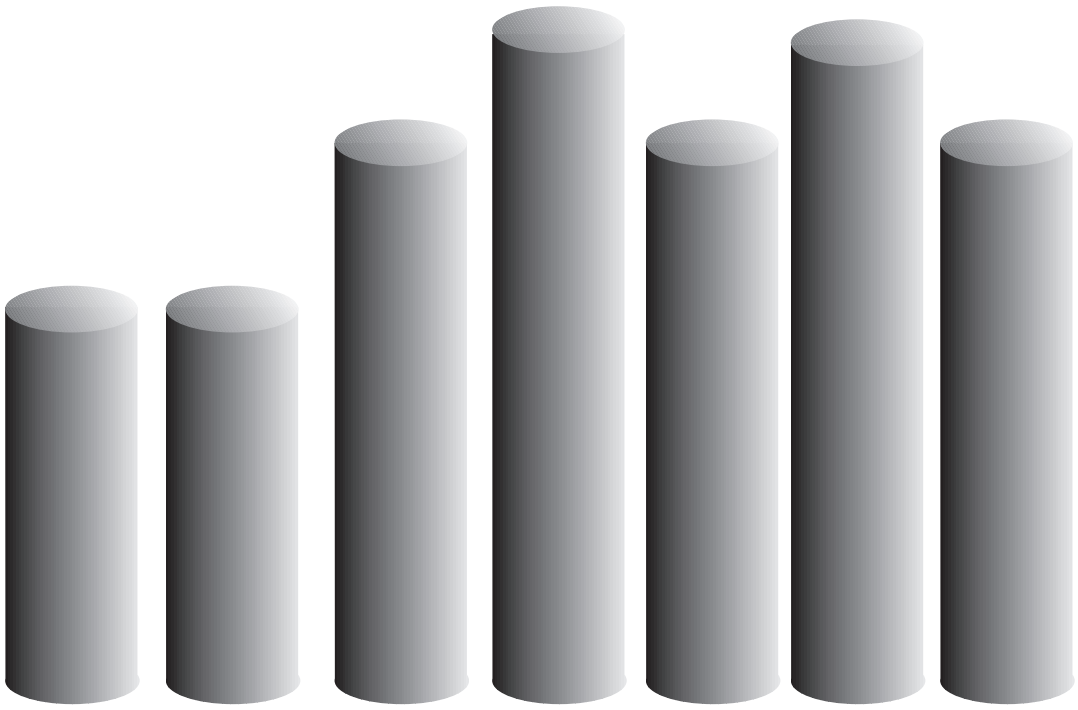
TIMSS Physics Achievement Comparison Study



Third International Mathematics and Science Study

TIMSS International Study Center
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TIMSS Physics Achievement Comparison Study

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Executive Summary

The National Science Foundation (NSF) sponsors teacher enhancement and physics material development programs. This study reports on how students in these programs perform on the Third International Mathematics and Science Study (TIMSS) physics, and mathematics and science literacy tests, compared to students in almost 20 countries.

Students in NSF-sponsored programs significantly outperformed physics students from the United States, and two other countries (Czech Republic, Austria), and performed about the same as four countries (Latvia, Greece, Canada and France). The significant gender difference, favoring boys, was approximately the same in the NSF-sponsored physics programs and the United States. Students in the NSF-sponsored physics programs performed significantly higher on both the science, and composite mathematics and science literacy tests than physics students from the United States. Across the four content areas, the NSF-sponsored physics students were stronger than the United States in mechanics, electricity and magnetism, and modern physics. They performed about the same as United States physics students on the heat component of the TIMSS physics test.

Similar to the United States and many other countries, there was a clear relationship between parents' education and student achievement. However, within any particular level of parents' education, students in the NSF-sponsored physics programs significantly outperformed physics students in the United States. Sixty-five percent of students in NSF-sponsored programs reported that at least one parent had finished university, compared with 55% for U.S. physics students in general.

Forty-five percent of the students in the NSF-sponsored physics programs reported receiving four or more hours of physics instruction a week, compared with just 17% for physics students in general in the United States, and a further 43%of the students reported receiving five or more hours of physics instruction per week.

While no clear relationship between amount of homework assigned and physics achievement was evident across countries, the students in the NSF-sponsored physics programs who were assigned homework most frequently outperformed other students.

Roughly equal proportions of students in the NSF-sponsored physics programs reported doing reasoning tasks in most or every lesson. Those students who reported doing reasoning tasks every lesson outperformed students who reported doing reasoning tasks most lessons by 36 points. A small percentage of students in the NSF sponsored physics programs reported doing reasoning tasks some lessons, and these students had the lowest achievement of the three categories to which these students responded.

Roughly 40% percentage of students in the NSF-sponsored physics programs reported doing experiments some or most lessons, while 15% reported doing experiments every lesson, and 2% reported not doing any experiments. The highest achievement was associated with those students who reported doing experiments in only some lessons. The performance of these students was close to the international mean. These NSF students outperformed NSF students who did experiments every lesson by 18 points, and those that did experiments most lessons by 28 points.

The NSF-sponsored physics programs who reported using computers to solve exercises or problems in every lesson performed 68 points lower that those that used the computer most lessons, and 47 points lower than those that used the computer some lessons.

Most (95%) of the students in the NSF-sponsored physics programs reported intending to attend university. This figure is comparable to the percentage reported by the United States students. Compared with the United States students, the students in the NSF-sponsored programs indicated a preference for engineering, mathematics, or computer/information science, and relatively fewer for the health sciences or related occupations.

Introduction

The Goals 2000: Educate America Act states that United States students will be first in the world in mathematics and science achievement by the year 2000. However, the Third International Mathematics and Science Study (TIMSS), the largest, most comprehensive, and most rigorous international study of student achievement ever undertaken, showed that United States high-school students are, on average, not leading, but lagging the world in mathematics and science achievement, and ranked last in physics achievement by the final year of secondary school.[1] The release of the TIMSS reports has promoted, and in some cases instigated, research for ways of reconciling widely held United States education goals and the low ranking of the United States students at the middle-school and high school levels.

The National Science Foundation (NSF) has long recognized the need to develop innovative high school science programs to enhance the science attainment by United States students and has been active in sponsoring a range of teacher enhancement and material development programs directed to this end. Concerned at the low performance in mathematics and physics of United States high school seniors, NSF commissioned the TIMSS International Study Center at Boston College to administer the TIMSS twelfth-grade tests of physics and of mathematics and science literacy to a sample of twelfth-grade students taught by teachers who had participated in NSF-sponsored programs.

Comparing the performance of these students with United States twelfth-grade students in general, as well as with final-year secondary school students in 16 other countries, should give some indication of the potential for the NSF-sponsored programs to improve the teaching and learning of physics in our nation's schools.

THE NSF-PHYSICS PROGRAMS AND THEIR STUDENTS

The NSF sponsors a range of teacher enhancement and physics material development programs. The NSF-physics programs included in this study are led by physics education specialists from Arizona State University, San Diego State University, University of Dallas, University of Massachusetts, University of Washington, and Seminole County.[2] The programs are offered to Physics teachers, who are invited to participate in them, and to implement the programs in their classes.

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[1] Mullis, I. V. S., Martin, M. O., Beaton, A. E., Gonzalez, E. J., Kelly, D. L., and Smith, T. A. (1998) Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study, TIMSS International Study Center, Boston College, Chestnut Hill, MA.

[2] Further information about the specific programs can be obtained from Gerhard Salinger of the National Science Foundation.

The sample of students for the TIMSS testing was obtained by randomly sampling from all of the final-year physics classes in 1999 that had been taught by a teacher who had participated in one of the NSF-sponsored physics programs. A total of 23 classes were selected from the population of 185 classes, and 296 students were administered the TIMSS physics test while 195 took the mathematics and science literacy tests.

WHAT IS TIMSS?

TIMSS is the third international comparative study of mathematics achievement and the third international comparative study of science achievement carried out by the International Association for the Evaluation of Educational Achievement (IEA). Previous IEA studies of mathematics and science were conducted for each subject separately at various times during the 1960s, 1970s, and 1980s. TIMSS is the first IEA study that has assessed both mathematics and science at the same time.

TIMSS was designed to focus on students at three different stages of schooling: midway through elementary school, midway through secondary school, and at the end of upper secondary school. Initial findings for the 41 countries in the lower secondary school component, the 26 countries that participated in the elementary school component, and for the 23 countries that participated in the final years of schooling component have been reported in IEA publications[3], and the Pursuing Excellence[4] series within the United States.

TIMSS ASSESSMENTS AND NATURE OF THIS REPORT

The TIMSS assessments for the final years of secondary school were conducted in 1995 and focused on four broad areas of performance:

- Mathematics literacy for all students in the final year of secondary education, including those who had taken advanced mathematics and science courses;
- Science literacy for all students in the final year of secondary education, including those who had taken advanced mathematics and science courses;
- Advanced mathematics for students in the final year of secondary education who had taken or were taking advanced courses in mathematics;

[3] The IEA TIMSS publications are available on the internet: http://isc.bc.edu/TIMSS1/TIMSSPublications.html

[4] Available for downloading at http://nces.ed.gov/timss/

- Physics for students in the final year of secondary education who had taken or were taking advanced courses in physics.

This report presents achievement on the TIMSS physics test, for students in the NSF-sponsored physics programs, and compares it with achievement in 1995 of physics students in 16 countries: Australia, Austria, Canada, Cyprus, the Czech Republic, Denmark, France, Germany, Greece, Latvia, Norway, the Russian Federation, Slovenia, Sweden, Switzerland, and the United States. Additionally, the performance on the TIMSS tests of mathematics and science literacy of students in the NSF-sponsored physics programs is presented in Appendix A, together with the performance of students from 21 countries: Australia, Austria, Canada, Cyprus, the Czech Republic, Denmark, France, Germany, Hungary, Iceland, Italy, Lithuania, the Netherlands, New Zealand, Norway, the Russian Federation, Slovenia, South Africa, Sweden, Switzerland, and the United States.

Achievement in Physics Content Areas

The physics test for final year students was designed to enable reporting by five content areas as well as for physics overall. The physics content areas are:

- Mechanics
- Electricity and magnetism
- Heat
- Wave phenomena
- Modern physics: particle, quantum and astrophysics, and relativity

TIMSS is the most fair and accurate international comparison of students that has ever been undertaken. In each country, the final year students that participated in TIMSS were randomly sampled to represent all students in the final grade of high school. Martin and Kelly (eds.) (1998)[5] describe the procedures and quality control methods implemented for TIMSS, and duplicated for the present study, while Mullis, Martin, Beaton, Gonzalez, Kelly and Smith (1998) describe the level of adherence to the rigorous sampling standards set by TIMSS.

WHAT WAS THE NATURE OF THE TIMSS 1995 PHYSICS SAMPLE?

The TIMSS 1995 physics study was designed to provide information about how well prepared the population of school leavers that has taken physics is to pursue higher education or occupations in science. In all countries the students participating in the physics testing had taken courses in physics and were in the final year of secondary

[5] Martin, M. O. and Kelly, D. L. (eds.) (1998) Third International Mathematics and Science Study: Technical Report, Volume III: Implementation and Analysis, Final Year of Secondary School, TIMSS International Study Center, Boston College, Chestnut Hill, MA.

school at the time of testing. However, the exact definition of the population varied across countries in terms of which courses and how much physics the students had taken (see Mullis and others (1998) Appendix A for more details).

TIMSS developed the Physics TIMSS Coverage Index (PTCI) to estimate the percentage of a country's school-leaving age cohort that has taken physics, as an indicator of the selectivity of the country's physics students. Table 1 confirms that in most of the TIMSS countries, physics in upper secondary school is taken by only a small proportion of students. The PTCI was low in Norway (8%), and particularly low in Denmark (3%), Latvia (3%), and the Russian Federation (1.5%) indicating that physics students in these countries are a very select group. In contrast, in Slovenia and in Austria, about one third of the school-leaving age cohort takes physics. A number of countries had PTCI's about the same as the United States (15%). These countries include: Australia, Canada, Czech Republic, France, Sweden, and Switzerland.

How Does the Physics Performance of Students in NSF Physics Programs Compare with Students Internationally?

The average achievement of students in the NSF-sponsored programs and of students in 16 countries that participated in the physics study for students in their final year of secondary school is shown in Table 2. This table also indicates whether the country averages were significantly above or below the international average of 501. In Norway, Sweden, the Russian Federation, and Denmark, the country average was significantly above the international average, while in six countries, Switzerland, Canada, France, the Czech Republic, Austria, the United States, and the NSF-sponsored physics programs it was significantly below the international average.

To illustrate the broad range of achievement both across and within countries, Table 2 graphically represents the distribution of student performance. Achievement for each country is shown for the 25th and 75th percentiles as well as for the 5th and 95th percentiles. Each percentile point indicates the percentages of students performing below and above that point on the scale. For example, 25% of the students in each country performed below the 25th percentile for that country, and 75% performed above the 25th percentile. The range between the 25th and 75th percentiles represents performance by the middle half of the students. In contrast, performance at the 5th and 95th percentiles represents the extremes in lower and higher achievement. The dark boxes at the midpoints of the distributions are the 95% confidence intervals around the achievement mean.[6]

[6] See the "IRT Scaling and Data Analysis" section of Mullis and others (1998), Appendix B, for more details about calculating standard errors and confidence intervals for the TIMSS statistics.

Table 1
TIMSS Coverage Indices (TCIs) for Physics

Country	TIMSS Coverage Index (TCI)*	Sample Exclusions	Others Not Covered	Percentage of Students in Sample Having Taken Physics	TIMSS Coverage Index for Physics (PTCI)*
Australia	68.1%	4.0%	27.9%	18.5%	12.6%
Austria	75.9%	16.8%	7.3%	43.5%	33.1%
Canada	70.3%	6.8%	22.9%	19.4%	13.7%
Cyprus	47.9%	13.5%	38.6%	18.5%	8.8%
Czech Republic	77.6%	5.0%	17.4%	14.1%	11.0%
Denmark	57.7%	1.3%	41.0%	5.5%	3.2%
France	83.9%	0.9%	15.3%	23.8%	19.9%
Germany	75.3%	9.6%	—	11.2%	8.4%
[1] Greece	10.0%	56.8%	33.2%	—	10.0%
[2] Latvia	3.0%	16.8%	80.3%	—	3.0%
Lithuania	42.5%	0.0%	57.5%	—	—
Norway	84.0%	3.3%	12.7%	10.0%	8.4%
Russian Federation	48.1%	36.3%	15.7%	3.2%	1.5%
Slovenia	87.8%	5.6%	6.6%	43.9%	38.6%
Sweden	70.6%	0.2%	29.2%	23.1%	16.3%
Switzerland	81.9%	2.1%	16.0%	17.3%	14.2%
United States	63.1%	2.5%	34.5%	22.9%	14.5%

† PTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of physics students. See Mullis and others, 1998 Appendix A for characteristics of students sampled and Mullis and others, 1998 Appendix B for details about the PTCI.

