. - French | + | - | - | + |
| Newfoundland | + | 0 | 0 | + |
| Nova Scotia | + | 0 | - | + |
| Ontario - English | + | - | - | 0 |
| Ontario - French | + | 0 | - | + |
| Quebec - English | + | - | - | + |
| Quebec - French | + | 0 | - | + |
| Sask. - English | + | - | - | + |
| Sask. - French | + | 0 | - | + |
| Other Interesting Comparisons | | | | |
| China | + | 0 | 0 | 0 |
| Hungary | + | + | - | 0 |
| Jordan | 0 | + | 0 | + |
| Korea | + | 0 | - | + |
| Soviet Union | + | + | 0 | + |
| Switzerland | 0 | 0 | 0 | 0 |
| Taiwan | + | + | - | + |
| United States | + | 0 | - | + |

* Student Questionnaire

+ Statistically significant positive relationship

- Statistically significant negative relationship

0 No statistically significant linear relationship

Observations (Figures 4.7, 4.8, 4.9, and 4.10)

Many factors are related to student performance. This study addressed some of them.

In every population, mathematics achievement is positively related to the number of books in the home. This relationship supports the importance of language in relation to performance.

Most students in every population think that their parents want them to do well in mathematics. However, a lower percentage of students report that they discuss their mathematics class with someone at home. Support from a student's parents clearly contributes to better mathematics performance (Figure 4.8).

Results indicate that parents help their children more often with their mathematics homework than with their science homework. Approximately three-quarters of students in Alberta, British Columbia, Newfoundland, Ontario (English), Saskatchewan (English), the United States, and Hungary indicated that they receive help at home with their mathematics homework. Curiously, in China, the top-performing population, students spend more time on homework and receive less help at home than do students in other populations.

The information reported on home activities and mathematics achievement is similar to that reported for science. Regular reading is positively related to achievement in the majority of populations. However, the lowest percentage of daily readers are in Korea (11%) and Taiwan (19%), both high-performing countries. In China, the top-performing country, only 28% of students report that they read for fun on a daily basis. In Alberta, 40% of participants report daily leisure reading.

As in Science, there is a negative relationship between time spent on all homework and mathematics achievement in Canada. In contrast, there is a positive relationship between time spent on all homework and mathematics achievement in the majority of populations. Compared with other populations, Alberta reports a relatively low percentage of students spending two hours or more on all homework every day. Results for Alberta show no effect on achievement with increased time spent on homework.

In many populations, there is a significant negative relationship between increased time spent watching television and mathematics performance. North American children report that they spend more time watching television than do children in other countries. Twelve percent of participants in Alberta report watching five hours or more of television every day. In Alberta, as in many other populations, math achievement decreases as time spent watching television increases.

Figure 4.11 probes student attitudes toward mathematics. The percentage of males and females agreeing with the statements is reported for Alberta's students.

Figure 4.11. Mathematics, Age 13: Attitudes Toward Mathematics* and Average Percent Correct

