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Environmental Awareness in TIMSS 2023:

Patterns in Achievement, Attitudes, Behaviors, and Contexts

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Overview

Introduction

Environmental sustainability and how best to promote sustainable development is a problem of increasing urgency for policymakers and researchers. Several international projects have been initiated to address these issues and provide frameworks for thinking about the development of individuals' environmental awareness and their proclivities for environmental action.[a] TIMSS 2023 sought to contribute to these efforts by providing a measure of students' environmental knowledge, accompanied by information about students' environmental attitudes and behaviors. TIMSS 2023 also collected additional contextual information about the degree to which parents, schools, and teachers promote the development of these attributes. This TIMSS Insights report brings these different sources of information together, exploring environmental awareness in greater detail than the high level results provided in the _TIMSS 2023 International Results_.[b] The report highlights how environmental knowledge, attitudes, and behaviors are linked with the goal of providing valuable information for education policy to support efforts in enhancing students' environmental literacy both nationally and globally.

The report begins with a brief overview of how environmental awareness has been conceptualized and how the construct is represented in the TIMSS 2023 instruments measuring student knowledge and attitudes. It then provides an overview of students' average environmental knowledge across countries, before continuing to report environmental knowledge by contextual variables of interest—for girls and boys, for different levels of home resources, and for different school geographic locations. The report then takes a deeper dive into the different sources of contextual data related to environmental awareness, presenting the results of multiple group latent class analysis (MG-LCA) that explore patterns in responses across the different sets of items addressing environmental topics beyond students' environmental awareness. These results are presented for student, parent, school, and teacher variables. Finally, the report concludes with key takeaways and suggestions for policy use and future research related to environmental awareness in TIMSS.

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a   For example, Bianchi, G., Pisiotis, U. and Cabrera Giraldez, M., GreenComp, The European sustainability competence framework, Bacigalupo, M. and Punie, Y. (Eds.), EUR 30955 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-46485-3, doi:10.2760/13286, JRC128040; and Impact Assessment for Action Competence (https://impactforaction.eu)

b   For general information about TIMSS 2023, see Appendix A of this report.

Conceptualizing Environmental Awareness

Environmental awareness is the first stage in becoming environmentally literate.[1,2] Environmental literacy has become an important aspect of science learning because of the increased concern for the environment and the consequences of human activity on the natural world. Environmental literacy refers to the detailed knowledge of environmental issues, an understanding of human-nature interactions, and the cognitive skills, attitudes, and motivation necessary to make informed decisions that improve environmental issues.[3,4] Awareness of topics in ecology and environmental science and of human-nature interactions is first needed to ultimately be able to act in environmentally responsible ways and become environmentally literate. Environmental literacy is a continuum, beginning with having awareness, progressing to developing concern and understanding, and then to ultimately taking action and engaging in pro-environmental behavior. Movement through the phases of environmental literacy is not always linear, and awareness and pro-environmental behavior may often develop together and reinforce each other over time.[5] While there are many factors that influence engagement in pro-environmental behavior, there is consensus that environmental knowledge and positive environmental attitudes are necessary to begin to develop a concern towards the environment and potentially enact pro-environmental behaviors.[6]

Many cognitive models exist to help explain the concept of environmental literacy and the factors it comprises, ranging from very simple to more complex models. Early, simplistic models illustrate a linear relationship between environmental knowledge and attitudes and pro-environmental behavior, whereas more recent, complex models include internal and external factors, such as personality traits and economic situation, that have moderating effects on enactment of pro-environmental behavior.[8,7] These cognitive models share commonalities in that they include environmental knowledge and attitudes as prerequisites to engaging in pro-environmental behavior and becoming environmentally literate. Figure 1 depicts one model that shows how environmental knowledge and attitudes ultimately influence pro-environmental behavior. The model is based on the theory of planned behavior[8] and the norm activation model,[9] which have been adapted by researchers for use in the context of various pro-environmental behaviors.[10,11,12] Attitudes towards environmental behaviors, along with perceived behavioral control and perceived social norms, influence motivations to perform the behaviors and therefore pro-environmental behavior. This model includes environmental knowledge as a moderator of the attitude-behavior relationship, as knowing about the environment can lead to engagement in these behaviors when coupled with pro-environmental attitudes.[13,14,15]

Figure 1: *Cognitive Model of Environmental Literacy*
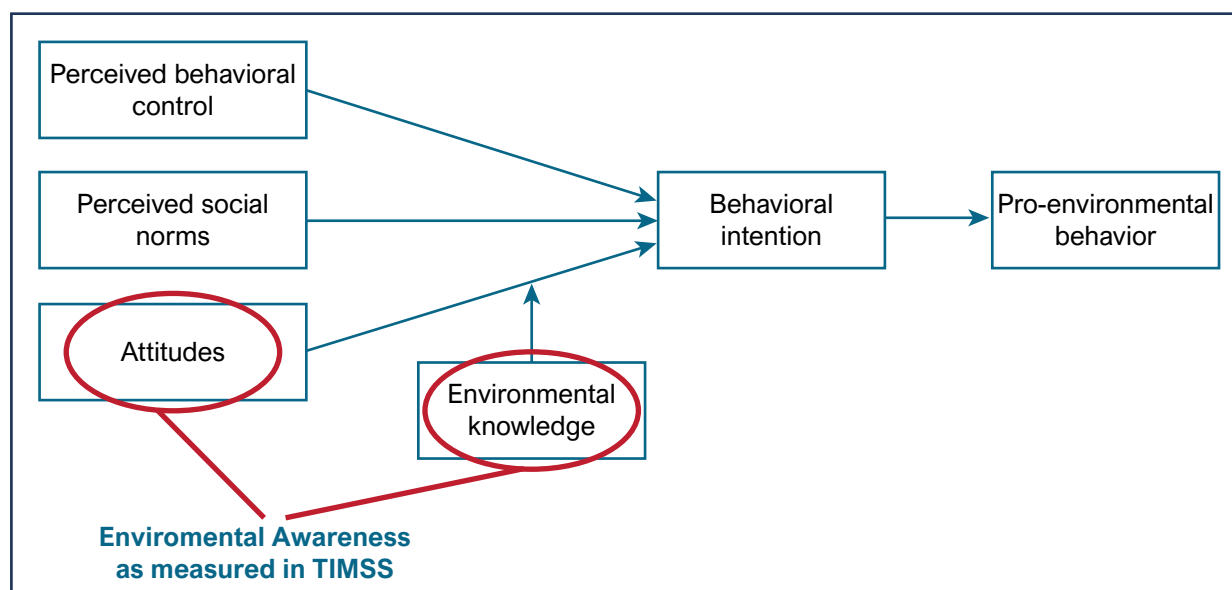
Environmental Awareness in TIMSS

Both environmental knowledge and attitudes are needed to develop environmental awareness, the first step to becoming environmentally literate. TIMSS assesses both environmental knowledge and pro-environmental attitudes. *Environmental knowledge* is defined as factual knowledge about the environment, systems knowledge, action-related knowledge, and effectiveness knowledge.[16,17] Thus, environmental knowledge includes knowing scientific concepts, understanding how humans interact with the natural world, knowing about major environmental issues, and knowing about potential solutions. In TIMSS, environmental knowledge is measured by items targeting specific topics within the biology and earth science content domains such as climate change, Earth's resources, and ecosystem relationships. *Environmental attitudes* as measured in TIMSS are beliefs and attitudes about the environment and are captured through the Student Questionnaires.[c] Although TIMSS cannot directly measure students' enactment of *pro-environmental behavior*, it does include self-reported measures of the frequency of these kinds of behaviors in the Student Questionnaires.[d]

Characterizing Students' Environmental Knowledge

This report section presents an overview of fourth- and eighth-grade students' environmental knowledge. In the following exhibits, average environmental knowledge scale scores are presented by country, as well as for girls and boys in each country. The association between environmental knowledge and selected contextual variables is also reported.

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c   For more detailed information on environmental knowledge and environmental attitudes in TIMSS, see the *TIMSS 2027 Science Framework*, the *TIMSS 2027 Contextual Framework* (both forthcoming), and the TIMSS 2023 Environmental Attitudes and Behaviors Framework.

d   For information about the history of environmental awareness in TIMSS, see Appendix B of this report.

Students' Achievement in Environmental Knowledge

Students' Environmental Knowledge

Exhibit 1.1 reports the average achievement in environmental knowledge at the fourth grade. The exhibit also includes confidence intervals, standard deviations, and the associated standard errors (given in parentheses). Additionally, visualizations of the score distributions show the percentiles and confidence intervals for the estimated averages.

At the fourth grade, average scale scores in environmental knowledge range from 389 scale score points (in Kuwait) to 577 scale score points (in Singapore), indicating a wide range of achievement scores across countries. Most countries also had standard deviations higher than 80, highlighting considerable variability in environmental knowledge both within and across countries.

Exhibit 1.1: Average Environmental Knowledge and Scale Score Distributions

Country	Average Scale Score	95% Confidence Interval for Average	Standard Deviation	Environmental Knowledge Distribution
[3] Singapore	577 (4.0)	570 - 585	102 (1.7)	
Korea, Rep. of	575 (3.6)	568 - 582	89 (2.5)	
Chinese Taipei	566 (2.4)	561 - 571	86 (1.7)	
[2] Poland	557 (2.5)	552 - 562	78 (1.6)	
[2] England	557 (3.2)	551 - 563	91 (2.4)	
[3] Türkiye (5)	553 (3.9)	545 - 560	102 (2.6)	
Australia	550 (3.0)	544 - 556	90 (1.8)	
[†] Hong Kong SAR	543 (3.7)	536 - 551	102 (3.2)	
Finland	542 (3.4)	535 - 549	89 (2.0)	
Japan	541 (3.4)	535 - 548	77 (1.5)	
Ireland	536 (3.9)	529 - 544	92 (2.8)	
[†] Denmark	536 (3.0)	530 - 542	82 (1.5)	
[2 †] United States	535 (3.2)	529 - 542	102 (1.6)	
[2] Norway (5)	535 (2.8)	529 - 541	84 (1.4)	
Hungary	534 (3.8)	526 - 541	93 (2.9)	
Bulgaria	532 (5.7)	521 - 544	118 (5.1)	
Macao SAR	528 (1.6)	525 - 531	87 (1.7)	
[2] Sweden	526 (3.6)	519 - 533	87 (2.5)	
[1 3] Canada	524 (2.2)	520 - 528	80 (1.4)	
[2] Lithuania	521 (3.3)	514 - 527	85 (2.0)	
[2 ≡] Romania	521 (5.3)	510 - 531	93 (2.8)	
Slovenia	520 (3.2)	514 - 526	83 (1.8)	
[2] Czech Republic	519 (3.1)	513 - 526	79 (1.2)	
Portugal	519 (3.6)	512 - 526	89 (1.9)	
[†] Netherlands	518 (2.3)	514 - 523	73 (1.7)	
[2 †] New Zealand	518 (2.8)	512 - 523	97 (2.2)	
[2] Italy	517 (2.7)	512 - 523	79 (1.3)	
[2] Serbia	517 (3.3)	511 - 523	86 (2.0)	
Germany	513 (2.8)	508 - 519	91 (1.8)	
[2] Spain	510 (2.7)	505 - 515	81 (1.5)	
Slovak Republic	509 (4.4)	500 - 518	96 (3.5)	
Latvia	503 (3.4)	496 - 510	84 (2.4)	
[2] France	496 (3.6)	489 - 503	90 (1.7)	
United Arab Emirates	494 (1.8)	490 - 497	122 (0.9)	
[2 †] Belgium (Flemish)	489 (3.8)	481 - 496	77 (2.1)	
[2 †] Chile	484 (2.9)	479 - 490	86 (1.7)	
[2 ≡] Albania	483 (5.4)	472 - 494	96 (3.1)	
[2] Belgium (French)	481 (2.8)	475 - 486	89 (1.7)	
[2] Cyprus	480 (3.1)	473 - 486	90 (2.0)	
Bahrain	474 (4.1)	466 - 482	110 (3.0)	
[2] Montenegro	466 (2.5)	461 - 471	93 (2.5)	
[2] Armenia	465 (4.8)	456 - 475	95 (1.8)	
Qatar	464 (4.1)	456 - 472	108 (1.8)	
[1] Georgia	459 (4.7)	450 - 469	84 (3.3)	
[2] Kazakhstan	456 (4.2)	447 - 464	106 (2.0)	
[1] Bosnia & Herzegovina	446 (4.3)	438 - 455	92 (3.2)	
North Macedonia	435 (4.5)	426 - 444	101 (2.7)	
[3] Saudi Arabia	428 (4.1)	420 - 436	96 (2.2)	
Iran, Islamic Rep. of	427 (5.2)	417 - 437	118 (2.4)	
[2] Brazil	425 (4.8)	416 - 435	114 (2.6)	
Oman	424 (4.3)	416 - 433	106 (2.4)	
Uzbekistan	416 (3.2)	410 - 423	85 (2.4)	
Azerbaijan	410 (4.0)	402 - 418	98 (2.8)	
Jordan	410 (5.2)	400 - 420	109 (2.5)	
[2] Kosovo	400 (3.7)	393 - 407	82 (2.4)	
Morocco	392 (6.1)	380 - 404	126 (3.5)	
[Ψ] Kuwait	389 (5.7)	378 - 400	129 (3.2)	
[Җ] South Africa (5)	- -	-	- -	
Benchmarking Participants				
Dubai, UAE	565 (1.9)	562 - 569	98 (1.2)	
[3] Ontario, Canada	533 (3.5)	526 - 540	79 (1.9)	
[2] Quebec, Canada	504 (3.0)	498 - 510	75 (1.7)	
Sharjah, UAE	499 (4.4)	490 - 507	107 (2.2)	
Abu Dhabi, UAE	443 (2.9)	437 - 449	127 (1.4)	

Percentiles of Performance

| 5th | 25th | | 75th | 95th |

95% Confidence Interval for Average (±2SE)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
See Appendix B.2 in the *TIMSS 2023 International Results* for population coverage notes 1, 2, and 3. See Appendix B.5 in the *TIMSS 2023 International Results* for sampling guidelines and sampling participation notes †, ‡, and ≡.
Ψ Reservations about reliability because the percentage of students with achievement too low for estimation exceeds 15% but does not exceed 25%.
Җ Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.
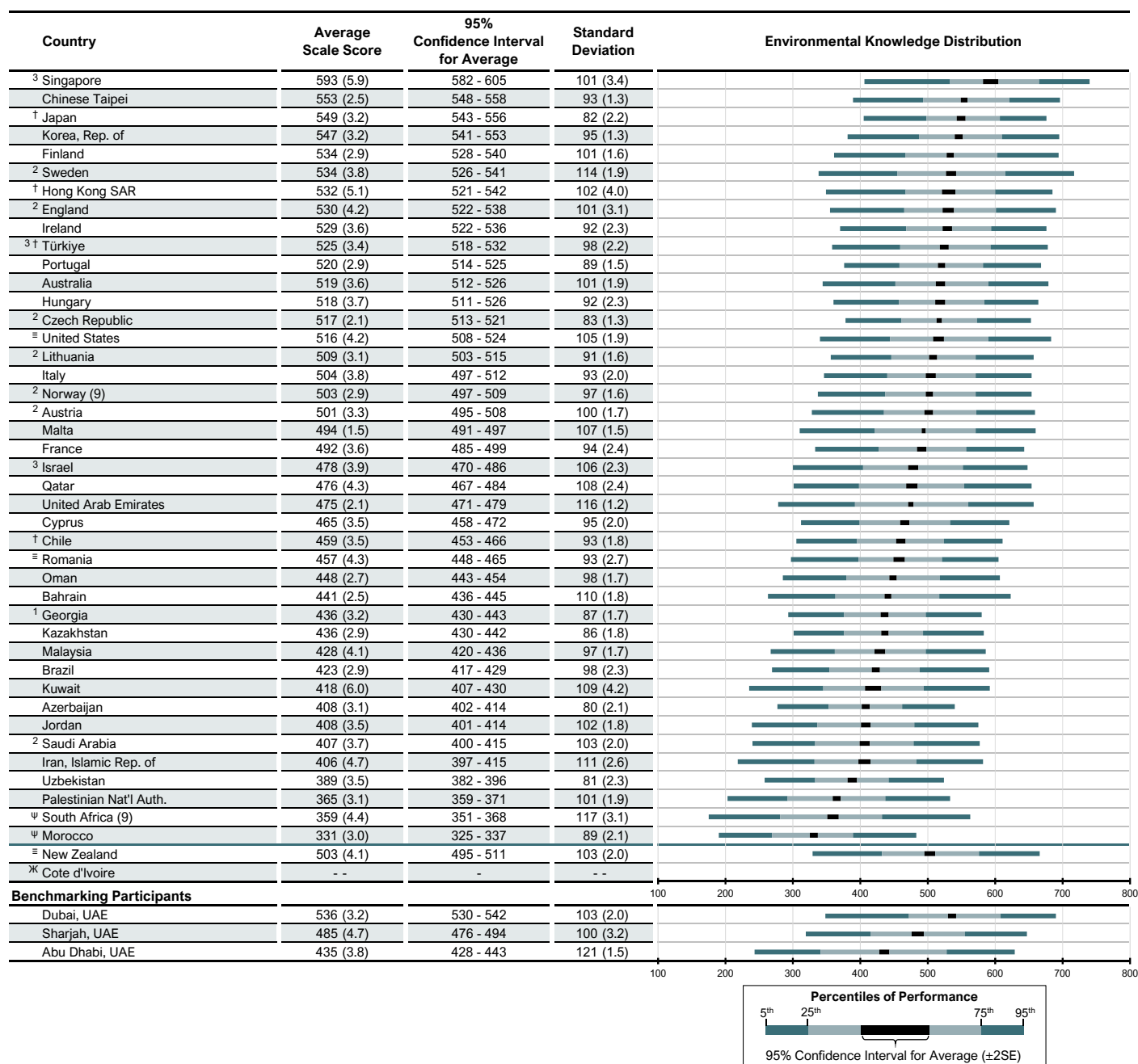A dash (-) indicates comparable data not available because average achievement could not be accurately estimated.

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Exhibit 1.2 presents averages in environmental knowledge at the eighth grade, following a parallel structure to Exhibit 1.1. Average achievement on this scale ranges from 331 scale score points (Morocco) to 593 scale score points (Singapore). Variation in achievement within countries is high at the eighth grade, with standard deviations above 80 for all countries.

Grade 8

Exhibit 1.2: Average Environmental Knowledge and Scale Score Distributions

TIMSS 2023

Country	Average Scale Score	95% Confidence Interval for Average	Standard Deviation	Environmental Knowledge Distribution
[3] Singapore	593 (5.9)	582 - 605	101 (3.4)	
Chinese Taipei	553 (2.5)	548 - 558	93 (1.3)	
[†] Japan	549 (3.2)	543 - 556	82 (2.2)	
Korea, Rep. of	547 (3.2)	541 - 553	95 (1.3)	
Finland	534 (2.9)	528 - 540	101 (1.6)	
[2] Sweden	534 (3.8)	526 - 541	114 (1.9)	
[†] Hong Kong SAR	532 (5.1)	521 - 542	102 (4.0)	
[2] England	530 (4.2)	522 - 538	101 (3.1)	
Ireland	529 (3.6)	522 - 536	92 (2.3)	
[3†] Türkiye	525 (3.4)	518 - 532	98 (2.2)	
Portugal	520 (2.9)	514 - 525	89 (1.5)	
Australia	519 (3.6)	512 - 526	101 (1.9)	
Hungary	518 (3.7)	511 - 526	92 (2.3)	
[2] Czech Republic	517 (2.1)	513 - 521	83 (1.3)	
[≡] United States	516 (4.2)	508 - 524	105 (1.9)	
[2] Lithuania	509 (3.1)	503 - 515	91 (1.6)	
Italy	504 (3.8)	497 - 512	93 (2.0)	
[2] Norway (9)	503 (2.9)	497 - 509	97 (1.6)	
[2] Austria	501 (3.3)	495 - 508	100 (1.7)	
Malta	494 (1.5)	491 - 497	107 (1.5)	
France	492 (3.6)	485 - 499	94 (2.4)	
[3] Israel	478 (3.9)	470 - 486	106 (2.3)	
Qatar	476 (4.3)	467 - 484	108 (2.4)	
United Arab Emirates	475 (2.1)	471 - 479	116 (1.2)	
Cyprus	465 (3.5)	458 - 472	95 (2.0)	
[†] Chile	459 (3.5)	453 - 466	93 (1.8)	
[≡] Romania	457 (4.3)	448 - 465	93 (2.7)	
Oman	448 (2.7)	443 - 454	98 (1.7)	
Bahrain	441 (2.5)	436 - 445	110 (1.8)	
[1] Georgia	436 (3.2)	430 - 443	87 (1.7)	
Kazakhstan	436 (2.9)	430 - 442	86 (1.8)	
Malaysia	428 (4.1)	420 - 436	97 (1.7)	
Brazil	423 (2.9)	417 - 429	98 (2.3)	
Kuwait	418 (6.0)	407 - 430	109 (4.2)	
Azerbaijan	408 (3.1)	402 - 414	80 (2.1)	
Jordan	408 (3.5)	401 - 414	102 (1.8)	
[2] Saudi Arabia	407 (3.7)	400 - 415	103 (2.0)	
Iran, Islamic Rep. of	406 (4.7)	397 - 415	111 (2.6)	
Uzbekistan	389 (3.5)	382 - 396	81 (2.3)	
Palestinian Nat'l Auth.	365 (3.1)	359 - 371	101 (1.9)	
[Ψ] South Africa (9)	359 (4.4)	351 - 368	117 (3.1)	
[Ψ] Morocco	331 (3.0)	325 - 337	89 (1.8)	
[≡] New Zealand	503 (4.1)	495 - 511	103 (2.0)	
[Ж] Cote d'Ivoire	- -	-	- -	
Benchmarking Participants				
Dubai, UAE	536 (3.2)	530 - 542	103 (2.0)	
Sharjah, UAE	485 (4.7)	476 - 494	100 (3.2)	
Abu Dhabi, UAE	435 (3.8)	428 - 443	121 (1.5)	

Percentiles of Performance

5th 25th 75th 95th

95% Confidence Interval for Average (±2SE)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
See Appendix B.7 in the *TIMSS 2023 International Results* for population coverage notes 1, 2, and 3. See Appendix B.10 in the *TIMSS 2023 International Results* for sampling guidelines and sampling participation notes †, ‡, and ≡.
Ψ Reservations about reliability because the percentage of students with achievement too low for estimation exceeds 15% but does not exceed 25%.
Ж Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated.
New Zealand did not satisfy guidelines for minimum school participation rates. Achievement could not be reliably estimated for Cote d'Ivoire.

Reporting the averages on the environmental knowledge scale is just a starting point for understanding how the construct operates within countries. To better understand relative country achievement on this scale, its relation to contextual information and student characteristics is examined in the following sections of the report.

Environmental Knowledge for Girls and Boys

Exhibits 1.3 and 1.4 illustrate the difference in average environmental knowledge between girls and boys across and within countries. Similar to the TIMSS 2023 results for overall science achievement, the environmental knowledge gap between girls and boys varies across countries at both the fourth and eighth grades.

Exhibit 1.3 presents the differences in average environmental knowledge between girls and boys at the fourth grade. Countries are listed by the size of the achievement difference, where negative numbers correspond to a difference favoring girls and positive differences correspond to a difference favoring boys.

Among the 57 countries and five benchmarking participants, 25 countries and two benchmarking participants had no statistically significant difference in average environmental knowledge between girls and boys. However, in 30 countries and three benchmarking participants, boys had higher average environmental knowledge than girls. There were only two countries where girls had higher average achievement than boys. This is quite different from overall science achievement, where 11 of the 57 countries also present in Exhibit 1.3 had statistically significant differences favoring girls, and only 20 countries and one benchmarking participant had statistically significant differences favoring boys.

