CHAPTER 3

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> Chapter ₃ presents results by the major content areas in science to provide information about the possible effects of curricular variation on average achievement. Average performance is provided for six content areas: earth science; life science; physics; chemistry; environmental and resource issues; scientific inquiry and the nature of science. Information on trends also is provided for earth science, life science, physics, and chemistry.



Curriculum data collected as part of TIMSS 1995 and TIMSS 1999 indicate differences among countries in the structure of the science curriculum, especially in the grades at which topics are introduced, the relative emphasis given to topics, the time allocated to science education, and the expectations placed upon the students. The TIMSS curriculum frameworks were constructed to be powerful organizing tools, rich enough to make possible comparative analyses of curriculum and curriculum change in a wide variety of settings and from a variety of curriculum perspectives. The TIMSS 1999 science assessment, based upon the science framework, was designed to allow as fair comparisons as possible among participating countries, and maintained a common structure with TIMSS 1995 enabling the tracking of changes over time.¹

To facilitate comparative analyses of the science data, the TIMSS 1999

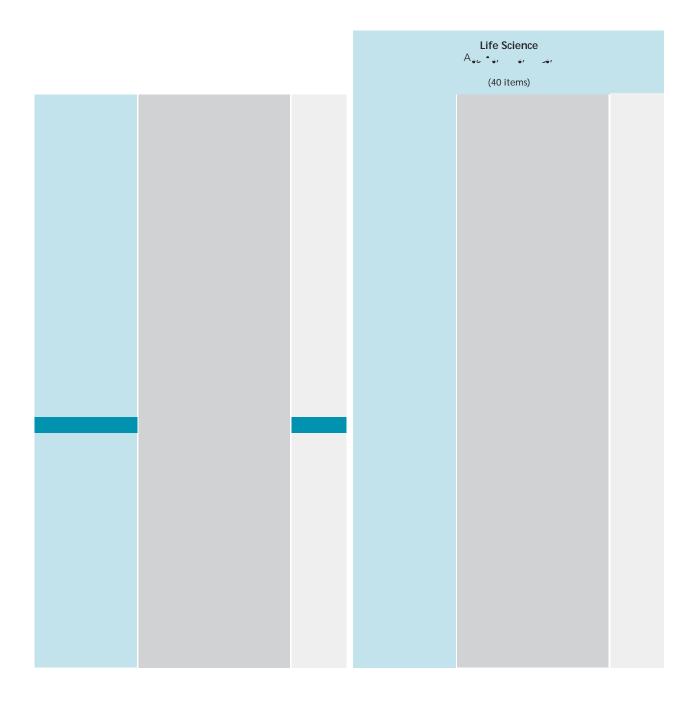
• Scientific inquiry and the nature of science

Incl de he na e of cien i c kno ledge; he cien i c en e i e; in e ac ion of cience, echnolog, ma hema ic, and ocie; and he ool, oced e, and oce e ed in cond c ing cien i c in e iga ion.

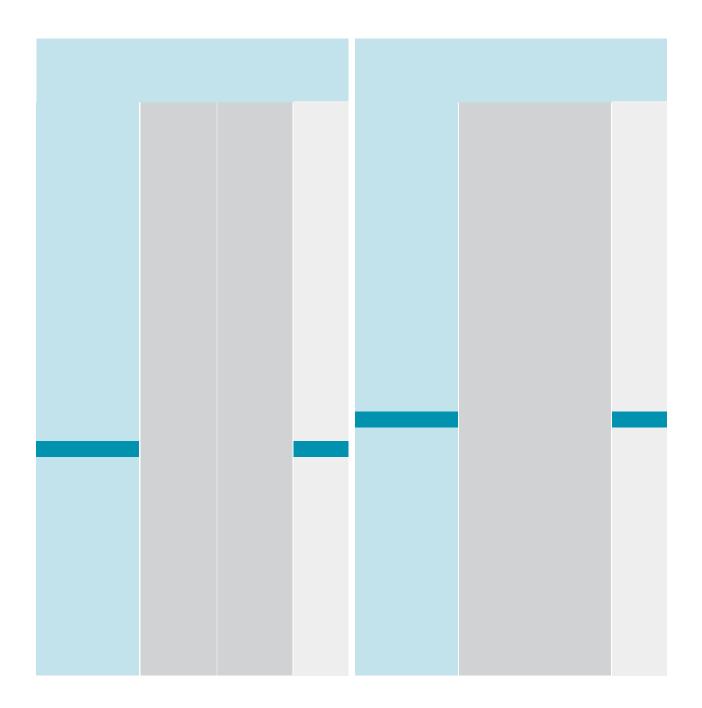
Chapter $_3$ presents average achievement for the six major content areas covered by the TIMSS 1999 science test. Gender differences in each content area are shown, and trends in achievement between 1995 and 1999