[1] Greece sampled only students having taken advanced mathematics and physics.

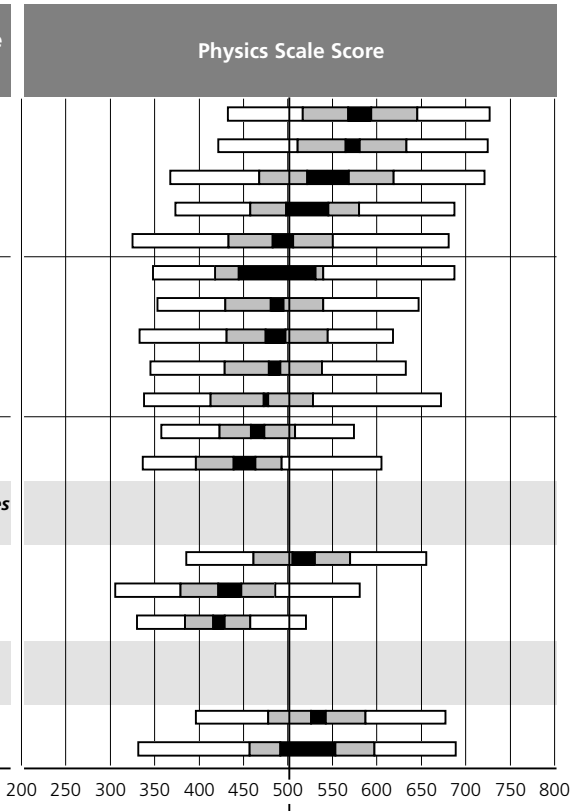
[2] Latvia sampled only students having taken physics.

Note: Hungary, Iceland, the Netherlands, New Zealand, and South Africa did not participate in the advanced mathematics and physics testing. Norway did not participate in the advanced mathematics testing and Lithuania did not participate in the physics testing.

Table 2

Distributions of Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Country	Mean	PTCI‡	Average Age
† Norway	▲ 581 (6.5)	8%	19.0
Sweden	▲ 573 (3.9)	16%	18.9
[2] Russian Federation	▲ 545 (11.6)	2%	16.9
† Germany	● 522 (11.9)	8%	19.1
[2] Cyprus	● 494 (5.8)	9%	17.7
[1] Latvia (LSS)	● 488 (21.5)	3%	18.0
Switzerland	▼ 488 (3.5)	14%	19.5
† Greece	● 486 (5.6)	10%	17.7
Canada	▼ 485 (3.3)	14%	18.6
NSF Physics Programs	▼ 475 (1.2)	–	17.9
France	▼ 466 (3.8)	20%	18.2
Czech Republic	▼ 451 (6.2)	11%	18.1
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)			
Australia	● 518 (6.2)	13%	17.7
[2] Austria	▼ 435 (6.4)	33%	19.1
United States	▼ 423 (3.3)	14%	18.0
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)			
Denmark	▲ 534 (4.2)	3%	19.1
Slovenia	● 523 (15.5)	39%	18.8

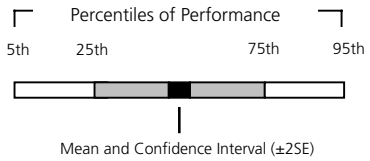


International Average = 501
Average of all country means

▲ Country mean significantly higher than international mean

▼ Country mean significantly lower than international mean

● No statistically significant difference between country mean and international mean



* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

‡ The Physics TIMSS Coverage Index (PTCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year physics student sample (see Mullis and others, 1998 Appendix B for more information).

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

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Comparisons can be made across the means and percentiles. For example, the NSF-sponsored physics programs have a greater range than the United States. While the 5th percentile for the NSF-sponsored programs is approximately the same as the United States, the 95th percentile for the NSF-sponsored physics programs is almost 75 points higher than the comparable percentile for the United States.

Figure 1 allows comparison of overall mean achievement between countries.[7] It shows whether or not the differences in mean achievement between pairs of countries are statistically significant. Selecting a country of interest and reading across the table, a triangle pointing up indicates significantly higher performance than the country listed across the top, a dot indicates no significant difference, and a triangle pointing down indicates significantly lower performance.

In terms of average physics achievement, students in the NSF-sponsored programs performed worse than nine countries: Norway, Sweden, Russian Federation, Denmark, Slovenia, Germany, Australia, Cyprus and Switzerland. The NSF-sponsored physics programs students performed about the same as students in Latvia, Greece, Canada, and France, and better than students in the Czech Republic, Austria and the United States.

HOW DOES PERFORMANCE IN PHYSICS COMPARE BY GENDER?

Table 3, which shows the differences in physics achievement by gender, reveals that males had significantly higher achievement than females in all but one of the participating countries. The table presents mean physics achievement separately for males and females for each country, as well as the difference between the means. The gender difference for each country, shown by a bar, indicates the amount of the difference, whether the direction of difference favors females or males, and whether the difference was statistically significant (a darkened bar). Only in Latvia (LSS) was the average physics score for males not significantly greater than that for females, and this may have been partly the result of a larger than usual sampling variance. The gender difference in achievement for students in the NSF-sponsored physics programs was significant and approximately the same as for students in Australia, Cyprus and Denmark. More males than females were involved in the NSF-sponsored physics program, and these males outperformed female students on average by 41 points. In the United States, male physics students significantly out-performed female physics students by 33 points.

[7] The significant tests in Figure 1 are based on a Bonferroni procedure for multiple comparisons that holds to 5% the probability of erroneously declaring the mean of one country to be different from that of another country.

Figure 1

Multiple Comparisons of Physics Achievement for Students Having Taken Physics – Final Year of Secondary School*

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.‡

	Norway	**Sweden**	*Russian Federation*	**Denmark**	*Slovenia*	**Germany**	*Australia*	**Cyprus**	**Switzerland**	**Latvia (LSS)**	**Greece**	**Canada**	**NSF Physics Programs**	**France**	**Czech Republic**	*Austria*	*United States*
Norway		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	●		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Russian Federation	●	●		●	●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	●		●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	●	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲
Germany	▼	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲
Australia	▼	▼	●	●	●	●		●	▲	●	▲	▲	▲	▲	▲	▲	▲
Cyprus	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	●	●	▼	●		●	●	●	▲	▲	▲	▲	▲
Latvia (LSS)	▼	▼	●	●	●	●	●	●	●		●	●	●	●	●	●	▲
Greece	▼	▼	▼	▼	●	●	▼	●	●	●		●	●	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●	▼	▼	●	●	●	●		●	▲	▲	▲	▲
NSF Physics Programs	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●		●	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	●		●	▲
Austria	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	▼	●		●
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

‡ Statistically significant at .05 level, adjusted for multiple comparisons.

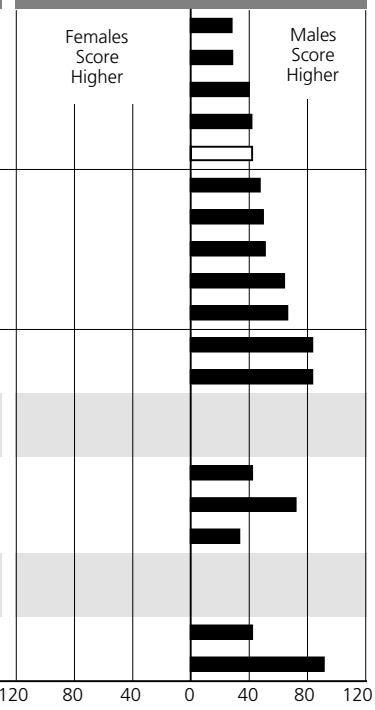
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

Because population coverage falls below 65%, Latvia is annotated LSS for Latvia Speaking School only.

Table 3

Gender Differences in Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Country	Males		Females		Difference	PTCI	Gender Difference
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement			
† Greece	68 (2.1)	495 (6.1)	32 (2.1)	468 (8.1)	28 (10.1)	10%	
France	61 (2.0)	478 (4.2)	39 (2.0)	450 (5.6)	28 (7.0)	20%	
[2] Cyprus	63 (2.5)	509 (8.9)	37 (2.5)	470 (7.1)	40 (11.4)	9%	
NSF Physics Programs	54 (0.5)	494 (1.9)	46 (0.5)	453 (2.4)	41 (3.1)	–	
[1] Latvia (LSS)	51 (3.7)	509 (19.0)	49 (3.7)	467 (22.6)	42 (29.5)	3%	
Canada	57 (3.2)	506 (6.0)	43 (3.2)	459 (6.3)	47 (8.7)	14%	
Sweden	67 (3.4)	589 (5.1)	33 (3.4)	540 (5.3)	49 (7.4)	16%	
† Norway	74 (1.8)	594 (6.3)	26 (1.8)	544 (9.3)	51 (11.2)	8%	
† Germany	69 (3.0)	542 (14.3)	31 (3.0)	479 (9.1)	64 (17.0)	8%	
[2] Russian Federation	54 (2.0)	575 (9.9)	46 (2.0)	509 (15.3)	66 (18.2)	2%	
Czech Republic	38 (2.4)	503 (8.8)	62 (2.4)	419 (3.9)	83 (9.7)	11%	
Switzerland	51 (1.8)	529 (5.2)	49 (1.8)	446 (3.6)	83 (6.3)	14%	
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	66 (3.8)	532 (6.7)	34 (3.8)	490 (8.4)	42 (10.8)	13%	
[2] Austria	38 (3.5)	479 (8.1)	62 (3.5)	408 (7.4)	71 (11.0)	33%	
United States	52 (2.4)	439 (4.3)	48 (2.4)	405 (3.1)	33 (5.3)	14%	
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	80 (2.3)	542 (5.2)	20 (2.3)	500 (8.1)	42 (9.6)	3%	
Slovenia	72 (3.7)	546 (16.3)	28 (3.7)	455 (18.7)	91 (24.8)	39%	



International Averages

Males	Females	Difference
523	469	54

(Average of all country means)

Gender difference statistically significant at .05 level.

Gender difference not statistically significant.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some differences may appear inconsistent. Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

How Well Did Students Having Taken Physics Perform in Mathematics and Science Literacy?

Table 4 compares the performance of students having taken physics with the performance of final-year students in general on the TIMSS science literacy test, and on the composite mathematics and science literacy test. It is clear from this table that students having taken physics generally have high levels of mathematics and science literacy. For example, physics students in the United States had an average score of 553 compared to 480 for students in the United States in general. As might be expected, there was a tendency for achievement differences to be greatest in countries where the coverage index was least. The science literacy difference between all students and physics students ranged from 49 in Slovenia (PTCI of 39%) to 124 in Norway (PTCI of 8%).

The students in the NSF-sponsored physics programs performed approximately 40 points higher than physics students in the United States on both the science literacy and the composite mathematics and science literacy tests. The students in the NSF-sponsored physics programs performed at about the international average for physics students.

How Does Performance Compare Across Content Areas?

As well as scaling the complete physics item pool to obtain an overall physics scale, TIMSS scaled each of the five physics content areas separately to facilitate analyses at the content level. Table 5 summarizes the country means and standard errors on each content scale for each country, and also provides the Physics TIMSS Coverage Index. Not surprising given their performance on the physics tests overall, students in the NSF-sponsored physics programs performed below the international average in each of the five content areas. However, they outperformed physics students in the United States in mechanics and wave phenomena by at least 40 points, and by over 30 points in modern physics. The students in the NSF-sponsored programs performed roughly the same as the United States students in the heat content area. In their weakest content area, electricity and magnetism, the NSF-sponsored programs students still outperformed the United States students by 26 points.

Figure 2 graphically depicts each country's strengths and weaknesses in the physics content areas compared with their average performance across all five content areas. The horizontal line indicates each country's overall average achievement in physics, and the five darkened boxes indicate the 95% confidence intervals around the mean achievement in each of the five content areas. If the darkened box is below the line, then the country performed significantly less well in that content area than it did overall. Similarly, if the darkened box is above the line, then the country performed significantly better in that content area than it did overall.

Table 4

Comparison Between All Students in Their Final Year of Secondary School and Final-Year Students Having Taken Physics in Mathematics and Science Literacy

Country	Mean Achievement				Overall TCI	Physics TCI
	Mathematics and Science Literacy		Science Literacy			
	All Students	Physics Students	All Students	Physics Students		
NSF Physics Programs	– –	587 (3.6)	– –	595 (4.1)	–	–
Canada	526 (2.6)	594 (5.5)	532 (2.6)	596 (5.5)	70%	14%
[1] Cyprus	447 (2.5)	521 (6.1)	448 (3.0)	526 (6.2)	48%	9%
Czech Republic	476 (10.5)	582 (7.2)	487 (8.8)	591 (6.8)	78%	11%
France	505 (4.9)	572 (5.0)	487 (5.1)	553 (4.9)	84%	20%
† Germany	496 (5.4)	591 (7.3)	497 (5.1)	586 (7.5)	75%	8%
† Norway	536 (4.0)	658 (6.7)	544 (4.1)	668 (8.0)	84%	8%
Sweden	555 (4.3)	664 (3.7)	559 (4.4)	668 (4.1)	71%	16%
Switzerland	531 (5.4)	618 (4.2)	523 (5.3)	617 (4.5)	82%	14%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	525 (9.5)	610 (7.7)	527 (9.8)	610 (8.9)	68%	13%
[1] Austria	519 (5.4)	567 (5.9)	520 (5.6)	570 (6.2)	76%	33%
United States	471 (3.1)	548 (5.2)	480 (3.3)	553 (5.7)	63%	14%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	528 (3.2)	610 (6.7)	509 (3.6)	592 (7.3)	58%	3%
Slovenia	514 (8.2)	563 (8.0)	517 (8.2)	566 (8.7)	88%	39%
International Average	510 (1.6)	592 (1.7)	510 (1.6)	592 (1.8)		

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

The procedures used by Latvia (LSS) and Russian Federation do not permit estimating literacy achievement for students taking physics.

Greece did not test the population of all students in their final year of secondary school.