Exhibit 1.3: Average Environmental Knowledge for Girls and Boys

Country	Girls Percent of Students	Girls Average Scale Score	Boys Percent of Students	Boys Average Scale Score	Difference	Difference (Girls Scored Higher / Boys Scored Higher)
Bahrain	48 (1.1)	486 (6.3)	52 (1.1)	462 (4.8)	-24 (7.5)	
[3] Saudi Arabia	49 (1.0)	438 (5.5)	51 (1.0)	418 (5.6)	-20 (7.7)	
Iran, Islamic Rep. of	49 (1.6)	434 (6.5)	51 (1.6)	420 (7.5)	-15 (9.5)	
Ψ Kuwait	51 (2.1)	394 (7.1)	49 (2.1)	384 (8.3)	-10 (10.4)	
Jordan	52 (2.6)	414 (8.3)	48 (2.6)	406 (6.0)	-8 (10.1)	
Morocco	48 (0.9)	395 (6.2)	52 (0.9)	389 (7.0)	-6 (5.2)	
Finland	49 (0.9)	545 (3.7)	51 (0.9)	540 (3.9)	-5 (3.3)	
North Macedonia	50 (0.7)	437 (5.5)	50 (0.7)	433 (5.0)	-5 (5.6)	
Azerbaijan	46 (0.8)	412 (4.8)	54 (0.8)	408 (3.9)	-4 (3.4)	
[2] ≡ Albania	48 (1.8)	485 (5.9)	52 (1.8)	481 (6.4)	-3 (6.0)	
Oman	50 (0.6)	426 (4.6)	50 (0.6)	423 (4.6)	-3 (3.3)	
[1] Georgia	50 (0.8)	461 (5.3)	50 (0.8)	458 (5.1)	-3 (4.3)	
[2] Lithuania	49 (0.8)	522 (2.9)	51 (0.8)	520 (4.7)	-2 (4.1)	
Germany	49 (0.7)	513 (3.3)	51 (0.7)	513 (3.4)	0 (3.8)	
[1] Bosnia & Herzegovina	50 (1.1)	446 (4.8)	50 (1.1)	446 (8.3)	0 (10.4)	
[2] ≡ Romania	49 (1.0)	520 (5.2)	51 (1.0)	521 (6.6)	1 (5.1)	
Ireland	49 (1.3)	535 (4.8)	51 (1.3)	537 (4.6)	2 (5.1)	
Bulgaria	47 (0.8)	531 (5.6)	53 (0.8)	533 (6.6)	2 (4.5)	
[2] Armenia	49 (1.0)	464 (6.1)	51 (1.0)	467 (4.4)	3 (4.5)	
[2] Norway (5)	50 (0.8)	533 (3.0)	50 (0.8)	537 (3.9)	5 (4.1)	
Latvia	49 (1.2)	501 (4.7)	51 (1.2)	505 (3.8)	5 (5.1)	
[2] † New Zealand	49 (0.9)	515 (3.4)	51 (0.9)	520 (4.6)	5 (5.9)	
[2] Poland	50 (0.9)	554 (3.4)	50 (0.9)	561 (3.2)	7 (4.4)	
United Arab Emirates	49 (0.7)	490 (2.3)	51 (0.7)	497 (2.3)	7 (2.8)	
Slovak Republic	50 (0.9)	505 (5.2)	50 (0.9)	513 (4.4)	7 (3.9)	
[2] England	50 (0.9)	554 (4.3)	50 (0.9)	561 (3.8)	8 (4.7)	
[2] Spain	49 (0.6)	506 (2.9)	51 (0.6)	514 (3.2)	8 (3.0)	
Slovenia	49 (0.8)	516 (3.6)	51 (0.8)	524 (3.4)	8 (3.0)	
[2] Kazakhstan	49 (0.6)	451 (4.2)	51 (0.6)	460 (5.1)	9 (4.1)	
† Denmark	51 (0.8)	531 (3.5)	49 (0.8)	540 (3.9)	9 (4.2)	
[2] † United States	49 (0.5)	530 (3.6)	51 (0.5)	540 (3.5)	10 (2.8)	
[2] Serbia	51 (0.9)	512 (3.6)	49 (0.9)	522 (3.9)	10 (3.8)	
Uzbekistan	49 (0.9)	411 (4.3)	51 (0.9)	421 (4.4)	10 (5.9)	
[2] Montenegro	48 (0.8)	461 (4.1)	52 (0.8)	471 (3.6)	10 (5.9)	
[1] [3] Canada	51 (0.6)	518 (2.8)	49 (0.6)	530 (2.3)	11 (2.8)	
[2] Sweden	51 (0.8)	521 (4.0)	49 (0.8)	532 (4.1)	12 (3.7)	
[2] Belgium (French)	50 (0.9)	475 (4.1)	50 (0.9)	487 (3.4)	12 (4.8)	
[2] † Chile	47 (1.1)	478 (4.7)	53 (1.1)	490 (3.3)	12 (5.7)	
[2] Italy	48 (0.8)	510 (3.2)	52 (0.8)	524 (3.8)	13 (4.5)	
Chinese Taipei	48 (0.5)	559 (2.5)	52 (0.5)	573 (4.2)	14 (5.1)	
[2] Czech Republic	49 (0.7)	512 (3.4)	51 (0.7)	527 (3.9)	14 (3.9)	
Qatar	49 (1.2)	456 (4.7)	51 (1.2)	471 (5.1)	15 (5.5)	
[2] Cyprus	49 (0.8)	472 (3.5)	51 (0.8)	487 (4.0)	15 (4.1)	
[2] Kosovo	48 (0.9)	392 (5.4)	52 (0.9)	407 (4.1)	15 (5.9)	
[3] Singapore	49 (0.5)	569 (4.2)	51 (0.5)	585 (4.4)	16 (3.2)	
† Netherlands	50 (0.8)	510 (3.8)	50 (0.8)	526 (4.6)	16 (7.0)	
[2] Brazil	50 (0.6)	417 (5.2)	50 (0.6)	434 (5.0)	16 (3.3)	
Hungary	50 (0.9)	525 (4.8)	50 (0.9)	542 (3.8)	17 (4.2)	
Japan	51 (0.5)	533 (3.5)	49 (0.5)	550 (4.1)	17 (3.5)	
Macao SAR	48 (0.7)	519 (2.2)	52 (0.7)	537 (2.4)	17 (3.4)	
Korea, Rep. of	50 (0.5)	566 (4.4)	50 (0.5)	584 (5.2)	18 (6.4)	
[2] France	50 (0.8)	487 (3.8)	50 (0.8)	505 (4.4)	18 (4.0)	
[2] † Belgium (Flemish)	49 (0.7)	479 (4.5)	51 (0.7)	498 (4.0)	19 (3.7)	
Australia	52 (1.0)	541 (4.0)	48 (1.0)	561 (3.6)	20 (4.6)	
Portugal	50 (0.7)	508 (4.4)	50 (0.7)	529 (3.6)	21 (3.7)	
[3] Türkiye (5)	48 (1.2)	541 (4.7)	52 (1.2)	563 (4.6)	22 (5.1)	
† Hong Kong SAR	49 (1.2)	530 (4.7)	51 (1.2)	556 (4.2)	27 (5.0)	
International Average	**49 (0.1)**	**492 (0.6)**	**51 (0.1)**	**499 (0.6)**	**7 (0.7)**	
Ӝ South Africa (5)	- -	- -	- -	- -	- -	

Benchmarking Participants

Country	Girls Percent of Students	Girls Average Scale Score	Boys Percent of Students	Boys Average Scale Score	Difference	Difference
Abu Dhabi, UAE	50 (0.4)	442 (3.0)	50 (0.4)	443 (3.5)	1 (2.8)	
Sharjah, UAE	48 (0.7)	495 (4.8)	52 (0.7)	502 (4.6)	7 (3.4)	
Dubai, UAE	48 (2.2)	560 (3.0)	52 (2.2)	571 (2.1)	11 (3.5)	
[2] Quebec, Canada	50 (0.8)	498 (3.6)	50 (0.8)	510 (3.3)	11 (3.2)	
[3] Ontario, Canada	52 (1.0)	527 (4.5)	48 (1.0)	539 (3.9)	13 (4.4)	

Students' gender information was obtained from school tracking data.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
See Appendix B.2 in the TIMSS 2023 International Results for population coverage notes 1, 2, and 3. See Appendix B.5 in the TIMSS 2023 International Results for sampling guidelines and sampling participation notes †, ‡, and ≡.
Ψ Reservations about reliability because the percentage of students with achievement too low for estimation exceeds 15% but does not exceed 25%.
Ӝ Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated.

■ Difference statistically significant ($p < 0.05$)
■ Difference not statistically significant

Exhibit 1.4 presents the differences in average environmental knowledge between girls and boys at the eighth grade. Among the 42 countries and three benchmarking participants, girls had significantly higher achievement in environmental knowledge than boys in seven countries, while boys had higher achievement than girls in 16 countries and one benchmarking participant.[e] In 19 countries and two benchmarking participants, there was no statistically significant difference between the average achievement in environmental knowledge of eighth-grade girls and boys. There are fewer countries at the eighth grade in which girls had higher achievement than boys for environmental knowledge compared to the gender difference in overall science achievement (seven out of 42 countries, compared to 11 out of 42 countries).

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e New Zealand, which did not satisfy guidelines for minimum school participation rates at the eighth grade, also had a statistically significant difference favoring boys.

Exhibit 1.4: Average Environmental Knowledge for Girls and Boys

Country	Girls		Boys		Difference	Difference	
	Percent of Students	Average Scale Score	Percent of Students	Average Scale Score		Girls Scored Higher	Boys Scored Higher
[2] Saudi Arabia	48 (0.5)	424 (5.0)	52 (0.5)	392 (5.4)	-32 (7.3)		
Palestinian Nat'l Auth.	49 (2.7)	381 (4.0)	51 (2.7)	350 (4.6)	-31 (6.1)		
Bahrain	49 (0.8)	455 (3.2)	51 (0.8)	427 (4.1)	-27 (5.5)		
Oman	48 (0.8)	461 (3.6)	52 (0.8)	437 (3.4)	-24 (4.4)		
Kuwait	49 (1.4)	429 (5.7)	51 (1.4)	408 (9.4)	-21 (9.9)		
Jordan	48 (2.1)	416 (4.6)	52 (2.1)	400 (5.5)	-17 (7.5)		
Ψ South Africa (9)	51 (0.8)	366 (5.1)	49 (0.8)	353 (4.5)	-13 (3.7)		
Qatar	48 (2.1)	480 (5.2)	52 (2.1)	472 (5.7)	-9 (6.8)		
Cyprus	49 (0.7)	467 (4.0)	51 (0.7)	463 (4.4)	-5 (4.4)		
[3] Israel	50 (1.0)	480 (4.4)	50 (1.0)	476 (4.5)	-3 (4.4)		
Finland	49 (0.9)	536 (3.7)	51 (0.9)	533 (3.2)	-3 (3.8)		
Chinese Taipei	48 (0.8)	554 (3.2)	52 (0.8)	552 (3.7)	-2 (4.7)		
Malaysia	52 (1.1)	428 (4.5)	48 (1.1)	427 (4.4)	-1 (3.5)		
Iran, Islamic Rep. of	49 (1.4)	407 (6.4)	51 (1.4)	406 (6.3)	-1 (8.6)		
[2] Lithuania	50 (0.8)	509 (3.1)	50 (0.8)	508 (4.0)	-1 (3.7)		
[2] Norway (9)	47 (0.7)	503 (3.2)	53 (0.7)	503 (3.5)	0 (3.5)		
[2] Sweden	49 (0.7)	534 (4.3)	51 (0.7)	533 (4.4)	0 (4.2)		
United Arab Emirates	49 (0.4)	475 (2.1)	51 (0.4)	475 (2.7)	0 (2.5)		
≡ Romania	48 (1.1)	456 (5.0)	52 (1.1)	457 (5.1)	1 (5.4)		
[1] Georgia	49 (0.8)	435 (3.8)	51 (0.8)	437 (4.2)	2 (4.9)		
[3] † Türkiye	51 (1.7)	524 (3.9)	49 (1.7)	526 (4.4)	2 (4.7)		
Uzbekistan	50 (0.9)	387 (4.4)	50 (0.9)	391 (4.6)	4 (5.6)		
Azerbaijan	48 (0.8)	406 (4.2)	52 (0.8)	410 (3.1)	4 (4.0)		
Kazakhstan	47 (0.8)	434 (3.1)	53 (0.8)	439 (3.5)	5 (3.2)		
[3] Singapore	48 (2.3)	590 (6.8)	52 (2.3)	596 (8.1)	6 (9.2)		
Malta	50 (0.7)	491 (2.3)	50 (0.7)	498 (2.5)	7 (3.7)		
Ψ Morocco	50 (0.6)	325 (3.7)	50 (0.6)	336 (3.2)	11 (3.5)		
[2] Austria	49 (1.0)	495 (4.4)	51 (1.0)	507 (3.9)	12 (3.9)		
Portugal	49 (1.0)	513 (3.6)	51 (1.0)	526 (3.7)	13 (4.4)		
France	50 (0.7)	485 (4.3)	50 (0.7)	498 (4.9)	14 (5.7)		
† Hong Kong SAR	49 (1.6)	524 (6.4)	51 (1.6)	538 (5.8)	14 (6.3)		
[2] England	50 (2.0)	523 (5.2)	50 (2.0)	537 (5.8)	14 (7.2)		
Brazil	50 (0.5)	416 (2.9)	50 (0.5)	430 (3.5)	14 (2.5)		
Korea, Rep. of	49 (1.0)	539 (3.0)	51 (1.0)	554 (4.6)	15 (4.4)		
Hungary	50 (1.0)	511 (3.8)	50 (1.0)	526 (4.8)	16 (4.6)		
Ireland	47 (1.6)	519 (4.3)	53 (1.6)	537 (4.3)	18 (4.7)		
† Japan	49 (1.3)	540 (4.3)	51 (1.3)	558 (3.3)	18 (4.3)		
Australia	47 (1.7)	509 (4.8)	53 (1.7)	528 (4.0)	19 (5.2)		
[2] Czech Republic	48 (0.7)	507 (2.3)	52 (0.7)	526 (2.4)	19 (2.3)		
≡ United States	49 (0.7)	506 (4.8)	51 (0.7)	526 (4.5)	19 (4.0)		
Italy	49 (0.7)	493 (4.2)	51 (0.7)	514 (5.1)	21 (5.4)		
† Chile	49 (1.1)	447 (4.0)	51 (1.1)	472 (4.0)	25 (3.8)		
International Average	**49 (0.2)**	**473 (0.7)**	**51 (0.2)**	**476 (0.7)**	**2 (0.8)**		
≡ New Zealand	46 (1.7)	492 (5.2)	54 (1.7)	512 (6.2)	20 (8.1)		
Ж Cote d'Ivoire	- -	- -	- -	- -	- -		
Benchmarking Participants							
Abu Dhabi, UAE	50 (0.5)	436 (4.2)	50 (0.5)	434 (4.7)	-2 (4.7)		
Sharjah, UAE	50 (0.8)	486 (5.0)	50 (0.8)	485 (5.6)	-1 (5.2)		
Dubai, UAE	48 (0.7)	532 (3.3)	52 (0.7)	541 (4.3)	9 (4.4)		

80 40 0 40 80

80 40 0 40 80

■ Difference statistically significant (*p* < 0.05)

▪ Difference not statistically significant

Students' gender information was obtained from school tracking data.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
See Appendix B.7 in the *TIMSS 2023 International Results* for population coverage notes 1, 2, and 3. See Appendix B.10 in the *TIMSS 2023 International Results* for sampling guidelines and sampling participation notes †, ‡, and ≡.
Ψ Reservations about reliability because the percentage of students with achievement too low for estimation exceeds 15% but does not exceed 25%.
Ж Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.
New Zealand did not satisfy guidelines for minimum school participation rates. Achievement could not be reliably estimated for Cote d'Ivoire.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated.

In summary, the differences in average environmental knowledge between girls and boys at the fourth and eighth grades showed a different pattern to that observed in overall science achievement. Across countries and benchmarking participants that are present in both Exhibits 1.3 and 1.4 and in the overall science exhibit in the *TIMSS 2023 International Results*, there is a range of gender differences for environmental knowledge, with many countries not showing significant differences between girls and boys. However, at both grades, fewer countries had statistically significant achievement differences favoring girls in environmental knowledge

compared to overall science achievement. This shift is more pronounced at the fourth grade than at the eighth grade. Researchers may build on these findings to gain further insight into the patterns of gender differences in achievement for environmental knowledge compared to overall science.

Contexts and Students' Environmental Knowledge

Environmental Knowledge and Home Resources

Resources available at home have a strong relationship with students' environmental knowledge across and within countries at both the fourth and eighth grades. Measures of home resources are also among the strongest predictors of overall science achievement in the *TIMSS 2023 International Results*.[18]

Exhibit 1.5 shows the relationship between fourth-grade students' average achievement in environmental knowledge and classification regions of the TIMSS 2023 *Home Socioeconomic Status* scale, derived from parent/guardian responses to items in the Home Questionnaire.[f] On average across countries, the 30 percent of students with "higher" home socioeconomic status (SES) had the highest average achievement in environmental knowledge (537 scale score points), followed by the 48 percent of students with "middle" home SES (490 scale score points); the 21 percent of students with "lower" home SES had the lowest average achievement in environmental knowledge (441 scale score points).

The international average Pearson correlation[g] between scores on the Home SES scale and achievement in environmental knowledge is 0.35, indicating a moderate positive relationship across countries. All within-country correlations are also positive, with most countries and benchmarking participants having estimated correlations between 0.3 and 0.5.

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f   The Home Questionnaire was only administered for Grade 4 students in TIMSS 2023. Further details about all TIMSS 2023 context scales and questionnaires are available at timss2023.org.

g   The Pearson correlation coefficient ranges from –1 to 1 and measures the strength and direction of a linear relationship between two variables. A positive value indicates that higher scores on one variable tend to be associated with higher scores on the other. Values closer to –1 or 1 indicate stronger relationships, while values near 0 suggest little to no linear relationship.

Exhibit 1.5: Students' Environmental Knowledge and Home Socioeconomic Status (Parents' Reports)

Country		Higher Socioeconomic Status		Middle Socioeconomic Status		Lower Socioeconomic Status		Correlation with Achievement
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	
Albania	s	12 (1.7)	513 (12.8)	39 (2.9)	486 (8.6)	48 (3.4)	468 (7.8)	0.14 (0.06)
Armenia		18 (0.9)	491 (7.8)	58 (1.1)	464 (4.7)	24 (1.1)	449 (7.3)	0.16 (0.03)
Azerbaijan		7 (0.6)	452 (11.6)	48 (1.3)	422 (3.6)	45 (1.4)	390 (5.6)	0.23 (0.03)
Bahrain		20 (1.0)	524 (7.7)	62 (0.9)	473 (4.5)	19 (0.8)	427 (7.4)	0.31 (0.03)
Belgium (Flemish)		41 (1.4)	527 (4.8)	47 (1.3)	479 (3.7)	13 (0.8)	433 (6.9)	0.43 (0.03)
Belgium (French)		40 (1.1)	528 (4.0)	46 (0.9)	465 (3.0)	14 (0.7)	424 (5.4)	0.45 (0.02)
Bosnia & Herzegovina	s	20 (1.7)	504 (8.0)	48 (1.8)	463 (5.6)	33 (2.5)	408 (10.4)	0.40 (0.04)
Brazil		7 (1.3)	546 (14.9)	36 (1.2)	465 (5.4)	57 (1.4)	391 (4.2)	0.46 (0.03)
Bulgaria		34 (1.1)	597 (4.3)	39 (1.4)	551 (4.2)	27 (1.6)	429 (13.7)	0.59 (0.03)
Chile	s	10 (0.8)	545 (6.6)	57 (1.4)	493 (3.5)	33 (1.6)	461 (4.5)	0.31 (0.03)
Chinese Taipei		37 (1.3)	604 (2.8)	50 (1.0)	556 (2.9)	14 (0.6)	507 (8.0)	0.40 (0.02)
Cyprus		44 (1.0)	519 (2.9)	48 (0.8)	460 (4.2)	8 (0.5)	409 (7.9)	0.44 (0.02)
Czech Republic	r	47 (1.1)	553 (4.4)	48 (1.0)	509 (3.7)	5 (0.4)	462 (7.2)	0.37 (0.03)
Denmark		49 (1.5)	569 (3.4)	44 (1.2)	517 (3.4)	7 (0.7)	469 (6.6)	0.42 (0.03)
Finland		51 (1.5)	574 (3.0)	44 (1.3)	526 (3.4)	6 (0.5)	477 (9.4)	0.37 (0.02)
France		40 (1.8)	545 (2.9)	49 (1.5)	481 (3.2)	11 (0.9)	429 (7.9)	0.47 (0.02)
Georgia		36 (1.2)	476 (4.8)	52 (1.1)	453 (4.8)	12 (0.8)	444 (13.2)	0.14 (0.05)
Germany	s r	42 (1.5)	574 (3.1)	49 (1.3)	513 (3.7)	9 (0.7)	430 (9.5)	0.50 (0.02)
Hong Kong SAR	r	39 (1.6)	586 (4.4)	46 (1.3)	525 (4.8)	15 (1.0)	483 (7.1)	0.41 (0.02)
Hungary	s	47 (1.9)	584 (4.3)	40 (1.7)	536 (5.2)	13 (1.7)	449 (13.0)	0.51 (0.04)
Iran, Islamic Rep. of		9 (0.8)	522 (9.1)	40 (1.2)	459 (4.8)	52 (1.6)	389 (5.8)	0.39 (0.02)
Ireland		50 (1.7)	567 (4.2)	42 (1.5)	522 (4.7)	7 (0.8)	461 (8.9)	0.37 (0.03)
Italy		26 (1.4)	558 (2.8)	51 (1.2)	515 (3.6)	23 (1.1)	484 (4.3)	0.36 (0.02)
Japan		25 (1.4)	582 (4.3)	62 (1.2)	535 (2.7)	13 (1.0)	496 (4.6)	0.37 (0.02)
Jordan		6 (0.7)	466 (9.7)	49 (1.3)	432 (5.4)	45 (1.5)	386 (7.2)	0.25 (0.03)
Kazakhstan		10 (0.8)	511 (11.7)	66 (1.2)	460 (4.1)	23 (1.3)	422 (5.7)	0.25 (0.03)
Korea, Rep. of		65 (1.5)	597 (3.4)	32 (1.3)	543 (5.0)	3 (0.4)	490 (13.7)	0.36 (0.02)
Kosovo	s	16 (1.2)	451 (7.3)	51 (1.3)	413 (3.7)	33 (1.6)	382 (7.4)	0.28 (0.03)
Kuwait		13 (1.0)	448 (9.0)	70 (1.0)	394 (5.8)	17 (1.0)	349 (8.0)	0.23 (0.03)
Latvia	s	39 (1.5)	539 (5.3)	49 (1.4)	501 (3.9)	12 (1.2)	453 (11.6)	0.33 (0.04)
Lithuania	s	42 (1.4)	558 (3.7)	50 (1.2)	515 (3.9)	8 (0.8)	441 (10.0)	0.40 (0.03)
Macao SAR		30 (0.6)	562 (3.7)	53 (0.6)	521 (2.8)	17 (0.5)	494 (4.3)	0.31 (0.02)
Montenegro	r	31 (1.1)	501 (4.8)	53 (0.9)	461 (3.1)	16 (0.8)	425 (5.1)	0.29 (0.02)
Morocco		3 (0.4)	448 (13.6)	19 (0.9)	423 (8.7)	78 (1.1)	385 (6.7)	0.16 (0.03)
North Macedonia		18 (1.2)	496 (6.4)	47 (1.2)	442 (4.7)	35 (1.5)	401 (7.0)	0.36 (0.03)
Norway (5)	s	54 (1.7)	576 (3.4)	42 (1.6)	525 (5.6)	4 (0.5)	454 (13.2)	0.40 (0.03)
Oman		10 (0.5)	486 (7.6)	59 (0.7)	436 (4.8)	31 (0.8)	387 (4.5)	0.31 (0.02)
Poland		47 (1.3)	585 (2.7)	46 (1.1)	542 (3.1)	7 (0.7)	501 (8.6)	0.36 (0.02)
Portugal		32 (1.6)	560 (4.4)	46 (1.1)	511 (4.2)	21 (1.2)	477 (4.9)	0.35 (0.02)
Qatar	s	22 (1.3)	516 (7.5)	65 (1.3)	465 (5.2)	13 (1.0)	417 (8.5)	0.29 (0.03)
Romania	s	31 (2.7)	571 (6.9)	44 (2.4)	532 (5.8)	25 (2.7)	479 (11.4)	0.41 (0.04)
Saudi Arabia	r	8 (0.5)	466 (7.9)	61 (1.1)	440 (4.5)	32 (1.2)	411 (5.7)	0.19 (0.03)
Serbia		28 (1.2)	558 (3.4)	52 (1.3)	516 (3.5)	21 (1.4)	467 (6.2)	0.39 (0.03)
Singapore	r	54 (0.8)	624 (3.1)	43 (0.7)	557 (4.5)	4 (0.3)	485 (11.1)	0.43 (0.02)
Slovak Republic		33 (1.3)	555 (4.0)	48 (1.2)	514 (4.3)	18 (1.2)	415 (11.2)	0.52 (0.03)
Slovenia		45 (1.2)	555 (3.8)	47 (1.1)	509 (3.1)	8 (0.5)	444 (7.9)	0.40 (0.02)
Spain		34 (1.1)	546 (3.3)	47 (0.8)	507 (2.5)	19 (1.0)	469 (4.2)	0.38 (0.02)
Sweden	r	55 (1.8)	565 (3.2)	39 (1.4)	502 (4.3)	6 (0.6)	449 (6.5)	0.45 (0.02)
Türkiye (5)		25 (1.6)	611 (5.7)	48 (1.3)	551 (4.1)	26 (1.8)	507 (6.2)	0.40 (0.03)
Uzbekistan		6 (0.6)	462 (8.1)	53 (1.1)	422 (4.1)	41 (1.2)	403 (3.5)	0.20 (0.02)
International Average		**30 (0.2)**	**537 (0.9)**	**48 (0.2)**	**490 (0.6)**	**21 (0.2)**	**441 (1.2)**	**0.35 (0.00)**
Canada	x	55 (1.2)	558 (3.0)	41 (1.1)	518 (4.4)	4 (0.4)	470 (7.8)	0.33 (0.03)
United Arab Emirates	x	25 (0.5)	564 (2.4)	65 (0.5)	504 (2.2)	11 (0.3)	435 (4.6)	0.35 (0.01)
New Zealand	y	- -	- -	- -	- -	- -	- -	- -
Australia		- -	- -	- -	- -	- -	- -	- -
England		- -	- -	- -	- -	- -	- -	- -
Netherlands		- -	- -	- -	- -	- -	- -	- -
South Africa (5)		- -	- -	- -	- -	- -	- -	- -
United States		- -	- -	- -	- -	- -	- -	- -

Benchmarking Participants

Country		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Correlation with Achievement
Sharjah, UAE	s	20 (0.9)	558 (5.4)	70 (1.0)	512 (4.6)	10 (0.7)	461 (9.0)	0.28 (0.02)
Abu Dhabi, UAE	x	25 (0.9)	527 (5.1)	64 (1.0)	466 (4.5)	10 (0.6)	377 (7.2)	0.36 (0.02)
Dubai, UAE	x	36 (0.9)	612 (3.0)	59 (1.0)	565 (3.0)	5 (0.4)	483 (11.7)	0.34 (0.02)
Quebec, Canada	x	55 (1.8)	532 (3.3)	41 (1.6)	493 (5.8)	4 (0.6)	439 (12.3)	0.34 (0.04)
Ontario, Canada	y	- -	- -	- -	- -	- -	- -	- -

See the *TIMSS 2023 International Results* for information about the *Home Socioeconomic Status* scale.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
An "x" indicates data are available for at least 40% but less than 50% of the students—interpret with caution.
A "y" indicates data are available for less than 40% of the students.
A dash (-) indicates comparable data not available.

Exhibit 1.6 shows the relationship between eighth-grade students' average achievement in environmental knowledge and classification regions of the TIMSS 2023 *Home Educational Resources* scale, derived from student responses to items in the Student Questionnaire. Overall, more home resources are associated with higher student achievement. Internationally, the 27 percent of eighth-grade students with "many" resources show the highest average environmental knowledge (522 scale score points), and the 27 percent of students with "few" resources had the lowest (426 scale score points). Average achievement in environmental knowledge scores for the 46 percent of students with "some" resources were in between the two (475 scale score points).