| | Average Percent Correct | Percent of Students Agreeing with Statement: | | | | | |
|-------------------------------|-------------------------|--|-----------------------------------|--|--|------------------------------------|--|
| | | I am Good at Math. | Math is More for Boys than Girls. | Math is Useful in Solving Everyday Problems. | It is Important to Know Some Math to get a Good Job. | Learning Math is Mostly Memorizing | Knowing How to Solve a Math Problem is as Important as Getting the Right Answer. |
| Populations | | | | | | | |
| Canada | 62 | 70 | 2 | 83 | 97 | 58 | 86 |
| Alberta** | 64 | 63 71/56 | 2 4/1 | 80 83/76 | 97 97/98 | 57 61/52 | 83 84/82 |
| British Columbia | 66 | 60 | 2 | 78 | 97 | 59 | 84 |
| Manitoba-Engl.. | 58 | 60 | 2 | 74 | 95 | 56 | 81 |
| Manitoba-French | 63 | 73 | 2 | 80 | 93 | 61 | 88 |
| N. Bruns.-Engl. | 58 | 54 | 2 | 78 | 95 | 51 | 83 |
| N. Bruns.-French | 61 | 70 | 2 | 83 | 95 | 75 | 91 |
| Newfoundland | 59 | 66 | 2 | 84 | 98 | 58 | 86 |
| Nova Scotia | 60 | 63 | 1 | 84 | 98 | 45 | 82 |
| Ontario - English | 58 | 68 | 2 | 84 | 98 | 59 | 84 |
| Ontario - French | 54 | 77 | 3 | 88 | 98 | 70 | 91 |
| Quebec - English | 66 | 67 | 2 | 79 | 96 | 44 | 83 |
| Quebec - French | 69 | 78 | 1 | 84 | 94 | 56 | 89 |
| Sask. - English | 62 | 64 | 2 | 79 | 97 | 57 | 87 |
| Sask. - French | 68 | 73 | 2 | 86 | 92 | 60 | 86 |
| Other Interesting Comparisons | | | | | | | |
| China | 80 | 57 | 1 | 80 | 66 | 19 | 67 |
| Hungary | 68 | 32 | 5 | 72 | 93 | 54 | 88 |
| Jordan | 40 | 76 | 15 | 50 | 77 | 41 | 82 |
| Korea | 73 | 22 | 27 | 82 | 68 | 13 | 94 |
| Soviet Union | 70 | 25 | 14 | 64 | 85 | 26 | 78 |
| Switzerland | 71 | 48 | 8 | 76 | 90 | 34 | 89 |
| Taiwan | 73 | 14 | 15 | 80 | 81 | 54 | 87 |
| United States | 55 | 64 | 3 | 76 | 96 | 56 | 86 |

* Student Questionnaire

** Male/female percentages. Gender data not available for other populations.

Observations (Figure 4.11)

Having a positive attitude toward mathematics is favorably related to mathematics performance in the majority of populations. In Alberta, more male students than females see themselves as being good at mathematics. In all participating North American populations, the majority of students feel they are good at math. However, there is not a consistent pattern between student responses to the statement, "I am good at math" and performance. In Jordan, for example, 76% of students feel they are good at math, whereas in Taiwan, only 14% of participants feel this way. With the exception of China, students in the higher performing populations do not perceive themselves as being as good in mathematics as students from low-performing populations do. Although not as pronounced, a similar pattern is evident in attitudes toward science.

Students in most populations feel mathematics is useful in solving everyday problems. Most students also agree that it is important to know some math to get a good job, especially in Canada and the United States, where an exceptionally high percentage of students agree with the statement. China is below the norm, with only 66% of participating students agreeing. Alberta students (97%) believe mathematics is important for getting a good job.

Responses to the statement "Learning math is mostly memorizing" ranged from 13% to 75% of students agreeing. China, Korea, and the Soviet Union report a relatively low percentage of students indicating that mathematics is mostly memorizing. In Alberta, females are less inclined to view mathematics as mostly memorizing than are males.

The majority of students display a healthy attitude in agreeing that knowing how to solve a mathematics problem is as important as getting the right answer.

SECTION 5: GEOGRAPHY RESULTS

The geography assessment was conducted as a minimal attempt to measure basic geography skills and was not planned to reflect a full range of geography knowledge and skills that might be considered important. International differences in performance on the geography assessment were not as pronounced as they were on the mathematics and science assessments. In every participating population, students achieved the highest average percent correct on questions that measured the content area of geographic skills and tools.

Nine countries including eight Canadian provinces administered this optional geography component. Nova Scotia and Prince Edward Island did not take part. In Alberta, 2881 students wrote the geography assessment and answered related background questions.

The information is displayed in the following way: geography performance of 13-year-olds, topics that students report studying, and communication with parents and student activities.