How Does Achievement Differ Across Science Content Areas?

Exhibit



	Physics	١			Chemistr A _{er} • •, •,	y Tr	
Singapore Chinese Taipei Japan Korea, Rep. of Hungary Netherlands [†] Australia	A., ., ., (39 items)	<i>Ā</i>	570 (6.7) 552 (3.9) 544 (2.9) 544 (5.1) 543 (4.3) 537 (6.5) 531 (6.3)	Chinese Taipe Hungar Singapor Finlan Japa Bulgari Slovak Republi	A _{ec} •, •, (20 items) i y e d h a	<i>1</i> 01	563 (4.3) 548 (4.7) 545 (8.3) 535 (4.5) 530 (3.1) 527 (5.7)
	 ▲ Country average international av Country average international av ▼ Country average international av 	e significantly higher therage e not significantly differ erage e significantly lower that erage d , ed r , et r	an ent from In		200	500 8	00



In Which Content Areas Are Countries Relatively Strong or Weak?

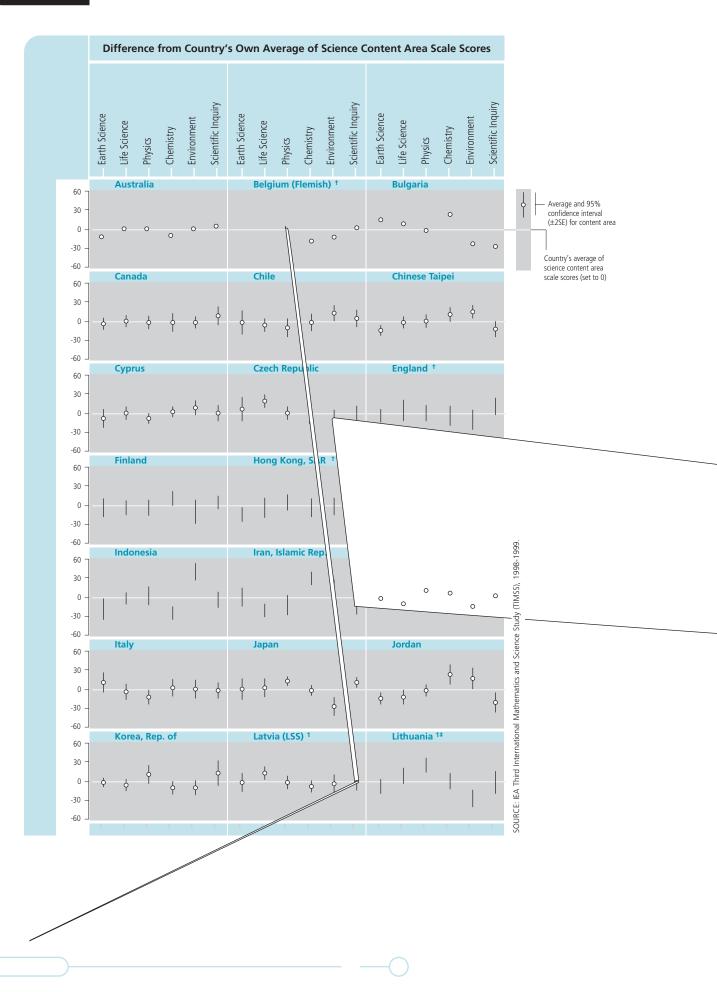
Exhibit 3.2 profiles the relative performance in science content areas within each country, highlighting any variation in performance. For each country, Exhibit 3.2 displays the difference between average performance in each content area and average performance overall. The profiles reveal that many countries performed relatively better or worse in some content areas than in others. For example, students in Bulgaria performed relatively better in chemistry, but less well in environmental and resource issues and in scientific inquiry and the nature of science.