Grade 8

Exhibit 1.6: Students' Environmental Knowledge and Home Educational Resources

Country	Many Resources		Some Resources		Few Resources		Correlation with Achievement
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	
Australia	42 (1.2)	565 (3.3)	45 (0.9)	506 (3.9)	13 (0.8)	437 (7.0)	0.44 (0.02)
Austria	36 (1.1)	550 (3.0)	44 (0.9)	498 (3.3)	19 (1.0)	418 (6.8)	0.47 (0.02)
Azerbaijan	12 (0.6)	447 (5.6)	50 (1.0)	415 (3.4)	38 (1.2)	388 (3.9)	0.24 (0.02)
Bahrain	20 (0.7)	491 (5.0)	48 (0.8)	446 (3.0)	33 (0.8)	410 (3.7)	0.26 (0.02)
Brazil	8 (0.8)	514 (12.7)	34 (0.9)	449 (3.3)	58 (1.0)	398 (2.4)	0.38 (0.03)
Chile	16 (0.8)	516 (4.9)	51 (0.9)	469 (3.6)	34 (1.0)	423 (4.9)	0.33 (0.02)
Chinese Taipei	36 (1.0)	594 (3.4)	43 (0.8)	548 (2.8)	21 (0.8)	494 (3.8)	0.40 (0.02)
Cyprus	42 (1.0)	503 (4.5)	43 (0.9)	453 (4.0)	15 (0.7)	404 (4.4)	0.39 (0.02)
Czech Republic	32 (1.0)	558 (2.4)	53 (0.8)	510 (1.9)	15 (0.8)	456 (4.6)	0.40 (0.02)
England	36 (1.6)	581 (5.5)	44 (1.2)	522 (4.6)	20 (1.1)	462 (6.1)	0.45 (0.03)
Finland	42 (1.2)	577 (3.2)	46 (0.9)	520 (2.8)	12 (0.6)	458 (5.7)	0.40 (0.02)
France	32 (1.3)	547 (3.4)	46 (1.0)	484 (3.7)	22 (1.1)	427 (4.8)	0.48 (0.02)
Georgia	36 (1.1)	462 (3.7)	47 (0.9)	431 (3.6)	17 (0.8)	403 (8.5)	0.25 (0.03)
Hong Kong SAR	26 (1.0)	575 (9.9)	42 (0.8)	529 (4.9)	32 (0.9)	506 (6.6)	0.26 (0.04)
Hungary	42 (1.4)	565 (3.1)	41 (1.2)	508 (3.0)	17 (1.4)	428 (6.2)	0.53 (0.02)
Iran, Islamic Rep. of	16 (0.9)	478 (5.3)	39 (0.9)	421 (4.1)	44 (1.4)	371 (5.7)	0.36 (0.02)
Ireland	39 (1.3)	570 (3.0)	45 (1.1)	520 (4.4)	16 (0.8)	465 (6.0)	0.42 (0.02)
Israel s	29 (1.3)	539 (7.2)	60 (1.2)	477 (4.1)	11 (0.7)	404 (6.9)	0.43 (0.02)
Italy	33 (1.5)	549 (3.6)	42 (0.9)	502 (4.2)	25 (1.4)	448 (4.9)	0.42 (0.02)
Japan	43 (1.1)	572 (4.2)	46 (0.9)	544 (3.6)	12 (0.7)	497 (5.1)	0.28 (0.02)
Jordan	11 (0.6)	440 (6.7)	49 (0.8)	419 (4.0)	39 (1.0)	387 (4.1)	0.20 (0.02)
Kazakhstan	13 (0.8)	472 (6.5)	58 (0.8)	439 (3.0)	30 (1.0)	417 (3.1)	0.21 (0.02)
Korea, Rep. of	56 (1.2)	572 (3.0)	34 (0.9)	528 (4.4)	10 (0.7)	477 (6.2)	0.34 (0.02)
Kuwait	13 (1.0)	459 (11.2)	50 (1.0)	432 (5.9)	37 (1.2)	393 (6.3)	0.20 (0.03)
Lithuania	31 (1.3)	553 (4.1)	53 (0.9)	499 (2.8)	16 (0.9)	450 (3.9)	0.40 (0.02)
Malaysia	13 (0.7)	490 (4.8)	55 (0.7)	433 (3.9)	32 (1.0)	394 (4.4)	0.34 (0.01)
Malta	32 (0.7)	545 (3.3)	47 (0.6)	492 (2.5)	21 (0.6)	430 (4.7)	0.40 (0.02)
Morocco	5 (0.4)	375 (7.6)	30 (0.8)	351 (4.8)	65 (1.0)	319 (3.5)	0.21 (0.03)
Norway (9)	47 (1.1)	541 (3.1)	42 (0.8)	486 (3.1)	12 (0.6)	425 (6.0)	0.40 (0.02)
Oman	16 (0.6)	489 (4.3)	48 (0.6)	458 (3.3)	36 (0.7)	425 (2.9)	0.23 (0.02)
Palestinian Nat'l Auth.	12 (0.5)	393 (5.3)	48 (0.7)	379 (3.3)	41 (0.8)	343 (3.6)	0.19 (0.01)
Portugal	26 (1.2)	565 (2.8)	42 (0.9)	526 (3.0)	32 (1.3)	476 (3.5)	0.38 (0.02)
Qatar	24 (1.2)	523 (6.4)	51 (1.0)	483 (4.3)	25 (1.1)	428 (5.1)	0.31 (0.03)
Romania	28 (1.7)	501 (5.6)	48 (1.2)	461 (3.8)	24 (1.4)	407 (7.2)	0.37 (0.03)
Saudi Arabia	12 (0.6)	441 (7.3)	48 (0.8)	424 (4.4)	40 (0.9)	382 (3.3)	0.23 (0.02)
Singapore	33 (1.3)	637 (5.5)	47 (0.9)	590 (5.2)	20 (1.2)	531 (8.8)	0.38 (0.02)
South Africa (9)	5 (0.5)	469 (16.4)	39 (1.0)	379 (4.7)	56 (1.2)	335 (4.2)	0.25 (0.02)
Sweden	42 (1.5)	592 (3.8)	43 (1.1)	511 (3.6)	15 (0.9)	449 (5.7)	0.47 (0.01)
Türkiye	27 (1.4)	577 (4.5)	42 (1.0)	519 (3.2)	31 (1.4)	487 (5.7)	0.36 (0.02)
United Arab Emirates	24 (0.4)	533 (2.9)	50 (0.5)	479 (2.2)	25 (0.5)	423 (2.5)	0.34 (0.01)
United States	31 (1.4)	575 (4.4)	45 (0.9)	508 (3.8)	23 (1.0)	460 (4.7)	0.41 (0.02)
Uzbekistan	12 (0.8)	427 (5.7)	54 (1.0)	395 (3.7)	34 (1.3)	367 (3.7)	0.26 (0.02)
International Average	**27 (0.2)**	**522 (0.9)**	**46 (0.1)**	**475 (0.6)**	**27 (0.2)**	**426 (0.8)**	**0.34 (0.00)**
Cote d'Ivoire	- -	- -	- -	- -	- -	- -	- -
Benchmarking Participants							
Abu Dhabi, UAE	22 (0.6)	499 (5.0)	50 (0.7)	444 (3.9)	28 (0.7)	385 (4.2)	0.34 (0.01)
Dubai, UAE	33 (0.8)	580 (2.6)	48 (0.9)	533 (3.5)	19 (1.2)	473 (4.8)	0.36 (0.01)
Sharjah, UAE	22 (1.2)	526 (9.7)	53 (1.1)	488 (3.7)	25 (0.8)	450 (4.5)	0.25 (0.02)

See the *TIMSS 2023 International Results* for information about the *Home Educational Resources* scale.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A dash (-) indicates comparable data not available because average achievement could not be reliably estimated.

Across countries, there is a moderate positive relationship between achievement in environmental knowledge and scores on the Home Educational Resources scale, as indicated by the international average Pearson correlation of 0.34. The correlations are moderate and positive in all countries and benchmarking participants, with the majority having estimated correlations between 0.3 and 0.5.

The results presented in Exhibits 1.5 and 1.6 provide a valuable starting point for future research on the relationship between students' environmental knowledge and home resources. Overall, there is evidence for a relationship between home resources and achievement in environmental knowledge at both fourth and eighth grades. It is possible that the relationships observed here are a more specific manifestation of the well-known relationship between resources and general academic achievement. Households with more resources may have greater capacity or inclination to focus on environmental issues and promote children's environmental knowledge, along with broadly fostering educational achievement.

Environmental Knowledge and Geographic Location

Exhibits 1.7 and 1.8 show the relationship between fourth- and eighth-grade students' environmental knowledge and the geographic location of their schools as reported by school principals. It is important to keep in mind the differences in countries' distribution across the different categories when interpreting these results. Some countries and benchmarking participants have very few or no students in some types of locations, whereas others have more balanced distributions. Although the international average is presented in the exhibits, these findings are more meaningful within countries rather than across countries.

Exhibit 1.7 presents the results for fourth grade. School geographic location does not appear to have a clear-cut relationship with environmental knowledge that is consistent across countries and benchmarking participants. Some countries show progressively higher achievement in more populated areas, although the achievement differences between groups of students are often very small—for example, in Japan. Other countries, such as Ireland, have a different pattern, with their highest-performing students in rural areas (560 scale score points for remote rural schools versus 517 scale score points for schools in urban areas). Other countries show very small differences with no clear pattern across different geographic areas; Slovenia, for example, has average achievement ranging between 515 and 525 scale score points with no clear pattern by geographic location.

TIMSS INSIGHTS Series

Exhibit 1.7: Students' Environmental Knowledge and School Geographic Location (Principals' Reports)

Country	Urban – Densely Populated		Suburban – On Fringe or Outskirts of Urban Area		Medium Size City or Large Town		Small Town or Village		Remote Rural	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Albania	41 (4.5)	480 (10.6)	12 (4.1)	472 (13.3)	18 (3.8)	487 (14.7)	22 (4.5)	490 (12.9)	7 (3.1)	484 (20.8)
Armenia	27 (3.3)	469 (7.1)	20 (3.0)	463 (6.7)	18 (3.4)	458 (10.9)	28 (2.7)	460 (6.4)	6 (1.6)	498 (17.8)
Australia	32 (3.7)	559 (6.2)	40 (3.7)	554 (5.0)	16 (2.7)	552 (7.3)	8 (1.8)	526 (13.2)	4 (1.9)	525 (15.8)
Azerbaijan	29 (2.9)	430 (5.6)	18 (2.7)	412 (6.3)	18 (3.0)	419 (9.2)	23 (2.6)	386 (8.6)	12 (2.1)	397 (14.3)
Bahrain	30 (2.9)	459 (6.2)	16 (1.9)	497 (9.8)	25 (2.7)	482 (10.3)	29 (2.8)	469 (9.1)	0 ~	~ ~
Belgium (Flemish)	16 (2.5)	454 (10.8)	22 (3.6)	495 (8.4)	6 (2.1)	496 (9.0)	43 (4.4)	497 (5.0)	14 (2.8)	505 (5.2)
Belgium (French)	33 (3.4)	456 (5.4)	12 (2.4)	491 (8.3)	11 (2.8)	472 (8.0)	25 (3.0)	500 (4.8)	17 (2.8)	499 (9.4)
Bosnia & Herzegovina r	33 (5.4)	475 (6.7)	20 (4.6)	450 (7.5)	8 (3.3)	463 (10.1)	31 (5.1)	424 (8.0)	8 (5.1)	424 (14.4)
Brazil	43 (3.7)	439 (9.3)	16 (2.4)	396 (14.2)	11 (2.1)	451 (16.3)	21 (3.1)	424 (11.3)	8 (1.5)	388 (7.4)
Bulgaria	39 (2.8)	569 (8.3)	0 ~	~ ~	27 (3.2)	541 (10.8)	34 (2.1)	483 (13.0)	0 ~	~ ~
Canada	31 (2.4)	526 (4.1)	24 (2.2)	539 (3.8)	25 (2.2)	520 (3.2)	17 (2.0)	515 (3.9)	2 ~	~ ~
Chile r	56 (4.6)	491 (4.8)	14 (3.4)	479 (10.4)	15 (3.5)	492 (7.7)	10 (2.9)	468 (8.9)	5 (1.8)	474 (7.8)
Chinese Taipei	39 (2.5)	581 (3.8)	22 (3.1)	559 (5.1)	25 (2.7)	563 (3.6)	11 (1.4)	544 (5.2)	3 (0.6)	537 (9.9)
Cyprus	33 (2.2)	476 (6.1)	28 (2.9)	477 (5.0)	14 (2.8)	480 (9.0)	22 (2.8)	490 (8.5)	2 ~	~ ~
Czech Republic	13 (2.3)	526 (7.5)	10 (2.3)	532 (9.2)	20 (2.8)	515 (5.4)	32 (3.4)	513 (3.7)	25 (3.3)	519 (6.6)
Denmark	14 (3.2)	528 (9.2)	29 (3.8)	548 (5.8)	17 (3.0)	533 (5.3)	35 (3.7)	535 (4.5)	5 (1.8)	524 (17.4)
England r	29 (4.4)	539 (7.5)	19 (4.0)	567 (9.2)	17 (4.0)	569 (13.7)	33 (4.7)	565 (4.7)	2 ~	~ ~
Finland	11 (2.4)	561 (9.4)	21 (3.1)	522 (9.8)	19 (2.8)	545 (5.2)	30 (3.5)	546 (3.9)	19 (3.0)	539 (7.0)
France	8 (3.1)	503 (15.9)	13 (2.4)	460 (11.5)	22 (3.8)	490 (5.8)	50 (4.7)	503 (4.8)	7 (2.4)	483 (11.9)
Georgia	39 (3.4)	463 (4.8)	19 (3.3)	459 (8.2)	14 (3.0)	445 (8.7)	22 (2.6)	460 (12.1)	5 (1.8)	468 (20.7)
Germany	16 (2.6)	518 (11.4)	16 (2.6)	530 (7.1)	18 (2.6)	485 (8.3)	42 (3.5)	520 (3.5)	8 (2.0)	530 (7.0)
Hong Kong SAR r	63 (4.8)	553 (5.8)	31 (4.5)	534 (6.7)	2 ~	~ ~	3 (1.9)	534 (52.7)	0 ~	~ ~
Hungary	19 (2.8)	560 (8.1)	15 (2.6)	568 (6.4)	17 (3.4)	535 (11.5)	48 (3.3)	510 (6.6)	1 ~	~ ~
Iran, Islamic Rep. of	29 (3.1)	453 (7.1)	23 (3.0)	404 (11.2)	30 (3.3)	442 (8.1)	14 (1.8)	380 (13.5)	4 (0.9)	402 (19.6)
Ireland	20 (2.7)	517 (8.6)	17 (3.1)	532 (9.3)	19 (3.3)	531 (7.1)	25 (4.5)	542 (6.6)	18 (3.2)	560 (6.3)
Italy	12 (2.9)	520 (9.5)	10 (2.3)	499 (9.8)	25 (3.6)	516 (5.0)	43 (4.0)	520 (4.3)	10 (2.2)	529 (6.3)
Japan	18 (2.7)	550 (8.4)	24 (3.6)	548 (5.5)	44 (4.2)	539 (3.7)	12 (2.0)	527 (5.0)	1 ~	~ ~
Jordan	32 (3.4)	410 (7.2)	16 (2.8)	409 (13.2)	18 (3.1)	394 (14.0)	26 (3.2)	423 (14.2)	8 (2.3)	400 (20.1)
Kazakhstan	22 (2.5)	482 (11.5)	10 (2.2)	437 (13.5)	25 (2.7)	478 (8.3)	14 (2.1)	446 (11.6)	29 (2.4)	428 (6.9)
Korea, Rep. of	50 (3.6)	586 (4.1)	12 (2.9)	581 (5.4)	24 (2.9)	562 (8.2)	15 (2.8)	556 (6.8)	0 ~	~ ~
Kosovo r	37 (3.5)	416 (6.1)	9 (2.5)	414 (9.6)	8 (1.9)	395 (14.1)	32 (4.1)	386 (8.6)	14 (3.2)	375 (8.6)
Kuwait	60 (4.3)	393 (7.5)	0 ~	~ ~	35 (4.1)	372 (10.4)	4 (1.7)	413 (34.5)	1 ~	~ ~
Latvia	35 (3.1)	507 (7.0)	11 (2.2)	506 (6.4)	20 (2.7)	501 (7.6)	29 (2.7)	501 (5.7)	5 (1.4)	486 (7.9)
Lithuania	48 (2.4)	537 (4.4)	5 (1.7)	502 (13.3)	23 (2.7)	520 (3.8)	24 (2.0)	493 (7.2)	0 ~	~ ~
Macao SAR	90 (0.1)	529 (1.4)	5 (0.0)	539 (7.3)	3 (0.0)	507 (10.1)	2 ~	~ ~	0 ~	~ ~
Montenegro	45 (0.6)	477 (3.4)	20 (0.3)	453 (4.1)	15 (0.8)	461 (4.4)	14 (0.5)	460 (6.4)	5 (0.1)	480 (7.7)
Morocco	30 (3.1)	396 (8.2)	15 (3.4)	406 (19.6)	17 (2.6)	411 (11.4)	23 (2.9)	367 (13.8)	16 (2.3)	407 (14.4)
Netherlands s	28 (6.0)	505 (7.9)	11 (3.7)	502 (12.6)	11 (2.9)	528 (6.8)	42 (5.2)	525 (4.1)	9 (3.6)	522 (7.7)
New Zealand r	34 (4.0)	524 (7.5)	29 (3.8)	539 (5.7)	18 (2.9)	487 (11.9)	16 (3.1)	517 (11.6)	3 (1.9)	519 (30.2)
North Macedonia	49 (2.6)	448 (6.2)	13 (2.2)	411 (9.2)	14 (2.4)	438 (10.2)	18 (1.7)	420 (10.9)	7 (1.4)	450 (12.7)
Norway (5) r	16 (3.1)	534 (6.7)	32 (4.0)	541 (4.8)	9 (2.8)	549 (9.0)	18 (3.3)	525 (5.0)	24 (3.2)	537 (5.9)
Oman	30 (2.9)	407 (7.0)	19 (2.9)	417 (8.5)	20 (2.6)	439 (10.6)	26 (2.8)	435 (9.0)	6 (1.2)	425 (16.8)
Poland	23 (1.8)	568 (6.8)	9 (2.1)	569 (5.5)	20 (2.4)	562 (3.9)	39 (3.2)	548 (3.4)	10 (2.1)	547 (8.5)
Portugal	29 (3.3)	527 (6.7)	24 (3.4)	514 (5.5)	27 (3.3)	520 (5.9)	18 (2.8)	512 (8.6)	2 ~	~ ~
Qatar	50 (3.1)	456 (6.3)	15 (2.1)	494 (11.3)	30 (3.1)	457 (7.7)	5 (1.3)	479 (16.6)	0 ~	~ ~
Romania s	36 (5.3)	556 (5.9)	4 (2.4)	481 (27.1)	20 (5.2)	519 (5.6)	28 (5.2)	516 (9.6)	12 (4.2)	465 (26.1)
Saudi Arabia	56 (3.3)	433 (5.7)	8 (2.0)	420 (14.2)	20 (3.1)	428 (8.1)	15 (2.6)	422 (12.1)	1 ~	~ ~
Serbia	37 (3.2)	538 (4.1)	18 (2.8)	508 (7.1)	20 (2.9)	511 (5.8)	23 (2.3)	496 (7.4)	2 ~	~ ~
Singapore	100 (0.0)	577 (4.0)	0 ~	~ ~	0 ~	~ ~	0 ~	~ ~	0 ~	~ ~
Slovak Republic	23 (3.0)	536 (6.1)	7 (2.2)	525 (14.6)	14 (2.9)	509 (10.6)	56 (3.3)	495 (5.6)	0 ~	~ ~
Slovenia	24 (3.7)	525 (5.7)	17 (3.1)	515 (4.8)	18 (3.3)	516 (4.0)	23 (3.6)	521 (4.5)	18 (2.8)	519 (6.4)
Spain	31 (2.6)	506 (4.8)	15 (2.3)	513 (6.4)	38 (2.8)	510 (3.8)	15 (1.8)	515 (5.4)	1 ~	~ ~
Sweden	8 (2.3)	514 (15.9)	26 (3.6)	522 (9.8)	21 (3.4)	530 (7.4)	25 (4.4)	526 (6.0)	20 (2.9)	527 (5.8)
Türkiye (5)	55 (3.2)	567 (5.2)	10 (2.4)	540 (16.6)	24 (2.8)	539 (6.9)	11 (1.5)	528 (11.8)	0 ~	~ ~
United Arab Emirates	42 (1.1)	522 (2.7)	21 (1.3)	475 (7.0)	30 (0.8)	479 (5.4)	6 (0.3)	455 (4.7)	1 ~	~ ~
United States	22 (2.0)	499 (7.5)	34 (3.1)	555 (5.2)	24 (3.2)	531 (6.9)	17 (2.3)	548 (5.8)	3 (0.9)	543 (18.8)
Uzbekistan	23 (3.0)	420 (8.4)	15 (3.1)	408 (9.1)	8 (2.4)	407 (9.3)	33 (3.3)	418 (5.6)	19 (2.8)	420 (5.1)
International Average	**34 (0.4)**	**501 (1.0)**	**17 (0.4)**	**494 (1.4)**	**19 (0.4)**	**492 (1.2)**	**23 (0.4)**	**487 (1.6)**	**7 (0.3)**	**482 (2.3)**
South Africa (5)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Benchmarking Participants										
Ontario, Canada r	33 (3.9)	534 (6.8)	27 (3.9)	544 (5.4)	24 (3.2)	533 (5.0)	14 (2.8)	517 (9.1)	1 ~	~ ~
Quebec, Canada	25 (4.3)	503 (5.9)	19 (3.5)	515 (6.7)	31 (4.5)	506 (5.0)	23 (3.8)	508 (4.9)	2 ~	~ ~
Abu Dhabi, UAE r	30 (1.5)	463 (5.3)	29 (2.5)	416 (10.0)	32 (1.7)	439 (7.1)	7 (0.6)	447 (8.1)	3 (0.5)	333 (9.3)
Dubai, UAE	63 (0.2)	564 (2.4)	16 (0.1)	583 (3.7)	19 (0.1)	559 (4.0)	1 ~	~ ~	0 ~	~ ~
Sharjah, UAE r	43 (4.5)	520 (6.9)	22 (4.5)	482 (10.5)	32 (1.8)	491 (7.1)	3 (0.7)	406 (10.5)	0 ~	~ ~

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A tilde (~) indicates insufficient data to report result.
A dash (-) indicates comparable data not available because average achievement could not be reliably estimated.

TIMSS & PIRLS BOSTON COLLEGE

Exhibit 1.8: Students' Environmental Knowledge and School Geographic Location (Principals' Reports)

Country	Urban – Densely Populated		Suburban – On Fringe or Outskirts of Urban Area		Medium Size City or Large Town		Small Town or Village		Remote Rural	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Australia r	29 (3.6)	539 (5.1)	38 (3.6)	519 (5.7)	17 (3.2)	515 (8.6)	15 (2.9)	503 (12.3)	1 ~	~ ~
Austria	27 (2.6)	483 (9.6)	12 (2.8)	494 (16.5)	31 (3.5)	507 (6.6)	26 (3.2)	513 (6.4)	4 (1.3)	510 (10.1)
Azerbaijan	30 (2.6)	427 (4.9)	19 (3.1)	422 (6.3)	12 (2.3)	401 (5.5)	28 (2.7)	393 (5.8)	12 (1.9)	394 (9.1)
Bahrain	31 (0.9)	430 (5.1)	12 (0.4)	492 (7.9)	37 (0.8)	434 (4.3)	20 (0.9)	438 (5.6)	0 ~	~ ~
Brazil	40 (3.1)	437 (6.2)	16 (1.8)	398 (6.3)	14 (2.1)	434 (9.8)	24 (2.3)	414 (8.4)	7 (1.2)	376 (6.7)
Chile r	55 (4.3)	469 (4.8)	11 (3.2)	458 (13.6)	20 (4.0)	457 (8.7)	8 (2.9)	431 (15.2)	5 (1.7)	440 (6.3)
Chinese Taipei	32 (3.0)	577 (4.8)	30 (3.5)	552 (5.5)	21 (3.2)	545 (5.6)	13 (2.4)	520 (6.4)	3 (0.7)	510 (10.2)
Cyprus	46 (1.9)	465 (4.2)	17 (2.0)	468 (12.7)	18 (2.4)	460 (9.2)	15 (1.6)	466 (12.8)	4 (1.6)	472 (10.5)
Czech Republic	18 (2.2)	531 (8.1)	9 (1.9)	519 (6.4)	31 (3.1)	514 (4.6)	28 (2.9)	512 (4.0)	14 (2.3)	511 (4.1)
England r	23 (4.4)	497 (13.2)	23 (3.9)	536 (8.5)	24 (3.9)	525 (11.8)	27 (4.6)	549 (10.2)	2 ~	~ ~
Finland	5 (1.9)	519 (15.5)	18 (2.9)	551 (7.4)	34 (3.9)	533 (5.6)	31 (4.0)	530 (4.2)	11 (1.6)	527 (6.7)
France	28 (4.0)	490 (7.5)	20 (3.7)	483 (10.2)	18 (3.5)	485 (11.6)	23 (3.6)	505 (6.1)	11 (1.9)	506 (11.5)
Georgia	37 (3.3)	440 (4.5)	20 (2.9)	435 (6.3)	16 (3.1)	434 (6.2)	22 (2.6)	435 (7.5)	5 (1.7)	423 (13.5)
Hong Kong SAR s	49 (5.1)	550 (12.0)	37 (5.0)	532 (10.6)	12 (3.5)	521 (14.6)	1 ~	~ ~	0 ~	~ ~
Hungary	19 (2.6)	553 (9.8)	15 (2.7)	525 (9.0)	20 (3.1)	527 (7.4)	45 (3.1)	499 (6.2)	1 ~	~ ~
Iran, Islamic Rep. of	32 (2.9)	441 (6.5)	25 (3.0)	382 (6.5)	26 (2.9)	422 (9.0)	12 (1.9)	353 (13.4)	4 (1.1)	337 (13.5)
Ireland	27 (4.5)	526 (8.0)	19 (2.9)	540 (7.1)	20 (3.5)	535 (9.0)	31 (4.1)	530 (4.3)	3 (1.4)	487 (21.3)
Israel	46 (3.8)	494 (7.8)	5 (1.7)	440 (16.2)	26 (3.1)	464 (8.1)	18 (3.1)	477 (9.7)	5 (1.4)	449 (19.3)
Italy	13 (2.4)	511 (9.7)	9 (2.4)	484 (16.4)	28 (3.9)	512 (6.7)	45 (4.1)	500 (5.7)	6 (2.0)	521 (11.9)
Japan	19 (3.5)	539 (9.6)	23 (3.7)	564 (6.9)	46 (3.5)	547 (4.5)	12 (2.3)	546 (5.2)	0 ~	~ ~
Jordan	34 (3.3)	413 (6.9)	12 (2.7)	422 (14.4)	22 (3.5)	405 (7.5)	28 (3.7)	398 (6.8)	4 (1.5)	387 (11.3)
Kazakhstan	19 (2.2)	452 (7.9)	12 (2.4)	433 (14.4)	24 (2.6)	454 (6.5)	14 (2.2)	432 (6.6)	32 (2.5)	420 (4.5)
Korea, Rep. of	49 (3.3)	558 (9.3)	15 (3.0)	545 (9.0)	21 (2.7)	531 (5.7)	15 (0.8)	536 (4.8)	0 ~	~ ~
Kuwait	57 (4.5)	422 (8.0)	0 ~	~ ~	41 (4.5)	412 (8.6)	2 ~	~ ~	0 ~	~ ~
Lithuania	44 (3.2)	526 (4.9)	5 (1.7)	497 (8.6)	27 (3.0)	500 (4.9)	24 (1.9)	481 (5.6)	0 ~	~ ~
Malaysia	25 (3.2)	433 (9.1)	25 (3.3)	423 (7.6)	21 (3.3)	422 (10.2)	24 (2.8)	431 (8.2)	5 (1.3)	433 (12.3)
Malta	0 ~	~ ~	0 ~	~ ~	48 (0.1)	486 (2.2)	46 (0.1)	499 (2.5)	6 (0.0)	509 (7.8)
Morocco	33 (3.2)	342 (7.1)	14 (2.4)	339 (12.6)	20 (2.9)	337 (7.4)	25 (2.5)	310 (6.4)	8 (2.0)	315 (17.8)
Norway (9) r	15 (3.0)	512 (9.2)	24 (3.6)	511 (4.4)	11 (3.0)	512 (12.1)	34 (4.1)	500 (4.5)	16 (2.7)	488 (8.2)
Oman	38 (2.8)	449 (4.4)	18 (2.6)	449 (7.3)	20 (2.6)	456 (7.3)	22 (2.5)	442 (5.8)	2 ~	~ ~
Palestinian Nat'l Auth.	28 (3.2)	383 (7.3)	13 (2.6)	345 (7.0)	24 (3.3)	360 (5.8)	28 (3.2)	369 (5.7)	6 (1.8)	331 (11.6)
Portugal	31 (3.5)	523 (7.1)	23 (3.2)	511 (6.4)	31 (3.4)	520 (4.1)	13 (2.2)	521 (6.9)	3 (1.0)	520 (10.7)
Qatar	48 (4.3)	477 (7.8)	17 (3.3)	492 (13.0)	30 (3.5)	466 (8.3)	5 (1.4)	490 (16.8)	0 ~	~ ~
Romania s	28 (4.8)	492 (7.6)	6 (2.8)	451 (22.5)	19 (5.1)	460 (10.8)	36 (5.2)	441 (8.3)	11 (3.5)	423 (27.2)
Saudi Arabia	61 (3.4)	417 (5.1)	7 (1.9)	406 (12.1)	21 (2.8)	399 (8.3)	11 (2.3)	378 (11.6)	1 ~	~ ~
Singapore	100 (0.0)	593 (6.1)	0 ~	~ ~	0 ~	~ ~	0 ~	~ ~	0 ~	~ ~
South Africa (9) r	22 (3.0)	361 (11.1)	17 (2.5)	419 (16.9)	10 (1.9)	419 (16.0)	26 (3.2)	340 (7.4)	25 (2.8)	311 (5.9)
Sweden	9 (2.0)	536 (17.1)	21 (3.2)	542 (8.6)	27 (3.7)	538 (7.2)	34 (3.9)	523 (7.0)	9 (2.2)	536 (10.3)
Türkiye	53 (3.7)	527 (5.3)	7 (2.2)	531 (14.8)	28 (3.8)	533 (8.6)	12 (2.3)	495 (11.9)	0 ~	~ ~
United Arab Emirates	39 (1.7)	507 (4.6)	19 (1.6)	477 (6.1)	32 (1.8)	454 (4.6)	8 (0.8)	414 (8.3)	2 ~	~ ~
United States	25 (2.9)	490 (11.3)	31 (3.7)	540 (7.9)	19 (3.0)	525 (8.5)	20 (2.8)	509 (7.5)	6 (1.4)	504 (16.1)
Uzbekistan	20 (2.8)	395 (9.0)	18 (3.3)	386 (8.0)	7 (2.2)	390 (12.4)	39 (3.4)	391 (5.5)	15 (2.3)	379 (6.6)
International Average	**33 (0.5)**	**481 (1.3)**	**16 (0.4)**	**475 (1.7)**	**23 (0.5)**	**472 (1.3)**	**22 (0.4)**	**462 (1.3)**	**6 (0.2)**	**445 (2.4)**
Cote d'Ivoire	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Benchmarking Participants										
Abu Dhabi, UAE r	23 (2.6)	459 (10.0)	24 (3.3)	436 (9.7)	41 (3.9)	428 (8.0)	10 (1.7)	391 (16.8)	2 ~	~ ~
Dubai, UAE	61 (2.8)	537 (5.5)	21 (2.1)	537 (11.9)	16 (2.0)	546 (4.7)	2 ~	~ ~	0 ~	~ ~
Sharjah, UAE	43 (5.4)	521 (9.7)	21 (4.6)	475 (10.4)	31 (3.4)	461 (6.9)	4 (0.1)	422 (8.7)	1 ~	~ ~

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A tilde (~) indicates insufficient data to report result.
A dash (-) indicates comparable data not available because average achievement could not be reliably estimated.