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

Table 5

Achievement in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Country	PTCI	Physics Content Areas Mean Achievement Scale Scores				
		Mechanics (16 items)	Electricity and Magnetism (16 items)	Heat (9 items)	Wave Phenomena (10 items)	Modern Physics: Particle, Quantum and Astrophysics, and Relativity (14 items)
NSF Physics Programs	–	▼ 477 (1.3)	▼ 446 (0.9)	▼ 481 (0.8)	▼ 492 (1.2)	▼ 489 (1.0)
Canada	14%	▼ 473 (3.6)	▼ 485 (3.7)	● 508 (4.2)	▼ 488 (3.2)	● 494 (2.7)
[2] Cyprus	9%	▲ 530 (6.6)	● 502 (6.3)	▼ 476 (6.7)	● 507 (6.5)	▼ 434 (5.2)
Czech Republic	11%	▼ 469 (6.0)	▼ 465 (5.5)	● 488 (4.7)	▼ 447 (5.4)	▼ 453 (4.9)
France	20%	▼ 457 (4.3)	● 494 (4.1)	● 491 (3.4)	▼ 463 (3.6)	▼ 474 (3.4)
† Germany	8%	● 495 (9.4)	● 512 (9.9)	● 496 (6.4)	▲ 530 (10.3)	▲ 545 (13.1)
† Greece	10%	● 514 (6.5)	● 520 (6.6)	● 481 (7.2)	▼ 453 (5.3)	▼ 447 (4.9)
[1] Latvia (LSS)	3%	● 489 (18.1)	● 485 (17.4)	● 504 (21.4)	● 498 (17.6)	● 488 (19.0)
† Norway	8%	▲ 572 (6.4)	▲ 565 (6.2)	▲ 536 (4.3)	▲ 560 (5.4)	▲ 576 (5.3)
[2] Russian Federation	2%	▲ 537 (9.3)	▲ 549 (9.2)	▲ 530 (10.4)	● 515 (9.4)	▲ 542 (9.9)
Sweden	16%	▲ 563 (4.0)	▲ 570 (3.3)	▲ 522 (4.3)	▲ 560 (4.7)	▲ 560 (3.5)
Switzerland	14%	▼ 482 (3.5)	▼ 480 (4.5)	● 509 (3.6)	● 498 (3.1)	▼ 488 (3.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)						
Australia	13%	● 507 (6.1)	● 512 (4.4)	▲ 517 (4.3)	● 519 (6.9)	▲ 521 (5.8)
[2] Austria	33%	▼ 420 (4.9)	▼ 432 (6.3)	▼ 445 (5.6)	▼ 468 (7.3)	▼ 480 (6.0)
United States	14%	▼ 420 (2.8)	▼ 420 (3.0)	▼ 477 (3.0)	▼ 451 (2.2)	▼ 456 (2.5)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)						
Denmark	3%	▲ 529 (4.9)	● 513 (3.8)	● 512 (4.3)	▲ 537 (5.5)	▲ 544 (4.9)
Slovenia	39%	▲ 552 (17.3)	● 509 (14.6)	● 521 (10.4)	● 514 (11.5)	● 511 (15.1)
International Average		501 (2.1)	501 (2.0)	501 (2.0)	500 (1.9)	501 (2.1)

▲ Country average significantly higher than the international average for the scale

● No significant difference between country average and international average for the scale

▼ Country average significantly lower than the international average for the scale

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

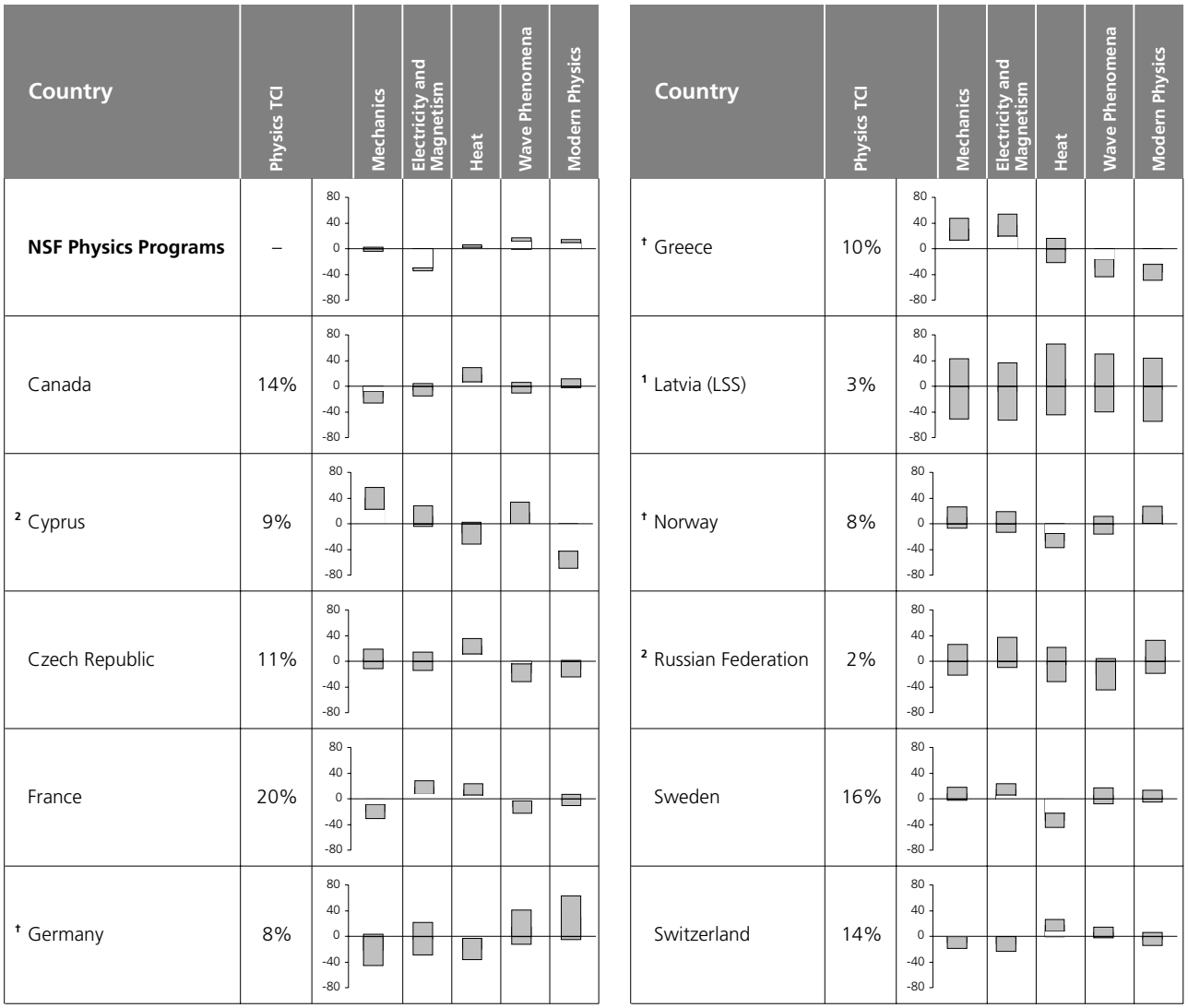
[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

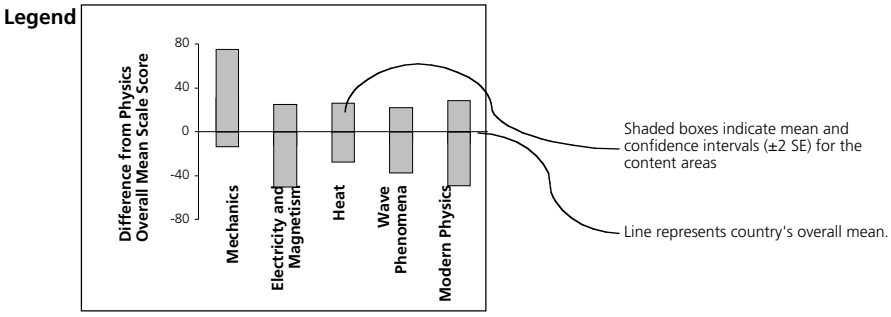
[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Figure 2

Profiles of Performance in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*





* See Mullis and others, 1998 Appendix A for characteristics of students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvia Speaking School only.

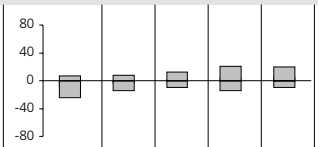
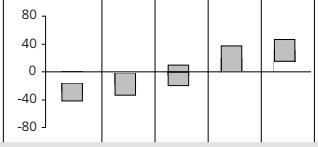
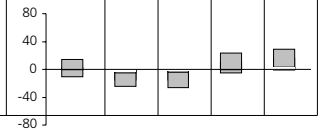
† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

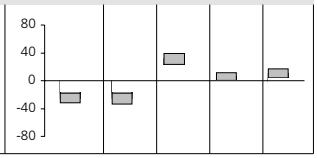
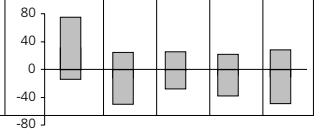
[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

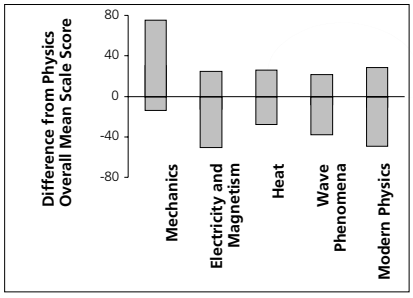
Figure 2 (Continued)

Profiles of Performance in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Country	Physics TCI	Mechanics	Electricity and Magnetism	Heat	Wave Phenomena	Modern Physics
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details):						
Australia	13%					
[2] Austria	33%					
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B):						
Denmark	3%					

Country	Physics TCI	Mechanics	Electricity and Magnetism	Heat	Wave Phenomena	Modern Physics
United States	14%					
Slovenia	39%					

Legend



Shaded boxes indicate mean and confidence intervals (±2 SE) for the

Line represents country's overall mean.

* See Mullis and others, 1998 Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

Most countries did relatively better in some areas and less well in others. Students in the NSF-sponsored physics programs performed better in wave phenomena and modern physics, but had a relative weakness in electricity and magnetism.

It was evident from Table 3 that male students outperformed female students on the overall physics test in all countries but one. Table 6 provides further information on this issue by presenting gender differences for each country on each physics content area scale. The international average for males was significantly higher than the average for females on each of the content area scales, with the greatest differences in mechanics. For students in the NSF-sponsored physics program, the average performance for males also was significantly higher in all five content areas. The gender gap for these students was least in modern physics (22), then heat (32), and equally large in mechanics, electricity and magnetism, and wave phenomena (40).

WHAT ARE THE INSTRUCTIONAL PRACTICES IN PHYSICS CLASSES?

The amount of physics instruction received by students in physics classes in their final year varied considerably across countries, but in general was less than five hours per week (Table 7). Students in Australia, the Russian Federation, and the United States mostly reported between three and five hours of physics instruction per week, while in Canada, about half of the students then taking physics reported having five hours or more of physics instruction each week. In Cyprus, Denmark, Greece, and Norway, almost all physics students reported between three and four hours of instruction per week, whereas less than three hours was the norm for students in the Czech Republic, Germany, Latvia (LSS), Sweden, and Switzerland. Forty-five percent of the students in the NSF-sponsored physics programs reported receiving four or more hours of physics instruction a week, compared with just 17% for physics students in general in the United States, and a further 43%of the students reported receiving five or more hours of physics instruction per week.

The relationship between physics achievement and amount of instruction varied across countries; the most common was a curvilinear relationship, with the highest achievement associated with between three and five hours of instruction. This curvilinear relationship is also present in the NSF-sponsored physics program. Those students who received 4 to 5 hours of physics instruction outperformed students who received five or more hours of instruction per week by 26 points, and performed about the same as those that received 3 to 4 hours of instruction per week, and substantially higher than those students receiving less than 3 hours physics instruction per week.

Table 6

Achievement in Physics Content Areas by Gender for Students Having Taken Physics Final Year of Secondary School*

Country	Physics TCI	Physics Content Areas Mean Achievement Scale Scores					
		Mechanics (16 items)		Electricity and Magnetism (16 items)		Heat (9 items)	
		Females	Males	Females	Males	Females	Males
NSF Physics Programs	–	455 (1.8)	▲ 495 (1.9)	423 (1.5)	▲ 463 (1.6)	463 (1.5)	▲ 495 (1.5)
Canada	14%	440 (5.7)	▲ 499 (6.6)	468 (6.5)	▲ 497 (6.2)	492 (8.1)	520 (5.2)
[2] Cyprus	9%	496 (10.3)	▲ 551 (9.6)	494 (7.4)	507 (8.5)	461 (11.2)	484 (9.8)
Czech Republic	11%	440 (4.8)	▲ 514 (8.4)	443 (3.3)	▲ 501 (8.7)	472 (4.5)	▲ 513 (6.6)
France	20%	437 (5.5)	▲ 470 (5.6)	491 (5.2)	495 (4.2)	487 (5.7)	496 (4.0)
† Germany	8%	453 (10.6)	▲ 515 (9.6)	491 (7.7)	522 (12.1)	461 (10.6)	▲ 513 (6.3)
† Greece	10%	489 (7.2)	▲ 525 (7.0)	515 (11.0)	522 (6.5)	460 (10.5)	490 (8.1)
[1] Latvia (LSS)	3%	468 (19.8)	509 (15.2)	474 (18.4)	496 (16.8)	484 (23.4)	523 (17.8)
† Norway	8%	523 (9.0)	▲ 589 (6.1)	549 (10.0)	570 (6.2)	511 (7.0)	▲ 545 (4.4)
[2] Russian Federation	2%	507 (12.3)	▲ 563 (7.4)	519 (12.9)	▲ 575 (7.7)	501 (14.8)	▲ 555 (7.5)
Sweden	16%	517 (4.4)	▲ 586 (4.6)	551 (4.7)	▲ 579 (4.8)	507 (5.4)	529 (5.8)
Switzerland	14%	444 (3.5)	▲ 519 (5.3)	452 (4.5)	▲ 507 (7.1)	480 (5.7)	▲ 538 (4.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	13%	474 (6.8)	▲ 524 (7.8)	488 (8.3)	▲ 525 (6.7)	503 (6.2)	524 (5.0)
[2] Austria	33%	399 (6.3)	▲ 459 (6.6)	409 (6.9)	▲ 468 (9.1)	420 (6.8)	▲ 485 (8.0)
United States	14%	393 (2.8)	▲ 446 (3.5)	409 (3.6)	▲ 430 (3.5)	474 (2.7)	480 (4.2)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	3%	483 (10.2)	▲ 540 (5.5)	498 (7.8)	515 (4.5)	487 (9.6)	517 (5.3)
Slovenia	39%	487 (21.7)	▲ 576 (17.5)	470 (13.8)	522 (16.6)	470 (18.7)	▲ 538 (13.1)
International Average		466 (2.6)	▲ 524 (2.2)	483 (2.3)	▲ 514 (2.2)	479 (2.7)	▲ 516 (2.0)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent. Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 6 (Continued)

