Chapter 3

Average Achievement in the Science Content Areas

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 five content areas at the eighth grade: life science, chemistry, physics, earth science, and environmental science, and for three at the fourth grade: life science, physical science, and earth science. Relative achievement is shown among the content areas for each country and results are presented by gender. Trends from 1999 are shown for the eighth grade (insufficient items are available from 1995 to report trends within content areas).

The TIMSS 2003 science assessments at the eighth and fourth grades were designed to allow as fair comparisons as possible among participating countries. Considerable effort was devoted to updating the science framework newly published in the *TIMSS Assessment Frameworks and Specifications 2003*.[1] IEA gratefully acknowledges the generous support of the US National Science Foundation in helping to fund this work, which took about two years, including a special international expert panel, iterative reviews by the NRCs, and a curriculum questionnaire completed by the countries. The effort focused on specifying

1 . (2003), *TIMSS Assessment Frameworks and Specifications 2003 (2nd Edition),*

the particular topics and subtopics to be assessed at each grade within

4. Acids and bases
5. Chemical change.

At grade 4, chemistry is not reported separately, but combined with physics as physical science. At this grade level, the particulate structure of matter and acids and bases are not included.

Physics

1. Physical states and changes in matter
2. Energy types, sources, and conversions
3. Heat and temperature
4. Light
5. Sound and vibration
6. Electricity and magnetism
7. Forces and motion.

At grade 4, physics is not reported separately, but combined with chemistry as physical science. At this grade level, sound and vibration is not included.

Earth science

1. Earth's structure and physical features
2. Earth's processes, cycles, and history
3. Earth in the solar system and the universe.