Exhibit 1.8 shows the eighth-grade results. There is no consistent relationship between school geographic location and achievement in environmental knowledge that is applicable across all (or even a clear majority of) countries and benchmarking participants. There are some countries where students in more populated areas tend to have higher achievement in environmental knowledge (e.g., Republic of Korea with 558 scale score points for schools in urban areas versus 536 scale score points for schools in small towns or villages), some countries where students in rural areas tend to have higher achievement (e.g., Italy with 521 scale score points for remote rural schools compared to 511 scale score points for schools in urban areas), and some countries where there are achievement differences in varying directions across the different geographic areas (e.g., Cyprus).

Although it is challenging to draw any conclusions from these results based on individual context variables or single background scales, these findings may suggest areas for additional exploration at the national level (i.e., within countries). For example, do students with greater access to natural areas or with access to different types of natural areas consistently show greater environmental knowledge? Or are any relationships observed with respect to geographic area simply an outgrowth of differing school resources across different geographic areas? More information about the characteristics of schools in different geographical locations within countries could help address these questions.

The following section provides analyses that go beyond individual background variables and context scales, examining whether it is possible to identify clusters of respondents that differ with respect to a range of context indicators that relate to environmental awareness.

Profiles of Students' Environmental Attitudes, Behaviors, and Contextual Variables

This section presents results from a series of multiple-group latent class analyses (MG-LCAs)[19,20] that characterize patterns in responses to environmental items in the TIMSS 2023 context questionnaires. These include students' self-reports of environmental attitudes and behaviors, as well as response patterns in contextual variables related to environmental sustainability based on reports by the parents, school principals, and teachers of the students sampled in TIMSS. Latent class analysis (LCA) assumes that individuals can be classified into a finite number of distinct and relatively homogeneous classes based on variables of interest. The MG-LCA extends the traditional LCA framework by identifying classes of individuals based on their response patterns, while permitting the size of these classes to vary across predefined groups—in this case, countries.

Since it is impossible to know the "true" number of classes, models with varying numbers of classes were compared. The final numbers of classes were determined based on both commonly used numerical model selection criteria and considerations of substantive interpretability.

This section focuses on qualitatively describing the classes identified using the MG-LCA, as well as associations between class membership and expected achievement in environmental knowledge.[h] Further details about the analysis procedures, tables of item response probabilities conditional on class membership, and relevant fit statistics supporting the number of classes selected are available in Appendix C: Technical Details.

Each of the following subsections begins with an overview of the variables from each questionnaire included in the MG-LCA. This is followed by a discussion and interpretation of the final classes selected for each questionnaire, as well as the relationship between predicted class membership and expected environmental knowledge.

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h Expected achievement for each class refers to the average of students' achievement scores weighted by their posterior probabilities of belonging to that class. This approach accounts for uncertainty in class membership and aligns with the probabilistic framework of latent class modeling.

Students' Environmental Attitudes and Behaviors

The TIMSS 2023 Student Questionnaires included items about students' environmental attitudes and behaviors, presented in Exhibit 2.1. Fourth-grade students were asked to indicate their level of agreement with five attitude statements, and eighth-grade students were asked to do so for nine attitude statements.[i] Students in both grades reported their frequency of engaging in six environmentally responsible behaviors. Students' reports of attitudes and behaviors were considered together in an MG-LCA for each grade, leading to the inclusion of 11 items for fourth-grade students and 15 items for eighth-grade students.

Exhibit 2.1: Student Questionnaire Items

Item Label	Item Text	Response Categories
	How much do you agree with these statements?	• Disagree a lot
Protection of plants and animals	I care about the protection of plants and animals	• Disagree a little • Agree a little
Nature benefits humans*	Nature exists to benefit humans regardless of the consequences	• Agree a lot
Protect nature for enjoyment*	The most important reason for protecting natural areas is so people can enjoy them	
Confidence in sci and tech solve*	I am confident that environmental problems will be solved by science and technology	
Sad when nature destroyed	It makes me sad when nature is destroyed by humans	
Enjoy learning about plants and animals	I enjoy finding out what kinds of plants and animals live in my surrounding area	
Enjoy being in nature	I enjoy being in nature (<e.g., forests, parks, deserts>)	
Protecting nature more important*	Protecting nature is more important than economic growth	
Climate change priority	Addressing climate change should be a high priority	
	How often do you do these things to help the natural environment?	• Never • Sometimes • Almost every day
Reuse things	I try to reuse things (e.g., <bags, bottles>)	• Every day
Save resources	I try to use less resources (e.g., <water, food>)	
Talk about environment	I talk about how to help the environment (e.g., <saving water, picking up trash>)	
Learn about environment	I try to learn about environmental problems (e.g., <climate change, endangered animals>)	
Participate in activities	I try to participate in group activities to help the environment	
Tell when friends do harm	I tell my friends when they are doing things that harm the environment	

Terms in brackets <> required country-specific adaptation.
*Item administered to eighth-grade students only.

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i Four items included in the Grade 8 Student Questionnaire were not included in the Grade 4 version because they were hypothesized to be too complex for fourth-grade students.

Grade 4 Results

Three classes were identified to characterize the environmental attitudes and behaviors of fourth-grade students. Exhibits 2.2 and 2.3 provide summary information about the classes. Exhibit 2.2 provides the class number, as well as the label derived to refer to each class. The Class Description Overview column provides a summary of how individuals in each class are most likely to respond to different questionnaire items, based upon the conditional item response probabilities that are presented in Exhibit 2.3.

Exhibit 2.2: Profiles of Students' Environmental Attitudes and Behaviors (Grade 4)

Class Number	Class Label	Class Description Overview
Class 1	**Somewhat Pro-Environmental** Attitudes and Behaviors	• Most likely to select "agree a lot" for *Protection of plants and animals* and *Enjoy being in nature* and "agree a little" for other 3 attitude items • Relatively close probabilities for selecting "agree a lot" or "agree a little" across all 5 attitude items • Most likely to select "never" for *Talk about environment* and *Participate in activities* and "sometimes" for other 4 behavior items; however, the probabilities for these options are close across all 6 behavior items
Class 2	**Pro-Environmental** Attitudes and Behaviors	• Most likely to select "agree a lot" for all 5 attitude items • Most likely to select "almost every day" for *Reuse things* and *Save resources* • Most likely to select "sometimes" for *Talk about environment*, *Learn about environment*, *Participate in activities*, and *Tell when friends do harm*
Class 3	**Very Pro-Environmental** Attitudes and Behaviors	• Most likely to select "agree a lot" for all 5 attitude items • Most likely to select "every day" for all 6 behavior items

Specifically, Exhibit 2.3 shows the estimated probability of choosing each response category for items related to environmental behaviors and attitudes in the Grade 4 Student Questionnaire, conditional on class membership. The overall probability (at the population level) of falling into each class is shown in parentheses. The shaded areas reflect the probability of selecting a particular response, with darker shades corresponding to higher response categories for the items and larger areas denoting higher response probabilities. Throughout this report, a response of 1 to items with a four-point rating consistently represents "disagree a lot" or "never," while more positive or higher frequency response categories indicate greater agreement with statements (4 = "agree a lot") or more frequent engagement in behaviors (4 = "every day").

Across countries, marginal probabilities of being classified as having **Very Pro-Environmental** or **Pro-Environmental** attitudes and behaviors are higher than that of being classified as having **Somewhat Pro-Environmental** attitudes and behaviors (37%, 40%, and 23% respectively). Students classified as having Very Pro-Environmental Attitudes and Behaviors (Class 3) were most likely to "agree a lot" with the five attitude items and to report engaging in the six behavior items "every day."

Exhibit 2.3: Conditional Item Response Probabilities by Profile of Students' Environmental Attitudes and Behaviors (Grade 4)
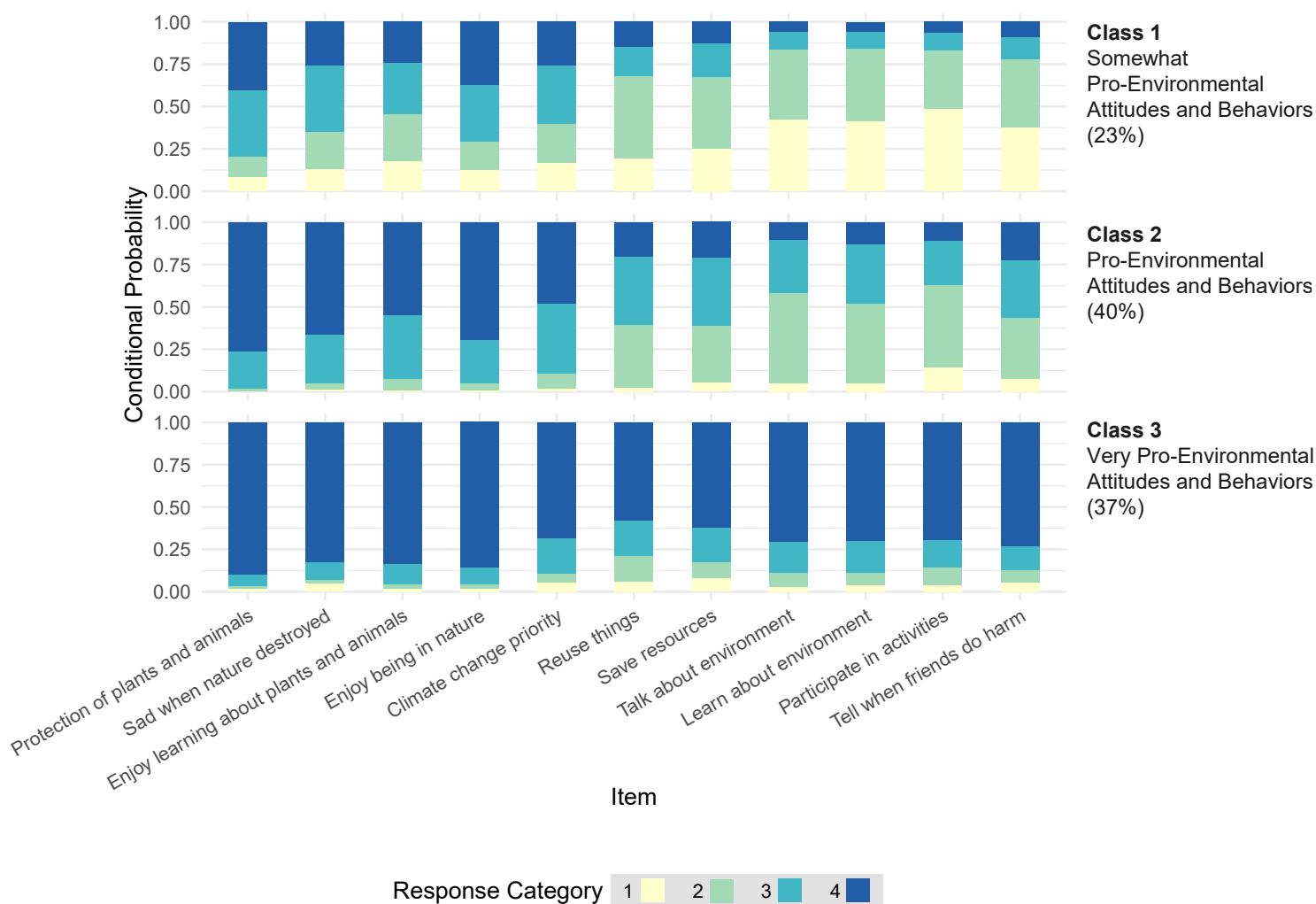
Students classified as having Pro-Environmental Attitudes and Behaviors (Class 2) were most likely to "agree a lot" with the five attitude statements; however, they reported slightly less frequent engagement in the six behaviors than students with Very Pro-Environmental Attitudes and Behaviors. These students were most likely to select "almost every day" for two of the items and "sometimes" for the other four; however, the conditional probabilities were quite close for these response options across all six behavioral items. Possible explanations could be that these students are slightly less likely to act upon their attitudes compared to the Very Pro-Environmental class, or that they are less engaged in socially desirable responding[21] when reporting their behaviors.

The final class of students, those classified as having Somewhat Pro-Environmental Attitudes and Behaviors (Class 1), had the least pro-environmental attitudes and reported the lowest frequencies of engaging in environmentally responsible behaviors of the three classes. However, these students still displayed some degree of pro-environmental attitudes—their most likely response was "agree a lot" for two of the attitude items and "agree a little" for the other three. What distinguishes this group is that they have much higher probabilities of selecting "never" across the six behavioral items compared to students in the other two classes. However, "never" is their most likely response only for *Talk about environment* and *Participate in activities*. These students were most likely to select "sometimes" for the other four behavior items.

Exhibit 2.4: Students' Environmental Attitudes and Behaviors and Achievement in Environmental Knowledge

Country	Somewhat Pro-Environmental Attitudes and Behaviors		Pro-Environmental Attitudes and Behaviors		Very Pro-Environmental Attitudes and Behaviors	
	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Albania	5 (0.5)	466 (18.8)	29 (1.5)	497 (6.9)	66 (1.7)	484 (5.6)
Armenia	16 (0.6)	458 (7.1)	32 (0.7)	479 (5.2)	52 (0.8)	462 (5.0)
Australia	27 (0.7)	553 (5.1)	53 (0.8)	560 (3.7)	20 (0.7)	529 (6.1)
Azerbaijan	18 (0.7)	391 (7.2)	32 (0.7)	423 (4.8)	50 (0.8)	413 (3.4)
Bahrain	18 (0.7)	458 (6.5)	30 (0.7)	499 (5.3)	52 (1.1)	467 (4.3)
Belgium (Flemish)	39 (0.9)	478 (4.1)	47 (0.8)	502 (3.5)	14 (0.6)	485 (7.5)
Belgium (French)	25 (0.7)	468 (3.9)	38 (0.7)	497 (3.8)	36 (0.9)	475 (3.9)
Bosnia & Herzegovina	15 (0.7)	457 (9.6)	37 (1.2)	463 (4.9)	48 (1.2)	433 (5.9)
Brazil	22 (0.5)	407 (6.2)	30 (0.6)	455 (6.3)	48 (0.8)	422 (4.8)
Bulgaria	14 (1.1)	493 (17.1)	44 (1.5)	553 (5.7)	42 (1.3)	525 (6.4)
Canada	23 (0.4)	515 (3.8)	50 (0.5)	534 (2.3)	28 (0.6)	516 (3.3)
Chile	18 (0.7)	483 (5.8)	38 (0.8)	503 (2.9)	44 (1.0)	472 (3.9)
Chinese Taipei	28 (0.8)	562 (3.5)	45 (0.6)	573 (2.7)	27 (0.8)	560 (3.6)
Cyprus	17 (0.7)	476 (5.5)	43 (0.9)	492 (3.8)	40 (0.9)	470 (3.7)
Czech Republic	25 (0.8)	515 (3.4)	55 (0.8)	528 (3.2)	20 (0.8)	504 (4.8)
Denmark	46 (1.0)	528 (4.2)	45 (0.9)	545 (3.1)	9 (0.4)	538 (5.3)
England	31 (1.2)	549 (3.6)	50 (1.1)	569 (4.6)	19 (0.8)	548 (6.2)
Finland	36 (0.7)	537 (4.5)	49 (0.7)	554 (3.8)	15 (0.6)	526 (5.2)
France	31 (0.8)	486 (5.0)	42 (0.7)	508 (3.7)	26 (0.7)	491 (5.0)
Georgia	8 (0.4)	441 (5.5)	37 (0.8)	468 (5.8)	54 (0.9)	459 (5.7)
Germany	32 (0.8)	504 (4.2)	49 (0.8)	528 (2.8)	19 (0.6)	507 (6.4)
Hong Kong SAR	28 (0.8)	544 (4.0)	46 (0.8)	555 (4.2)	26 (0.9)	523 (5.8)
Hungary	19 (0.8)	522 (6.5)	51 (0.8)	547 (3.9)	30 (1.0)	523 (4.8)
Iran, Islamic Rep. of	9 (0.5)	402 (8.4)	28 (1.0)	446 (6.2)	63 (1.1)	424 (5.4)
Ireland	21 (0.9)	518 (7.2)	59 (0.9)	548 (3.9)	20 (0.9)	522 (6.4)
Italy	22 (0.8)	506 (4.4)	51 (0.7)	528 (2.4)	27 (0.9)	508 (5.1)
Japan	38 (1.0)	535 (4.2)	51 (0.8)	549 (4.3)	11 (0.6)	530 (7.8)
Jordan	25 (1.2)	401 (7.8)	24 (0.8)	416 (6.0)	50 (1.4)	413 (5.0)
Kazakhstan	20 (0.7)	445 (5.6)	39 (0.8)	471 (5.0)	41 (1.0)	448 (4.3)
Korea, Rep. of	39 (0.9)	566 (5.3)	45 (0.7)	582 (4.0)	17 (0.6)	578 (4.8)
Kosovo	7 (0.5)	382 (7.2)	26 (0.9)	413 (5.3)	67 (1.0)	398 (3.6)
Kuwait	20 (0.8)	375 (9.0)	25 (0.8)	423 (7.5)	55 (1.1)	386 (5.7)
Latvia	22 (0.7)	502 (5.4)	55 (1.0)	513 (3.1)	22 (0.8)	482 (5.0)
Lithuania	17 (0.6)	517 (6.3)	55 (0.8)	531 (4.1)	29 (0.8)	505 (3.7)
Macao SAR	27 (0.5)	523 (2.8)	50 (0.5)	533 (2.2)	23 (0.5)	524 (3.5)
Montenegro	12 (0.5)	451 (5.9)	28 (0.6)	484 (5.3)	60 (0.7)	463 (2.5)
Morocco	17 (1.0)	372 (7.7)	22 (1.3)	425 (10.2)	60 (1.8)	386 (6.3)
Netherlands	52 (1.1)	511 (2.6)	35 (0.8)	533 (2.9)	14 (0.8)	512 (5.7)
New Zealand	28 (0.8)	514 (4.0)	50 (0.8)	531 (2.6)	22 (0.6)	499 (7.2)
North Macedonia	9 (0.5)	410 (8.5)	26 (0.7)	445 (4.8)	65 (0.8)	439 (4.5)
Norway (5)	43 (0.9)	531 (4.5)	49 (0.8)	544 (2.3)	8 (0.4)	519 (6.9)
Oman	22 (0.6)	393 (6.1)	26 (0.7)	443 (5.1)	52 (0.8)	432 (4.5)
Poland	23 (0.8)	561 (3.0)	57 (0.9)	562 (3.5)	20 (0.8)	539 (3.4)
Portugal	6 (0.4)	511 (6.6)	43 (0.8)	529 (3.7)	51 (1.0)	512 (4.5)
Qatar	23 (0.6)	441 (5.6)	33 (0.7)	491 (4.5)	44 (0.8)	460 (4.6)
Romania	12 (0.5)	530 (6.5)	47 (1.5)	536 (6.4)	41 (1.6)	506 (5.7)
Saudi Arabia	26 (0.8)	405 (4.3)	21 (0.5)	445 (5.3)	53 (0.9)	437 (4.2)
Serbia	18 (0.8)	519 (5.0)	43 (1.1)	527 (3.7)	39 (1.2)	506 (4.8)
Singapore	28 (0.5)	569 (4.5)	49 (0.6)	588 (4.0)	22 (0.5)	564 (5.3)
Slovak Republic	23 (1.0)	487 (8.3)	52 (0.9)	524 (4.4)	25 (1.0)	502 (5.5)
Slovenia	15 (0.7)	516 (4.9)	51 (0.9)	530 (3.4)	34 (1.0)	510 (4.6)
Spain	15 (0.6)	498 (4.8)	46 (0.6)	520 (3.2)	39 (0.7)	503 (2.9)
Sweden	46 (0.9)	519 (3.8)	42 (0.8)	538 (4.0)	11 (0.6)	513 (8.6)
Türkiye (5)	9 (0.4)	532 (8.2)	41 (0.8)	566 (4.4)	49 (1.0)	545 (4.6)
United Arab Emirates	18 (0.3)	461 (3.0)	39 (0.3)	519 (2.2)	43 (0.4)	489 (1.9)
United States	35 (0.7)	531 (3.7)	43 (0.6)	554 (3.7)	22 (0.6)	518 (4.7)
Uzbekistan	12 (0.7)	388 (4.9)	23 (0.7)	428 (4.9)	65 (1.0)	418 (3.3)
International Average	**23 (0.1)**	**484 (0.9)**	**41 (0.1)**	**510 (0.6)**	**36 (0.1)**	**488 (0.7)**
South Africa (5)	- -	- -	- -	- -	- -	- -
Benchmarking Participants						
Ontario, Canada	22 (0.6)	525 (5.6)	51 (0.8)	542 (3.7)	27 (0.8)	528 (4.6)
Quebec, Canada	26 (0.8)	500 (4.2)	46 (0.8)	513 (3.0)	28 (0.9)	494 (4.2)
Abu Dhabi, UAE	23 (0.6)	410 (4.4)	37 (0.6)	473 (3.3)	40 (0.6)	440 (3.2)
Dubai, UAE	15 (0.5)	550 (4.3)	48 (0.5)	579 (2.2)	37 (0.7)	558 (2.7)
Sharjah, UAE	15 (0.6)	465 (5.7)	36 (0.9)	517 (4.6)	48 (1.1)	498 (5.1)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated.

The descriptions of these three classes suggest that strongly pro-environmental attitudes are quite frequently reported internationally by fourth-grade students. Reported frequencies of environmentally responsible behaviors have more variation than do pro-environmental attitudes, but many students report at least occasional engagement in these behaviors. Exhibit 2.4 shows the distribution of students across classes within each of the TIMSS 2023 countries, as well as the expected achievement in environmental knowledge for students in each class.[j]

Internationally, students classified as having Pro-Environmental Attitudes and Behaviors had the highest average expected achievement in environmental knowledge (510 scale score points), followed by those with Very Pro-Environmental Attitudes and Behaviors (488 scale score points) and those with Somewhat Pro-Environmental Attitudes and Behaviors (484 scale score points). Although the magnitude of expected achievement differences between classes varies by country, the Pro-Environmental Attitudes and Behaviors class—not the Very Pro-Environmental Class—has the highest average expected achievement across all countries and benchmarking participants. There is no consistent pattern in expected achievement differences between students classified as having Very Pro-Environmental Attitudes and Behaviors and students classified as having Somewhat Pro-Environmental Attitudes and Behaviors; depending on the country, students in either class may have higher expected achievement.

It is important to acknowledge the potential role that socially desirable response behavior may play in the Very Pro-Environmental Class, both in interpreting students' questionnaire item responses and in observing that this class does not have the highest average achievement in environmental knowledge among the three classes. While in most cases it can be assumed that students do their best to answer according to their understanding of the question, in some cases student responses may be affected by what they believe is expected of them. Responses may sometimes be skewed towards what students think their parents, peers, or teachers want to hear. Some students may have selected the most "positive" response options even if these are not reflective of their actual attitudes and behaviors. The analyses presented here do not disentangle this phenomenon from students who genuinely exhibit high levels of agreement and daily engagement in the behaviors.

The magnitude of expected achievement differences between classes also varies across countries. Some countries show substantial differences in expected achievement between groups, while for others there is virtually no difference. The expected achievement difference between students with Pro-Environmental and Very Pro-Environmental behaviors and attitudes ranges from 39 scale score points (Morocco) to 3 scale score points (Jordan). An even wider range of differences is observed between students with Pro-Environmental and Somewhat Pro-Environmental attitudes and behaviors, ranging from 60 scale score points (Bulgaria) to 1 scale score point (Poland).[k]

Also worth noting are the differences in the distribution of students across the three classes within countries. In 16 countries, 50 percent or more of fourth-grade students are classified as having Very Pro-Environmental Attitudes and Behaviors, and percentages in this class range from 67 percent (Kosovo) to 8 percent (Norway). Another 15 countries and one benchmarking participant had 50 percent or more of their students classified as having Pro-Environmental

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j   Note that the international averages presented in this and subsequent tables differ slightly from the marginal probabilities reported as part of the latent class analysis. This is due to differential weighting of countries between the two procedures.

k   One benchmarking participant (Abu Dhabi, UAE) had a 63-point difference favoring students in the Pro-Environmental class.

Attitudes and Behaviors. Only a single country (the Netherlands) had more than 50 percent of students classified as having Somewhat Pro-Environmental Attitudes and Behaviors.

These results suggest that students with more moderate reports of environmental attitudes and behaviors have higher levels of environmental knowledge than their peers with more extreme reports of attitudes and behaviors. Although more pro-environmental attitudes and behaviors do not necessarily equate with greater environmental knowledge, this finding merits further exploration. For example, as noted above, some students classified as having Very Pro-Environmental Attitudes and Behaviors may have been engaged in socially desirable responding, perhaps distorting the observed relationship between environmental attitudes, behaviors, and achievement for fourth-grade students.

Grade 8 Results

Grade 8 students responded to several additional context questionnaire items concerning environmental attitudes; however, three classes with interpretations similar to Grade 4 were also selected to characterize eighth-grade students' environmental attitudes and behaviors. Exhibit 2.5 presents a summary of the three classes and Exhibit 2.6 shows the conditional item response probabilities for each class.