Achievement in Physics Content Areas by Gender for Students Having Taken Physics Final Year of Secondary School*

Country	Physics TCI	Physics Content Areas Mean Achievement Scale Scores							
		Wave Phenomena (10 items)				Modern Physics: Particle, Quantum and Astrophysics, and Relativity (14 items)			
		Females		Males		Females		Males	
NSF Physics Programs	–	471	(1.3)	▲ 511	(1.7)	478	(0.6)	▲ 500	(1.6)
Canada	14%	476	(6.4)	497	(4.3)	471	(5.1)	▲ 513	(6.0)
[2] Cyprus	9%	486	(8.4)	519	(10.4)	411	(9.9)	▲ 450	(7.7)
Czech Republic	11%	419	(4.9)	▲ 491	(7.2)	425	(4.6)	▲ 498	(6.9)
France	20%	448	(4.6)	▲ 475	(5.6)	457	(4.1)	▲ 485	(4.3)
† Germany	8%	485	(10.1)	▲ 551	(12.7)	508	(13.5)	561	(15.3)
† Greece	10%	444	(7.2)	457	(7.4)	426	(5.7)	▲ 456	(6.4)
[1] Latvia (LSS)	3%	480	(16.2)	515	(17.3)	470	(20.8)	505	(16.6)
† Norway	8%	519	(10.2)	▲ 575	(4.9)	549	(9.9)	▲ 585	(5.0)
[2] Russian Federation	2%	487	(12.4)	▲ 539	(7.9)	520	(13.9)	561	(7.9)
Sweden	16%	528	(5.9)	▲ 576	(6.1)	538	(6.2)	▲ 570	(3.3)
Switzerland	14%	460	(4.4)	▲ 533	(4.8)	457	(4.4)	▲ 519	(5.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)									
Australia	13%	498	(7.2)	529	(9.0)	497	(7.8)	▲ 533	(6.7)
[2] Austria	33%	444	(9.7)	▲ 506	(7.3)	465	(6.1)	▲ 505	(9.9)
United States	14%	442	(3.0)	▲ 460	(2.6)	446	(2.3)	▲ 466	(3.6)
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)									
Denmark	3%	493	(10.0)	▲ 547	(6.3)	529	(7.4)	546	(6.0)
Slovenia	39%	446	(13.4)	▲ 538	(11.9)	458	(14.1)	▲ 528	(18.7)
International Average		472	(2.3)	▲ 519	(2.2)	477	(2.4)	▲ 518	(2.3)

▲ = Difference from other gender statistically significant at .05 level, adjusted for multiple comparisons

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and Others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 7

Physics Students' Reports on the Amount of Physics Instruction They Are Currently Receiving Each Week – Physics – Final Year of Secondary School*

Country	Amount of Physics Instruction Per Week[1]									
	Not Currently Taking Physics		Less Than 3 Hours		3 to Less Than 4 Hours		4 to Less Than 5 Hours		5 Hours or More	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	1 (0.0)	~ ~	5 (0.1)	435 (7.5)	6 (0.4)	487 (8.4)	45 (0.6)	491 (2.0)	43 (0.5)	465 (2.2)
Australia	2 (0.6)	~ ~	1 (0.6)	~ ~	39 (4.9)	507 (9.5)	46 (5.4)	530 (9.1)	13 (2.1)	551 (10.0)
Austria	44 (2.6)	413 (7.5)	- -	- -	- -	- -	- -	- -	- -	- -
Canada	31 (2.2)	463 (5.3)	4 (0.8)	465 (18.6)	22 (3.0)	507 (9.7)	23 (3.0)	516 (13.1)	52 (3.6)	487 (5.2)
Cyprus	0 (0.0)	~ ~	1 (0.4)	~ ~	92 (1.6)	496 (6.6)	3 (1.1)	483 (17.9)	5 (1.0)	464 (28.9)
Czech Republic	[r] 9 (3.9)	436 (11.9)	81 (3.1)	448 (6.0)	17 (2.9)	529 (22.9)	1 (0.6)	~ ~	0 (0.4)	~ ~
[2] *Denmark*	[r] 0 (0.0)	~ ~	0 (0.0)	~ ~	100 (0.0)	535 (5.0)	0 (0.0)	~ ~	0 (0.0)	~ ~
France	0 (0.0)	~ ~	- -	- -	- -	- -	- -	- -	- -	- -
Germany	8 (4.1)	421 (20.5)	52 (5.2)	489 (8.1)	42 (5.0)	580 (8.6)	6 (1.5)	558 (10.6)	1 (0.5)	~ ~
Greece	[r] 0 (0.0)	~ ~	0 (0.0)	~ ~	100 (0.0)	492 (5.8)	0 (0.0)	~ ~	0 (0.0)	~ ~
Latvia (LSS)	2 (1.1)	~ ~	53 (7.6)	453 (11.2)	10 (5.4)	599 (27.1)	33 (5.0)	501 (14.2)	5 (3.8)	494 (12.6)
Norway	0 (0.2)	~ ~	0 (0.2)	~ ~	98 (0.5)	585 (6.3)	0 (0.0)	~ ~	1 (0.4)	~ ~
Russian Federation	0 (0.1)	~ ~	22 (3.9)	485 (21.7)	23 (3.9)	527 (15.5)	44 (5.3)	569 (12.4)	11 (2.7)	610 (14.7)
Slovenia	17 (4.0)	394 (9.5)	42 (8.8)	527 (15.0)	53 (8.3)	567 (17.4)	3 (1.2)	578 (135.2)	2 (0.5)	~ ~
Sweden	0 (0.1)	~ ~	65 (3.5)	579 (4.3)	26 (3.2)	568 (7.5)	7 (1.5)	569 (19.1)	2 (0.5)	~ ~
Switzerland	22 (3.9)	452 (8.4)	72 (4.2)	485 (5.5)	24 (4.1)	535 (10.4)	3 (0.8)	544 (13.7)	0 (0.1)	~ ~
United States	23 (2.3)	421 (5.1)	9 (0.8)	396 (6.8)	26 (4.9)	429 (8.3)	49 (4.6)	425 (5.7)	17 (2.9)	423 (3.5)

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

[1] Percentages based only on those students reporting that they are currently taking physics. Hours of instruction computed from lessons per week and minutes per lesson.

[2] Data for Denmark obtained from ministry.

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

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

An "r" indicates a 70-84% student response rate.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

The assignment of homework to final-year physics students is also something that varies considerably from country to country, as may be seen in Table 8. On one hand, most students taking physics in Austria, the Czech Republic, Latvia (LSS), and Slovenia reported that they were assigned physics homework less than once a week, while on the other, most students in Australia, Canada, Cyprus, Greece, Norway, the Russian Federation, and the United States reported physics homework assignments three or more times a week. Roughly 40% of the students in the NSF-sponsored physics programs reported being assigned physics homework either once or twice a week, or three or more times a week, with most of the remaining students being assigned homework less than once a week. While no clear relationship between amount of homework assigned and physics achievement was evident across countries, the students in the NSF-sponsored physics programs who were assigned homework most frequently outperformed other students. There was little difference between those students in NSF sponsored physics programs who reported being assigned homework less than once a week and once or twice a week.

To provide information about instructional practices, students were asked how often in their physics lessons they are asked to do reasoning tasks, apply science to everyday problems, conduct laboratory experiments, and use computers to do exercises or solve problems. As shown in Table 9, virtually all students in every country except Austria reported being asked to do reasoning tasks in at least some lessons. While there was essentially no relationship between the frequency of doing reasoning tasks in class for students within the United States, the students in the NSF-sponsored programs show a clear relationship with higher achievement being paired with higher frequency of reasoning tasks. Roughly equal proportions of students in the NSF-sponsored physics programs reported doing reasoning tasks in most or every lesson. Those students who reported doing reasoning tasks every lesson outperformed students who reported doing reasoning tasks most lessons by 36 points. A small percentage of students in the NSF sponsored physics programs reported doing reasoning tasks some lessons, and these students had the lowest achievement of the three categories to which these students responded.

Students reported that applying science to everyday problems is a frequent activity in physics classes. As may be seen in Table 10, most students in every country reported that they are asked to do this in some or most lessons. The practice was reportedly least common in Sweden, where 30% of physics students reported that they were never, or almost never, asked in class to apply science to everyday problems. The application of physics to every day problems was common in the NSF-sponsored physics programs, where 28% of the physics students reported being asked to apply science to everyday problems during every lesson

Table 8

Physics Students' Reports on How Often They Are Assigned Physics Homework
Physics – Final Year of Secondary School*

Country	Not Currently Taking Physics		How Often Physics Homework Is Assigned[1]					
			Less Than Once a Week		Once or Twice a Week		3 or More Times a Week	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	1 (0.0)	~ ~	17 (0.8)	463 (2.8)	42 (0.4)	455 (1.9)	41 (0.6)	505 (3.7)
Australia	2 (0.6)	~ ~	12 (2.8)	529 (14.5)	27 (2.6)	525 (10.6)	60 (3.8)	518 (7.7)
Austria	44 (2.6)	413 (7.5)	97 (1.2)	450 (9.1)	3 (1.2)	454 (21.7)	0 (0.3)	~ ~
Canada	31 (2.2)	463 (5.3)	6 (1.3)	535 (16.0)	25 (3.1)	514 (9.1)	68 (3.9)	487 (4.9)
Cyprus	0 (0.0)	~ ~	2 (0.5)	~ ~	6 (1.1)	508 (24.9)	92 (1.0)	493 (6.9)
Czech Republic	r 9 (3.9)	436 (11.9)	84 (2.5)	459 (7.9)	15 (2.4)	480 (12.2)	1 (0.4)	~ ~
Denmark	r 0 (0.0)	~ ~	7 (1.4)	531 (13.4)	45 (3.0)	525 (7.3)	48 (3.4)	545 (8.4)
France	0 (0.0)	~ ~	- -	- -	- -	- -	- -	- -
Germany	8 (4.1)	421 (20.5)	41 (4.7)	507 (13.4)	40 (3.3)	538 (6.7)	18 (3.3)	579 (15.6)
Greece	0 (0.0)	~ ~	8 (1.9)	465 (20.5)	10 (1.4)	488 (17.0)	82 (2.2)	496 (5.6)
Latvia (LSS)	2 (1.1)	~ ~	53 (4.8)	482 (23.0)	30 (3.4)	497 (20.2)	17 (3.3)	473 (16.9)
Norway	0 (0.2)	~ ~	10 (2.1)	595 (20.8)	15 (2.6)	589 (7.8)	75 (3.6)	581 (6.9)
Russian Federation	0 (0.1)	~ ~	6 (1.1)	554 (22.8)	20 (2.6)	541 (24.2)	74 (2.9)	546 (12.6)
Slovenia	17 (4.0)	394 (9.5)	67 (4.6)	559 (15.3)	29 (4.1)	535 (20.2)	3 (1.1)	506 (37.6)
Sweden	0 (0.1)	~ ~	33 (3.8)	569 (7.2)	64 (3.8)	577 (4.9)	3 (0.9)	551 (18.5)
Switzerland	22 (3.9)	452 (8.4)	41 (3.1)	475 (7.4)	51 (2.9)	514 (6.0)	7 (1.2)	529 (15.3)
United States	23 (2.3)	421 (5.1)	13 (2.2)	418 (7.6)	36 (2.3)	422 (4.6)	51 (2.7)	425 (4.8)

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

[1] Percentages based only on those students reporting that they are currently taking physics.

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

An "r" indicates a 70-84% student response rate.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

Table 9

Physics Students' Reports on How Often They Are Asked to Do Reasoning Tasks in Their Physics Lessons†

Physics – Final Year of Secondary School*

Country	Never or Almost Never		Some Lessons		Most Lessons		Every Lesson	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	0 (0.0)	~ ~	8 (0.1)	450 (5.0)	47 (0.5)	461 (2.5)	45 (0.4)	497 (1.4)
Australia	0 (0.3)	~ ~	22 (1.7)	504 (10.7)	57 (2.9)	531 (9.3)	20 (2.1)	513 (9.2)
Austria	15 (3.3)	418 (25.5)	42 (3.4)	445 (10.9)	33 (3.3)	467 (10.0)	11 (2.0)	466 (11.8)
Canada	1 (0.2)	~ ~	16 (1.0)	495 (10.6)	56 (2.1)	495 (6.6)	28 (2.0)	500 (5.5)
Cyprus	1 (0.5)	~ ~	8 (1.4)	498 (30.0)	43 (2.4)	500 (10.5)	49 (2.8)	490 (6.3)
Czech Republic	r 0 (0.1)	~ ~	16 (1.7)	440 (9.8)	53 (3.2)	465 (11.1)	31 (3.5)	473 (7.6)
Denmark	r 2 (0.7)	~ ~	23 (2.9)	515 (7.4)	65 (2.9)	538 (6.6)	11 (1.6)	557 (14.1)
France	1 (0.4)	~ ~	14 (1.2)	460 (6.5)	52 (1.6)	470 (4.7)	33 (1.5)	465 (4.6)
Germany	1 (0.2)	~ ~	19 (1.5)	506 (13.7)	57 (2.1)	539 (9.5)	23 (2.2)	535 (16.6)
Greece	1 (0.4)	~ ~	8 (1.5)	463 (10.6)	45 (2.7)	492 (7.5)	46 (3.2)	500 (7.5)
Latvia (LSS)	3 (0.9)	482 (36.7)	52 (3.3)	475 (20.8)	41 (3.3)	495 (21.3)	5 (0.9)	490 (15.9)
Norway	1 (0.3)	~ ~	48 (1.9)	571 (8.6)	45 (2.0)	596 (6.3)	6 (0.8)	593 (16.4)
Russian Federation	1 (0.3)	~ ~	26 (2.3)	517 (11.6)	54 (1.8)	551 (12.7)	19 (1.5)	568 (16.8)
Slovenia	2 (0.8)	~ ~	43 (4.3)	546 (26.2)	42 (4.0)	552 (11.6)	12 (1.5)	576 (12.8)
Sweden	0 (0.2)	~ ~	26 (1.9)	576 (8.9)	58 (2.1)	571 (4.2)	16 (1.6)	581 (8.2)
Switzerland	2 (0.5)	~ ~	16 (1.4)	480 (15.3)	57 (2.1)	504 (7.0)	26 (2.4)	506 (7.2)
United States	1 (0.2)	~ ~	13 (1.2)	428 (7.0)	50 (1.8)	424 (4.5)	36 (1.8)	420 (4.1)

† Based on most frequent response for: explain reasoning behind an idea; represent and analyze relationships using tables, charts, or graphs; work on problems for which there is no immediately obvious method solution; write equations to represent relationships; and put events or objects in order and give a reason for their organization. Percentages based only on those students reporting that they are currently taking physics.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate.
A tilde (~) indicates insufficient data to report achievement.