Summary of Geography Information

There appear to be positive relationships between many background variables (books in the home, study of geographic topics, reading habits, international travel) and achievement in geography. The correlations between these factors should be investigated more fully along with other background variables such as the different geography courses of study, student access to geographic reference materials, and student attitudes toward geography. For example, geography is not a separate subject in Alberta but is integrated into other subject areas. This fact needs to be considered when interpreting results. Overall, Alberta students demonstrate a good grasp of the geography concepts assessed. Alberta performed in the top third compared with other participants.

Geography Performance of 13-Year-Old Students

Figure 5.1 shows the overall results for participating populations. It reports performance on three main content and skill categories. Below is a brief description of each topic.

Skills (Geographic Skills and Tools): Students show skill in using and interpreting information from maps, charts, and globes.

Physical (Physical Geography): Students can identify physical features of land forms from maps and show an understanding of basic concepts of climate.

Cultural (Cultural Geography): Students show an understanding of the location of cultural entities, such as countries, regions, language groups, and population concentrations, as well as an understanding of human impact on the environment.

Figure 5.1 shows overall performance for all populations that chose to participate in the Geography option.

| Figure 5.1. Geography, Age 13: Distribution of Percent Correct Scores by Country/Province | | | | |
|---|---------------------|--------|----------|----------|
| Populations | Overall Average (%) | Topic | | |
| | | Skills | Physical | Cultural |
| IAEP II Average | 61 | 68 | 60 | 57 |
| Canada | 63 | 70 | 61 | 58 |
| Alberta | 65 | 71 | 62 | 61 |
| British Columbia | 67 | 71 | 67 | 64 |
| Manitoba - English | 63 | 68 | 63 | 58 |
| Manitoba - French | 61 | 67 | 59 | 56 |
| N. Bruns. - English | 57 | 63 | 57 | 50 |
| N. Bruns. - French | 55 | 60 | 54 | 50 |
| Newfoundland | 57 | 65 | 56 | 49 |
| Ontario - English | 62 | 68 | 61 | 58 |
| Ontario - French | 52 | 60 | 49 | 48 |
| Quebec - English | 67 | 72 | 64 | 64 |
| Quebec - French | 64 | 72 | 61 | 58 |
| Sask. - English | 63 | 71 | 60 | 58 |
| Sask. - French | 61 | 69 | 58 | 56 |
| Other Participating Countries | | | | |
| Hungary | 70 | 76 | 68 | 65 |
| Ireland | 59 | 63 | 60 | 52 |
| Korea | 60 | 68 | 52 | 60 |
| Scotland | 58 | 66 | 57 | 51 |
| Slovenia | 65 | 68 | 64 | 64 |
| Soviet Union | 63 | 72 | 61 | 53 |
| Spain | 60 | 62 | 59 | 59 |
| United States | 62 | 69 | 58 | 58 |

Figure 5.2 shows performance scores and the percentage of students who report studying particular sub-topics in school.