Exhibit 2.5: Profiles of Students' Environmental Attitudes and Behaviors (Grade 8)

Class Number	Class Label	Class Description Overview
Class 1	**Somewhat Pro-Environmental** Attitudes and Behaviors	• Most likely to select "disagree a little" for *Enjoy learning about plants and animals* and "agree a little" for other 8 attitude items • Most likely to select "sometimes" for *Reuse things* and *Save resources* and "never" for other 4 behavior items
Class 2	**Pro-Environmental** Attitudes and Behaviors	• Most likely to select "agree a lot" for *Protection of plants and animals*, *Nature benefits humans*, *Sad when nature destroyed*, *Enjoy being in nature*, and *Climate change priority*. • Most likely to select "agree a little" for *Protect nature for enjoyment*, *Confidence in sci and tech solve*, *Enjoy learning about plants and animals*, and *Protecting nature more important* • Most likely to select "sometimes" for all 6 behavior items, although "almost every day" is close for *Reuse things* and *Save resources*
Class 3	**Very Pro-Environmental** Attitudes and Behaviors	• Most likely to select "agree a lot" for all 9 attitude items • Most likely to select "every day" for all 6 behavior items

Exhibit 2.6: Conditional Item Response Probabilities by Profile of Students' Environmental Attitudes and Behaviors (Grade 8)
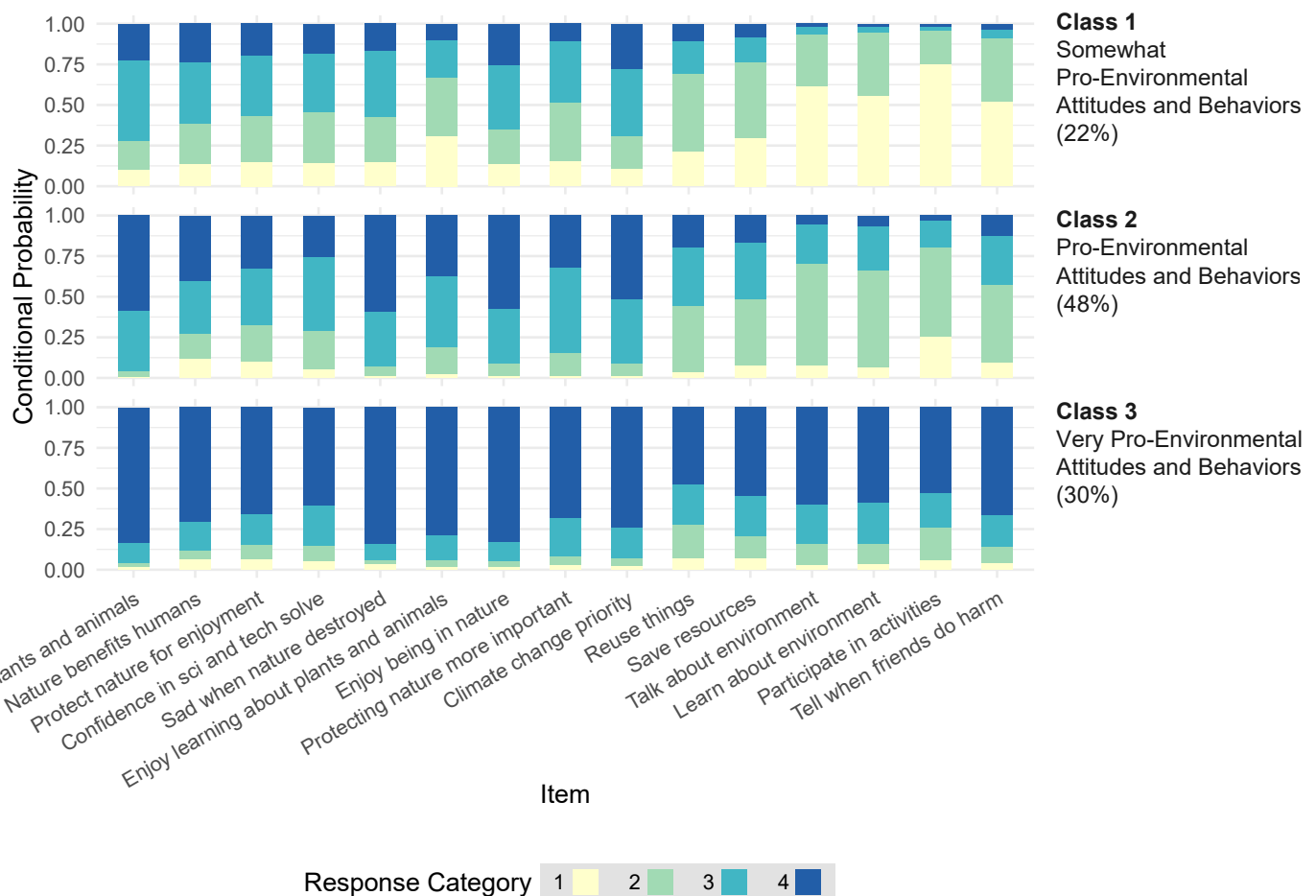
Interpretations and overall probabilities for the three eighth-grade student classes are similar as for fourth grade. Eighth-grade students are most likely to be classified as having **Pro-Environmental** attitudes and behaviors (48%), followed by **Very Pro-Environmental** attitudes and behaviors (30%), and finally **Somewhat Pro-Environmental** attitudes and behaviors (22%).

Students classified as having Very Pro-Environmental Attitudes and Behaviors (Class 3) were most likely to select "agree a lot" for all nine attitude items and "every day" for all six behavior items. However, as with Grade 4, it is possible that there are multiple explanations for these response patterns. Social desirability may play a role in some students' reports if they feel they are expected to hold pro-environmental views or behave in environmentally responsible ways. Another possible explanation is that this class combines students with very high levels of environmental attitudes and behaviors and students who exhibited careless and insufficient effort responding (such as straight lining)[22] or extreme response styles,[23,24] in both cases mechanically choosing the highest response to all questionnaire items without considering the content of the questions. For example, a complication arises in interpreting students' expected response to the Grade 8-specific item *Nature benefits humans*. Students with strong pro-environmental attitudes would not intuitively be expected to endorse the statement "Nature exists to benefit humans regardless of the consequences"; however, students in this class were most likely to "agree a lot" with this statement. Although it is not possible to say for certain, this unexpected response probability may be evidence of a certain lack of effort or understanding when responding to the questionnaire,[25] a possibility that could be explored further in future research.

Students classified as having Pro-Environmental Attitudes and Behaviors (Class 2) were most likely to select "agree a lot" or "agree a little" for all nine of the attitude items and "sometimes" for all six behavior items. These students are more moderate in their self-reported attitudes and behaviors compared to those in the Very Pro-Environmental class.

Lastly, students classified as having Somewhat Pro-Environmental Attitudes and Behaviors (Class 1) were most likely to select "disagree a little" for *Enjoy learning about plants and animals* and "agree a little" for the remaining eight attitude items. These students were also most likely to select "sometimes" for *Reuse things* and *Save resources* and "never" for the other four behavior items and had a much higher probability of selecting "never" for all behavior items compared to students in the other two classes.

Grade 8

Exhibit 2.7: Students' Environmental Attitudes and Behaviors and Achievement in Environmental Knowledge

Country	Somewhat Pro-Environmental Attitudes and Behaviors		Pro-Environmental Attitudes and Behaviors		Very Pro-Environmental Attitudes and Behaviors	
	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Australia	37 (0.9)	509 (4.4)	52 (0.8)	535 (3.8)	11 (0.4)	505 (5.9)
Austria	45 (0.9)	489 (3.7)	47 (0.8)	517 (3.8)	8 (0.5)	489 (8.2)
Azerbaijan	14 (0.5)	412 (7.0)	41 (0.8)	419 (3.4)	45 (0.9)	401 (3.2)
Bahrain	16 (0.8)	449 (5.8)	43 (0.7)	461 (3.1)	40 (1.0)	424 (3.2)
Brazil	15 (0.5)	441 (4.4)	48 (0.5)	440 (3.5)	37 (0.7)	397 (2.8)
Chile	20 (0.7)	460 (5.0)	55 (0.9)	472 (2.7)	26 (0.9)	442 (6.8)
Chinese Taipei	23 (0.8)	549 (5.0)	58 (0.8)	560 (2.8)	19 (0.8)	540 (4.6)
Cyprus	21 (0.9)	461 (4.3)	54 (0.7)	477 (4.6)	25 (0.9)	456 (4.7)
Czech Republic	42 (0.7)	511 (2.5)	53 (0.7)	525 (2.2)	6 (0.3)	490 (6.2)
England	45 (1.1)	520 (5.0)	46 (0.9)	549 (4.9)	8 (0.6)	507 (8.7)
Finland	55 (0.8)	534 (2.7)	37 (0.7)	552 (3.9)	8 (0.5)	496 (8.3)
France	37 (1.0)	484 (3.6)	51 (0.9)	506 (4.1)	13 (0.6)	480 (6.0)
Georgia	10 (0.5)	438 (4.9)	51 (0.8)	448 (3.4)	39 (0.8)	427 (4.0)
Hong Kong SAR	22 (0.8)	539 (7.2)	58 (0.9)	534 (5.2)	20 (0.8)	525 (6.8)
Hungary	28 (0.9)	503 (5.5)	61 (0.8)	527 (3.7)	11 (0.5)	509 (5.1)
Iran, Islamic Rep. of	8 (0.4)	398 (8.4)	48 (0.7)	419 (5.1)	44 (0.7)	394 (4.8)
Ireland	32 (1.0)	520 (4.6)	57 (0.8)	538 (3.6)	11 (0.7)	523 (6.7)
Israel	40 (0.9)	477 (4.2)	43 (0.8)	497 (4.3)	17 (0.7)	446 (6.1)
Italy	29 (0.9)	488 (4.7)	61 (0.8)	516 (3.7)	10 (0.5)	483 (8.2)
Japan	37 (0.8)	546 (4.2)	57 (0.7)	555 (3.3)	6 (0.4)	530 (6.7)
Jordan	14 (0.6)	399 (6.3)	38 (0.8)	422 (4.4)	48 (0.9)	402 (4.1)
Kazakhstan	10 (0.4)	452 (6.5)	61 (0.6)	439 (3.0)	29 (0.6)	425 (4.5)
Korea, Rep. of	37 (0.8)	539 (3.5)	48 (0.7)	554 (3.6)	15 (0.8)	546 (7.9)
Kuwait	15 (0.7)	423 (8.6)	45 (0.9)	441 (6.1)	39 (1.0)	397 (5.7)
Lithuania	19 (0.6)	510 (4.0)	59 (0.8)	517 (3.2)	22 (0.7)	489 (5.0)
Malaysia	10 (0.4)	386 (6.3)	70 (0.6)	434 (3.8)	21 (0.6)	427 (5.6)
Malta	21 (0.6)	484 (4.2)	57 (0.6)	510 (2.1)	22 (0.5)	479 (3.0)
Morocco	11 (0.4)	342 (6.4)	40 (0.6)	341 (3.2)	49 (0.7)	321 (3.6)
Norway (9)	53 (0.7)	497 (3.5)	39 (0.6)	522 (3.1)	7 (0.3)	486 (5.9)
Oman	17 (0.6)	441 (4.9)	43 (0.6)	465 (3.2)	39 (0.8)	440 (3.1)
Palestinian Nat'l Auth.	16 (0.6)	347 (5.0)	31 (0.6)	378 (3.6)	53 (0.7)	368 (3.3)
Portugal	10 (0.5)	510 (7.2)	57 (0.7)	531 (3.2)	33 (0.8)	504 (2.7)
Qatar	18 (0.8)	467 (7.3)	44 (1.0)	498 (4.5)	38 (1.3)	461 (4.9)
Romania	14 (0.7)	459 (7.8)	47 (1.0)	473 (4.4)	38 (1.2)	445 (5.0)
Saudi Arabia	11 (0.5)	410 (5.2)	32 (0.7)	432 (4.1)	57 (0.8)	399 (4.2)
Singapore	24 (0.8)	584 (7.8)	60 (0.8)	601 (5.7)	17 (0.6)	581 (7.1)
South Africa (9)	17 (0.6)	376 (6.1)	54 (0.5)	366 (4.4)	29 (0.7)	333 (4.8)
Sweden	53 (1.1)	526 (5.1)	39 (0.9)	560 (3.9)	9 (0.6)	505 (8.0)
Türkiye	10 (0.6)	530 (8.1)	54 (1.0)	535 (3.8)	36 (0.9)	509 (3.6)
United Arab Emirates	15 (0.3)	484 (2.7)	45 (0.5)	500 (2.2)	40 (0.6)	454 (3.0)
United States	33 (0.6)	515 (4.4)	52 (0.7)	529 (4.2)	15 (0.5)	488 (6.2)
Uzbekistan	4 (0.3)	380 (10.0)	37 (0.8)	398 (4.1)	59 (0.9)	384 (3.6)
International Average	**24 (0.1)**	**471 (0.9)**	**49 (0.1)**	**488 (0.6)**	**27 (0.1)**	**460 (0.9)**
Cote d'Ivoire	- -	- -	- -	- -	- -	- -
Benchmarking Participants						
Abu Dhabi, UAE	17 (0.4)	441 (4.4)	46 (0.7)	463 (3.9)	37 (0.7)	415 (4.5)
Dubai, UAE	19 (0.6)	538 (3.4)	53 (0.9)	551 (3.5)	29 (1.0)	515 (4.3)
Sharjah, UAE	9 (0.9)	491 (6.1)	42 (1.0)	505 (4.5)	49 (1.6)	471 (7.1)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
A dash (-) indicates comparable data not available because average achievement could not be reliably estimated.

The class descriptions for eighth-grade students suggest that reported pro-environmental attitudes and behaviors are relatively prevalent across countries; however, students are more likely to report pro-environmental attitudes than they are to report engaging in environmentally responsible behaviors. Exhibit 2.7 shows the prevalence of each class across countries, along with expected achievement for each class in environmental knowledge for the eighth grade.

Across countries, eighth-grade students classified as having Pro-Environmental Attitudes and Behaviors had the highest expected achievement in environmental knowledge (488 scale score points) on average, followed by those with Somewhat Pro-Environmental Attitudes and Behaviors (471 scale score points), and then by those with Very Pro-Environmental Attitudes and Behaviors (460 scale score points). The Pro-Environmental Attitudes and Behaviors class had the highest expected achievement in environmental knowledge in all but five countries (Brazil, Hong Kong SAR, Kazakhstan, Morocco, and South Africa). In these five countries, students in the Somewhat Pro-Environmental Attitudes and Behaviors class had the highest expected achievement in environmental knowledge. There were no countries where students in the Very Pro-Environmental Attitudes and Behaviors class had the highest expected environmental knowledge. As a follow-up analysis, expected achievement was recomputed excluding students who exhibited "straight lining" behavior (assumed to be related to careless and insufficient effort responding) in the most positive response categories (i.e., selecting "agree a lot" and "every day" for all answered items). Expected achievement differences were evident across countries for the Very Pro-Environmental Attitudes and Behaviors class, but this is still below expected achievement in the other two classes.

The magnitude of differences in expected achievement in environmental knowledge across classes varied across countries. The difference in expected achievement for students in the Pro-Environmental and Somewhat Pro-Environmental classes ranged from 48 points favoring the Pro-Environmental class (Malaysia) to 13 points favoring the Somewhat Pro-Environmental class (Kazakhstan). Nine countries had expected achievement differences of 10 points or fewer between these classes. Expected achievement in environmental knowledge differences between students in the Pro-Environmental and Very Pro-Environmental classes ranged from 56 scale score points (Finland) to 7 scale score points (Malaysia), with only four countries having expected achievement differences of 10 points or fewer between these classes. For the Very Pro-Environmental and Somewhat Pro-Environmental classes, the expected achievement differences varied from 41 points favoring the Very Pro-Environmental class (Malaysia) to 44 points favoring Somewhat Pro-Environmental class (Brazil); these differences were overall more moderate, with 17 countries having a difference of 10 points or fewer favoring either class.

Twenty-one countries and one benchmarking participant (Dubai, UAE) had more than 50 percent of their eighth-grade students classified as having Pro-Environmental Attitudes and Behaviors, and no country or benchmarking participant had fewer than 30 percent of its students in this class. Three countries (Finland, Sweden, and Norway) had more than 50 percent of students classified as having Somewhat Pro-Environmental Attitudes and Behaviors and seven countries and one benchmarking participant (Sharjah, UAE) had 10 percent or fewer of students in this class. Similarly, three countries (Palestinian National Authority, Saudi Arabia, and Uzbekistan) had more than 50 percent of students classified as having Very Pro-Environmental Attitudes and Behaviors and eight countries had 10 percent or fewer of students in this class.

As noted earlier in this report, results between the fourth and eighth grades cannot be directly compared. However, the eighth-grade MG-LCA results and accompanying relationships

with achievement present a similar, if slightly more complex, picture than in the fourth grade. In most countries, students in the Pro-Environmental Attitudes and Behaviors class who reported moderate levels of agreement with the environmental attitude items, and occasional engagement in environmentally responsible behaviors, had higher expected achievement in environmental knowledge than their peers who reported more extreme attitudes. In the five countries defying this pattern, students classified as having Somewhat Pro-Environmental Attitudes and Behaviors had the highest expected achievement in environmental knowledge. As in Grade 4, self-reported attitudes and behaviors do not necessarily equate to knowledge; however, these results suggest the possibility of social desirability, response styles, or careless and insufficient effort responding by at least some respondents in the Very Pro-Environmental class. This merits further investigation in future research.

Parental Encouragement of Environmentally Responsible Attitudes and Behavior

The TIMSS 2023 Home Questionnaire included items about how frequently students' parents or family members did different activities to promote the development of children's environmentally responsible attitudes and behaviors. Fourth-grade students' parents or guardians responded to five items asking how often they engaged in these activities.[l] These five items, shown in Exhibit 3.1, were included in the MG-LCA procedure.

Exhibit 3.1: Home Questionnaire Items

Item Label	Item Text	Response Categories
	How often do you or someone else in your home do these things with your child?	• Never
		• Sometimes
		• Almost every day
Discuss problems	Discuss environmental problems (e.g., <climate change, endangered animals>)	• Every day
Read/watch information	Read or watch information about environmental problems (e.g., <climate change, endangered animals>)	
Save resources	Show him/her how to use less resources (e.g., <water, energy>) to help the natural environment	
Time in nature	Spend time in nature (e.g., <forest, parks, deserts>)	
Encourage action	Encourage him/her to take action to protect the natural environment	

Terms in brackets <> required country-specific adaptation.

The MG-LCA produced three classes characterizing parents' responses to the five items. Exhibit 3.2 presents a summary of the three classes and Exhibit 3.3 shows the conditional item response category probabilities for each class.

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l   TIMSS 2023 did not include a Home Questionnaire for Grade 8.

Exhibit 3.2: Profiles of Parental Encouragement of Environmentally Responsible Attitudes and Behaviors

Class Number	Class Label	Class Description Overview
Class 1	**Rarely** Encourage Environmentally Responsible Attitudes and Behavior	• Most likely to select "never" for *Discuss problems* and *Read/watch information* (conditional probabilities of 0.53 and 0.66) • Most likely to select "sometimes" for *Save resources*, *Time in nature*, and *Encourage action* (conditional probabilities of 0.49, 0.64, and 0.53)
Class 2	**Sometimes** Encourage Environmentally Responsible Attitudes and Behavior	• Most likely to select "sometimes" for all 5 items • Much more likely to select "almost every day" for *Save resources*, *Time in nature*, and *Encourage action* (conditional probabilities of 0.41, 0.25, and 0.35) compared to *Discuss problems* and *Read/watch information* (conditional probabilities of (0.10 and 0.04)
Class 3	**Frequently** Encourage Environmentally Responsible Attitudes and Behavior	• Most likely to select "every day" for 2 items, "almost every day" for 2 items, and "sometimes" for the other one • Conditional probability of selecting "every day" for *Save resources* and *Encourage action* is greater than 0.5

Exhibit 3.3: Conditional Item Response Probabilities by Profile of Parental Encouragement of Environmentally Responsible Attitudes and Behaviors
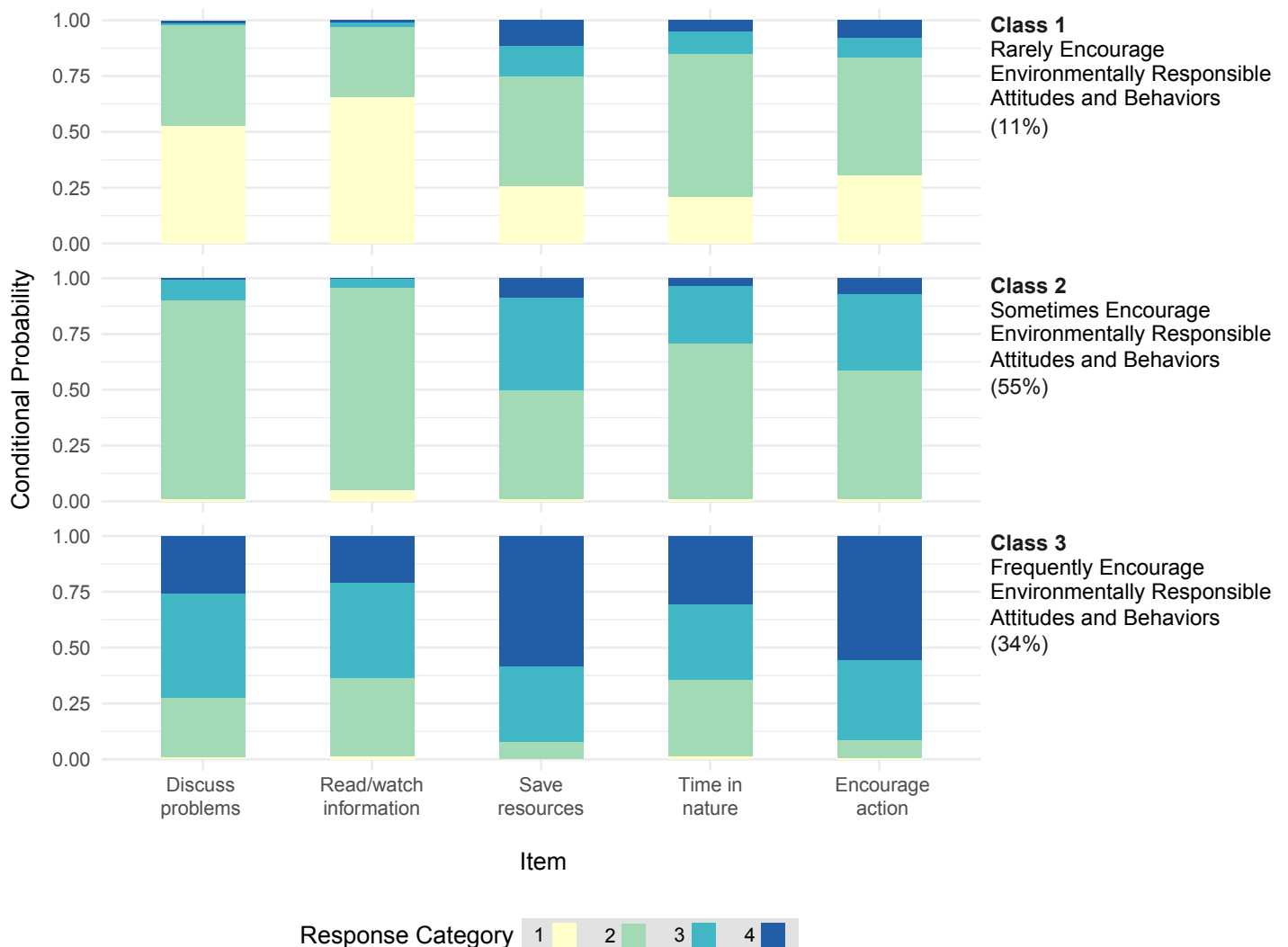
The MG-LCA identified three classes that reflect varying degrees to which parents or families encourage the development of environmentally responsible attitudes and behaviors in their children. Parents had the greatest overall probability of being classified as **Sometimes** encouraging environmentally responsible attitudes and behaviors (55%), followed by **Frequently** encouraging these attitudes and behaviors (34%). The overall probability was lowest for being classified as **Rarely** encouraging environmentally responsible attitudes and behaviors (11%).

Parents classified as Frequently Encouraging Environmentally Responsible Attitudes and Behavior (Class 3) were most likely to select "every day" for *Save resources* and *Encourage action*, and "almost every day" for *Discuss problems* and *Read/watch information*. The pervasive use of the "most positive" response options that was observed in the Very Pro-Environmental student classes is not evident in the class for parents classified as Frequently encouraging pro-environmental attitudes and behaviors in their children. The two items for which parents in this class were most likely to select "every day" are those that likely do not require special effort outside of a family's everyday routine. There are likely to be multiple opportunities throughout a typical day when parents can show children how to save resources (for example, by turning off the lights when leaving a room). Similarly, encouraging students to take action to protect the environment can easily occur within everyday conversations between parents and children. In contrast, the three items for which parents in this class were most likely to select "almost every day" or "sometimes" require some additional effort—for example, seeking out information about environmental issues or actively traveling to a natural area.

Parents classified as Sometimes Encouraging Environmentally Responsible Attitudes and Behaviors (Class 2) were most likely to select "sometimes" for all five items. However, they had a much higher conditional probability of selecting "almost every day" for *Save resources*, *Time in nature*, and *Encourage action* compared to *Discuss problems* and *Read/watch information*. This suggests that parents in this class have a greater proclivity for encouraging environmentally responsible attitudes and behaviors in ways that do not require them to actively seek out or engage with information about environmental issues. These parents may encourage the development of their children's pro-environmental attitudes and behaviors, but not through the explicit lens of solving environmental problems.

Parents classified as Rarely Encouraging Environmentally Responsible Attitudes and Behaviors (Class 1) displayed a similar pattern in their responses; parents in this class were most likely to select "never" for the two items requiring them to actively seek out and engage with information about environmental issues. They were most likely to select "sometimes" for the other three items. This suggests that parents in this class do occasionally encourage the development of environmentally responsible attitudes and behaviors in their children, but, like the parents in the Sometimes class, are more likely to do this without the explicit framing of environmental problems. Follow-up analyses revealed that being classified as Rarely encouraging environmentally responsible attitudes and behaviors was associated with the lowest average scale score on the Home Socioeconomic Status scale across the three classes.

The three classes identified for fourth-grade students' parents suggest that many parents at least occasionally engage in activities that promote the development of students' environmentally responsible attitudes and behaviors, even if not explicitly to address environmental problems. Exhibit 3.4 shows the distribution of students whose parents were assigned to each class in conjunction with their expected achievement in environmental knowledge.