Table 10

Physics Students' Reports on How Often They Are Asked to Apply Science to Everyday Problems in Their Physics Lessons†
Physics – Final Year of Secondary School*

Country	Never or Almost Never		Some Lessons		Most Lessons		Every Lesson	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	4 (0.4)	466 (9.1)	30 (0.6)	478 (2.7)	38 (0.6)	469 (2.3)	28 (0.4)	487 (3.4)
Australia	7 (1.4)	493 (16.6)	40 (3.2)	514 (9.0)	38 (3.4)	536 (8.8)	14 (1.8)	521 (12.4)
Austria	25 (2.8)	436 (14.6)	40 (3.8)	461 (7.8)	26 (2.9)	459 (13.6)	9 (2.6)	422 (18.6)
Canada	8 (0.8)	451 (17.1)	35 (1.8)	504 (7.8)	39 (2.4)	498 (4.7)	17 (2.5)	501 (10.4)
Cyprus	14 (1.6)	491 (25.1)	41 (2.3)	489 (9.7)	35 (2.5)	505 (7.9)	11 (1.5)	480 (21.1)
Czech Republic	r 13 (1.4)	448 (10.6)	49 (2.0)	461 (8.5)	31 (1.7)	470 (9.8)	7 (2.5)	478 (16.3)
Denmark	r 10 (1.5)	497 (12.3)	40 (2.7)	531 (7.5)	45 (2.7)	544 (7.1)	6 (1.3)	540 (22.4)
France	16 (1.3)	450 (7.7)	44 (1.1)	473 (4.7)	30 (1.3)	469 (5.6)	10 (1.1)	463 (8.0)
Germany	16 (2.0)	519 (11.1)	57 (2.4)	529 (10.7)	22 (1.8)	551 (15.4)	5 (0.9)	523 (21.2)
Greece	22 (2.4)	485 (11.5)	51 (2.9)	488 (8.4)	20 (2.2)	505 (9.0)	7 (1.4)	514 (13.8)
Latvia (LSS)	29 (3.6)	485 (21.0)	55 (4.1)	484 (21.0)	12 (1.3)	480 (19.2)	3 (0.8)	472 (19.2)
Norway	26 (1.6)	565 (7.6)	57 (1.6)	588 (7.2)	16 (1.0)	597 (8.8)	1 (0.4)	~ ~
Russian Federation	22 (2.0)	522 (14.8)	50 (1.5)	546 (13.6)	25 (2.0)	562 (10.3)	3 (0.6)	555 (24.3)
Slovenia	15 (2.4)	513 (18.3)	52 (2.8)	554 (15.5)	28 (2.4)	565 (20.9)	5 (1.2)	560 (19.8)
Sweden	30 (1.9)	564 (8.6)	54 (1.7)	577 (4.4)	14 (1.3)	577 (10.1)	2 (0.6)	~ ~
Switzerland	16 (1.3)	464 (11.2)	49 (1.5)	504 (7.1)	31 (1.8)	508 (6.4)	4 (0.8)	522 (21.7)
United States	6 (0.9)	412 (7.0)	31 (1.4)	422 (4.7)	40 (1.7)	421 (4.2)	23 (2.1)	430 (6.6)

† Percentages based only on those students reporting that they are currently taking physics.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
An "r" indicates a 70-84% student response rate.
A tilde (~) indicates insufficient data to report achievement.

The percentages of students for each category of the table are similar for the NSF-sponsored physics programs and the United States. For both the NSF-sponsored physics programs and the United States there is no clear relationship between the frequency of students being asked to apply science to everyday problems and achievement. Although experimentation is the cornerstone of at least some branches of physics and might be expected to play a central role in physics classes for students in the final year of upper secondary school, students' reports indicate a wide range of approaches (Table 11). In Austria, Germany, and Greece, the majority of the students reported that they never or almost never conduct laboratory experiments, whereas one-fourth or more of the students in Canada, Cyprus, Denmark, France, Switzerland, and the United States reported conducting experiments in most or all lessons. In about half of the countries, the majority of students reported conducting experiments in some lessons. Roughly 40% percentage of students in the NSF-sponsored physics programs reported doing experiments some or most lessons, while 15% reported doing experiments every lesson, and 2% reported not doing any experiments. The highest achievement was associated with those students who reported doing experiments in only some lessons. The performance of these students was close to the international mean. These NSF students outperformed NSF students who did experiments every lesson by 18 points, and those that did experiments most lessons by 28 points.

In eight countries, Australia, Austria, the Czech Republic, Latvia (LSS), Norway, the Russian Federation, Sweden, and Switzerland, 80% or more of the students reported never or almost never using computers in physics classes (Table 12). Only in Cyprus and Slovenia did more than 20% of the physics students report using a computer in every lesson. Computer use in physics lessons was reportedly more common among students in NSF-sponsored programs than among U.S. physics students in general. Less than one fourth of students in NSF-sponsored programs reported never or almost never using a computer in physics class, compared with more than half U.S. physics students in general. While there was no consistent relationship between computer use in class and physics achievement across the countries, it is noteworthy that those students in the NSF-sponsored physics programs who reported using computers to solve exercises or problems in every lesson performed 68 points lower that those that used the computer most lessons, and 47 points lower than those that used the computer some lessons.

Table 11

Physics Students' Reports on How Often They Are Asked to Conduct Laboratory Experiments in Their Physics Lessons†

Physics – Final Year of Secondary School*

Country	Never or Almost Never		Some Lessons		Most Lessons		Every Lesson	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	2 (0.0)	~ ~	41 (0.4)	493 (2.3)	42 (0.5)	465 (2.9)	15 (0.2)	475 (3.9)
Australia	12 (1.7)	508 (16.0)	80 (2.2)	523 (6.0)	8 (1.9)	524 (28.3)	0 (0.3)	~ ~
Austria	52 (4.8)	434 (10.6)	33 (4.3)	465 (10.8)	10 (1.9)	476 (25.2)	6 (4.0)	469 (21.1)
Canada	8 (1.1)	496 (11.9)	65 (2.5)	493 (7.5)	24 (2.8)	506 (15.4)	3 (0.4)	504 (12.5)
Cyprus	7 (1.1)	541 (36.1)	68 (2.2)	489 (7.5)	19 (1.9)	487 (12.1)	6 (1.1)	513 (32.4)
Czech Republic	r 33 (2.9)	449 (9.0)	58 (3.1)	470 (9.1)	8 (1.4)	480 (14.5)	1 (0.8)	~ ~
Denmark	r 4 (1.2)	505 (20.3)	48 (3.0)	537 (6.8)	48 (3.2)	535 (7.6)	0 (0.0)	~ ~
France	5 (0.9)	449 (14.9)	62 (2.1)	471 (4.0)	30 (2.3)	464 (5.5)	3 (0.5)	446 (8.8)
Germany	62 (3.2)	515 (9.6)	33 (3.2)	556 (16.8)	4 (1.2)	551 (21.6)	1 (0.4)	~ ~
Greece	78 (2.7)	500 (5.7)	17 (2.3)	468 (13.0)	4 (1.2)	453 (29.6)	2 (0.6)	~ ~
Latvia (LSS)	17 (3.6)	450 (27.4)	77 (3.2)	489 (16.6)	6 (1.4)	512 (28.5)	0 (0.2)	~ ~
Norway	3 (0.9)	583 (23.2)	93 (1.6)	584 (6.3)	4 (0.9)	575 (19.9)	0 (0.3)	~ ~
Russian Federation	9 (1.6)	539 (13.3)	72 (1.9)	545 (13.9)	18 (1.7)	544 (13.4)	2 (0.3)	~ ~
Slovenia	14 (2.9)	532 (23.3)	68 (3.9)	560 (18.6)	16 (3.4)	531 (14.9)	2 (0.9)	~ ~
Sweden	4 (1.0)	581 (20.6)	79 (1.8)	576 (4.4)	16 (1.4)	562 (6.5)	1 (0.7)	~ ~
Switzerland	31 (4.4)	477 (10.8)	36 (2.1)	512 (6.9)	28 (2.9)	507 (8.6)	5 (1.7)	503 (15.4)
United States	4 (0.6)	410 (11.2)	49 (2.6)	425 (4.1)	37 (2.2)	423 (5.3)	10 (1.1)	414 (6.9)

† Percentages based only on those students reporting that they are currently taking physics.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

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

An "r" indicates a 70-84% student response rate.

A tilde (~) indicates insufficient data to report achievement.

Table 12

Physics Students' Reports on How Often in Physics Lessons They Are Asked to Use Computers to Solve Exercises or Problems†
Physics – Final Year of Secondary School*

Country	Never or Almost Never		Some Lessons		Most Lessons		Every Lesson	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	23 (0.5)	449 (3.4)	46 (0.5)	482 (2.0)	25 (0.7)	503 (3.6)	7 (0.1)	435 (3.8)
Australia	80 (3.5)	518 (6.0)	16 (3.5)	528 (16.3)	3 (1.1)	573 (30.1)	1 (0.5)	~ ~
Austria	87 (3.0)	441 (9.0)	8 (2.2)	511 (17.7)	3 (1.1)	542 (20.2)	2 (0.6)	~ ~
Canada	72 (3.0)	501 (6.4)	20 (2.8)	488 (9.0)	6 (1.9)	485 (43.6)	1 (0.4)	~ ~
Cyprus	54 (2.8)	509 (6.5)	9 (2.1)	455 (25.5)	15 (1.8)	479 (15.2)	22 (2.3)	481 (14.2)
Czech Republic	r 91 (1.7)	462 (8.3)	7 (1.5)	481 (19.1)	1 (0.4)	~ ~	1 (0.8)	~ ~
Denmark	r 46 (3.3)	534 (7.3)	42 (2.2)	540 (7.3)	12 (2.0)	528 (12.6)	0 (0.2)	~ ~
France	69 (2.7)	468 (4.5)	25 (2.3)	465 (5.3)	4 (1.0)	466 (9.9)	1 (0.4)	~ ~
Germany	77 (3.1)	519 (9.0)	20 (3.0)	575 (14.9)	3 (0.9)	553 (22.1)	1 (0.6)	~ ~
Greece	r 63 (3.0)	499 (6.3)	22 (2.3)	482 (9.8)	11 (1.5)	468 (16.7)	4 (1.3)	507 (23.0)
Latvia (LSS)	88 (1.6)	480 (17.4)	9 (1.5)	522 (32.0)	3 (0.6)	464 (26.8)	0 (0.3)	~ ~
Norway	88 (2.5)	583 (6.5)	11 (2.4)	603 (19.6)	1 (0.4)	~ ~	1 (0.6)	~ ~
Russian Federation	83 (2.1)	542 (10.2)	12 (1.5)	577 (29.9)	3 (1.0)	533 (30.3)	1 (0.4)	~ ~
Slovenia	13 (1.9)	567 (12.4)	21 (2.4)	559 (17.7)	44 (3.0)	551 (22.7)	22 (2.2)	535 (15.4)
Sweden	83 (2.6)	571 (4.3)	17 (2.5)	585 (7.4)	0 (0.2)	~ ~	0 (0.2)	~ ~
Switzerland	80 (3.0)	489 (6.2)	17 (2.5)	545 (12.0)	2 (0.7)	~ ~	0 (0.2)	~ ~
United States	58 (4.5)	418 (4.2)	30 (3.6)	431 (5.6)	8 (1.7)	425 (8.7)	4 (1.5)	435 (22.7)

† Percentages based only on those students reporting that they are currently taking physics.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

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

An "r" indicates a 70-84% student response rate.

A tilde (~) indicates insufficient data to report achievement.

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

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

WHAT ARE SECONDARY SCHOOL STUDENTS' EDUCATIONAL RESOURCES AND PLANS?

The results for final-year students having taken physics are given for three levels of parents' education: finished university, finished upper secondary school but not university, and finished primary school but not upper secondary school (Table 13). A clear positive relationship between parents' education and achievement is apparent for students having taken physics. More than 30% of the physics students reported that at least one parent had finished university in every country except Austria. More than half the physics students in Canada, Germany, Latvia (LSS), the Russian Federation, and the United States reported that at least one parent had completed university. Sixty-five percent of students in NSF-sponsored programs reported that at least one percent had finished university, compared with 55% for U.S. physics students in general.

The plans for further education of final-year final-year physics students center mainly on university. The students planning to attend university, as reported in Table 14, are in the majority in every country; and in 11 countries, Australia, Canada, Cyprus, the Czech Republic, Greece, Latvia (LSS), the Russian Federation, Slovenia, Sweden, Switzerland, and the United States, the percentage planning a university career exceeded 80%. Most (95%) of the students in the NSF-sponsored physics programs reported intending to attend university. This figure is comparable to the percentage reported by the United States students.

Students who have studied physics in upper secondary school are well positioned to continue their education in the sciences or in areas of scientific application. Table 15 presents students' reports of their choices for study after secondary school from a range of areas where students with advanced preparation in physics might seek further education. The areas include physics or chemistry, biological or earth science, health sciences or related occupations, mathematics or computer/information sciences, engineering, and business. An "other" category was provided for students whose preferred area of study was not included. Although choice of study area varied considerably across countries, the most popular were engineering, mathematics or computer/information sciences, health sciences or related occupations, and business. For the NSF-sponsored physics programs students, 25% of the students selected the "other" category. A further 22% chose engineering, 14% selected health sciences or related occupations, 14% business and 13% indicated mathematics or computer/information sciences. Compared to the United States physics students, relatively more students in the NSF-sponsored physics programs indicated a preference for engineering or mathematics or computer/information sciences, and relatively fewer for the health sciences or related occupations.