Environmental science

1. Changes in population
2. Use and conservation of natural resources
3. Changes in environments.

	453	(3.3)	▼	466	(4.2)	▼	47	(3.2)		460	(3.7)	▼	417	(4.4)	▼
	532	(3.8)	▲	506	(3.8)	▲	521	(3.7)	▲	531	(4.2)	▲	536	(3.4)	▲
	445	(1.)	▼	441	(2.6)	▼	443	(2.0)	▼	440	(2.4)	▼	43	(3.1)	▼
	526	(2.4)	▲	503	(2.0)	▲	514	(2.5)	▲	508	(2.5)	▲	523	(2.7)	▲
	370	(2.7)	▼	348	(3.1)	▼	371	(3.2)	▼	361	(3.1)	▼	381	(3.3)	▼
	474	(5.2)		482	(5.7)		485	(5.0)	▲	4 1	(4.)	▲	464	(5.0)	▼
	427	(2.7)	▼	405	(3.3)	▼	401	(3.1)	▼	435	(3.1)	▼	436	(2.)	▼
	563	(3.1)	▲	584	(4.0)	▲	56	(3.3)	▲	548	(3.1)	▲	560	(3.1)	▲
	437	(2.2)	▼	443	(2.6)	▼	450	(1.7)	▼	447	(2.1)	▼	441	(2.3)	▼
	425	(3.7)	▼	442	(3.8)	▼	414	(4.1)	▼	403	(4.4)	▼	430	(4.0)	▼
	547	(2.4)	▲	552	(2.1)	▲	544	(2.4)	▲	558	(2.)	▲	540	(2.2)	▲
	256	(5.6)	▼	276	(6.6)	▼	23	(5.4)	▼	254	(5.6)	▼	267	(6.2)	▼
†	551	(2.)	▲	542	(2.6)	▲	555	(2.8)	▲	54	(2.)	▲	555	(2.6)	▲
	536	(2.7)	▲	560	(3.1)	▲	536	(2.7)	▲	537	(3.1)	▲	528	(2.)	▲
1	424	(3.)	▼	3 1	(3.8)	▼	430	(4.0)	▼	431	(3.8)	▼	454	(3.4)	▼
	447	(2.6)	▼	445	(2.7)	▼	445	(3.0)	▼	468	(2.)	▼	487	(2.1)	▲
2	4 1	(3.0)	▲	4	(3.4)	▲	484	(2.)	▲	485	(3.0)	▲	486	(2.)	▲
	4 8	(3.2)	▲	487	(3.3)	▲	470	(3.2)		513	(3.2)	▲	4 7	(3.0)	▲
	54	(2.0)	▲	552	(2.1)	▲	564	(1.)	▲	530	(2.1)	▲	537	(2.0)	▲
	475	(4.0)		478	(4.4)		465	(3.8)	▼	472	(4.0)		4 2	(3.2)	▲
	558	(1.6)	▲	52	(2.5)	▲	57	(1.6)	▲	540	(1.)	▲	544	(1.4)	▲
	511	(2.5)	▲	514	(3.2)	▲	512	(2.4)	▲	514	(2.8)	▲	508	(3.3)	▲
	360	(5.0)	▼	433	(4.)	▼	41	(4.0)	▼	3 5	(4.0)	▼	374	(5.1)	▼
1	517	(2.4)	▲	534	(2.3)	▲	51	(2.7)	▲	512	(2.7)	▲	507	(2.0)	▲
2	448	(3.8)	▼	467	(3.)	▼	458	(3.1)	▼	440	(4.3)	▼	442	(3.7)	▼
	504	(3.7)	▲	514	(3.8)	▲	51	(3.6)	▲	502	(3.8)	▲	513	(3.2)	▲
	466	(3.7)	▼	47	(3.)		47	(3.7)		475	(4.0)		454	(3.8)	▼
1 ‡	3 0	(2.6)	▼	402	(2.7)	▼	410	(2.7)	▼	3 7	(3.4)	▼	3 6	(3.3)	▼
†	536	(3.3)	▲	514	(2.6)	▲	538	(3.4)	▲	534	(3.2)	▲	53	(2.8)	▲
	523	(5.1)	▲	501	(5.6)	▲	515	(4.7)	▲	525	(4.8)	▲	525	(3.)	▲
	4 6	(2.5)	▲	485	(3.0)	▲	488	(2.6)	▲	517	(2.7)	▲	4 6	(2.2)	▲
	435	(3.6)	▼	444	(3.)	▼	432	(3.6)	▼	43	(3.0)	▼	444	(3.7)	▼
	387	(5.8)	▼	342	(6.1)	▼	380	(4.7)	▼	377	(5.7)	▼	403	(5.4)	▼
	471	(4.8)		474	(4.)		473	(4.1)		46	(5.2)		472	(4.7)	
	514	(3.3)	▲	527	(4.0)	▲	511	(3.4)	▲	518	(3.3)	▲	4 1	(3.2)	▲
	412	(3.)	▼	382	(4.8)	▼	3 4	(3.)	▼	3 4	(4.0)	▼	410	(3.8)	▼
†	512	(3.3)	▲	4	(3.2)	▲	515	(3.0)	▲	515	(3.8)	▲	511	(3.5)	▲
	468	(2.6)	▼	474	(3.2)		471	(2.6)		471	(3.0)		457	(2.4)	▼
	56	(4.0)	▲	582	(4.2)	▲	57	(3.4)	▲	54	(3.)	▲	568	(3.8)	▲
	514	(2.)	▲	51	(3.6)	▲	51	(2.)	▲	523	(3.3)	▲	50	(2.8)	▲
	521	(2.2)	▲	532	(2.6)	▲	50	(1.8)	▲	523	(2.2)	▲	515	(2.2)	▲
	250	(6.0)	▼	285	(5.)	▼	244	(6.2)	▼	247	(6.3)	▼	261	(6.6)	▼
	528	(2.7)	▲	526	(2.6)	▲	525	(2.)	▲	532	(3.3)	▲	4	(2.6)	▲
	417	(2.0)	▼	413	(2.5)	▼	386	(2.5)	▼	408	(2.0)	▼		▲	532