Exhibit 3.4: Parental Encouragement of Environmentally Responsible Attitudes and Behavior and Achievement in Environmental Knowledge

Country	Rarely Encourage Environmentally Responsible Attitudes and Behavior		Sometimes Encourage Environmentally Responsible Attitudes and Behavior		Frequently Encourage Environamentally Responsible Attitudes and Behavior	
	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Albania	s	4 (1.5)	457 (19.1)	36 (10.8)	479 (8.6)	60 (11.8)	489 (7.2)
Armenia	2 ~	~ ~	47 (1.1)	468 (5.2)	51 (1.2)	467 (5.4)
Azerbaijan	13 (3.2)	380 (7.6)	41 (0.9)	419 (4.5)	46 (3.3)	416 (4.1)
Bahrain	11 (0.5)	463 (6.0)	56 (1.0)	482 (4.4)	33 (1.2)	470 (5.6)
Belgium (Flemish)	24 (0.8)	476 (4.8)	63 (2.8)	500 (3.7)	14 (2.9)	496 (5.1)
Belgium (French)	19 (0.9)	472 (4.3)	58 (1.0)	489 (3.5)	23 (0.6)	489 (3.6)
Bosnia & Herzegovina	s	5 (0.7)	429 (18.1)	61 (4.8)	456 (7.3)	33 (4.9)	458 (7.7)
Brazil	15 (2.6)	401 (5.3)	39 (2.1)	442 (5.7)	46 (1.1)	436 (5.3)
Bulgaria	11 (1.8)	428 (18.7)	44 (1.0)	543 (5.4)	45 (1.5)	553 (5.1)
Chile	s	5 (1.1)	470 (20.0)	56 (1.2)	487 (4.6)	38 (1.5)	494 (4.7)
Chinese Taipei	14 (0.6)	542 (4.7)	77 (0.7)	571 (2.8)	9 (0.6)	574 (5.6)
Cyprus	7 (0.4)	451 (7.6)	67 (0.9)	486 (2.8)	26 (0.8)	484 (4.5)
Czech Republic	r	9 (0.4)	508 (5.6)	75 (0.6)	528 (3.2)	15 (0.7)	532 (7.1)
Denmark	18 (0.9)	522 (4.5)	73 (1.3)	546 (2.8)	9 (0.7)	531 (7.4)
Finland	9 (0.9)	523 (6.1)	74 (1.4)	552 (3.5)	17 (0.7)	549 (4.4)
France	6 (0.4)	460 (8.0)	50 (0.9)	498 (3.9)	44 (0.9)	510 (3.9)
Georgia	3 (0.5)	434 (14.8)	47 (1.4)	463 (5.1)	49 (1.2)	464 (4.9)
Germany	s	5 (0.4)	475 (9.9)	59 (1.6)	530 (3.7)	36 (1.6)	548 (4.4)
Hong Kong SAR	11 (1.0)	506 (5.3)	79 (1.4)	548 (3.5)	10 (0.8)	548 (8.2)
Hungary	s	9 (1.3)	485 (15.9)	57 (1.2)	554 (4.5)	34 (1.0)	556 (4.6)
Iran, Islamic Rep. of	10 (0.9)	409 (9.3)	50 (0.9)	434 (5.2)	39 (1.0)	430 (5.9)
Ireland	9 (0.6)	515 (9.4)	66 (0.9)	540 (4.1)	25 (1.0)	549 (5.1)
Italy	5 (0.5)	486 (8.3)	50 (0.9)	519 (3.2)	45 (1.1)	524 (3.3)
Japan	55 (1.5)	533 (3.7)	42 (1.5)	553 (3.7)	2 ~	~ ~
Jordan	20 (0.7)	397 (7.0)	54 (1.6)	419 (5.9)	25 (1.5)	418 (6.8)
Kazakhstan	6 (0.4)	436 (6.6)	50 (1.0)	469 (5.7)	44 (1.0)	452 (4.5)
Korea, Rep. of	18 (0.8)	545 (6.4)	78 (0.8)	583 (3.2)	4 (0.3)	577 (11.8)
Kosovo	s	1 ~	~ ~	24 (1.0)	414 (6.3)	75 (1.1)	409 (4.8)
Kuwait	10 (0.6)	394 (8.8)	52 (2.0)	400 (6.6)	38 (2.2)	395 (6.4)
Latvia	s	10 (1.2)	483 (11.2)	73 (1.7)	516 (4.3)	17 (1.0)	507 (9.0)
Lithuania	s	7 (0.4)	513 (8.0)	66 (1.4)	530 (4.1)	27 (0.9)	529 (5.4)
Macao SAR	9 (0.3)	513 (6.2)	81 (0.5)	529 (1.7)	10 (0.4)	540 (5.3)
Montenegro	r	5 (0.4)	433 (7.7)	51 (2.4)	472 (4.3)	45 (2.2)	471 (4.0)
Morocco	29 (1.7)	371 (8.9)	39 (1.3)	404 (6.8)	32 (1.6)	402 (7.6)
North Macedonia	4 (0.6)	399 (10.6)	43 (0.9)	447 (6.0)	53 (1.0)	438 (4.5)
Norway (5)	s	17 (1.0)	535 (7.1)	76 (0.9)	554 (3.5)	7 (0.5)	549 (12.7)
Oman	12 (1.3)	407 (5.8)	60 (0.8)	434 (4.0)	28 (1.0)	425 (6.5)
Poland	4 (0.3)	547 (8.6)	67 (0.9)	561 (2.6)	29 (0.9)	561 (3.4)
Portugal	3 (0.4)	470 (8.5)	57 (0.7)	520 (3.7)	40 (0.6)	524 (4.1)
Qatar	s	9 (0.9)	453 (8.1)	58 (1.8)	475 (5.4)	34 (1.4)	473 (5.8)
Romania	s	4 (0.8)	467 (27.5)	49 (1.7)	532 (7.1)	47 (1.7)	537 (6.2)
Saudi Arabia	r	9 (0.9)	429 (7.3)	32 (1.1)	442 (4.0)	60 (0.9)	432 (4.6)
Serbia	5 (0.5)	494 (10.7)	55 (1.1)	520 (3.3)	40 (1.1)	520 (3.7)
Singapore	r	11 (0.4)	575 (4.3)	71 (0.5)	593 (3.9)	19 (0.5)	590 (5.2)
Slovak Republic	11 (1.9)	446 (14.7)	67 (2.3)	519 (4.1)	22 (0.9)	517 (4.9)
Slovenia	1 ~	~ ~	59 (1.2)	528 (3.7)	40 (0.9)	523 (3.2)
Spain	5 (0.3)	479 (7.5)	51 (1.3)	515 (2.6)	44 (1.5)	516 (3.5)
Sweden	r	22 (0.6)	514 (4.7)	67 (0.7)	543 (3.5)	11 (0.5)	523 (7.8)
Türkiye (5)	12 (0.8)	512 (8.7)	46 (1.0)	561 (4.9)	43 (1.2)	562 (4.7)
Uzbekistan	6 (0.5)	397 (8.4)	25 (1.0)	415 (4.8)	70 (1.0)	419 (3.8)
International Average	**11 (0.1)**	**469 (1.5)**	**56 (0.3)**	**500 (0.7)**	**33 (0.3)**	**497 (0.8)**
Canada	x	9 (0.5)	519 (9.9)	64 (2.9)	541 (2.7)	27 (3.1)	543 (4.8)
United Arab Emirates	x	5 (0.2)	488 (5.1)	53 (0.5)	513 (2.7)	42 (0.6)	517 (2.1)
New Zealand	y	- -	- -	- -	- -	- -	- -
Australia	- -	- -	- -	- -	- -	- -
England	- -	- -	- -	- -	- -	- -
Netherlands	- -	- -	- -	- -	- -	- -
South Africa (5)	- -	- -	- -	- -	- -	- -
United States	- -	- -	- -	- -	- -	- -
Benchmarking Participants						
Sharjah, UAE	s	5 (0.4)	501 (8.9)	51 (2.1)	517 (5.9)	44 (2.0)	521 (5.1)
Abu Dhabi, UAE	x	8 (1.0)	450 (7.2)	53 (1.0)	477 (4.9)	39 (0.8)	478 (4.2)
Dubai, UAE	x	4 (0.3)	566 (10.0)	54 (0.9)	578 (3.5)	42 (0.9)	581 (3.3)
Quebec, Canada	x	10 (1.6)	490 (10.7)	66 (1.6)	515 (3.4)	25 (2.7)	516 (6.5)
Ontario, Canada	y	- -	- -	- -	- -	- -	- -

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
An "x" indicates data are available for at least 40% but less than 50% of the students—interpret with caution.
A "y" indicates data are available for less than 40% of the students.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated. A tilde (~) indicates insufficient data to report result.

Across countries, there is very little difference in the average expected achievement in environmental knowledge for students whose parents were classified as either Sometimes or Frequently encouraging environmentally responsible attitudes and behaviors (500 versus 497 scale score points, respectively). Students whose parents were classified as Rarely encouraging environmentally responsible attitudes and behaviors had noticeably lower average achievement than the other two classes (469 scale score points), although it is important to keep in mind that this was the smallest class (overall, 11% of students' parents assigned to this class), which led to larger standard errors in the expected achievement estimates for this class.

There are also relatively small differences in expected achievement in environmental knowledge between students whose parents Sometimes or Frequently encourage pro-environmental attitudes and behavior within countries and benchmarking participants. These differences range from an 18-point difference favoring students whose parents are in the Frequently class (Germany) to a 20-point difference favoring students whose parents are in the Sometimes class (Sweden). All but seven countries have an expected achievement in environmental knowledge difference of 10 points or less.

Within-country expected achievement differences in environmental knowledge are often larger when comparing students whose parents were assigned to the Rarely class to students whose parents were assigned the other two classes. The expected achievement difference between students whose parents are in the Frequently and Rarely classes is as high as 125 scale score points (Bulgaria) and is greater than 40 scale score points in nine countries, with differences favoring the Frequently class in all countries and benchmarking participants. However, there are also five countries where the expected achievement difference between these classes is less than 10 scale score points. Expected achievement in environmental knowledge differences between students whose parents were assigned to the Sometimes and Rarely classes are similar, ranging from 115 scale score points (Bulgaria) to 6 scale score points (Kuwait); all differences favor the Sometimes class.

The distribution of students across the three classes reveals that within-country majorities of students' parents in many countries report moderate frequencies of encouraging the development of environmentally responsible attitudes and behavior in their children. More than half of the countries and benchmarking participants have at least 50 percent of students' parents assigned to the Sometimes class, and only six countries have less than 40 percent of students' parents assigned to this class. Six countries have more than 50 percent of students' parents assigned to the Frequently class, and seven countries have 10 percent or fewer of students' parents assigned to this class. Only one country (Japan) had more than 50 percent of students' parents assigned to the Rarely class, while a large majority of countries and all benchmarking participants had less than 20 percent of students' parents in this class.

These results suggest that there is a weakly positive relationship between the frequency with which parents encourage development of children's pro-environmental attitudes and behaviors and students' environmental knowledge. However, increased encouragement is not necessarily associated with increased environmental knowledge. Across and within countries, the most notable differences in expected achievement were between students whose parents Rarely encouraged these attitudes and behaviors and students whose parents were assigned to the other two classes.

School Emphasis on Environmental Sustainability

The TIMSS 2023 School Questionnaire included eight items asking principals to indicate their level of agreement with statements about different ways the school might promote environmental sustainability. These items were identical across the Grade 4 and Grade 8 versions of the questionnaire and are presented in Exhibit 4.1.

Exhibit 4.1: School Questionnaire Items

Item Label	Item Text	Response Categories
	How much do you agree with these statements?	• Disagree a lot • Disagree a little • Agree a little • Agree a lot
Shared vision	This school has a shared vision about its role in supporting environmental sustainability	
Review sustainability practices	This school regularly reviews its practices to make them more environmentally sustainable	
Schoolwide approach	There is a schoolwide approach to teaching environmental sustainability to students	
Teach students to appreciate	This school teaches students to appreciate the natural environment	
Teach students how to take action	This school teaches students how to take action to protect the natural environment	
Encourage teachers' learning	This school encourages teachers to learn about teaching environmental sustainability	
Promotes within community	This school promotes environmental sustainability within the community	
Participation in networks/projects	This school promotes participation in networks or projects related to environmental sustainability	

The MG-LCA procedure identified three classes to characterize principals' responses to the eight items. Exhibits 4.2, 4.3, and 4.4 present summaries and conditional item probabilities for each of these classes. Note that the class descriptions on Exhibit 4.2 apply to both fourth and eighth grade; although the conditional probabilities for selecting item responses vary across grades, the same patterns in these probabilities were observed across grades such that the same descriptive overview is sufficient for both grades. Exhibit 4.3 shows the conditional item response probabilities for the Grade 4 classes and Exhibit 4.4 shows the conditional item response probabilities for the Grade 8 classes.

Exhibit 4.2: Profiles of School Emphasis on Environmental Sustainability (Grades 4 and 8)

Class Number	Class Label	Class Description Overview
Class 1	**Some** Emphasis on Environmental Sustainability	• Most likely to "disagree a little" with 5 out of 8 items • Most likely to "agree a little" with *Shared vision*, *Teach students to appreciate* and *Teach students how to take action*
Class 2	**High** Emphasis on Environmental Sustainability	• Most likely response is "agree a little" for all 8 items • Conditional probability of selecting "agree a lot" is highest for *Teach students to appreciate* and *Teach students how to take action* (greater than 0.4 in Grade 4 and greater than 0.3 in Grade 8)
Class 3	**Very High** Emphasis on Environmental Sustainability	• Most likely response is "agree a lot" for all 8 items • Conditional probability of selecting "agree a lot" for *Teach students to appreciate* and *Teach students how to take action* is greater than 0.95 (Grade 4 and Grade 8)

Exhibit 4.3: Conditional Item Response Probabilities by Profile of School Emphasis on Environmental Sustainability (Grade 4)
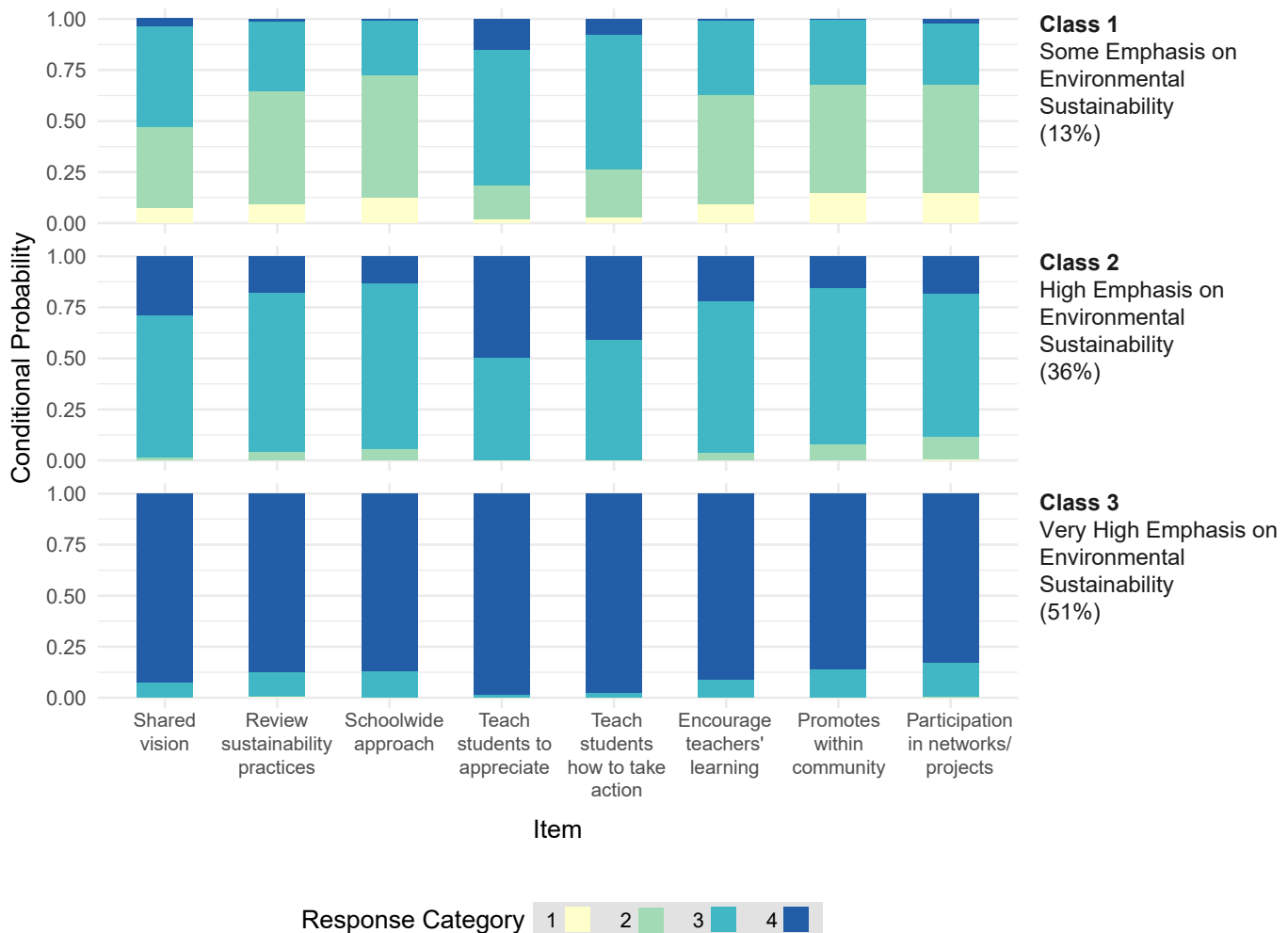
Exhibit 4.4: Conditional Item Response Probabilities by Profile of School Emphasis on Environmental Sustainability (Grade 8)

Class 1
Some Emphasis on Environmental Sustainability (12%)

Class 2
High Emphasis on Environmental Sustainability (37%)

Class 3
Very High Emphasis on Environmental Sustainability (51%)

Response Category 1 2 3 4
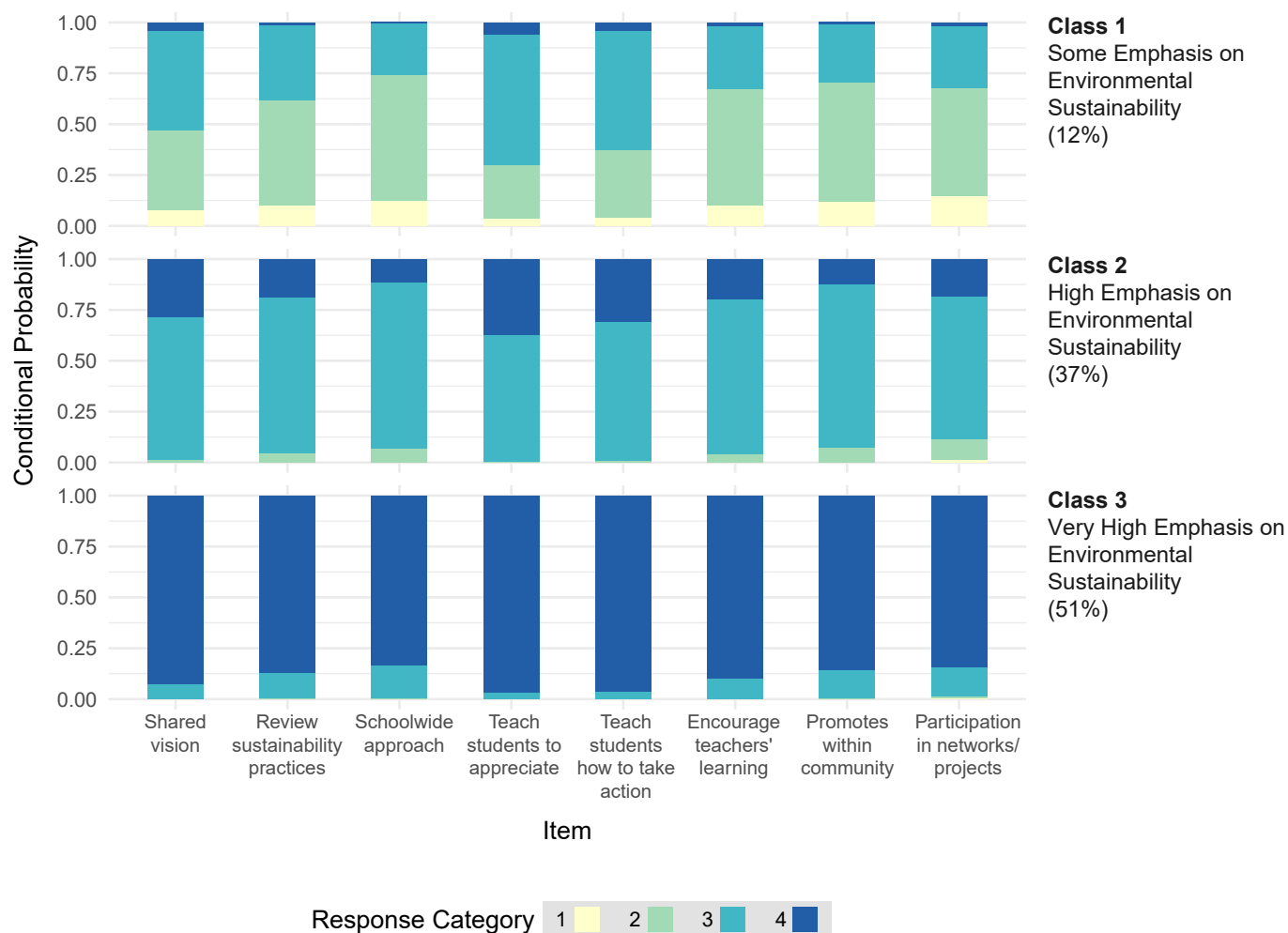
As can be seen in Exhibits 4.3 and 4.4, both the overall class probabilities and conditional item response probabilities within classes are quite similar across Grade 4 and Grade 8. Marginal probabilities were greatest for being assigned to the **Very High** emphasis on environmental sustainability class (51% in both grades), followed by the **High** emphasis class (36% in Grade 4 and 37% in Grade 8), and then the **Some** emphasis class (13% in Grade 4 and 12% in Grade 8). Because patterns in conditional item response probabilities are so similar across grades, the class descriptions in the following paragraphs can be applied to both Grade 4 and Grade 8.

Principals whose schools were classified as having a Very High Emphasis on Environmental Sustainability (Class 3) were most likely to "agree a lot" by a wide margin with all questionnaire items. Conditional probabilities for selecting "agree a lot" are greater than 0.8 for both grades. It is important to acknowledge potential limitations in interpreting this class. There is a possibility that principals with these extreme response patterns were engaged in socially desirable responding, believing that their schools may be expected to prioritize promoting environmentalism and sustainability. It is important to acknowledge that the principal's level of agreement with these statements is not necessarily indicative of specific actions or initiatives taken within a school.

Principals whose schools were classified as having a High Emphasis on Environmental Sustainability (Class 2) were most likely to "agree a little" with all eight items. It is worth noting in both grades that the conditional probabilities of selecting "agree a lot" for *Teach students how to appreciate* and *Teach students how to take action* are noticeably greater than for the other

items, even though "agree a little" remains the most likely response. These two items are focused explicitly on teaching students, whereas the other six items are about school policies or engaging with groups outside of the school. Promoting environmentalism through teaching students may require less additional effort on the part of school administrative staff compared to other types of activities, perhaps explaining the increased probability of "agreeing a lot" with the teaching-related statements for principals whose schools are in this class.

Principals whose schools were classified as having Some Emphasis on Environmental Sustainability (Class 1) were most likely to "agree a little" with the two teaching-related items (*Teach students how to appreciate* and *Teach students how to take action*) and *Shared vision*, and "disagree a little" with the other five items. This may be an even stronger expression of the phenomenon described in the previous paragraph—even when the principal is unlikely to agree that the school as an institution takes administrative or community action to promote environmentalism and sustainability, they are still likely to agree that the school teaches students to appreciate and/or protect the natural environment.

The class descriptions from the school-level MG-LCA suggest that many schools in both fourth and eighth grades have a relatively high degree of emphasis on environmentalism and sustainability. Even schools with less overall emphasis are still likely to have principals agree that students within the school are taught about environmental appreciation and potential actions they can take to protect the natural environment. Exhibits 4.5 and 4.6 present the distributions of students in schools in the three classes across countries, as well as the relationship between class membership and expected achievement in environmental knowledge. Exhibit 4.5 presents the results for Grade 4 and Exhibit 4.6 presents the results for Grade 8.

Across the Grade 4 countries, there is little to no difference in the average expected achievement in environmental knowledge for students in schools across the three classes. Students in schools with a Very High Emphasis on environmental sustainability have an international average expected achievement of 498 scale score points, students in schools with a High Emphasis have an average expected achievement of 495 scale score points, and students in schools with Some Emphasis have an average expected achievement of 498 scale score points.

Exhibit 4.5: School Emphasis on Environmental Sustainability and Achievement in Environmental Knowledge

Country	Some Emphasis on Environmental Sustainability		High Emphasis on Environmental Sustainability		Very High Emphasis on Environmental Sustainability	
	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Albania	0 ~	~ ~	4 (2.0)	493 (30.1)	96 (2.0)	487 (5.8)
Armenia	2 ~	~ ~	23 (3.4)	483 (8.5)	74 (3.7)	462 (5.4)
Australia	29 (3.8)	541 (6.5)	52 (3.9)	555 (4.9)	19 (2.7)	570 (6.0)
Azerbaijan	6 (1.9)	427 (10.1)	51 (3.8)	414 (6.2)	43 (4.0)	411 (5.6)
Bahrain	5 (1.4)	478 (16.8)	32 (2.9)	461 (6.2)	63 (3.2)	482 (5.6)
Belgium (Flemish)	20 (3.9)	484 (9.5)	56 (4.2)	495 (4.1)	24 (3.8)	493 (7.5)
Belgium (French)	40 (3.9)	482 (5.0)	48 (4.3)	483 (5.0)	12 (2.6)	475 (10.8)
Bosnia & Herzegovina r	2 ~	~ ~	22 (4.6)	455 (6.8)	76 (4.6)	451 (6.1)
Brazil	7 (1.5)	420 (26.1)	35 (3.4)	420 (8.3)	58 (3.8)	436 (7.2)
Bulgaria	4 (1.2)	484 (35.7)	26 (3.8)	534 (12.6)	70 (3.9)	535 (7.9)
Canada	29 (2.0)	516 (3.5)	49 (2.5)	533 (2.9)	22 (2.1)	526 (4.5)
Chile r	24 (4.0)	484 (6.0)	48 (4.7)	491 (4.6)	28 (3.9)	485 (7.3)
Chinese Taipei	6 (1.7)	569 (5.3)	53 (3.4)	567 (2.9)	40 (3.4)	565 (3.6)
Cyprus	7 (1.5)	500 (9.6)	31 (3.4)	475 (6.9)	62 (3.6)	481 (4.1)
Czech Republic	10 (2.1)	508 (7.2)	58 (3.5)	523 (3.4)	32 (3.3)	516 (4.9)
Denmark	71 (4.0)	540 (3.7)	23 (3.3)	532 (5.8)	6 (2.1)	540 (14.3)
England r	21 (4.1)	568 (10.1)	52 (5.4)	563 (6.1)	28 (4.1)	551 (7.5)
Finland	23 (3.3)	538 (5.7)	62 (3.7)	543 (4.0)	15 (2.5)	546 (8.7)
France r	29 (3.5)	498 (6.0)	43 (3.7)	490 (4.9)	28 (4.1)	496 (7.7)
Georgia	1 ~	~ ~	34 (3.6)	453 (6.9)	65 (3.6)	465 (5.0)
Germany	33 (3.2)	519 (5.2)	49 (3.6)	516 (5.4)	18 (2.7)	526 (6.6)
Hong Kong SAR r	10 (4.3)	566 (24.0)	53 (6.3)	545 (10.5)	37 (5.1)	540 (6.3)
Hungary	3 (1.5)	504 (22.4)	36 (3.7)	523 (8.4)	62 (3.9)	542 (5.1)
Iran, Islamic Rep. of	3 (1.0)	392 (24.3)	17 (2.6)	411 (11.6)	80 (2.8)	433 (5.7)
Ireland	11 (2.5)	518 (11.7)	51 (4.4)	531 (5.2)	38 (4.1)	551 (4.8)
Italy	14 (2.5)	517 (6.2)	57 (4.3)	519 (3.9)	30 (4.1)	517 (4.7)
Japan	51 (3.8)	541 (3.5)	49 (3.8)	542 (4.8)	0 ~	~ ~
Jordan	4 (1.5)	407 (21.0)	38 (4.0)	412 (9.1)	58 (4.1)	410 (6.7)
Kazakhstan	2 ~	~ ~	40 (3.5)	441 (6.2)	58 (3.6)	466 (6.7)
Korea, Rep. of	3 (1.3)	562 (15.7)	33 (4.1)	573 (4.6)	64 (4.2)	577 (4.8)
Kosovo r	0 ~	~ ~	15 (2.8)	397 (8.4)	85 (2.8)	400 (4.3)
Kuwait	6 (1.8)	402 (20.3)	33 (4.4)	398 (10.6)	60 (4.5)	388 (8.0)
Latvia	13 (1.8)	507 (7.2)	49 (3.6)	504 (4.0)	38 (3.6)	501 (5.8)
Lithuania	4 (1.5)	507 (13.4)	41 (3.8)	522 (4.9)	55 (3.7)	521 (4.5)
Macao SAR	4 (0.0)	484 (6.3)	30 (0.1)	517 (2.2)	67 (0.1)	536 (1.9)
Montenegro	2 ~	~ ~	35 (0.5)	467 (4.2)	63 (0.5)	469 (2.7)
Morocco	7 (1.7)	372 (11.9)	45 (3.8)	387 (9.3)	47 (3.9)	404 (8.4)
Netherlands s	65 (5.5)	512 (4.4)	35 (5.5)	524 (5.1)	1 ~	~ ~
New Zealand r	25 (3.8)	516 (7.4)	44 (4.1)	522 (5.0)	30 (4.2)	525 (10.7)
North Macedonia	5 (1.6)	418 (18.1)	18 (2.9)	442 (9.9)	77 (3.1)	441 (5.1)
Norway (5)	30 (3.5)	534 (5.3)	62 (3.6)	540 (3.6)	8 (2.0)	538 (8.4)
Oman	2 ~	~ ~	38 (3.4)	419 (7.7)	60 (3.4)	429 (4.9)
Poland	4 (1.6)	563 (26.8)	48 (3.6)	556 (3.0)	48 (3.7)	560 (3.4)
Portugal	3 (1.2)	532 (18.8)	16 (3.0)	523 (7.8)	81 (3.2)	518 (3.8)
Qatar	4 (1.4)	481 (19.2)	23 (2.9)	464 (9.5)	73 (3.0)	464 (4.6)
Romania s	2 ~	~ ~	16 (3.9)	514 (11.8)	82 (4.2)	522 (7.2)
Saudi Arabia	2 ~	~ ~	24 (3.0)	420 (8.6)	74 (3.1)	434 (4.6)
Serbia	6 (1.3)	509 (12.8)	36 (3.8)	517 (5.3)	58 (4.0)	519 (3.8)
Singapore	2 ~	~ ~	31 (0.0)	581 (5.2)	67 (0.0)	576 (4.5)
Slovak Republic	2 ~	~ ~	40 (3.7)	505 (6.8)	58 (3.7)	513 (5.4)
Slovenia	7 (1.8)	532 (5.6)	76 (2.9)	520 (3.2)	16 (2.8)	521 (6.2)
Spain	9 (1.5)	501 (8.0)	42 (2.7)	508 (3.9)	50 (2.8)	515 (3.3)
Sweden	54 (4.3)	527 (4.4)	43 (4.2)	523 (6.9)	3 (1.4)	533 (14.2)
Türkiye (5)	2 ~	~ ~	35 (3.3)	546 (6.8)	64 (3.5)	557 (4.8)
United Arab Emirates	6 (0.7)	427 (13.2)	20 (0.6)	476 (3.3)	74 (0.9)	504 (2.1)
United States	51 (3.4)	527 (4.6)	34 (3.2)	555 (5.7)	15 (2.5)	535 (9.3)
Uzbekistan	1 ~	~ ~	11 (2.3)	406 (7.2)	88 (2.4)	418 (3.4)
International Average	**14 (0.3)**	**498 (2.2)**	**38 (0.5)**	**495 (1.0)**	**48 (0.4)**	**498 (0.9)**
South Africa (5)	- -	- -	- -	- -	- -	- -
Benchmarking Participants						
Ontario, Canada r	20 (3.4)	535 (6.1)	49 (4.5)	540 (4.7)	31 (4.3)	530 (6.8)
Quebec, Canada r	55 (4.5)	501 (4.1)	34 (4.4)	511 (5.2)	11 (2.5)	519 (7.9)
Abu Dhabi, UAE r	11 (2.1)	383 (13.0)	25 (1.3)	432 (5.2)	64 (2.0)	451 (4.2)
Dubai, UAE	2 ~	~ ~	21 (0.2)	538 (2.9)	77 (0.2)	575 (2.3)
Sharjah, UAE	7 (0.6)	502 (7.6)	19 (2.0)	479 (10.1)	75 (2.2)	505 (5.7)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated. A tilde (~) indicates insufficient data to report result.