The profiles of relative performance show substantially more variation across the content areas in some countries than in others. For example, in Indonesia, South Africa, and Thailand, there were differences of more than 61 scale-score points (approximately two-thirds of a standard deviation) between the highest and lowest content area averages. In contrast, in countries such as Australia, Cyprus, England, Finland, Hong Kong, Israel, Latvia (LSS), Malaysia, New Zealand, and the Philippines, the difference in average achievement across content areas was 25 scale-score points or less.

Across countries, earth science, life science, and physics were the content areas that least often featured either relatively strong or weak performance. In comparison, relatively stronger or weaker performance in chemistry, environmental and resource issues, and scientific inquiry and the nature of science were observed for a larger number of countries. Of the eight countries in which performance in chemistry was relatively strong, five were countries where the sciences were taught as separate subjects (generally earth science, biology, physics, and chemistry) by the eighth gra points or lessnfit6001 Tc(0]TJnore poinn-i T)8re vD2204 0 8778land Hun 0]ry, eighth grade (see Exhibit 5.1). Students in Singapore had relatively higher performance in physics and environmental and resource issues, and relatively lower performance in earth science. In contrast, students in Japan had lower performance in environmental and resource issues than in other science content areas.



Exhibit 3.2 Profiles of Relative Performance in Science Content Areas



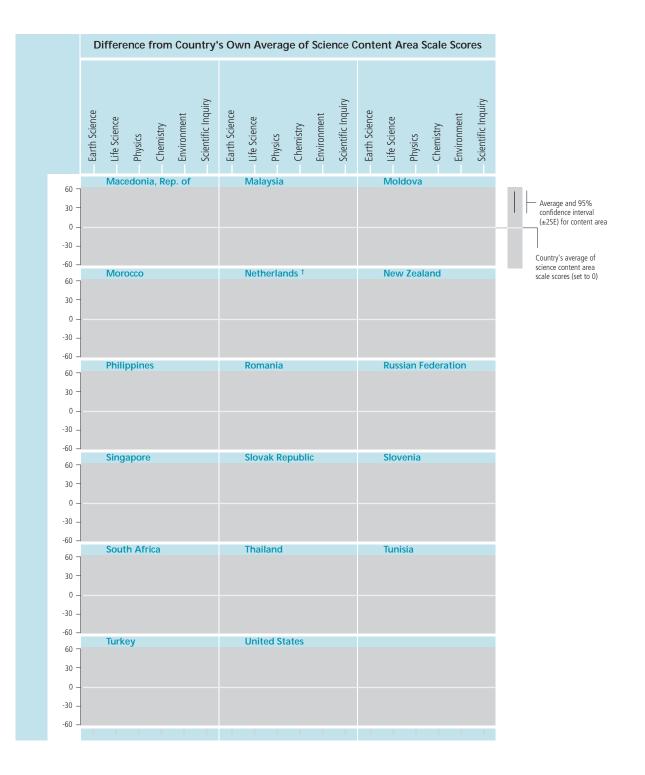






Exhibit 3.3 Overleaf

	Average Scale Scores for Science Content Areas					
	Earth Science		Life Science		Physics	
	1		1-		1 -	
Australia	507 (6.0)	532 (10.9)	531 (6.1)	529 (6.1)	519 (8.2)	542 (6.7)
Belgium (Flemish) [†]	521 (5.7)	544 (8.1)	530 (5.9)	539 (8.1)	521 (4.1)	539 (7.3)
Bulgaria	514 (6.3)	525 (7.3)	515 (8.6)	513 (7.9)	495 (6.8)	515 (6.9)
Canada	510 (8.6)	528 (3.0)	523 (5.0)	523 (4.6)	512 (4.3)	530 (4.9) ▲
Chile	420 (8.6)	451 (8.2)	430 (3.6)	433 (6.4)	416 (5.9)	439 (6.8) ▲
Chinese Taipei	529 (7.4)	546 (7.0)	543 (3.8)	557 (6.5)	542 (6.6)	563 (6.8)
Cyprus	450 (6.4)	468 (6.6)	473 (4.2)	463 (5.5)	451 (5.3)	468 (2.7)