| Figure 5.2. Geography, Age 13: Percentage of Students Who Report Studying Topics* and Average Percent Correct | | | | | | | | |
|---|-------------------------|---|----------------------------------|------------------------|---|-----------------------------|--|--|
| | Average Percent Correct | Percent of Students Who Reported Studying Topic in School | | | | | | |
| | | Geography Skills & Tools | | | Physical Geography | | Cultural Geography | |
| | | Reading Symbols on Maps & Globes | Using Scales to Measure Distance | Longitude and Latitude | Location of Continents, Oceans, Rivers, Mountains | Climate & Natural Resources | Location of Cities & Regions in Your Own Country | Location of Foreign Countries & Cultures |
| Populations | | | | | | | | |
| Canada | 63 | 91 | 88 | 94 | 91 | 84 | 89 | 75 |
| Alberta | 65 | 89 | 87 | 96 | 91 | 86 | 93 | 84 |
| British Columbia | 67 | 92 | 90 | 92 | 91 | 67 | 82 | 81 |
| Manitoba - English | 63 | 89 | 83 | 92 | 92 | 85 | 88 | 78 |
| Manitoba - French | 61 | 80 | 88 | 93 | 89 | 81 | 84 | 66 |
| N. Bruns. - Engl. | 57 | 79 | 73 | 76 | 81 | 60 | 86 | 59 |
| N. Bruns. - French | 55 | 82 | 83 | 91 | 89 | 85 | 88 | 73 |
| Newfoundland | 57 | 93 | 92 | 96 | 91 | 88 | 85 | 86 |
| Ontario - English | 62 | 92 | 87 | 95 | 92 | 87 | 90 | 75 |
| Ontario - French | 52 | 83 | 87 | 95 | 89 | 89 | 87 | 70 |
| Quebec - English | 67 | 93 | 89 | 97 | 95 | 81 | 90 | 74 |
| Quebec - French | 64 | 90 | 94 | 95 | 94 | 86 | 89 | 69 |
| Sask. - English | 63 | 90 | 88 | 96 | 91 | 86 | 91 | 81 |
| Sask. - French | 61 | 76 | 88 | 96 | 87 | 89 | 86 | 76 |
| Other Participating Countries | | | | | | | | |
| Hungary | 70 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Ireland | 59 | 70 | 67 | 71 | 84 | 76 | 85 | 66 |
| Korea | 60 | 65 | 80 | 74 | 85 | 85 | 82 | 81 |
| Scotland | 58 | 87 | 81 | 75 | 87 | 80 | 76 | 64 |
| Slovenia | 65 | 83 | 80 | 95 | 92 | 95 | 87 | 90 |
| Soviet Union | 63 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Spain | 60 | 54 | 69 | 88 | 93 | 92 | 91 | 76 |
| United States | 62 | 94 | 91 | 94 | 94 | 84 | 89 | 82 |

* Student Questionnaire.

N/A Information is not available.

Observations (Figure 5.2)

Alberta students report that they learn geography concepts in school in spite of not having a separate geography curriculum. This shows that geography concepts are studied through their integration into the science and social studies programs.

When looking at results for all participants, there does not seem to be a consistent relationship between student reports of having studied Physical Geography topics and their performance on Physical Geography questions. For example, over 90% of Slovenian students report that they study the Physical Geography topics and they perform quite well in this area. On the other hand, although Irish students report less emphasis on the two Physical Geography topics, they were the only group that, in relative terms, performed better on Physical Geography items than on the total assessment.

The IAEP II average on the Cultural Geography topics indicates that students did not perform as well on Cultural Geography questions as they did on the other two topics. Overall, there is a comparatively lower number of students that report studying the location of foreign countries and cultures. Ireland, Scotland, and New Brunswick (English) report the lowest percentage of students studying the location of foreign countries and cultures; these populations scored low on Cultural Geography in this assessment.

Communication with Parents and Student Activities

The information in Figure 5.3 is interesting and may suggest topics and questions for further study on future assessments.

Figure 5.3. Geography, Age 13: Communication With Parents, Student Activities* and Average Percent Correct

| | Average Percent Correct | Percent of Students Who: | | | |
|--------------------------------------|-------------------------|--|-----------------------------------|-------------------------------|-----------------------------------|
| | | Have Traveled More than 125 Miles from Home Town | Have Traveled Outside Own Country | Read for Fun almost Every Day | Never or Hardly Ever Read for Fun |
| Populations | | | | | |
| Canada | 63 | 96 | 79 | 38(67)** | 16(60)** |
| Alberta | 65 | 98 | 76 | 39(67) | 18(61) |
| British Columbia | 67 | 97 | 86 | 39(70) | 17(61) |
| Manitoba - Engl. | 63 | 96 | 82 | 36(66) | 21(58) |
| Manitoba - French | 61 | 96 | 87 | 43(64) | 12(55) |
| N. Bruns. - Engl. | 57 | 94 | 77 | 37(60) | 22(52) |
| N. Bruns. - French | 55 | 94 | 55 | 29(60) | 19(50) |
| Newfoundland | 57 | 93 | 42 | 38(59) | 18(53) |
| Ontario - English | 62 | 97 | 86 | 39(66) | 16(57) |
| Ontario - French | 52 | 96 | 67 | 34(57) | 16(47) |
| Quebec - English | 67 | 96 | 88 | 38(69) | 14(63) |
| Quebec - French | 64 | 92 | 61 | 32(68) | 14(59) |
| Sask. - English | 63 | 98 | 69 | 38(67) | 19(59) |
| Sask. - French | 61 | 98 | 82 | 45(63) | 11(55) |
| Other Participating Countries | | | | | |
| Hungary | 70 | N/A | N/A | 44(75) | 3(64) |
| Ireland | 59 | 89 | N/A | 41(63) | 16(52) |
| Korea | 60 | 71 | 3 | 11(68) | 13(53) |
| Scotland | 58 | 94 | 68 | 38(62) | 16(51) |
| Slovenia | 65 | 85 | 81 | 42(67) | 8(59) |
| Soviet Union | 63 | N/A | N/A | 47(66) | 10(56) |
| Spain | 60 | 89 | 38 | 35(63) | 13(57) |
| United States | 62 | 95 | 39 | 29(66) | 21(59) |