.1 Average Achievement in Science Content Areas

Countries	Average Scale Scores for Science Content Areas		
	[illegible]	[illegible]	[illegible]
	435 (4.4) ▼	42 (4.3) ▼	450 (3.6) ▼
†	523 (3.8) ▲	518 (3.) ▲	518 (4.1) ▲
	524 (1.7) ▲	507 (2.3) ▲	522 (1.7) ▲
	540 (1.6) ▲	554 (2.0) ▲	55 (2.6) ▲
	482 (2.1) ▼	47 (2.3) ▼	487 (2.5)
†	532 (3.1) ▲	546 (3.2) ▲	535 (3.5) ▲
†	535 (2.6) ▲	548 (2.7) ▲	536 (2.7) ▲
	536 (2.5) ▲	526 (2.7) ▲	526 (3.7) ▲
	424 (4.6) ▼	41 (4.5) ▼	428 (3.0) ▼
	521 (3.5) ▲	512 (3.5) ▲	51 (3.7) ▲
	530 (1.3) ▲	557 (1.7) ▲	535 (1.) ▲
	531 (2.3) ▲	532 (2.6) ▲	534 (2.) ▲
1	516 (2.0) ▲	512 (2.5) ▲	503 (3.2) ▲
	504 (3.) ▲	48 (3.)	505 (4.) ▲
	300 (6.1) ▼	308 (7.0) ▼	311 (6.1) ▼
†	547 (1.8) ▲	505 (1.) ▲	503 (2.3) ▲
	520 (2.3) ▲	516 (2.3) ▲	522 (2.3) ▲
	480 (2.2) ▼	456 (2.3) ▼	473 (2.8) ▼
	330 (.0) ▼	343 (.6) ▼	324 (.2) ▼
	526 (4.7) ▲	527 (5.2) ▲	527 (6.0) ▲
†	506 (3.1) ▲	503 (2.6) ▲	4 8 (2.6) ▲
	558 (5.0) ▲	577 (5.) ▲	538 (5.2) ▲
	48 (2.)	4 7 (2.3) ▲	4 0 (2.7)
	2 0 (5.) ▼	324 (5.3) ▼	336 (4.8) ▼
†	537 (2.2) ▲	531 (2.3) ▲	535 (2.5) ▲
	48 (0.7)	48 (0.8)	48 (0.8)
Benchmarking Participants			
	554 (2.) ▲	546 (3.5) ▲	552 (3.6) ▲
	541 (3.6) ▲	537 (3.5) ▲	53 (3.8) ▲
	503 (2.2) ▲	4 7 (2.4) ▲	507 (2.7) ▲

▲ [illegible]

▼ [illegible]