Table 13

Physics Students' Reports on the Highest Level of Education of Either Parent†

Physics – Final Year of Secondary School*

Country	Finished University[1]		Finished Upper Secondary but Not University[2]		Finished Primary but Not Upper Secondary[3]		Do Not Know	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	65 (0.5)	499 (1.8)	33 (0.6)	434 (1.3)	1 (0.3)	~ ~	0 (0.0)	~ ~
Australia	42 (3.3)	539 (8.3)	34 (3.0)	511 (8.1)	19 (2.1)	481 (9.7)	5 (1.5)	533 (24.8)
Austria	19 (2.0)	447 (10.0)	71 (2.0)	434 (7.5)	8 (1.5)	409 (11.7)	2 (0.6)	~ ~
Canada	51 (1.6)	502 (4.5)	37 (1.3)	472 (4.7)	7 (0.8)	481 (11.0)	6 (1.1)	444 (21.8)
Cyprus	44 (1.8)	507 (7.5)	36 (2.6)	488 (9.5)	17 (1.9)	481 (12.0)	3 (0.9)	477 (23.7)
Czech Republic	48 (1.9)	469 (9.1)	41 (1.8)	440 (5.7)	11 (1.1)	425 (6.1)	0 (0.0)	~ ~
Denmark	r 36 (2.1)	554 (9.8)	54 (2.3)	525 (4.8)	6 (1.2)	527 (20.7)	5 (1.1)	506 (30.2)
France	30 (2.1)	488 (4.9)	43 (2.1)	464 (4.0)	22 (2.3)	444 (8.4)	5 (0.7)	466 (12.5)
Germany	52 (3.2)	537 (13.4)	46 (3.1)	507 (13.3)	2 (0.6)	~ ~	- -	- -
Greece	34 (2.4)	510 (8.4)	42 (2.3)	479 (7.2)	21 (2.7)	472 (10.6)	3 (1.2)	449 (39.0)
Latvia (LSS)	52 (5.1)	508 (25.0)	44 (5.1)	467 (14.0)	2 (0.8)	~ ~	2 (0.5)	~ ~
Norway	43 (2.5)	599 (7.4)	45 (2.2)	575 (7.9)	7 (1.1)	559 (11.8)	5 (0.8)	555 (14.4)
Russian Federation	65 (2.2)	559 (10.4)	35 (2.2)	518 (15.7)	0 (0.1)	~ ~	0 (0.2)	~ ~
Slovenia	39 (3.0)	548 (23.5)	53 (2.1)	507 (12.9)	8 (1.3)	481 (15.3)	0 (0.2)	~ ~
Sweden	41 (2.0)	587 (6.2)	41 (2.0)	565 (7.4)	8 (1.6)	571 (11.1)	9 (1.3)	551 (9.4)
Switzerland	34 (1.4)	490 (4.9)	59 (1.8)	489 (4.7)	5 (1.0)	473 (10.5)	1 (0.4)	~ ~
United States	55 (2.5)	440 (3.9)	41 (2.4)	407 (4.1)	3 (0.5)	387 (6.8)	2 (0.3)	~ ~

† The response categories were defined by each country to conform to their own educational system and may not be strictly comparable across countries. See Mullis and others, 1998 Figure 4.5 for country modifications to the definitions of educational levels.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

[1] In most countries, defined as completion of at least a 4-year degree program at a university or an equivalent institute of higher education.

[2] Finished upper secondary school with or without some tertiary education not equivalent to a university degree. In most countries, finished secondary corresponds to completion of an upper secondary track terminating after 11 to 13 years of schooling.

[3] Finished primary or some secondary school not equivalent to completion of upper secondary.

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

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

An "r" indicates a 70-84% student response rate.

A dash (-) indicates data are not available. A tilde (~) indicates insufficient data to report achievement.

Table 14

Physics Students' Reports on Their Plans for Future Education†

Physics – Final Year of Secondary School*

Country	University[1]		Vocationally Oriented Programs[2]		Other Postsecondary[3] Education		Does Not Intend to Continue Education	
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement
NSF Physics Programs	95 (0.5)	478 (1.4)	2 (0.0)	~ ~	3 (0.5)	462 (11.5)	0 (0.0)	~ ~
Australia	89 (1.6)	524 (7.0)	4 (1.0)	460 (13.4)	2 (0.8)	~ ~	4 (1.3)	455 (9.4)
Austria	68 (2.0)	444 (7.1)	12 (1.5)	413 (12.8)	6 (1.0)	417 (12.6)	14 (1.6)	421 (13.1)
Canada	82 (1.6)	488 (4.7)	5 (1.2)	462 (10.3)	12 (1.8)	485 (12.6)	1 (0.9)	~ ~
Cyprus	91 (1.5)	500 (5.1)	6 (1.3)	454 (26.3)	2 (0.7)	~ ~	1 (0.7)	~ ~
Czech Republic	93 (1.0)	456 (6.5)	5 (0.7)	396 (8.9)	1 (0.3)	~ ~	2 (0.5)	~ ~
Denmark	r 74 (2.0)	555 (6.6)	5 (1.1)	453 (15.8)	10 (1.4)	490 (13.4)	10 (1.5)	518 (15.5)
France	75 (1.7)	471 (4.4)	12 (1.2)	453 (5.6)	12 (1.0)	457 (6.9)	1 (0.4)	~ ~
Germany	76 (5.5)	540 (9.6)	17 (4.6)	456 (17.9)	3 (0.9)	493 (22.1)	3 (0.8)	501 (15.1)
Greece	86 (1.9)	499 (5.2)	5 (1.3)	430 (19.7)	8 (1.2)	432 (15.4)	2 (0.7)	~ ~
Latvia (LSS)	85 (1.4)	491 (21.1)	7 (0.8)	478 (17.7)	8 (1.0)	447 (30.9)	1 (0.4)	~ ~
Norway	75 (2.2)	595 (6.4)	19 (1.9)	554 (10.8)	5 (0.9)	535 (11.5)	1 (0.3)	~ ~
Russian Federation	89 (2.2)	554 (10.7)	9 (1.9)	473 (24.2)	2 (0.5)	~ ~	0 (0.1)	~ ~
Slovenia	92 (1.6)	526 (16.5)	5 (1.3)	485 (20.4)	1 (0.5)	~ ~	1 (0.6)	~ ~
Sweden	92 (0.8)	580 (3.7)	3 (0.7)	503 (24.8)	4 (0.6)	508 (15.2)	2 (0.5)	~ ~
Switzerland	90 (1.1)	492 (3.7)	2 (0.5)	~ ~	4 (0.5)	454 (11.5)	4 (1.0)	465 (17.5)
United States	92 (0.7)	425 (3.4)	3 (0.4)	383 (6.7)	5 (0.7)	391 (6.4)	0 (0.0)	~ ~

† Educational options were defined by each country to conform to their national systems and may not be comparable across countries.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

[1] In most countries, defined as at least a 3-year degree program at a university or an equivalent institute of higher education.

[2] Defined in most countries as vocational or technical courses at a tertiary institution not equivalent to a university degree program (e.g., trade or business school, junior or community college, and other shorter vocational programs), but may also include higher-level upper secondary vocational programs in some countries

[3] Includes other postsecondary education defined in each country. Includes categories such as academic courses at junior or community college, short university or polytechnic courses, and college-preparatory courses.

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

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

An "r" indicates a 70-84% student response rate.

A tilde (~) indicates insufficient data to report achievement.

See Mullis and others, 1998 Figure 4.2 for definitions and any national adaptations of the international options in each category.

Table 15

Physics Students' Reports on the Area They Intend to Study After Secondary School†

Physics – Final Year of Secondary School*

Country	Percent of Students						
	Physics or Chemistry	Biological or Earth Sciences	Health Sciences or Related Occupations	Mathematics or Computer/ Information Sciences	Engineering	Business	Other
NSF Physics Programs	6 (0.1)	6 (0.3)	14 (0.2)	13 (0.1)	22 (0.7)	14 (0.2)	25 (0.6)
Australia	8 (1.4)	8 (1.2)	21 (2.2)	15 (2.8)	27 (3.0)	8 (1.2)	12 (2.1)
Austria	s 4 (1.0)	5 (1.3)	20 (1.9)	5 (1.2)	8 (1.6)	15 (1.8)	43 (2.7)
Canada	8 (1.0)	9 (1.3)	27 (1.5)	10 (0.7)	22 (1.9)	10 (1.3)	15 (1.0)
Cyprus	7 (1.5)	5 (1.3)	25 (2.4)	19 (1.8)	22 (1.7)	4 (1.1)	19 (1.6)
Czech Republic	2 (0.5)	14 (1.5)	13 (1.1)	12 (1.3)	3 (0.6)	20 (1.8)	37 (3.3)
Denmark	r 10 (1.5)	5 (1.3)	12 (1.6)	12 (1.5)	29 (2.7)	11 (1.5)	22 (2.7)
France	10 (1.3)	18 (1.8)	19 (1.3)	18 (1.2)	15 (1.6)	7 (1.1)	14 (1.3)
Germany	8 (1.7)	4 (0.8)	7 (1.8)	13 (2.2)	18 (1.5)	26 (3.9)	24 (2.6)
Greece	13 (1.9)	2 (0.9)	0 (0.3)	36 (2.1)	28 (2.1)	2 (0.9)	18 (1.8)
Latvia (LSS)	3 (0.6)	5 (0.8)	8 (1.2)	12 (1.6)	6 (0.9)	35 (2.3)	32 (2.6)
Norway	12 (1.0)	4 (0.9)	20 (1.3)	13 (1.5)	30 (1.7)	7 (1.1)	15 (0.9)
Russian Federation	6 (1.0)	3 (0.8)	6 (1.3)	29 (2.3)	9 (1.0)	30 (1.9)	17 (1.5)
Slovenia	7 (1.6)	5 (0.9)	12 (2.2)	21 (3.3)	18 (3.6)	18 (2.0)	19 (2.9)
Sweden	8 (1.2)	7 (1.1)	11 (1.9)	12 (2.2)	42 (3.6)	4 (0.7)	17 (2.1)
Switzerland	5 (0.7)	7 (1.0)	18 (1.4)	4 (0.7)	8 (1.1)	14 (1.6)	46 (1.7)
United States	3 (0.6)	7 (0.7)	23 (1.5)	7 (0.7)	15 (1.3)	16 (1.2)	29 (1.9)

† Percentages based only on those students reporting that they intend to continue their education after secondary school.

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

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

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

There were considerable differences between male and female physics students in their choice of area for further study (Table 16). Among students choosing health sciences or related occupations, and to a lesser extent biological or earth sciences, there were proportionately more females than males in many countries. For students in the NSF-sponsored programs, approximately three times as many females than males indicated that they intended to study in these occupations. However, in engineering, and in mathematics or computer/information sciences, males often outnumbered females by a substantial margin. This pattern was also evident in the responses of students in the NSF-sponsored physics programs where four times as many males indicated an intention to study engineering, or mathematics or computer/information science compared to female students.

Table 16

Physics Students' Reports on the Area They Intend to Study After Secondary School by Gender

Physics – Final Year of Secondary School*

Country		Percent of Students							
		Physics or Chemistry		Biological or Earth Sciences		Health Sciences or Related Occupations		Mathematics or Computer / Information Sciences	
		Males	Females	Males	Females	Males	Females	Males	Females
NSF Physics Programs		4 (0.1)	8 (0.1)	4 (0.5)	7 (0.1)	7 (0.1)	23 (0.6)	20 (0.3)	5 (0.1)
Australia		7 (1.8)	9 (2.5)	6 (1.5)	10 (2.5)	14 (2.6)	34 (4.1)	19 (4.0)	8 (2.3)
Austria	s	5 (1.7)	3 (1.1)	4 (2.1)	5 (1.5)	17 (2.4)	23 (2.8)	9 (2.5)	1 (0.7)
Canada		7 (1.3)	8 (1.5)	7 (1.2)	11 (2.0)	16 (2.3)	39 (2.9)	14 (0.9)	6 (1.0)
Cyprus		7 (2.0)	6 (1.5)	5 (1.6)	5 (2.1)	21 (3.4)	30 (3.8)	20 (2.1)	18 (3.4)
Czech Republic		4 (0.9)	1 (0.6)	11 (1.9)	16 (1.8)	11 (1.9)	14 (1.6)	23 (2.2)	4 (1.0)
Denmark	r	11 (1.8)	9 (3.7)	5 (1.5)	5 (2.3)	8 (1.9)	25 (4.0)	14 (2.0)	4 (1.5)
France		10 (1.4)	9 (1.9)	16 (2.1)	21 (2.5)	11 (1.6)	31 (2.6)	22 (1.7)	11 (1.7)
Germany		8 (2.0)	7 (3.2)	4 (1.1)	4 (1.3)	5 (2.6)	10 (2.6)	18 (3.0)	4 (1.6)
Greece		11 (2.2)	16 (3.3)	2 (0.8)	3 (1.4)	0 (0.3)	1 (0.5)	36 (2.6)	37 (5.2)
Latvia (LSS)		3 (0.9)	2 (1.3)	4 (1.4)	6 (1.4)	5 (1.6)	11 (1.6)	18 (2.3)	7 (1.1)
Norway		13 (1.2)	9 (1.5)	4 (1.1)	4 (1.1)	12 (1.4)	41 (2.6)	14 (1.7)	7 (2.2)
Russian Federation		9 (1.8)	3 (1.3)	3 (1.3)	3 (1.0)	3 (0.8)	11 (2.5)	36 (2.8)	20 (2.8)
Slovenia		7 (1.5)	8 (5.0)	5 (1.2)	5 (2.3)	7 (2.3)	24 (5.3)	26 (4.4)	10 (2.6)
Sweden		6 (1.4)	11 (1.9)	5 (1.1)	13 (2.4)	4 (0.9)	25 (4.0)	17 (2.9)	3 (1.0)
Switzerland		7 (1.2)	2 (0.7)	7 (1.3)	7 (1.2)	10 (1.4)	25 (2.4)	5 (1.1)	2 (0.8)
United States		5 (0.8)	2 (0.5)	7 (0.9)	8 (0.9)	16 (2.4)	31 (2.5)	10 (1.1)	4 (0.6)

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

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

An "r" indicates a 70-84% student response rate. An "s" indicates a 50-69% student response rate.