This lack of a clear association between students' schools' class membership and expected achievement in environmental knowledge is also evident within countries and benchmarking participants. It may be that school emphasis on environmental sustainability as captured in the questionnaire items does not capture contextual differences that directly impact student knowledge—even principals whose schools were in the Some Emphasis category were likely to agree that the school taught students about different aspects of the natural environment. While school policy- or community-level actions may be helpful in promoting larger goals related to environmental sustainability, they do not appear to be directly related to fourth-grade students' environmental knowledge.

Although there are no patterns in expected achievement differences across the classes, there are some interesting differences in the prevalence of classes within countries. Thirty-one countries and two benchmarking participants have 50 percent or more of their students in schools with a Very High Emphasis on environmental sustainability; however, there are also five countries with less than 10 percent of students in such schools (Denmark, Japan, Netherlands, Norway, Sweden). All of these five but Norway have more than 50 percent of students in schools classified as having only Some Emphasis on environmental sustainability. Thirty-eight countries and two benchmarking participants had 10 percent or fewer of their students in schools in the Some Emphasis class.

The Grade 8 results in Exhibit 4.6 also reveal little evidence for a meaningful relationship between school emphasis on environmental sustainability and students' expected achievement in environmental knowledge. Students whose schools were classified as having Very High Emphasis on Environmental Sustainability had an expected achievement of 479 scale score points, on average; students in schools with a High Emphasis, 474 scale score points; and students in schools with Some Emphasis, 475 scale score points.

Expected achievement differences within countries and benchmarking participants also reflect this lack of association; there are no clear patterns of students in schools in any particular class having consistently higher achievement in environmental knowledge. As noted above, it may be that school policies or practices to promote sustainability do not have a direct relationship with students' knowledge about environmental topics.

Exhibit 4.6: School Emphasis on Environmental Sustainability and Achievement in Environmental Knowledge

Country	Some Emphasis on Environmental Sustainability		High Emphasis on Environmental Sustainability		Very High Emphasis on Environmental Sustainability	
	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Australia r	34 (3.6)	510 (6.5)	42 (3.8)	527 (6.5)	24 (3.2)	538 (6.4)
Austria	15 (3.1)	503 (9.6)	50 (4.2)	492 (7.2)	35 (3.9)	515 (7.5)
Azerbaijan	5 (1.8)	404 (17.0)	36 (3.8)	407 (5.1)	59 (4.0)	414 (3.7)
Bahrain	3 (0.1)	449 (8.6)	44 (0.6)	425 (3.2)	54 (0.6)	460 (3.6)
Brazil	9 (1.6)	412 (15.7)	43 (2.7)	426 (5.1)	48 (2.8)	423 (5.0)
Chile r	25 (4.1)	455 (8.4)	49 (4.4)	469 (5.7)	26 (4.0)	460 (7.3)
Chinese Taipei	4 (1.3)	541 (13.9)	53 (3.5)	545 (3.9)	43 (3.7)	566 (4.2)
Cyprus	8 (1.5)	465 (13.6)	24 (1.3)	490 (7.7)	68 (2.2)	462 (3.9)
Czech Republic	12 (1.6)	520 (6.1)	54 (3.5)	518 (3.2)	34 (3.3)	514 (3.8)
England r	38 (4.9)	530 (8.9)	52 (4.8)	527 (7.2)	10 (3.8)	535 (13.2)
Finland	25 (3.4)	542 (5.1)	59 (4.2)	535 (3.3)	16 (3.2)	543 (8.9)
France	28 (3.8)	493 (6.9)	49 (4.2)	497 (5.0)	24 (3.4)	499 (8.1)
Georgia	3 (1.2)	441 (11.9)	34 (3.4)	436 (4.8)	63 (3.6)	441 (4.0)
Hong Kong SAR s	14 (3.8)	541 (12.7)	60 (4.6)	535 (9.4)	27 (3.9)	551 (14.6)
Hungary	4 (1.6)	533 (23.2)	38 (3.6)	524 (5.7)	57 (3.9)	516 (5.3)
Iran, Islamic Rep. of	4 (1.3)	414 (20.8)	20 (2.6)	414 (8.5)	76 (3.0)	404 (5.4)
Ireland	20 (3.7)	534 (4.7)	54 (4.3)	531 (5.0)	25 (3.8)	535 (5.7)
Israel	22 (3.1)	490 (8.1)	48 (3.4)	476 (5.6)	30 (3.3)	482 (9.2)
Italy	15 (2.8)	510 (7.9)	50 (4.3)	501 (5.7)	36 (3.9)	510 (5.4)
Japan	61 (4.1)	546 (4.4)	38 (4.1)	557 (5.3)	1 ~	~ ~
Jordan	6 (1.7)	412 (8.3)	33 (3.5)	402 (7.0)	61 (3.6)	411 (4.5)
Kazakhstan	0 ~	~ ~	36 (4.0)	421 (5.0)	63 (4.0)	446 (4.3)
Korea, Rep. of	5 (1.7)	550 (11.5)	46 (3.6)	548 (4.1)	49 (4.0)	547 (4.0)
Kuwait	7 (2.3)	410 (19.1)	36 (4.4)	413 (9.9)	57 (4.6)	427 (7.7)
Lithuania	4 (1.7)	530 (21.5)	43 (3.6)	503 (4.7)	53 (3.7)	509 (4.0)
Malaysia	4 (1.5)	404 (20.4)	41 (4.0)	417 (6.0)	55 (4.2)	437 (5.2)
Malta	12 (0.1)	494 (4.5)	55 (0.2)	488 (2.1)	33 (0.2)	513 (2.6)
Morocco	10 (2.0)	303 (10.2)	40 (3.5)	335 (6.3)	50 (3.7)	334 (4.9)
Norway (9) r	35 (3.2)	502 (4.5)	57 (3.6)	512 (4.0)	8 (2.3)	490 (9.6)
Oman	4 (1.4)	431 (5.7)	28 (2.8)	444 (5.5)	68 (3.1)	456 (3.4)
Palestinian Nat'l Auth.	7 (1.9)	363 (9.5)	51 (3.5)	360 (3.8)	42 (3.5)	378 (5.3)
Portugal	2 ~	~ ~	19 (3.1)	529 (5.8)	79 (3.1)	517 (3.3)
Qatar	2 ~	~ ~	34 (4.2)	484 (6.4)	64 (4.2)	476 (6.2)
Romania s	3 (1.9)	497 (12.9)	6 (2.4)	472 (13.3)	91 (3.0)	459 (5.6)
Saudi Arabia	3 (1.1)	367 (20.4)	33 (3.3)	398 (6.7)	65 (3.5)	419 (4.9)
Singapore	5 (1.5)	558 (24.7)	45 (3.8)	583 (8.9)	51 (3.8)	605 (8.2)
South Africa (9)	27 (3.3)	360 (11.5)	46 (3.4)	355 (6.9)	27 (3.7)	366 (12.2)
Sweden	49 (3.8)	537 (5.6)	44 (3.9)	537 (6.6)	7 (2.0)	556 (14.6)
Türkiye	5 (1.8)	526 (14.4)	23 (3.7)	509 (6.6)	71 (3.9)	530 (4.5)
United Arab Emirates	3 (0.6)	456 (8.8)	21 (1.2)	448 (4.1)	76 (1.2)	487 (2.9)
United States	42 (3.4)	519 (6.1)	42 (3.5)	522 (6.7)	16 (2.6)	513 (12.5)
Uzbekistan	2 ~	~ ~	9 (2.3)	382 (4.6)	89 (2.6)	390 (3.8)
International Average	**14 (0.4)**	**475 (2.1)**	**40 (0.5)**	**474 (1.0)**	**46 (0.5)**	**479 (1.1)**
Cote d'Ivoire	- -	- -	- -	- -	- -	- -
Benchmarking Participants						
Abu Dhabi, UAE r	6 (1.8)	448 (16.1)	31 (2.3)	406 (5.4)	63 (2.6)	451 (5.9)
Dubai, UAE	1 ~	~ ~	19 (2.0)	513 (8.8)	80 (2.0)	546 (4.0)
Sharjah, UAE r	2 ~	~ ~	11 (2.5)	485 (11.1)	86 (2.5)	491 (6.2)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A dash (-) indicates comparable data not available because average achievement could not be reliably estimated. A tilde (~) indicates insufficient data to report result.

Twenty-one countries and the three benchmarking participants had 50 percent or more of their eighth-grade students in schools assigned to the Very High Emphasis class, and only four countries (England, Japan, Norway, and Sweden) had 10 percent or fewer of their students in schools assigned to this class. Only Japan had more than 50 percent of students in schools assigned to the Some Emphasis class, and 25 countries and the three benchmarking participants had 10 percent or fewer of their students in schools assigned to this class.

In both fourth and eighth grades, no clear relationship is observed between school emphasis on environmental sustainability and students' expected achievement in environmental knowledge. It is possible that school policy or community actions, while contributing to sustainability more

holistically, may not have a direct association with students' environmental knowledge. This may contrast with more directly teaching students about the natural environment, which appeared to occur in schools across all three classes. Further research is needed to investigate this finding.

Teacher Emphasis on Environmental Sustainability

The TIMSS 2023 Science Teacher Questionnaire included nine items related to environmental sustainability. Four items asked teachers to report how often they engaged in certain classroom discussion-based activities to promote the development of students' pro-environmental attitudes and behaviors. An additional four binary items asked teachers to indicate whether or not they carried out larger projects (several of them outdoors) with students. Finally, teachers were asked to indicate their level of agreement that education about environmentalism and sustainability should be a priority for schools. These nine items (shown in Exhibit 5.1) were identical in Grades 4 and 8 and were included in the MG-LCA.

Exhibit 5.1: Teacher Questionnaire Items

Item Label	Item Text	Response Categories
Develop positive attitudes	How often do you do the following when teaching this class? Develop students' positive attitudes toward the natural environment	• Never or almost never • A few times a year • Once or twice a month • At least once a week
Encourage save resources	Encourage students to use less resources (e.g., <water, energy>)	
Discuss actions	Discuss how student actions in and outside of school can help the natural environment	
Discuss problems	Discuss environmental problems (e.g., <climate change, endangered animals>)	
Visit natural areas	Do you do these things to teach students about environmental issues and sustainability? Take students to visit natural areas (e.g., <a pond or meadow>)	• No • Yes
Responsible activities	Have students participate in environmentally responsible activities (e.g., <pick up trash>)	
Research topics	Have students do research or projects on a particular environmental topic (e.g., <pollution, climate change>)	
Outdoor programs	Provide opportunities for students to participate in outdoor environmental education programs outside of school	
Opinion on priority	How much do you agree or disagree that education about environmental sustainability should be a priority for schools?	• Disagree a lot • Disagree a little • Agree a little • Agree a lot

Terms in brackets <> required country-specific adaptation.

The MG-LCA identified four classes to characterize the responses of both fourth- and eighth-grade teachers. The overall profiles are similar for Grade 4 and Grade 8, leading to the choice for identical class labels; however, there are some minor differences between grades in the conditional item responses probabilities for each class. Therefore, results are described separately for each grade.

Grade 4 Results

Information about the four fourth-grade classes identified by the MG-LCA is presented in Exhibits 5.2 and 5.3. Exhibit 5.2 presents summary information about each class and Exhibit 5.3 presents the conditional item response probabilities for each class.

Exhibit 5.2: Profiles of Teacher Emphasis on Environmental Sustainability (Grade 4)

Class Number	Class Label	Class Description Overview
Class 1	**Little** Emphasis on Environmental Sustainability	• Most likely to select "a few times a year" for all 4 classroom discussion items • Most likely to select "yes" for *Responsible activities* and "no" for other 3 larger project items • Nearly equivalent chance of selecting "agree a lot" or "agree a little" that education about environmental sustainability should be a priority for schools (conditional probabilities of 0.45 and 0.47)
Class 2	**Some** Emphasis on Environmental Sustainability	• Most likely to select "once or twice a month" for all 4 classroom discussion items • Most likely to select "no" for *Outdoor programs* and "yes" for other 3 larger project items • Most likely to select "agree a lot" that education about environmental sustainability should be a priority for schools
Class 3	**Strong** Emphasis on Environmental Sustainability **with Limited Outdoor Activities**	• Most likely to select "at least once a week" for all 4 classroom discussion items • Most likely to select "yes" for *Responsible activities* and *Research topics* (conditional probabilities of 0.82 and 0.79), but most likely to select "no" for *Visit natural areas* and *Outdoor programs* (conditional probabilities of 1.00 and 0.61) • Most likely to select "agree a lot" that education about environmental sustainability should be a priority for schools
Class 4	**Strong** Emphasis on Environmental Sustainability **with Outdoor Activities**	• Most likely to select "at least once a week" for all 4 classroom discussion items • Most likely to select "yes" for all 4 larger project items • Most likely to select "agree a lot" that education about environmental sustainability should be a priority for schools

Exhibit 5.3: Conditional Item Response Probabilities by Profile of Teacher Emphasis on Environmental Sustainability (Grade 4)*
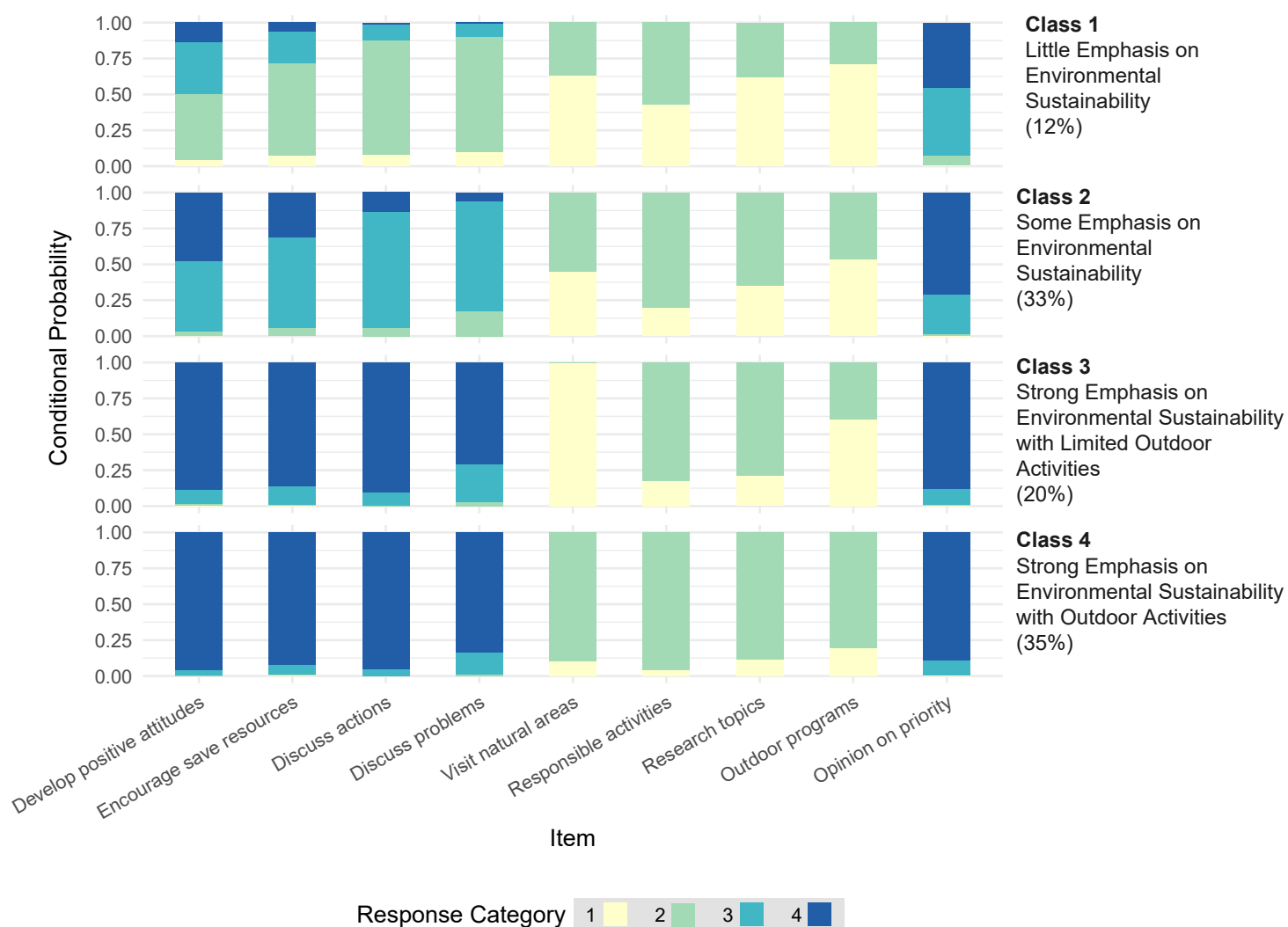
*For the four binary items in the Teacher Questionnaire, a response of 2 indicates "Yes" to items about teaching students about environmental issues and sustainability, while a response of 1 indicates "No."

The four classes identified for Grade 4 teachers reflect varying degrees of emphasis on environmental sustainability, as well as differential implementation of outdoor activities. Across countries, the overall probability was lowest for being classified as placing **Little Emphasis** on environmental sustainability (12%). Teachers had a greater overall probability of being classified as placing **Some Emphasis** on environmental sustainability (33%). Teachers had the greatest probability of being assigned to one of the **Strong Emphasis** classes, either with **Limited Outdoor Activities** (20%) or with **Outdoor Activities** (35%).

Teachers classified as placing a Strong Emphasis on Environmental Sustainability with Outdoor Activities (Class 4) were most likely to select "at least once a week" for all four items related to classroom discussions, "yes" for all four items related to larger projects, and "agree a lot" that education about environmental sustainability should be a priority for schools. Teachers in this class reported expending considerable effort to teach students about environmental problems, although it should be noted that some classroom discussion activities (for example, *Develop positive attitudes*) may be easily incorporated into lessons about a variety of science topics without having to expend too much additional effort (for example, by reading a book where a character exhibits care for the environment).

Teachers classified as placing a Strong Emphasis on Environmental Sustainability with Limited Outdoor Activities (Class 3) had conditional item response probabilities very similar to Class 4 teachers, with two notable exceptions: Teachers in this class were much more likely to select "no" for *Visit natural areas* and *Outdoor programs* (conditional probabilities of 1.00 and 0.61). These results do not show why teachers in this class report a lower engagement in these particular larger projects. It may be that teachers in this class prioritize environmental sustainability in their teaching but lack adequate access to outdoor areas because of their school's location or policies related to taking students off of school grounds. It is also possible that the mechanisms restricting outdoor activities in this class vary by country; further research at the country level is needed to investigate this.

Teachers classified as placing Some Emphasis on Environmental Sustainability (Class 2) were most likely to select "once or twice a month" for all four classroom discussion items, "yes" for all four larger project items but *Outdoor programs*, and "agree a lot" that education about environmental sustainability should be a priority for schools. Teachers in this class are distinguished by their much lower frequency of reported engagement in the classroom discussion items, compared to teachers in the two Strong Emphasis classes. The classroom discussion item for which these teachers are most likely to select "at least once a week" is *Develop positive attitudes*, which, as noted above, may be easily incorporated into science lessons about a variety of topics.

Teachers classified as placing Little Emphasis on Environmental Sustainability (Class 1) were most likely to select "a few times a year" for all four classroom discussion items. However, the pattern observed in other classes with *Develop positive attitudes* is also evident here: Teachers in this class were more likely to select "a few times a month" for this particular item than for any of the other classroom discussion items. Teachers in the Little Emphasis class were most likely to select "no" for three out of the four larger project items, with the exception being *Responsible activities*. Lastly, these teachers had a nearly equivalent chance of "agreeing a lot" or "agreeing a little" that education about environmental sustainability should be a priority for schools (conditional probabilities of 0.45 and 0.47, respectively).

The Grade 4 teacher class descriptions suggest that most teachers place at least a little emphasis on environmental sustainability in their teaching and agree that education about this topic should be a priority for schools. Exhibit 5.4 shows the distributions of students with teachers in each class within countries, as well as the relationship between class membership and students' expected achievement in environmental knowledge.

Internationally, there is no clear association between the class membership of fourth-grade students' teachers and students' expected achievement in environmental knowledge. Across countries, students whose teachers were classified as placing Little Emphasis on Environmental Sustainability had an average expected achievement of 500 scale score points; students whose teachers placed Some Emphasis, 496 scale score points. In the Strong Emphasis classes, students whose teachers were assigned to the Limited Outdoor Activities class had an expected achievement of 494 scale score points; students whose teachers were assigned to the With Outdoor Activities class, 501 scale score points. The average expected achievement differences are quite small across all four classes.

Exhibit 5.4: Teacher Emphasis on Environmental Sustainability and Achievement in Environmental Knowledge