* Student Questionnaire

N/A Information is not available

** Average Percent Correct ().

Observations (Figure 3.3)

There are many interesting bits of information that need more research. For example, a relatively high percentage of students report travel outside their home country. Does traveling abroad support improved learning and higher performance? More research is needed.

In every population, students who report reading for fun every day consistently achieve a higher average percent correct than do students who read less often or not at all. This consistent, positive relationship between reading and achievement is also evident in mathematics and science. Hungary, the highest performing country in the study, reports only 3% of students that never or almost never read for fun. Korea reports a relatively low percentage of students that read for fun on a daily basis, but daily readers score on average 15 percentage points higher than students who never or almost never read. These figures support the positive impact of reading on performance. As in mathematics and science, other factors must contribute to the explanation of the higher performances of Korean students.

FINAL WORD

IAEP II has provided a great amount of data that lead us to reflect on possible reasons why students in some countries do better than students in others. A number of variables examined in the study were associated with differences in curriculum, study conditions, cultural and family values. While very few were found to be clearly related to student performance, there are hints about the importance of some, such as instructional time and the prevalence of books in the home.

While there is a need for caution in interpreting results such as these, because of the significant variations among countries, this international perspective is very important in our reflections on how well our students are doing in various areas. The trends observed here can help us, at least in part, to understand better the learning environment in Alberta.

APPENDIX 1: Overall Summary of Test Administration by Country and Canadian Province for Age 9 and Age 13*

| | Scheduled Assessment Month | Who Gave Test | Test Administrator Training | Practice Test Used | Percent of Sites Visited | Percent of Accurate Scores** |
|--------------------|---------------------------------|-------------------------|-----------------------------|--------------------------|--------------------------|------------------------------|
| Brazil | Sept '90 | External Administrators | Yes | No | 23 | 99.5 |
| Canada Alberta | March '91 | School Personnel | No | No | 20 | 99.7 |
| British Columbia | March '91 | School Personnel | No | No | Informal | 99.5 |
| Manitoba | March '91 | School Personnel | Yes | No | 18 | 99.6 |
| N. Brunswick-Engl. | March '91 | School Personnel | Yes | Optional | 15 | 99.8 |
| N. Brunswick-Fr. | March '91 | School Personnel | Yes | Yes | 39 | - |
| Newfoundland | March '91 | School Personnel | No | No | 21 | 99.0 |
| Nova Scotia | March '91 | School Personnel | No | No | 21 | 99.9 |
| Ontario | March '91 | School Personnel | Yes | Yes (9) Optional (13) | 19 | 98.1 |
| Quebec | March '91 | School Personnel | Yes | Yes | 22 | 98.2 |
| Saskatchewan | March '91 | School Personnel | No | No | Informal | 99.3 |
| China | March '91 | School Personnel | Yes | No | 19 | 99.6 |
| England | March '91 | School Personnel | No | No | Informal | 99.4 |
| France | March '91 | School Personnel | Yes | Yes | 21 | 99.5 |
| Hungary | March '91 | School Personnel | Yes | No | 16 | 99.6 |
| Ireland | March '91 | School Personnel | No | No | Informal | 99.4 |
| Israel | March '91 | School Personnel | Yes | No | 19 | 99.5 |
| Italy | March '91 | School Personnel | Yes | No | 21 | 99.6 |
| Jordan | March '91 | School Personnel | Yes | Yes | 24 | 100.0 |
| Korea | Sept '90 | School Personnel | Yes | Yes | 20 | 98.0 |
| Mozambique | Sept '90 | External Administrators | Yes | No | Informal | 99.3 |
| Portugal | March '91 | External Administrators | Yes | Yes (9) No (13) | 20 | 99.5 |
| Scotland | March '91 | School Personnel | No | Optional (9) No (13) | Informal | Not Done |
| Slovenia | March '91 | External Administrators | Yes | Optional | 10 | 99.8 |
| Soviet Union | March '91 (9) April '91 (13) | School Personnel | Yes | Yes | 52 | 99.3 |
| Spain | March '91 | External Administrators | Yes | Optional (9) No (13) | 20 | 99.7 |
| Switzerland | March '91 | School Personnel | Yes | No | Informal | - |
| Taiwan | March '91 | School Personnel | Yes | No | 20 | 99.8 |
| United States | March '91 | School Personnel | No | No | 16 | 99.8 |