Table 16 (Continued)

Physics Students' Reports on the Area They Intend to Study After Secondary School by Gender

Physics – Final Year of Secondary School*

Country	Percent of Students					
	Engineering		Business		Other	
	Males	Females	Males	Females	Males	Females
NSF Physics Programs	33 (0.9)	8 (1.0)	15 (0.2)	13 (0.2)	16 (0.7)	35 (0.8)
Australia	37 (4.5)	10 (3.5)	6 (1.5)	13 (2.0)	10 (2.2)	16 (3.7)
Austria	13 (3.0)	3 (1.3)	20 (3.1)	11 (2.3)	30 (4.4)	53 (3.3)
Canada	33 (2.9)	9 (1.8)	10 (1.5)	10 (1.6)	13 (1.1)	17 (1.6)
Cyprus	26 (2.7)	16 (3.4)	4 (1.6)	3 (1.5)	18 (2.4)	22 (3.0)
Czech Republic	5 (1.2)	2 (0.5)	20 (2.6)	20 (2.0)	27 (2.6)	43 (3.9)
Denmark	34 (3.0)	11 (3.2)	12 (2.0)	6 (2.8)	16 (2.8)	41 (6.3)
France	22 (2.8)	5 (1.7)	5 (1.1)	9 (1.8)	14 (1.9)	14 (1.9)
Germany	23 (2.3)	7 (1.5)	24 (3.4)	29 (6.3)	17 (2.6)	39 (5.7)
Greece	29 (3.0)	25 (3.9)	2 (1.2)	2 (1.1)	18 (2.4)	18 (3.0)
Latvia (LSS)	11 (1.8)	1 (0.4)	35 (2.6)	34 (2.7)	25 (2.1)	39 (3.9)
Norway	33 (1.7)	21 (2.6)	8 (1.5)	2 (1.4)	15 (1.0)	16 (2.5)
Russian Federation	15 (1.7)	2 (0.6)	25 (2.8)	37 (2.4)	11 (1.5)	24 (2.8)
Slovenia	23 (4.4)	3 (1.4)	17 (2.3)	19 (3.5)	14 (2.7)	31 (5.7)
Sweden	51 (3.4)	22 (2.9)	4 (0.9)	4 (1.2)	14 (2.3)	23 (2.3)
Switzerland	12 (1.5)	4 (1.2)	24 (2.7)	4 (0.8)	36 (2.6)	56 (2.5)
United States	24 (1.9)	5 (0.7)	15 (1.8)	16 (1.3)	24 (1.9)	34 (2.4)

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.6).

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

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

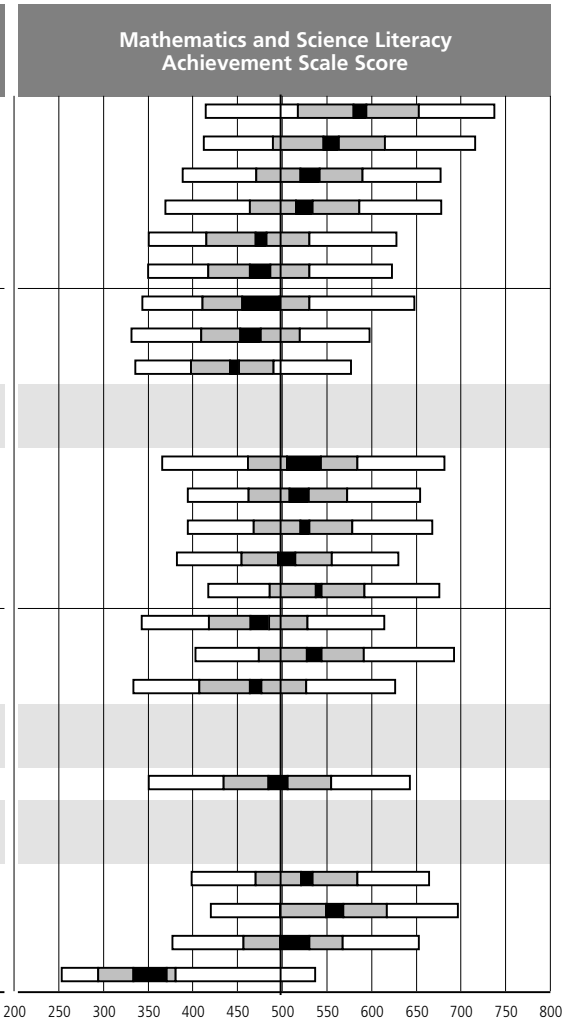
APPENDIX

MATHEMATICS AND SCIENCE LITERACY TABLES AND FIGURES

Table A1

Distributions of Mathematics and Science Literacy Achievement for Students in Their Final Year of Secondary School*

Country		Mean	TCI‡	Average Age
NSF Physics Programs	▲	587 (3.6)	–	17.9
Sweden	▲	555 (4.3)	71%	18.9
Switzerland	▲	531 (5.4)	82%	19.8
† New Zealand	▲	525 (4.7)	70%	17.6
Hungary	▼	477 (3.0)	65%	17.5
[2] Russian Federation	▼	476 (5.8)	48%	16.9
Czech Republic	●	476 (10.5)	78%	17.8
[1] Lithuania	▼	465 (5.8)	43%	18.1
[2] Cyprus	▼	447 (2.5)	48%	17.7
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)				
Australia	●	525 (9.5)	68%	17.7
[2] Austria	▲	519 (5.4)	76%	19.1
Canada	▲	526 (2.6)	70%	18.6
France	●	505 (4.9)	84%	18.8
Iceland	▲	541 (1.6)	55%	21.2
[1] Italy	▼	475 (5.3)	52%	18.7
Norway	▲	536 (4.0)	84%	19.5
United States	▼	471 (3.1)	63%	18.2
Countries With Unapproved Student Sampling (See Appendix B for Details)				
† Germany	●	496 (5.4)	75%	19.4
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)				
Denmark	▲	528 (3.2)	58%	19.1
[2] Netherlands	▲	559 (4.9)	78%	18.5
Slovenia	●	514 (8.2)	88%	18.8
South Africa	▼	352 (9.3)	49%	20.1



▲ Country mean significantly higher than international mean

▼ Country mean significantly lower than international mean

● No statistically significant difference between country mean and international mean

* See Mullis and others, 1998 Appendix A for characteristics of students sampled.

‡ The TIMSS Coverage Index (TCI) is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year student sample (see Mullis and others, 1998 Appendix B for more information).

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and Others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Figure A1

Multiple Comparisons of Mathematics and Science Literacy Achievement for Students in Their Final Year of Secondary School*

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.‡

	NSF Physics Programs	*Netherlands*	**Sweden**	*Iceland*	*Norway*	**Switzerland**	*Denmark*	*Canada*	**New Zealand**	*Australia*	*Austria*	*Slovenia*	*France*	*Germany*	**Hungary**	**Czech Republic**	**Russian Federation**	*Italy*	*United States*	**Lithuania**	**Cyprus**	**South Africa**
NSF Physics Programs		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼		●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	●		▲	▲	▲	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼		●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	●		●	●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	●	●	●	●	●	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	●	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	●	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●		▲	●	●	●	▲	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		●	●	●	●	●	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	●	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	▼	●		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

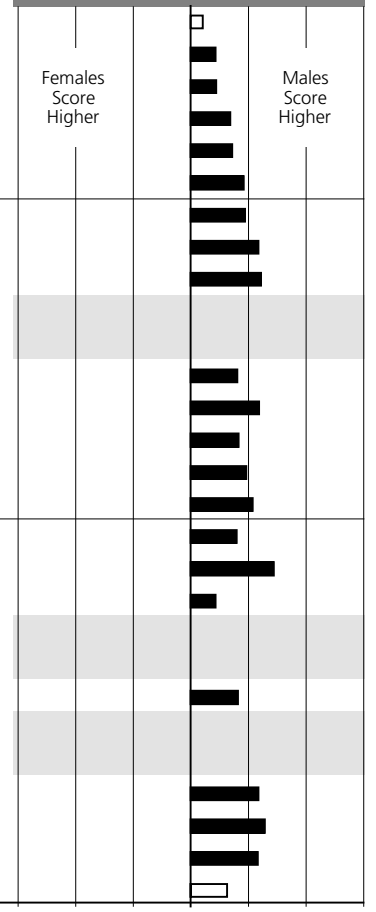
‡ Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.4).

Table A2

Gender Differences in Mathematics and Science Literacy Achievement for Students in Their Final Year of Secondary School*

Country	Males		Females		Difference	TCI	Gender Difference
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement			
NSF Physics Programs	57 (1.4)	592 (4.7)	43 (1.4)	584 (5.7)	8 (7.4)	–	
Hungary	52 (2.5)	485 (4.5)	48 (2.5)	468 (4.5)	17 (6.3)	65%	
[2] Cyprus	45 (2.1)	456 (4.9)	55 (2.1)	439 (3.0)	18 (5.8)	48%	
[1] Lithuania	35 (3.0)	483 (6.7)	65 (3.0)	456 (7.4)	27 (10.0)	43%	
† New Zealand	49 (1.7)	540 (5.7)	51 (1.7)	511 (5.5)	28 (7.9)	70%	
Switzerland	56 (2.5)	547 (6.0)	44 (2.5)	511 (7.5)	37 (9.6)	82%	
[2] Russian Federation	38 (1.0)	499 (5.9)	62 (1.0)	462 (6.5)	37 (8.8)	48%	
Sweden	49 (2.5)	579 (5.9)	51 (2.5)	533 (3.6)	46 (6.9)	71%	
Czech Republic	51 (5.1)	500 (9.9)	49 (5.1)	452 (13.8)	48 (17.0)	78%	
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	42 (2.9)	543 (10.7)	58 (2.9)	511 (9.3)	32 (14.2)	68%	
[2] Austria	39 (3.2)	549 (7.8)	61 (3.2)	502 (5.5)	47 (9.6)	76%	
Canada	47 (1.4)	544 (3.4)	53 (1.4)	511 (3.4)	33 (4.8)	70%	
France	47 (3.1)	526 (5.9)	53 (3.1)	487 (4.8)	38 (7.6)	84%	
Iceland	48 (0.8)	565 (2.9)	52 (0.8)	522 (1.9)	43 (3.5)	55%	
[1] Italy	46 (3.3)	492 (6.9)	54 (3.3)	461 (5.7)	31 (8.9)	52%	
Norway	51 (2.0)	564 (5.0)	49 (2.0)	507 (4.5)	57 (6.8)	84%	
United States	50 (1.3)	479 (4.2)	50 (1.3)	462 (3.5)	17 (5.5)	63%	
Countries With Unapproved Student Sampling (See Appendix B for Details)							
† Germany	56 (5.2)	512 (8.2)	44 (5.2)	479 (8.5)	32 (11.8)	75%	
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	45 (2.0)	554 (4.5)	55 (2.0)	507 (3.7)	47 (5.8)	58%	
[2] Netherlands	52 (2.3)	584 (5.5)	48 (2.3)	533 (5.9)	51 (8.0)	78%	
Slovenia	51 (3.3)	538 (12.6)	49 (3.3)	492 (7.1)	46 (14.4)	88%	
South Africa	49 (1.6)	366 (10.3)	51 (1.6)	341 (11.8)	25 (15.7)	49%	



International Averages

Males	Females	Difference
519	483	36

(Average of all country means)

Gender difference statistically significant at .05 level.

Gender difference not statistically significant.

* See Mullis and others, 1998 Appendix A for characteristics of students tested.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

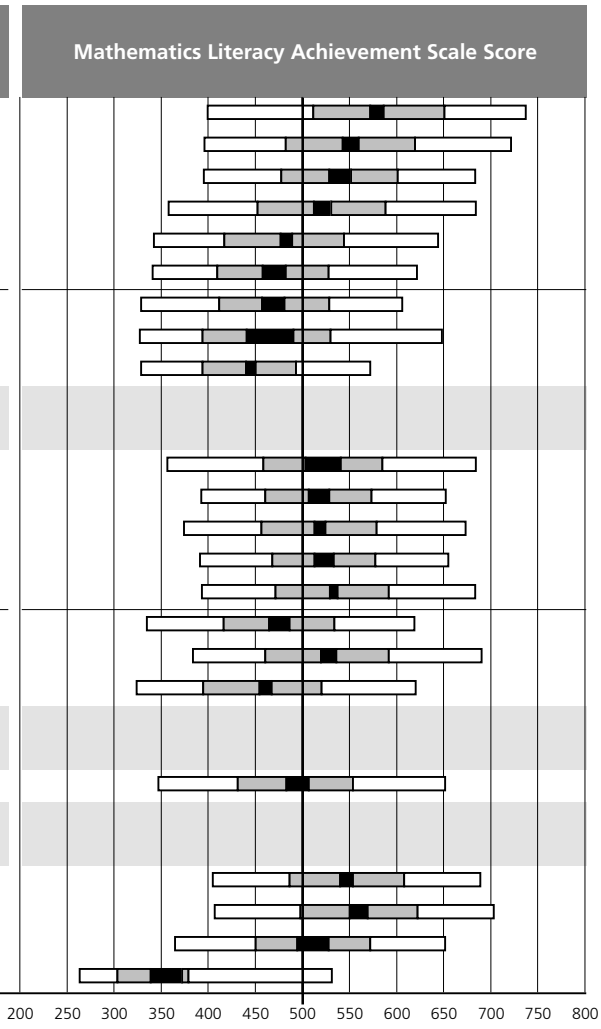
[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Table A3

Distributions of Achievement in Mathematics Literacy for Students in Their Final Year of Secondary School*

Country	Mean	TCI
NSF Physics Programs	▲ 580 (3.5)	–
Sweden	▲ 552 (4.3)	71%
Switzerland	▲ 540 (5.8)	82%
† New Zealand	▲ 522 (4.5)	70%
Hungary	▼ 483 (3.2)	65%
[2] Russian Federation	▼ 471 (6.2)	48%
[1] Lithuania	▼ 469 (6.1)	43%
Czech Republic	● 466 (12.3)	78%
[2] Cyprus	▼ 446 (2.5)	48%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)		
Australia	● 522 (9.3)	68%
[2] Austria	▲ 518 (5.3)	76%
Canada	▲ 519 (2.8)	70%
France	▲ 523 (5.1)	84%
Iceland	▲ 534 (2.0)	55%
[1] Italy	▼ 476 (5.5)	52%
Norway	▲ 528 (4.1)	84%
United States	▼ 461 (3.2)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)		
† Germany	● 495 (5.9)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)		
Denmark	▲ 547 (3.3)	58%
[2] Netherlands	▲ 560 (4.7)	78%
Slovenia	● 512 (8.3)	88%
South Africa	▼ 356 (8.3)	49%

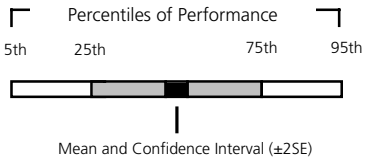


International Average =500
Average of all country means

▲ Country mean significantly higher than international mean

▼ Country mean significantly lower than international mean

● No statistically significant difference between country mean and international mean



* See Mullis and Others, 1998 Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and Others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and Others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and Others, 1998 Table B.4).