Czech Republic	513 (8.2)	554 (9.2)	537 (4.8)	552 (5.7)	510 (6.2)	544 (6.8) ▲
England [†]	514 (6.2)	536 (6.4)	525 (6.9)	540 (7.2)	513 (5.8)	543 (5.3) ▲
Finland	517 (6.1)	523 (6.1)	520 (5.5)	520 (8.2)	508 (4.6)	532 (6.0) ▲
Hong Kong, SAR [†]	499 (6.1)	513 (6.2)	512 (8.6)	520 (7.4)	514 (5.8)	 46.0) 556 (5.7) 465 (8.2) 464 (8.2) 493 (7.2)
Hungary	545 (6.4)	574 (7.0)	534 (6.4)	536 (4.6)	529 (6.2)	
Indonesia	418 (9.6)	445 (5.5)	450 (5.0)	447 (5.3)	440 (5.2)	
Iran, Islamic Rep.	439 (6.9)	472 (5.7)	430 (6.8)	443 (5.1)	419 (6.5)	
Israel ²	462 (6.8)	481 (6.7)	463 (4.8)	463 (4.8)	475 (7.2)	
Italy	493 (6.5)	512 (6.8)	482 (6.5)	494 (5.1)	469 (5.5)	490 (7.1)
Japan	527 (7.9)	539 (8.0)	532 (6.4)	536 (5.7)	537 (4.6)	552 (2.7)
Jordan	450 (4.2)	443 (5.3)	463 (6.9)	435 (5.6)	462 (4.8)	456 (6.2)
Korea, Rep. of	525 (4.0)	539 (4.2)	520 (5.6)	536 (3.3)	534 (6.5)	553 (5.7)
Latvia (LSS) ¹	488 (6.6)	504 (6.4)	511 (4.0)	507 (5.5)	481 (3.9)	510 (5.0)
Lithuania ^{1‡}	465 (7.4)	488 (5.2)	492 (6.7)	496 (5.3)	496 (6.3)	525 (6.0)
Macedonia, Rep. of	460 (7.1)	467 (5.0)	472 (5.1)	463 (7.7)	455 (7.0)	471 (5.9)
Malaysia	485 (5.1)	497 (5.2)	477 (9.5)	481 (6.1)	484 (4.6)	506 (7.5)
Moldova	461 (4.2)	471 (6.4)	476 (5.5)	478 (6.8)	446 (6.8)	470 (8.9)
Morocco	359 (4.1)	365 (3.6)	347 (3.9)	347 (3.5)	339 (6.3)	361 (5.2)
Netherlands [†]	525 (8.5)	544 (10.2)	535 (9.6)	537 (7.8)	524 (6.6)	550 (7.7)
New Zealand	499 (8.6)	510 (7.9)	506 (6.4)	496 (7.7)	494 (4.9)	504 (6.4)
Philippines	391 (6.1)	388 (6.2)	390 (7.0)	364 (6.6)	389 (7.6)	397 (6.6)
Romania	471 (7.0)	479 (6.2)	476 (7.0)	473 (7.0)	460 (8.3)	469 (6.4)
Russian Federation	518 (7.4)	541 (6.3)	513 (8.6)	522 (7.6)	518 (7.3)	542 (7.5)
Singapore	510 (7.0)	532 (9.9)	536 (7.9)	546 (9.8)	557 (6.9)	581 (8.4)
Slovak Republic	523 (5.1)	551 (6.4)	532 (6.9)	537 (7.4)	505 (5.4)	530 (5.4)
Slovenia	535 (6.4)	547 (5.8)	522 (5.4)	520 (6.5)	514 (4.5)	538 (7.3)
South Africa	338 (4.7)	359 (6.3)	289 (10.3)	290 (11.4)	291 (9.1)	328 (6.7)
Thailand	469 (4.4)	472 (4.7)	511 (4.9)	505 (4.8)	470 (4.7)	480 (5.6)
Tunisia	430 (6.1)	454 (7.3)	437 (6.1)	446 (4.5)	412 (8.9)	438 (4.4)
Turkey	431 (6.6)	438 (7.6)	452 (6.1)	438 (5.1)	438 (8.6)	444 (6.3)
United States	490 (5.2)	518 (5.5)	518 (4.4)	522 (5.0)	488 (6.7)	509 (6.8)
International Avg.	479 (1.1)	496 (1.1)	487 (1.0)	488 (1.1)	477 (1.0)	498 (1.1)