* Complete results for all countries can be found in the *Learning Mathematics* and *Learning Science* reports.

** This number represents the mean of the percent of accurate scores by scorers for constructed-response questions.

APPENDIX 2: Quality Control Procedures

Translations of Assessment Materials Independently Verified

Achievement and background questions and pupil directions were adapted and translated within each country and then checked independently by language experts in the United States. All countries used the same artwork and physical layouts for their tests.

Pilot Test of Assessment Questions

Achievement and background questions were pilot-tested with groups of pupils from each participating country (except Slovenia, which joined the project late) to determine which questions would work best in the final assessment.

Samples Independently Verified

Samples for each population were drawn using agreed-upon procedures and were independently checked in the United States to ensure that procedures were followed accurately and that sampling weights were appropriately calculated.

Procedural Manuals and Training Provided

Procedural manuals were developed for coordinating the project, drawing samples, administering the assessments, conducting a quality control program, and entering results into a database. Regional training sessions were held at which the individuals from each assessment centre who actually performed the tasks were provided detailed instructions and hands-on experience.

Computer Software Provided

Specially developed computer software was provided to the participants to facilitate sampling and data entry and to ensure uniformity and quality.

Standardized Test Administration

Test booklets were administered to students using the same instructions and the same time limits in each participating country. To ensure procedures were understood, test administrators, usually school personnel, were trained in 20 out of 29 assessment centres.

On-site Observation of Assessments

Unannounced observations of the test administrations were conducted by all assessment centres.

Independent Quality Control

In all countries except Brazil and Mozambique, an independent, trained observer interviewed the country project manager about all aspects of the project and visited one or more test administration sites. In most cases, the observer was fluent in the language of the assessment.

Data Files and Data Analysis Validated

The scoring of open-ended mathematics questions was checked in 10 percent of the booklets by 27 out of 29 assessment centres and in all cases, accuracy of scoring was 98 percent or higher. Each country validated its own data files, using software provided by the project, to ascertain their quality and accuracy. Data files were also independently validated by comparing the responses of a random set of 10 student booklets and 10 school questionnaires of each type to the data entered into the databases. If data files contained 1 percent errors or greater, participants were asked to rekey all the responses. This happened in one case. Data analysis procedures were checked by calculating statistics using different programs and computer equipment and comparing the results.

Assessment Questions Checked for Curricular or Cultural Bias

Assessment results were checked to verify that responses to individual questions could be summarized without misrepresenting curricular or cultural differences within particular countries. Cluster analyses and analyses of differential item functioning (DIF) resulted in the removal of one mathematics questions at each age level, two science questions at age 9, and eight at age 13 before final analyses were conducted.