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

Figure A2

Multiple Comparisons of Mathematics Literacy Achievement for Students in Their Final Year of Secondary School*

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.†

	NSF Physics Programs	*Netherlands*	**Sweden**	*Denmark*	**Switzerland**	*Iceland*	*Norway*	*France*	*Australia*	**New Zealand**	*Canada*	*Austria*	*Slovenia*	*Germany*	**Hungary**	*Italy*	**Russian Federation**	**Lithuania**	**Czech Republic**	*United States*	**Cyprus**	*South Africa*
NSF Physics Programs		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼	●		●	●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	●	●		●	▲	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	●	●	●		●	●	●	●	●	▲	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	▼	▼	▼	●		●	●	●	●	▲	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	▼	▼	▼	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	▼	▼	▼	▼	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	▼	●	●	●	●	●	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	●	●	●	●	●	●	●		●	●	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	●	●	●	●	●	●	●	●		●	▲	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	●	●	●	▲	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		●	●	●	●	▲	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	●	▲	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		▲	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

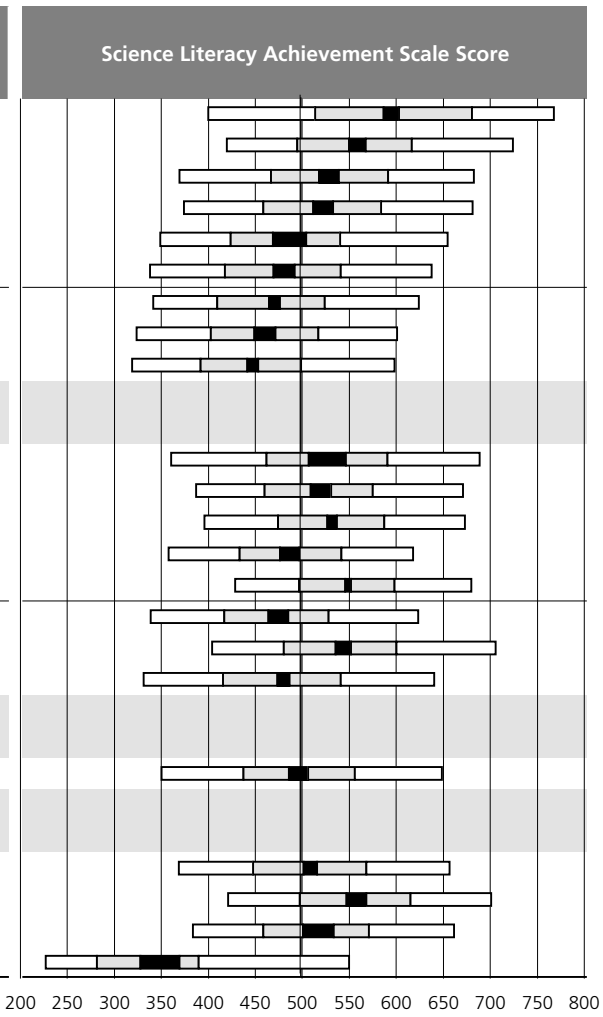
† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.4).

Table A4

Distributions of Achievement in Science Literacy for Students in Their Final Year of Secondary School*

Country	Mean	TCI‡
NSF Physics Programs	▲ 595 (4.1)	–
Sweden	▲ 559 (4.4)	71%
† New Zealand	▲ 529 (5.2)	70%
Switzerland	▲ 523 (5.3)	82%
Czech Republic	● 487 (8.8)	78%
[2] Russian Federation	▼ 481 (5.7)	48%
Hungary	▼ 471 (3.0)	65%
[1] Lithuania	▼ 461 (5.7)	43%
[2] Cyprus	▼ 448 (3.0)	48%
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)		
Australia	● 527 (9.8)	68%
[2] Austria	▲ 520 (5.6)	76%
Canada	▲ 532 (2.6)	70%
France	● 487 (5.1)	84%
Iceland	▲ 549 (1.5)	55%
[1] Italy	▼ 475 (5.3)	52%
Norway	▲ 544 (4.1)	84%
United States	▼ 480 (3.3)	63%
Countries With Unapproved Student Sampling (See Appendix B for Details)		
† Germany	● 497 (5.1)	75%
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)		
Denmark	● 509 (3.6)	58%
[2] Netherlands	▲ 558 (5.3)	78%
Slovenia	● 517 (8.2)	88%
South Africa	▼ 349 (10.5)	49%



▲ Country mean significantly higher than international mean

▼ Country mean significantly lower than international mean

● No statistically significant difference between country mean and international mean

* See Mullis and others, 1998 Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

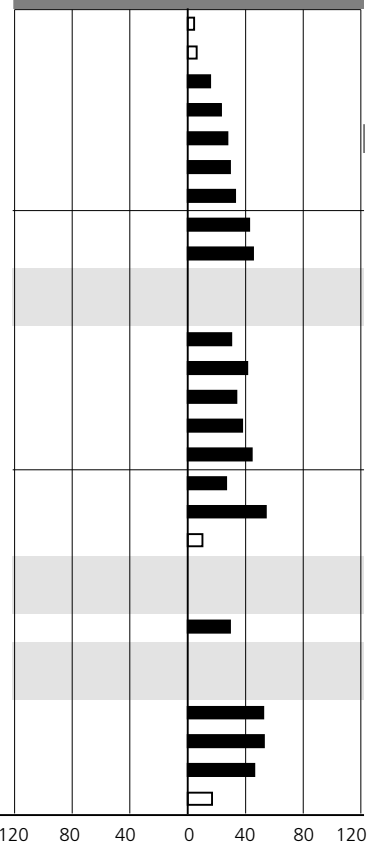
[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Table A5

Achievement in Mathematics Literacy by Gender for Students in Their Final Year of Secondary School*

Country	Males		Females		Difference	TCI	Gender Difference
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement			
Hungary	52 (2.5)	485 (4.9)	48 (2.5)	481 (4.8)	5 (6.9)	65%	
NSF Physics Programs	57 (1.4)	583 (4.0)	43 (1.4)	577 (6.3)	6 (7.5)	–	
[2] Cyprus	45 (2.1)	454 (4.9)	55 (2.1)	439 (3.7)	15 (6.1)	48%	
[1] Lithuania	35 (3.0)	485 (7.3)	65 (3.0)	461 (7.7)	23 (10.6)	43%	
[2] Russian Federation	38 (1.0)	488 (6.5)	62 (1.0)	460 (6.6)	27 (9.2)	48%	
† New Zealand	49 (1.7)	536 (4.9)	51 (1.7)	507 (6.2)	29 (7.9)	70%	
Switzerland	56 (2.5)	555 (6.4)	44 (2.5)	522 (7.4)	33 (9.8)	82%	
Sweden	49 (2.5)	573 (5.9)	51 (2.5)	531 (3.9)	42 (7.1)	71%	
Czech Republic	51 (5.1)	488 (11.3)	49 (5.1)	443 (16.8)	45 (20.2)	78%	
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	42 (2.9)	540 (10.3)	58 (2.9)	510 (9.3)	30 (13.9)	68%	
[2] Austria	39 (3.2)	545 (7.2)	61 (3.2)	503 (5.5)	41 (9.0)	76%	
Canada	47 (1.4)	537 (3.8)	53 (1.4)	504 (3.5)	34 (5.2)	70%	
France	47 (3.1)	544 (5.6)	53 (3.1)	506 (5.3)	38 (7.7)	84%	
Iceland	48 (0.8)	558 (3.4)	52 (0.8)	514 (2.2)	44 (4.1)	55%	
[1] Italy	46 (3.3)	490 (7.4)	54 (3.3)	464 (6.0)	26 (9.5)	52%	
Norway	51 (2.0)	555 (5.3)	49 (2.0)	501 (4.8)	54 (7.1)	84%	
United States	50 (1.3)	466 (4.1)	50 (1.3)	456 (3.6)	11 (5.5)	63%	
Countries With Unapproved Student Sampling (See Appendix B for Details)							
† Germany	56 (5.2)	509 (8.7)	44 (5.2)	480 (8.8)	29 (12.4)	75%	
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	45 (2.0)	575 (4.0)	55 (2.0)	523 (4.0)	52 (5.7)	58%	
[2] Netherlands	52 (2.3)	585 (5.6)	48 (2.3)	533 (5.9)	53 (8.2)	78%	
Slovenia	51 (3.3)	535 (12.7)	49 (3.3)	490 (8.0)	46 (15.0)	88%	
South Africa	49 (1.6)	365 (9.3)	51 (1.6)	348 (10.8)	17 (14.3)	49%	



International Averages

Males	Females	Difference
518	485	33

(Average of all country means)

■ Gender difference statistically significant at .05 level.

□ Gender difference not statistically significant.

* See Mullis and others, 1998 Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

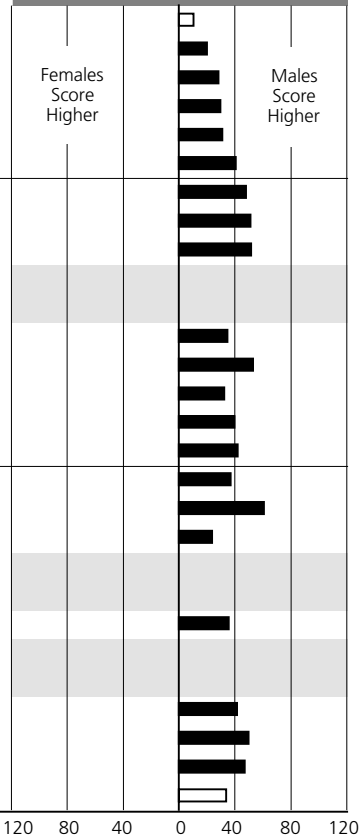
[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Table A6

Achievement in Science Literacy by Gender for Students in Their Final Year of Secondary School*

Country	Males		Females		Difference	TCI	Gender Difference
	Percent of Students	Mean Achievement	Percent of Students	Mean Achievement			
NSF Physics Programs	57 (1.4)	601 (5.5)	43 (1.4)	590 (6.3)	11 (8.3)	–	
[2] Cyprus	45 (2.1)	459 (5.8)	55 (2.1)	439 (3.0)	20 (6.5)	48%	
† New Zealand	49 (1.7)	543 (7.1)	51 (1.7)	515 (5.2)	28 (8.8)	70%	
Hungary	52 (2.5)	484 (4.2)	48 (2.5)	455 (4.3)	29 (6.0)	65%	
[1] Lithuania	35 (3.0)	481 (6.4)	65 (3.0)	450 (7.3)	31 (9.7)	43%	
Switzerland	56 (2.5)	540 (6.1)	44 (2.5)	500 (7.8)	40 (9.9)	82%	
[2] Russian Federation	38 (1.0)	510 (5.7)	62 (1.0)	463 (6.7)	47 (8.8)	48%	
Sweden	49 (2.5)	585 (6.0)	51 (2.5)	534 (3.5)	51 (6.9)	71%	
Czech Republic	51 (5.1)	512 (8.8)	49 (5.1)	460 (11.0)	51 (14.0)	78%	
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)							
Australia	42 (2.9)	547 (11.5)	58 (2.9)	513 (9.4)	34 (14.8)	68%	
[2] Austria	39 (3.2)	554 (8.7)	61 (3.2)	501 (5.8)	53 (10.4)	76%	
Canada	47 (1.4)	550 (3.6)	53 (1.4)	518 (3.8)	32 (5.2)	70%	
France	47 (3.1)	508 (6.7)	53 (3.1)	468 (4.8)	39 (8.3)	84%	
Iceland	48 (0.8)	572 (2.7)	52 (0.8)	530 (2.1)	41 (3.4)	55%	
[1] Italy	46 (3.3)	495 (6.7)	54 (3.3)	458 (5.6)	37 (8.8)	52%	
Norway	51 (2.0)	574 (5.1)	49 (2.0)	513 (4.5)	61 (6.8)	84%	
United States	50 (1.3)	492 (4.5)	50 (1.3)	469 (3.9)	23 (5.9)	63%	
Countries With Unapproved Student Sampling (See Appendix B for Details)							
† Germany	56 (5.2)	514 (7.9)	44 (5.2)	478 (8.5)	35 (11.6)	75%	
Countries With Unapproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)							
Denmark	45 (2.0)	532 (5.4)	55 (2.0)	490 (4.1)	41 (6.8)	58%	
[2] Netherlands	52 (2.3)	582 (5.7)	48 (2.3)	532 (6.2)	49 (8.4)	78%	
Slovenia	51 (3.3)	541 (12.7)	49 (3.3)	494 (6.4)	47 (14.3)	88%	
South Africa	49 (1.6)	367 (11.5)	51 (1.6)	333 (13.0)	34 (17.4)	49%	



Gender difference statistically significant at .05 level.

Gender difference not statistically significant.

International Averages

Males	Females	Difference
521	482	39

(Average of all country means)

* See Mullis and others, 1998 Appendix A for characteristics of students sampled.

† Met guidelines for sample participation rates only after replacement schools were included (see Mullis and others, 1998 Appendix B for details).

[1] National Desired Population does not cover all of International Desired Population (see Mullis and others, 1998 Table B.4).

[2] National Defined Population covers less than 90 percent of National Desired Population (see Mullis and others, 1998 Table B.4).

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

Figure A3

Multiple Comparisons of Science Literacy Achievement for Students in Their Final Year of Secondary School*

Instructions: Read ***across*** the row for a country to compare performance with the countries listed in the heading of the chart. The symbols indicate whether the mean achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the two countries.†

	NSF Physics Programs	Sweden	Netherlands	Iceland	Norway	Canada	New Zealand	Australia	Switzerland	Austria	Slovenia	Denmark	Germany	Israel	France	Czech Republic	Russian Federation	United States	Italy	Hungary	Lithuania	Cyprus	South Africa
NSF Physics Programs		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	▼		●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	▼	●		●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Iceland	▼	●	●		●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Norway	▼	●	●	●		●	●	●	▲	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Canada	▼	▼	▼	▼	●		●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	▼	▼	▼	▼	●	●		●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	▼	●	●	●	●	●	●		●	●	●	●	●	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Switzerland	▼	▼	▼	▼	▼	●	●	●		●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	●	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	▲	●	▲	▲	▲	▲	▲	▲	▲
Denmark	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	▲	●	▲	▲	▲	▲	▲	▲	▲
Germany	▼	▼	▼	▼	▼	▼	▼	●	▼	▼	●	●		●	●	●	●	●	●	▲	▲	▲	▲
Israel	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	●	●	●	●	●	▲	▲
France	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●		●	●	●	●	●	▲	▲	▲
Czech Republic	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	●	●	▲	▲
Russian Federation	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●		●	●	●	●	▲	▲
United States	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●		●	●	●	▲	▲
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	●	▲	▲
Hungary	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	●	●	●	●	●		●	▲	▲
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●	▼	●	●	●	●	●		●	▲
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	●		▲
South Africa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

Countries are ordered by mean achievement across the heading and down the rows.

▲ Mean achievement significantly higher than comparison country

● No statistically significant difference from comparison country

▼ Mean achievement significantly lower than comparison country

* See Mullis and others, 1998 Appendix A for characteristics of the students sampled.

† Statistically significant at .05 level, adjusted for multiple comparisons.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling (see Mullis and others, 1998 Figure B.4).