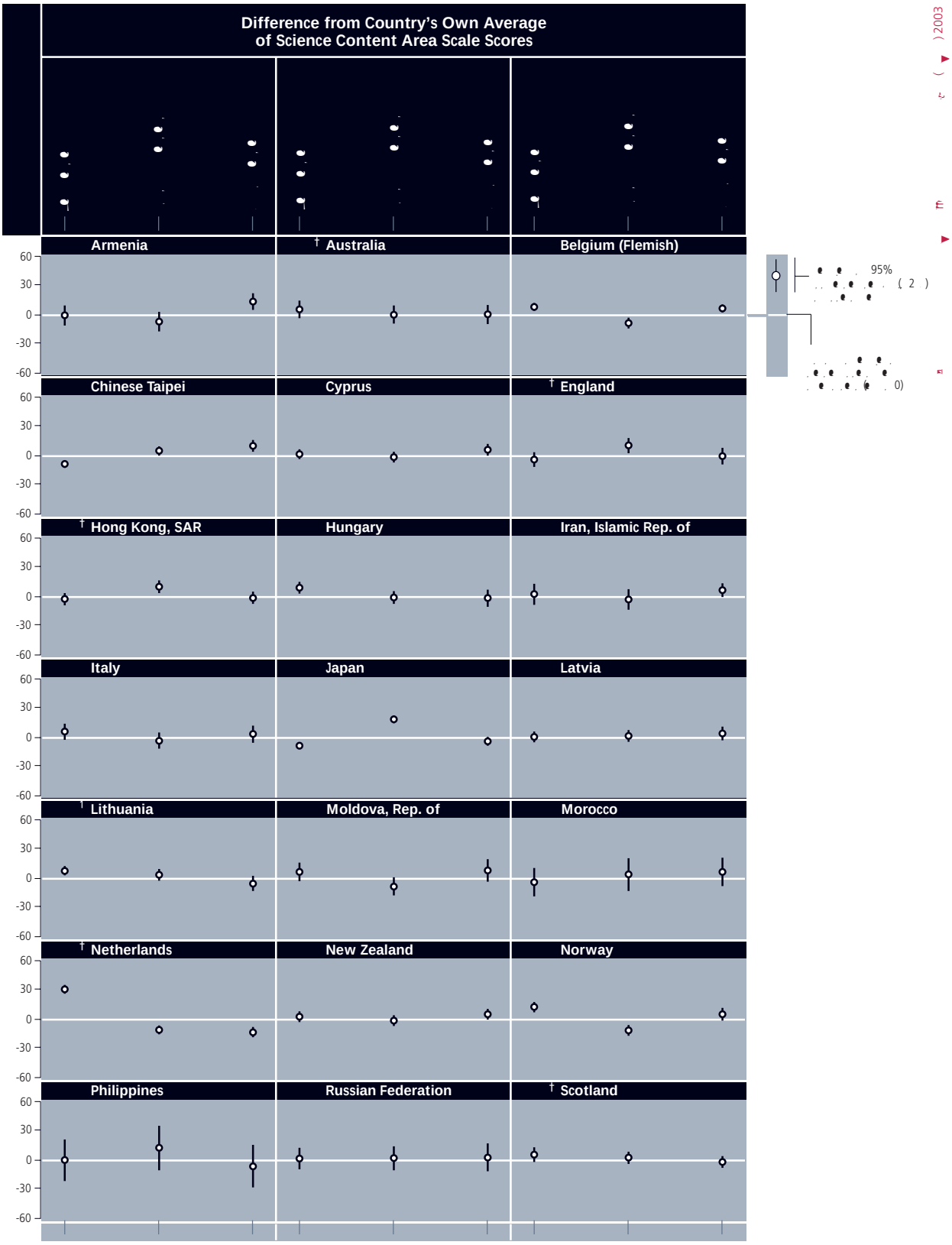
[illegible]

1 [illegible].

achievement across content areas showed considerable variation in some countries. For example, at the eighth grade, variation of 60 or more scale-score points (one area at least 30 above and one 30 below) was found in Lebanon, the Philippines, and Indonesia. On the other hand, there were only a small number of scale points of difference between highest and lowest content area means in some countries at the eighth grade, with good examples being Latvia, Romania, Bahrain, and Cyprus. For the latter group of countries, the TIMSS 2003 data indicate a greater balance in science content covered through the grades. At the fourth grade, no countries had differences as large as 60 points, even though several had a particular strength or weakness. Generally, countries had comparable levels of performance across the three fourth-grade content areas.

	Afccbobk`b col j @l rkqov¥p L t k >sbo^db lc P`fbk`b @l kqbkq >ob^ P`^ib P`lobp		
	I^qsf^	Ib_^k l k	1 Ifqe r^kf^
2 J ^`ba l kf^) Obm+ lc	J ^j^vpf^	J lia l s^) Obm+ lc	
‡1 J lol``l	† Kbqeboi^kap	Kb t Wb^i^ka	
Klo t ^v	M^ibpqfkf^k K^q¥i > rqe+	Mefifmmfkbp	
Ol j ^kf^	Orppf^k Cbabo^qf l k	P^r af >o^_f^	
† P`lqi^ka	Pbo_f^	Pfkd^m lob	
Pil s^h Obmr_if`	Pil sbkf^	Pl rqe >cof`^	

Profiles of Within-Country Relative Performance in Science Content Areas



	Difference from Country's Own Average of Science Content Area Scale Scores		
	Singapore	Slovenia	Tunisia
† United States			
Benchmarking Participants			
	Indiana State, US	Ontario Province, Can.	Quebec Province, Can.