Significantly higher than other gender

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	Average Scale Scores for Science Content Areas					
	Chemistry		Enviromental and Resource Issues		Scientific Inquiry and the Nature of Science	
	1 -		1 -		1 -	
Australia Belgium (Flemish) † Bulgaria Canada Chile Chinese Taipei Cyprus Cyprus Czech Republic England † Finland thong Kong, SAR † Hungary Indonesia Iran, Islamic Rep. Iran, Islamic Rep. Iran, Islamic Rep. Israel 2 1 Madayai Madaysia Moldova Morocco				540 (9.0) 523 (8.1) 493 (9.8) 529 (6.0) 529 (849) 486 (4.35 530 (6.1) 522 (5.46	540 (8.3) 528 (5.7) 482 (5.7) 535 (5.4) 439 (8.6) 544 (5.3) 474 (4.7) 524 (4.9) 536 (5.7) 532 (5.4) 535 (3.2) 522 (5.9) 449 (8.2) 439 (3.8) 475 (10.4) 486 (5.4) 546 (6.3) 451 (5.4) 547 (10.1) 495 (5.9) 486 (6.0) 463 (5.0) 485 (6.4) 467 (6.2) 390 (6.5) 539 (8.8)	529 (3.9) 524 (7.2) 476 (8.1) 530 (5.3) 442 (7.6) 537 (5.4) 461 (6.2) 519 (8.9) 540 (8.3) 524 (7.1) 527 (4.0) 531 (7.0) 442 (5.0) 451 (7.9) 477 (8.5) 492 (5.8) 540 (5.9) 431 (8.0) 544 (6.5) 495 (8.4) 479 (8.0) 465 (5.5) 492 (7.4) 476 (7.1) 391 (5.9) 530 (9.1)
New Zealand Philippines Romania Russian Federation					530 (6.6) 412 (6.0) 457 (6.8) 491 (4.3)	513 (11.4) 393 (6.8) 455 (6.9) 491 (9.5)
Singapore Slovak Republic Slovenia South Africa Thailand		*			552 (6.5) 509 (6.0) 516 (4.4) 321 (6.3) 463 (6.7)	548 (6.6) 506 (8.0) 509 (6.4) 339 (9.0) 461 (6.3)
Tunisia Turkey United States				•	448 (6.6) 452 (8.2) 521 (5.4)	454 (5.5) 441 (5.8) 523 (6.2)
International Avg.					489 (1.0)	486 (1.2)

▲ Significantly higher than other gender
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What Changes Have Occurred in Content Area Achievement?

To examine changes in achievement in the science content areas, Exhibit 3.4 shows the average percent correct for eighth-grade students in 1995 and 1999 for items given in both the 1995 and 1999 TIMSS assessments, and the difference in performance between assessments. Data are presented for the four content areas of earth science, life science, physics, and chemistry.⁴ This content area trend analysis uses average percent correct rather than average scale score because there were insufficient items to reliably link the results for both assessments to the TIMSS scale.

Changes in average achievement at a national level are not easy to bring about and inevitably take place over several years. Amending official curricula, producing relevant supporting resources, and changing teacher practice all take time, even under the most favorable conditions. TIMSS 1999 is only the second in what is expected to become a series of international surveys designed to reveal trends in achievement in mathematics and science. It is not surprising, therefore, that the trend data contained in Exhibit 3.4 reveal only a few significant changes in average achievement in the content areas. It is likely that the next TIMSS administration scheduled for 2003 will show more significant changes in achievement.

Still, even during the four years between 1995 and 1999, statistically significant improvements occurred for Canada in all four content areas and for Hungary and Latvia (LSS) in two content areas. The Slovak Republic increased significantly in life science but decreased significantly



A e a e Ac, e e__e_, _ e Sçe ce C _e_A ea



Australia	62 (0.6)	64 (0.7)	