What Are the Gender Differences in Achievement for the Content Areas?

Exhibit 3.3 displays average achievement in science content areas by gender for the eighth and fourth grades. Perhaps not surprising in view of the gender differences favoring boys in overall science eighth-grade achievement described in chapter 1, boys outperformed girls on average in four of the five content areas at this grade level. The most striking results were the large number of significant differences favoring boys in earth science and in physics.

physical science, girls had significantly higher achievement than boys (4 points in life science and 2 points in physical science). Girls performed better in life science than boys in 7 countries, whereas boys performed better in only one. In physical science, girls performed better than boys in six countries, and boys performed better in four countries.

In earth science, however, the boy-girl difference was rce, emenCHAPTERg sl acigher achieventage
In eaassessthansls per ife scieIn (ce than is inr1.pemeious & PIRassessthansboys oy-gSerindr c.060.0

	464 (4.2)	▲	455 (3.8)		425 (5.1)	▲	408 (4.3)	
	516 (4.8)		547 (4.)	▲	528 (4.4)		543 (4.0)	▲
	445 (1.)		436 (4.6)		452 (2.7)	▲	425 (5.6)	
( )	4 4 (2.)		525 (3.8)	▲	512 (3.4)		536 (3.5)	▲
	354 (4.7)		367 (4.1)	▲	385 (3.5)	▲	376 (4.1)	
	477 (5.7)		503 (5.3)	▲	455 (6.4)		471 (4.)	▲
	413 (3.4)		455 (3.5)	▲	424 (3.0)		446 (3.8)	▲
	542 (3.2)		554 (3.)	▲	561 (3.5)		558 (3.2)	
	442 (2.8)		452 (3.3)	▲	442 (2.8)		43 (3.0)	
	3 7 (4.7)		40 (6.)		435 (5.0)		426 (5.4)	
	560 (4.4)		556 (3.2)		540 (2.7)		53 (2.7)	
	230 (7.0)		274 (6.)	▲	256 (6.7)		276 (7.1)	▲
†	53 (3.4)		558 (3.5)	▲	554 (3.0)		557 (3.6)	
	520 (3.7)		555 (4.3)	▲	515 (3.4)		541 (3.4)	▲
1	424 (4.2)		438 (4.2)	▲	451 (4.1)		457 (4.0)	
	464 (4.2)		470 (4.1)		488 (3.1)		486 (3.1)	
2	475 (3.2)		4 6 (3.)	▲	476 (2.7)		4 7 (4.6)	▲
	504 (3.1)		523 (4.2)	▲	4 4 (3.3)		500 (3.)	
	524 (3.4)		536 (2.)	▲	533 (2.8)		540 (2.)	
	47 (4.2)	▲	466 (5.5)		507 (4.1)	▲	47 (4.7)	
	527 (2.0)		552 (2.4)	▲	538 (2.0)		548 (1.7)	▲
	504 (3.5)		524 (2.)	▲	503 (3.4)		513 (4.0)	▲
	38 (5.0)		402 (4.8)	▲	371 (6.2)		37 (7.0)	
1	504 (3.4)		520 (3.1)	▲	504 (2.6)		50 (2.6)	
2	438 (6.1)		443 (4.8)		443 (4.7)		442 (4.2)	
	4 4 (4.6)		510 (3.)	▲	50 (3.6)		516 (3.8)	

38 (6.2)527 (3.4) 510 22 -33.6206 0 ( ) /- 971 (4.5)451 03 (4 4)-386 52(4.4)) 221 18 3.6206 036 (1.4)/- 5 1 (3.451 0 46 5 1 3.345 56(0.7) 1/- 538 7.6 (3.4) 364 1.45 5 5.7((1.7))(2)/- 1 1 2 1 3 6206 03
(4.6) ▲ 1 5 13.7((4.7))-451 (527)-387.7(▲ 03 (6.2) (4.6)3.6206 0 ( ) /- ▲ 1 1 -48 52 206 403TD (n)Tj /F5 ▲ (4) (3.8)) 256 (3.5)494)-387.5(▲ 84 (6.5) 536)) 5 5 (5.5) 1 (1.7)) 1 1 4 3 4 (6.4) 1 4 1 3 (6.2)

Average Achievement in Science Content Areas by Gender

Countries	Average Scale Scores for Science Content Areas					
	Life Science		Physical Science		Earth Science	
	[illegible]		[illegible]		[illegible]	
	443 (4.5)	428 (5.0)	430 (4.5)	428 (4.)	455 (3.)	445 (4.1)
†	527 (3.5)	520 (4.)	518 (3.8)	518 (5.1)	51 (4.0)	518 (5.7)
	523 (1.)	524 (2.3)	507 (2.6)	507 (2.5)	521 (2.2)	524 (2.4)
	53 (1.6)	542 (2.0)	551 (2.2)	557 (2.6)	553 (2.)	565 (2.8)
	47 (2.7)	485 (2.7)	475 (2.5)	483 (3.0)	485 (2.6)	48 (3.0)
†	532 (3.0)	531 (3.8)	54 (3.3)	544 (4.1)	535 (3.8)	536 (4.2)
†	536 (2.8)	533 (2.7)	551 (3.2)	544 (2.8)	537 (3.4)	536 (3.0)
	537 (3.2)	536 (2.8)	522 (3.5)	530 (3.2)	520 (5.0)	531 (4.1)
	437 (6.6)	415 (5.3)	432 (7.4)	410 (5.2)	437 (5.2)	423 (3.7)
	521 (3.)	521 (3.7)	510 (4.1)	513 (3.6)	514 (4.5)	523 (3.6)
	52 (2.0)	530 (2.0)	557 (2.2)	557 (2.4)	530 (2.5)	53 (2.3)
	535 (2.4)	527 (2.)	536 (3.1)	528 (3.1)	534 (3.4)	534 (3.3)
1	518 (2.4)	517 (2.5)	514 (2.8)	513 (3.2)	503 (4.2)	507 (3.8)
	511 (4.2)	4 7 (4.5)	4 5 (4.1)	483 (4.4)	511 (5.2)	4 (5.6)
	303 (7.6)	2 7 (6.0)	311 (7.)	305 (7.4)	313 (7.5)	308 (6.1)
†	545 (2.2)	54 (2.2)	501 (2.2)	50 (2.2)	4 6 (2.)	50 (2.)
	524 (2.)	516 (2.7)	51 (2.)	513 (2.6)	523 (3.1)	522 (2.3)
	483 (2.6)	477 (2.8)	457 (3.0)	454 (2.6)	473 (3.4)	472 (3.5)
	33 (10.4)	322 (8.1)	34 (10.6)	337 (.3)	331 (10.7)	317 (8.6)
	528 (5.5)	525 (4.5)	527 (5.8)	526 (5.2)	528 (6.)	527 (5.7)
†	500 (3.5)	511 (3.)	4 (3.0)	507 (3.7)	4 2 (2.)	505 (3.6)
	55 (4.)	557 (5.7)	580 (5.8)	574 (6.6)	534 (5.0)	541 (6.1)
	4 0 (3.6)	488 (3.8)	4 (2.8)	4 6 (3.2)	48 (3.0)	4 2 (4.1)
	2 4 (6.5)	285 (6.3)	326 (5.)	322 (5.5)	337 (5.5)	336 (5.8)
†	536 (2.1)	538 (2.6)	52 (2.1)	533 (2.7)	531 (2.6)	53 (2.)
	4 1 (0.8)	487 (0.8)	4 0 (0.)	488 (0.8)	488 (0.)	4 0 (0.8)
Benchmarking Participants						
	551 (2.6)	558 (4.3)	544 (3.3)	548 (4.5)	547 (3.5)	557 (4.6)
	540 (3.7)	542 (4.7)	534 (3.6)	53 (4.6)	531 (4.0)	547 (5.1)
	506 (2.3)	500 (3.1)	4 6 (2.5)	4 7 (3.0)	505 (2.7)	510 (3.8)

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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 stu-

	57 (0.7)			61 (0.8)			53 (0.9)		
	56 (0.5)	60 (0.5)	▼	61 (0.6)	64 (0.5)	▼	49 (0.5)	51 (1.0)	▼
	50 (1.1)	57 (1.1)	▼	50 (1.2)	58 (1.3)	▼	53 (1.2)	62 (1.1)	▼
	40 (0.5)	38 (0.7)	▲	43 (0.6)	41 (0.8)	▲	41 (0.7)	38 (0.7)	▲
	66 (0.7)	67 (0.6)		62 (0.6)	64 (0.6)		71 (0.9)	72 (0.8)	
	42 (0.4)	46 (0.3)	▼	41 (0.5)	49 (0.6)	▼	42 (0.5)	47 (0.7)	▼
	61 (0.7)	59 (0.7)		61 (0.6)	59 (0.8)	▲	57 (0.7)	56 (0.7)	
	52 (0.1)	52 (0.1)	▲	52 (0.1)	52 (0.2)	▲	52 (0.1)	52 (0.2)	
Benchmarking Participants									
	59 (1.0)	60 (1.4)		64 (1.0)	66 (1.4)		56 (1.3)	57 (1.5)	
	59 (0.6)	56 (0.6)	▲	65 (0.7)	61 (0.8)	▲	51 (0.8)	51 (0.9)	
	60 (0.7)	61 (1.9)		60 (0.8)	61 (1.9)		55 (0.8)	57 (1.1)	

▲ 2003 1999

▼ 2003 1999

	59 (0.9)			57 (1.0)			56 (1.0)					
( )	61 (0.6)	64 (0.8)	▼	56 (0.7)	59 (1.0)	▼	49 (0.8)	54 (0.7)	▼			
	48 (1.1)	52 (1.4)	▼	57 (1.3)	63 (1.2)	▼	43 (1.3)	50 (1.3)	▼			
	40 (0.5)	37 (0.7)	▲	41 (0.6)	38 (0.7)	▲	33 (0.6)	37 (0.8)	▼			
	62 (0.8)	64 (0.7)		69 (0.8)	71 (0.7)		70 (0.9)	69 (0.8)				
	46 (0.6)	47 (0.5)		43 (0.6)	46 (0.6)	▼	35 (0.6)	42 (0.7)	▼			
	61 (0.7)	62 (0.8)		64 (0.8)	65 (0.9)		62 (1.0)	55 (1.0)	▲			
	62 (0.7)	63 (0.8)		66 (0.7)	70 (0.9)	▼	52 (1.0)	53 (1.0)				
	42 (0.7)	43 (0.7)		43 (0.8)	45 (0.9)		40 (0.8)	46 (0.9)	▼			
	41 (0.6)	42 (0.7)		54 (0.8)	53 (0.9)		42 (0.7)	40 (0.8)				
	53 (0.8)	48 (0.9)	▲	54 (0.7)	50 (1.1)	▲	42 (0.9)	42 (1.0)				
	49 (0.7)	50 (0.8)		61 (0.9)	58 (1.0)		47 (0.9)	49 (0.9)				
	65 (0.5)	68 (0.4)	▼	62 (0.6)	66 (0.6)	▼	54 (0.9)	50 (0.7)	▲			
	42 (0.8)	42 (0.6)		53 (0.8)	52 (0.7)		44 (1.0)	44 (0.8)				
	▲											