Country	Little Emphasis on Environmental Sustainability		Some Emphasis on Environmental Sustainability		Strong Emphasis on Environmental Sustainability with Limited Outdoor Activities		Strong Emphasis on Environmental Sustainability with Outdoor Activities	
	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Albania r	17 (12.9)	474 (12.7)	24 (17.4)	462 (7.4)	0 ~	~ ~	59 (7.8)	494 (7.1)
Armenia	1 ~	~ ~	14 (2.6)	461 (11.8)	8 (1.4)	470 (10.1)	77 (3.0)	468 (5.6)
Australia r	22 (4.2)	547 (7.8)	42 (6.3)	558 (5.6)	18 (3.2)	549 (7.3)	18 (3.4)	562 (6.8)
Azerbaijan r	2 ~	~ ~	38 (3.8)	407 (5.5)	6 (1.3)	413 (8.3)	54 (3.7)	416 (6.7)
Bahrain	6 (2.0)	473 (10.0)	28 (2.8)	474 (7.9)	36 (3.1)	463 (6.6)	30 (2.7)	490 (7.3)
Belgium (Flemish) r	31 (3.1)	482 (5.4)	55 (5.1)	498 (4.0)	0 ~	~ ~	14 (4.8)	488 (9.0)
Belgium (French)	40 (3.7)	483 (5.8)	37 (3.8)	488 (4.2)	9 (1.9)	485 (10.8)	14 (2.6)	470 (9.9)
Bosnia & Herzegovina r	2 ~	~ ~	33 (7.5)	454 (8.0)	3 (1.3)	466 (15.9)	63 (7.3)	448 (7.3)
Brazil	4 (1.3)	418 (20.4)	19 (3.2)	427 (11.2)	39 (3.7)	425 (9.8)	38 (3.9)	439 (7.7)
Bulgaria	1 ~	~ ~	14 (2.0)	533 (16.0)	9 (1.3)	530 (15.9)	77 (2.4)	534 (6.8)
Canada	20 (2.1)	521 (3.5)	38 (2.5)	525 (3.5)	18 (1.8)	519 (4.4)	24 (1.9)	532 (4.3)
Chile	5 (2.0)	498 (11.2)	18 (6.4)	479 (7.3)	53 (5.0)	490 (4.2)	25 (3.8)	482 (5.4)
Chinese Taipei	8 (1.9)	573 (7.5)	59 (4.1)	566 (3.0)	4 (1.2)	579 (6.0)	29 (3.3)	565 (4.0)
Cyprus	14 (2.4)	483 (9.4)	37 (3.1)	476 (5.5)	13 (1.9)	489 (6.2)	37 (3.2)	481 (4.8)
Czech Republic	19 (2.5)	515 (5.2)	44 (3.3)	521 (3.6)	4 (1.2)	527 (10.7)	33 (3.1)	522 (4.6)
Denmark s	38 (4.3)	532 (5.0)	53 (4.6)	539 (4.1)	1 ~	~ ~	8 (2.0)	544 (11.7)
England r	20 (5.6)	555 (7.9)	51 (8.7)	565 (6.1)	7 (4.2)	576 (10.5)	23 (8.9)	549 (8.6)
Finland	7 (1.2)	540 (7.1)	61 (2.9)	544 (4.1)	0 ~	~ ~	32 (2.9)	547 (4.7)
France r	20 (6.6)	493 (6.5)	47 (8.7)	498 (4.8)	13 (3.7)	496 (8.7)	20 (3.4)	496 (9.7)
Georgia	8 (1.9)	449 (11.3)	41 (3.3)	454 (5.8)	5 (1.2)	466 (6.2)	47 (3.3)	468 (6.2)
Germany r	12 (2.2)	514 (9.2)	66 (3.7)	513 (4.2)	1 ~	~ ~	21 (4.3)	524 (5.4)
Hong Kong SAR s	33 (4.9)	543 (6.1)	44 (4.5)	531 (6.2)	11 (2.6)	542 (15.6)	13 (2.2)	554 (14.4)
Hungary r	2 ~	~ ~	24 (3.4)	524 (9.1)	12 (2.8)	535 (8.8)	61 (4.9)	538 (5.6)
Iran, Islamic Rep. of	3 (1.0)	435 (26.5)	25 (2.6)	428 (9.7)	19 (2.0)	422 (8.3)	53 (2.8)	430 (6.4)
Ireland	11 (2.1)	545 (7.5)	42 (3.4)	531 (5.3)	22 (3.1)	535 (7.5)	25 (3.4)	544 (7.2)
Italy	2 ~	~ ~	17 (4.1)	528 (5.7)	20 (2.7)	514 (5.2)	60 (5.1)	515 (3.4)
Japan	70 (4.1)	540 (4.0)	24 (3.7)	545 (4.3)	3 (1.3)	546 (7.1)	3 (1.5)	559 (13.6)
Jordan	4 (1.5)	414 (17.1)	29 (3.4)	409 (8.4)	40 (3.7)	411 (7.9)	28 (3.6)	415 (9.8)
Kazakhstan r	3 (1.1)	495 (15.4)	22 (2.7)	447 (9.2)	14 (1.9)	446 (8.1)	60 (2.8)	465 (6.2)
Korea, Rep. of	14 (2.7)	580 (7.0)	46 (3.6)	575 (5.5)	15 (2.5)	574 (6.7)	25 (3.3)	578 (5.6)
Kosovo	0 ~	~ ~	19 (3.4)	398 (8.6)	13 (2.2)	409 (9.3)	68 (3.7)	403 (5.0)
Kuwait	9 (2.7)	387 (21.8)	31 (3.4)	380 (7.7)	43 (3.5)	391 (8.1)	17 (2.9)	422 (17.6)
Latvia	23 (3.4)	497 (6.4)	48 (3.8)	509 (4.6)	0 ~	~ ~	29 (3.7)	503 (4.9)
Lithuania	3 (1.1)	516 (15.9)	50 (3.2)	527 (4.4)	0 ~	~ ~	46 (3.0)	515 (4.9)
Macao SAR	27 (0.1)	530 (2.4)	51 (0.2)	525 (1.8)	11 (0.1)	534 (2.8)	11 (0.2)	530 (3.7)
Montenegro	4 (1.3)	433 (16.0)	25 (2.4)	463 (4.4)	1 ~	~ ~	70 (2.3)	469 (3.3)
Morocco	4 (1.1)	393 (27.8)	25 (2.6)	398 (11.3)	59 (2.9)	388 (7.6)	12 (2.1)	414 (14.9)
Netherlands s	38 (5.5)	512 (5.8)	44 (5.5)	525 (4.3)	10 (2.7)	510 (8.0)	9 (2.9)	534 (8.5)
New Zealand s	21 (3.1)	531 (9.7)	42 (4.3)	523 (5.1)	4 (1.5)	528 (18.7)	32 (3.9)	529 (5.3)
North Macedonia r	2 ~	~ ~	24 (3.2)	453 (11.2)	1 ~	~ ~	73 (3.3)	437 (5.8)
Norway (5) r	14 (2.3)	540 (7.3)	71 (3.8)	535 (3.2)	2 ~	~ ~	13 (2.9)	550 (6.7)
Oman	5 (1.4)	431 (12.8)	19 (2.3)	419 (5.9)	61 (3.6)	424 (5.1)	15 (3.3)	443 (12.1)
Poland	27 (3.2)	554 (3.8)	47 (3.3)	558 (3.3)	3 (0.8)	561 (7.7)	24 (3.1)	559 (4.9)
Portugal	5 (1.7)	536 (18.3)	22 (2.6)	519 (5.5)	22 (2.3)	514 (5.3)	50 (2.8)	519 (4.3)
Qatar	4 (1.2)	460 (20.0)	27 (2.8)	467 (8.0)	38 (3.9)	453 (6.2)	30 (3.2)	474 (7.2)
Romania s	0 ~	~ ~	12 (3.0)	549 (9.1)	2 ~	~ ~	86 (3.2)	522 (6.3)
Saudi Arabia	3 (1.4)	394 (16.7)	23 (5.4)	419 (6.2)	57 (6.2)	437 (5.5)	16 (2.4)	425 (8.4)
Serbia	7 (1.9)	501 (10.9)	30 (4.9)	520 (5.9)	2 ~	~ ~	61 (5.7)	518 (3.6)
Singapore	52 (2.6)	577 (4.4)	35 (2.7)	581 (5.8)	6 (1.2)	577 (11.4)	7 (1.2)	565 (14.1)
Slovak Republic	10 (2.3)	526 (7.6)	28 (3.4)	509 (7.2)	0 ~	~ ~	62 (4.7)	508 (5.6)
Slovenia	6 (1.5)	512 (5.6)	39 (3.2)	521 (4.0)	3 (0.7)	530 (8.5)	53 (3.3)	521 (3.5)
Spain	5 (1.1)	516 (10.1)	36 (3.7)	510 (3.5)	9 (1.5)	511 (7.2)	50 (4.2)	510 (3.6)
Sweden r	18 (3.0)	533 (6.4)	61 (3.5)	526 (5.2)	5 (1.4)	535 (10.4)	17 (3.0)	527 (7.5)
Türkiye (5)	1 ~	~ ~	40 (3.8)	546 (5.7)	21 (2.9)	546 (6.6)	38 (3.7)	565 (5.8)
United Arab Emirates	5 (0.6)	482 (12.1)	24 (1.3)	490 (5.6)	34 (1.4)	485 (4.8)	37 (1.2)	517 (3.1)
United States	34 (5.8)	543 (5.0)	42 (2.8)	537 (4.3)	15 (4.7)	526 (7.6)	9 (2.8)	543 (10.3)
Uzbekistan	1 ~	~ ~	8 (2.0)	413 (10.5)	5 (1.3)	405 (10.1)	86 (2.6)	419 (3.3)
International Average	**13 (0.4)**	**500 (1.8)**	**35 (0.6)**	**496 (0.9)**	**14 (0.3)**	**494 (1.4)**	**37 (0.5)**	**501 (1.0)**
South Africa (5)	- -	- -	- -	- -	- -	- -	- -	- -
Benchmarking Participants								
Ontario, Canada r	13 (3.0)	534 (6.2)	37 (6.2)	541 (5.5)	21 (4.6)	529 (6.8)	29 (3.7)	531 (6.8)
Quebec, Canada	34 (4.2)	501 (3.9)	36 (4.4)	502 (4.4)	19 (3.7)	501 (6.5)	10 (2.4)	527 (5.9)
Abu Dhabi, UAE	8 (1.4)	445 (16.9)	28 (2.3)	447 (9.1)	44 (3.0)	444 (8.1)	20 (2.3)	459 (7.4)
Dubai, UAE	5 (0.8)	553 (10.8)	27 (1.8)	560 (5.0)	26 (2.2)	570 (4.4)	43 (2.3)	577 (3.4)
Sharjah, UAE r	2 ~	~ ~	18 (2.5)	475 (10.4)	23 (2.4)	497 (10.2)	57 (2.7)	511 (5.4)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated. A tilde (~) indicates insufficient data to report result.

Within-country results also do not support a clear relationship between the class membership of students' teachers and their expected achievement in environmental knowledge. As noted in the School Questionnaire results, there is not necessarily a one-to-one correspondence between students' environmental knowledge and pro-environmental attitudes and behaviors. It is possible that teachers' efforts to promote environmental sustainability do help students develop pro-environmental attitudes and behaviors, but do not lead to greater environmental knowledge. This possibility merits further investigation.

The distribution of students whose teachers were assigned to each class varies dramatically across countries and benchmarking participants; however, it is worth noting that there are many countries with 10 percent or fewer of students having teachers who were classified as placing Little Emphasis on environmental sustainability (33 countries and 3 benchmarking participants), or having teachers who were classified as placing a Strong Emphasis with Limited Outdoor Activities (31 countries).

Grade 8 Results

Exhibits 5.5 and 5.6 provide information about the four classes MG-LCA results for Grade 8 teachers. Exhibit 5.5 shows a summary description for each class and Exhibit 5.7 shows the conditional probabilities for item response categories across the four classes.

Exhibit 5.5: Profiles of Teacher Emphasis on Environmental Sustainability (Grade 8)

Class Number	Class Label	Class Description Overview
Class 1	**Little** Emphasis on Environmental Sustainability	• Most likely to select "a few times a year" for all 4 classroom discussion items • Most likely to select "no" for all 4 larger project items • Similar chance of selecting "agree a lot" or "agree a little" that education about environmental sustainability should be a priority for schools (conditional probabilities of 0.49 and 0.44)
Class 2	**Some** Emphasis on Environmental Sustainability	• Most likely to select "once or twice a month" for all 4 classroom discussion items • Most likely to select "yes" for *Responsible activities* and *Research topics* (conditional probabilities of 0.66 and 0.74), but most likely to select "no" for *Visit natural areas* and *Outdoor programs* (conditional probabilities of 0.68 and 0.55) • Most likely to select "agree a lot" that education about environmental sustainability should be a priority for schools
Class 3	**Strong** Emphasis on Environmental Sustainability **with Limited Outdoor Activities**	• Most likely to select "at least once a week" for all 4 classroom discussion items • Most likely to select "yes" for *Responsible activities* and *Research topics* (conditional probabilities of 0.70 and 0.75), but most likely to select "no" for *Visit natural areas* and *Outdoor programs* (conditional probabilities of 0.82 and 0.70) • Most likely to select "agree a lot" that education about environmental sustainability should be a priority for schools
Class 4	**Strong** Emphasis on Environmental Sustainability **with Outdoor Activities**	• Most likely to select "at least once a week" for all 4 classroom discussion items • Most likely to select "yes" for all 4 larger project items • Most likely to select "agree a lot" that education about environmental sustainability should be a priority for schools

Exhibit 5.6: Conditional Item Response Probabilities by Profile of Teacher Emphasis on Environmental Sustainability (Grade 8)

Response Category   1   2   3   4
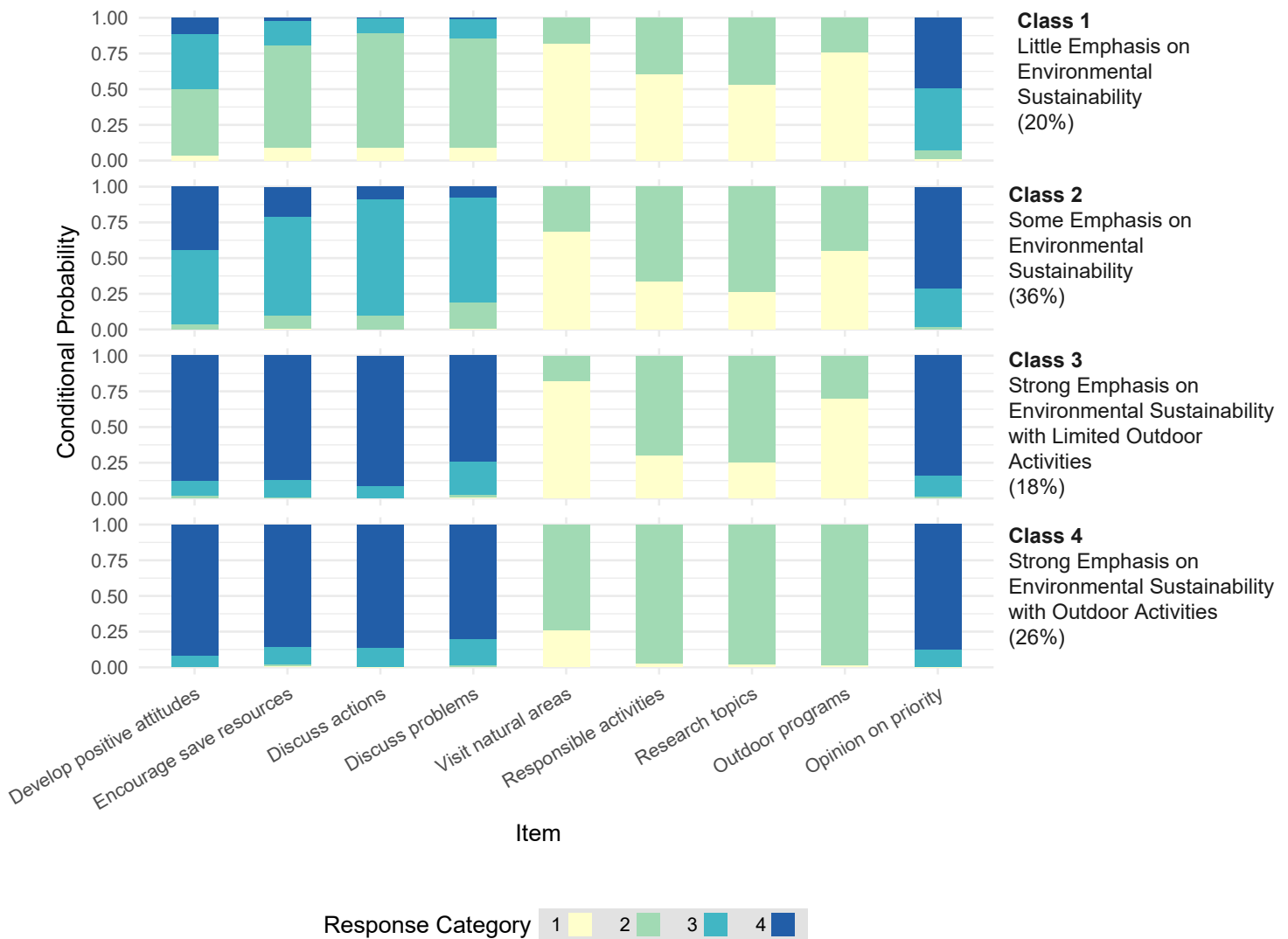
Similar to Grade 4, the four classes identified for Grade 8 teachers reflect varying degrees of emphasis on environmental sustainability, as well as differential implementation of outdoor activities. The overall probability was greatest for being classified as placing **Some Emphasis** on environmental sustainability (36%), followed by placing a **Strong Emphasis with Outdoor Activities** (26%), placing **Little Emphasis** (20%), and placing a **Strong Emphasis with Limited Outdoor Activities** (18%).

Grade 8 teachers classified as placing a Strong Emphasis on Environmental Sustainability with Outdoor Activities (Class 4) showed the same patterns in conditional item response probabilities as teachers in the Grade 4 version of this class. They were most likely to select "at least once a week" for all four items related to classroom discussions, "yes" for all four items related to larger projects, and "agree a lot" that education about environmental sustainability should be a priority for schools.

Eighth-grade teachers classified as placing a Strong Emphasis on Environmental Sustainability with Limited Outdoor Activities (Class 3) also showed the same patterns in conditional item response probabilities as fourth-grade teachers. Their conditional item response

probabilities were very similar to Class 4 teachers except for being much more likely to select "no" for *Visit natural areas* and *Outdoor programs* (conditional probabilities of 0.82 and 0.70).

Grade 8 teachers in the Some Emphasis on Environmental Sustainability class (Class 2) were most likely to select "once or twice a month" for all four classroom discussion items (with a higher probability of selecting "at least once a week for *Develop positive attitudes* compared to the other items) and "agree a lot" that education about environmental sustainability should be a priority for schools. However, they were most likely to select "yes" for two larger project items: *Responsible activities* and *Research topics*.

Eighth-grade teachers classified as placing Little Emphasis on Environmental Sustainability (Class 1) were most likely to select "a few times a year" for all four classroom discussion items. However, following the pattern established in other classes, they were more likely to select "a few times a month" for *Develop positive attitudes* compared to the other three items. Teachers in this class were also most likely to select "no" for all four larger project items, although the split in probabilities for "yes" and "no" is nearly even for *Research topics*. Teachers in this class also had similar conditional probabilities for "agreeing a lot" or "agreeing a little" that education about environmental sustainability should be a priority for schools.

Descriptions of the eighth-grade teacher classes suggest that many eighth-grade teachers report at least limited efforts to promote environmental sustainability in their science classes. The prevalence of classes within countries, as well as the association with expected achievement in environmental knowledge, is shown in Exhibit 5.7.

Exhibit 5.7: Teacher Emphasis on Environmental Sustainability and Achievement in Environmental Knowledge

Country		Little Emphasis on Environmental Sustainability		Some Emphasis on Environmental Sustainability		Strong Emphasis on Environmental Sustainability with Limited Outdoor Activities		Strong Emphasis on Environmental Sustainability with Outdoor Activities	
		Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement	Percent of Students	Expected Achievement
Australia	s	32 (3.9)	530 (6.6)	50 (5.0)	524 (5.6)	13 (2.3)	521 (9.1)	5 (1.9)	537 (9.8)
Austria		22 (1.8)	518 (5.1)	49 (2.1)	503 (4.1)	24 (1.8)	493 (5.8)	5 (0.7)	515 (6.4)
Azerbaijan		3 (0.7)	419 (7.7)	35 (2.8)	410 (3.9)	13 (2.5)	411 (4.5)	49 (5.3)	408 (3.4)
Bahrain		5 (1.1)	445 (17.7)	34 (5.1)	442 (5.6)	37 (3.2)	438 (5.5)	23 (4.5)	457 (4.9)
Brazil		11 (2.1)	427 (14.2)	26 (3.4)	427 (7.6)	33 (3.1)	425 (6.4)	30 (2.7)	418 (6.6)
Chile		5 (1.7)	462 (11.1)	47 (4.1)	466 (4.6)	32 (3.4)	464 (5.6)	16 (3.2)	445 (9.3)
Chinese Taipei		28 (3.2)	550 (5.5)	43 (3.6)	558 (4.1)	18 (2.5)	554 (5.4)	11 (1.9)	546 (6.5)
Cyprus		31 (1.4)	473 (5.3)	32 (1.3)	466 (4.4)	16 (1.3)	465 (6.4)	21 (1.9)	461 (3.9)
Czech Republic		49 (1.7)	520 (2.5)	39 (1.5)	515 (2.4)	6 (0.9)	512 (4.3)	6 (0.8)	512 (5.0)
England	s	56 (5.2)	537 (7.0)	32 (6.6)	539 (9.9)	13 (3.9)	489 (16.1)	0 ~	~ ~
Finland		29 (2.1)	536 (3.2)	55 (2.0)	540 (3.2)	13 (1.3)	533 (6.1)	2 ~	~ ~
France		52 (3.5)	497 (4.2)	37 (3.6)	498 (4.5)	8 (1.2)	492 (10.3)	3 (1.1)	492 (16.8)
Georgia		14 (1.2)	443 (4.5)	41 (2.0)	438 (3.5)	4 (0.7)	450 (5.5)	41 (2.3)	437 (3.6)
Hong Kong SAR	s	51 (5.0)	531 (11.0)	39 (4.9)	549 (10.8)	6 (2.0)	529 (32.2)	4 (1.5)	536 (27.7)
Hungary		10 (1.2)	521 (7.2)	33 (1.8)	524 (4.6)	35 (1.7)	516 (4.5)	22 (1.6)	516 (5.6)
Iran, Islamic Rep. of		12 (1.9)	413 (10.1)	31 (2.7)	427 (6.9)	17 (2.0)	399 (9.3)	40 (2.9)	392 (7.3)
Ireland		24 (3.1)	543 (3.3)	53 (2.9)	532 (6.1)	19 (2.2)	540 (6.6)	4 (1.8)	514 (18.3)
Israel		32 (3.9)	490 (7.9)	40 (3.1)	481 (6.5)	20 (2.9)	482 (10.1)	8 (1.7)	442 (15.2)
Italy		15 (2.3)	515 (7.5)	36 (3.6)	512 (4.5)	30 (3.1)	494 (8.2)	19 (2.5)	499 (6.5)
Japan		91 (2.5)	549 (3.0)	7 (2.1)	554 (15.0)	2 ~	~ ~	0 ~	~ ~
Jordan		3 (0.9)	411 (11.6)	41 (3.9)	410 (5.6)	24 (2.8)	413 (6.9)	32 (3.8)	406 (5.4)
Kazakhstan		3 (0.4)	464 (7.5)	26 (1.3)	439 (4.0)	12 (0.9)	438 (4.9)	58 (1.5)	434 (3.1)
Korea, Rep. of		36 (3.2)	546 (4.4)	39 (3.1)	550 (4.3)	15 (2.1)	544 (5.3)	10 (1.8)	548 (6.6)
Kuwait		14 (2.8)	429 (14.1)	35 (4.3)	407 (6.9)	30 (3.5)	420 (8.0)	21 (3.1)	444 (16.3)
Lithuania		22 (1.9)	513 (4.2)	46 (2.9)	507 (3.6)	8 (1.0)	510 (5.7)	24 (1.8)	509 (4.5)
Malaysia		17 (2.1)	425 (9.7)	38 (2.7)	427 (6.0)	21 (2.0)	429 (7.8)	24 (2.4)	430 (6.9)
Malta		42 (1.7)	502 (2.4)	34 (1.4)	508 (2.7)	21 (0.7)	493 (3.7)	4 (0.3)	498 (8.1)
Morocco		35 (2.8)	330 (5.7)	36 (2.3)	331 (4.6)	19 (1.5)	328 (5.4)	10 (1.7)	344 (11.9)
Norway (9)	r	27 (3.4)	506 (4.8)	61 (5.0)	512 (3.7)	6 (2.1)	495 (11.0)	5 (1.4)	503 (6.6)
Oman		10 (1.8)	441 (7.6)	37 (2.6)	446 (3.6)	35 (2.5)	451 (3.8)	18 (1.7)	467 (6.2)
Palestinian Nat'l Auth.		7 (1.4)	361 (9.3)	44 (3.3)	369 (3.9)	21 (2.3)	369 (5.1)	28 (2.8)	366 (5.4)
Portugal		22 (2.1)	520 (4.4)	29 (2.2)	521 (3.8)	33 (2.0)	518 (3.6)	16 (2.2)	526 (8.3)
Qatar		8 (2.6)	521 (24.4)	27 (3.6)	472 (6.7)	29 (4.0)	473 (6.6)	35 (4.2)	477 (7.0)
Romania		7 (1.2)	484 (9.0)	27 (2.2)	465 (5.2)	9 (2.1)	469 (7.2)	57 (2.3)	459 (4.5)
Saudi Arabia		5 (1.8)	415 (12.7)	25 (3.0)	406 (8.8)	49 (3.1)	411 (4.5)	21 (2.3)	415 (7.1)
Singapore		48 (3.4)	598 (7.9)	39 (3.4)	595 (9.2)	10 (1.8)	565 (17.6)	3 (0.9)	598 (22.9)
South Africa (9)	r	23 (7.3)	345 (10.0)	34 (5.2)	366 (10.3)	33 (4.9)	371 (10.9)	10 (2.3)	364 (10.7)
Sweden		29 (5.0)	548 (6.3)	57 (5.7)	536 (5.0)	11 (2.1)	541 (10.6)	3 (1.2)	523 (14.7)
Türkiye		1 ~	~ ~	34 (3.2)	523 (6.6)	20 (2.7)	519 (8.0)	45 (3.4)	529 (5.6)
United Arab Emirates		8 (1.3)	487 (9.9)	29 (1.4)	481 (4.8)	17 (1.0)	459 (4.2)	46 (1.7)	478 (3.4)
United States		42 (3.5)	525 (6.5)	36 (3.3)	526 (7.7)	19 (2.1)	496 (8.6)	4 (1.7)	526 (13.8)
Uzbekistan		1 ~	~ ~	12 (1.0)	386 (4.6)	8 (0.9)	386 (5.6)	80 (1.4)	390 (3.8)
International Average		**23 (0.4)**	**482 (1.4)**	**37 (0.5)**	**478 (1.0)**	**19 (0.4)**	**471 (1.4)**	**20 (0.4)**	**471 (1.7)**
Cote d'Ivoire		- -	- -	- -	- -	- -	- -	- -	- -
Benchmarking Participants									
Abu Dhabi, UAE	r	10 (1.9)	442 (15.6)	32 (3.7)	435 (7.3)	24 (2.0)	429 (7.3)	34 (5.1)	448 (7.4)
Dubai, UAE		11 (2.4)	548 (11.2)	35 (2.3)	541 (4.6)	13 (2.3)	523 (8.7)	41 (2.2)	541 (6.0)
Sharjah, UAE	r	6 (2.2)	467 (17.9)	24 (3.7)	480 (6.3)	11 (2.8)	460 (10.8)	59 (3.2)	485 (4.8)

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
An "r" indicates data are available for at least 70% but less than 85% of the students.
An "s" indicates data are available for at least 50% but less than 70% of the students.
A dash (-) indicates comparable data not available because average achievement could not be accurately estimated. A tilde (~) indicates insufficient data to report result.

Internationally, students whose teachers were classified as placing Little Emphasis on Environmental Sustainability had slightly higher average expected achievement in environmental knowledge (482 scale score points) than did students whose teachers placed Some Emphasis on the topic (478 scale score points). Across countries, students whose teachers were classified as placing Strong Emphasis on Environmental Sustainability, in both the Limited Outdoor Activities and with Outdoor Activities classes, had an average expected achievement of 471 scale score points. Although this pattern is a reversal of what might be expected, it is important to note that the

11-point expected achievement difference between the highest- and lowest-performing classes is relatively small and may in part be explained due to the variability of class sizes and average achievement across countries.

Within-country results do not suggest a consistent pattern of achievement differences in environmental knowledge across students whose teachers were assigned to each of the four classes. Other results presented in this report have suggested that a school or teacher's proclivity for emphasizing environmental sustainability does not necessarily translate to increased student environmental knowledge; these findings also suggest this, despite the apparent pattern observed in the expected achievement differences internationally.

For a sizable group of countries (18), 10 percent or fewer of eighth-grade students had teachers assigned to the Strong Emphasis with Outdoor Activities class. In three countries (Kazakhstan, Romania, and Uzbekistan) and one benchmarking participant (Sharjah, UAE), 50 percent or more of eighth-grade students were in this group. For 14 countries and two benchmarking participants, 10 percent or fewer students had teachers who were assigned to the Little Emphasis class; in three countries (England, France, and Japan), 50 percent or more students had teachers assigned to this class. There were also 10 countries in which 10 percent or fewer students had teachers assigned to the Strong Emphasis with Limited Outdoor Activities class, while in only one country (Saudi Arabia), more than 40 percent of eighth-grade students were in this group.

Key Takeaways

1. **Students' home resources have a stronger relationship with environmental knowledge than do geographic location or other contextual variables more directly related to environmental awareness.** Categories in the fourth-grade Home Socioeconomic Status scale and eighth-grade Home Resources scale had stronger associations with students' environmental knowledge than did any other variables presented in this report. The strength of the relationship between home resources and environmental knowledge is not surprising, given that resource-related constructs also have strong relationships with overall science achievement in TIMSS 2023.

2. **Patterns in environmental knowledge differences between girls and boys differ from those observed in overall science for both fourth and eighth grade.** In fourth grade, many more countries had statistically significant differences favoring boys, and fewer countries had differences favoring girls, in environmental knowledge versus overall science achievement (30 countries versus 20 countries favoring boys, 2 countries versus 11 countries favoring girls). A less extreme version of this pattern is observed in eighth grade (16 countries versus 12 countries favoring boys, 7 countries versus 11 countries favoring girls).

3. **Most fourth- and eighth-grade students report pro-environmental attitudes, but there is more variation in reported behaviors across classes of students.** Students in all three MG-LCA classes were likely to indicate some level of agreement with the environmental attitudes items; frequency of engaging in the behaviors was more distinguishing across classes. Within the behavioral items, students were most likely to report frequently reusing things or saving resources and were less likely to report frequently engaging in behaviors that require more active attention to environmental issues (such as participating in group activities).

4. **Students with reported pro-environmental attitudes and reported moderate enactment of environmentally responsible behaviors (e.g., Class 2 from the MG-LCA) had the highest expected achievement in environmental knowledge in all fourth-grade countries and a large majority of eighth-grade countries.** This finding provides evidence that there is not necessarily a one-to-one correspondence in development of the different components of environmental literacy (knowledge, attitudes, behaviors). However, it is also possible that social desirability, response styles, or careless and insufficient effort responding distort the expected achievement for students who actually have the highest levels of pro-environmental attitudes and behavior (see definitions of each response behavior in point 8).

5. **Fourth-grade students whose parents reported encouraging pro-environmental attitudes and behaviors at least sometimes show greater environmental knowledge than students whose parents reported rarely encouraging these attitudes and behaviors.** Students whose parents rarely encouraged environmentally responsible attitudes and behaviors had lower expected achievement than students whose parents provided at least some encouragement for these attitudes and behaviors. However, more frequent encouragement does not necessarily relate with large differences in environmental knowledge.

6. **School policies related to promoting environmental sustainability within the institution appear to have limited relationships with students' environmental knowledge in fourth and eighth grades.** No clear patterns were observed between the MG-LCA classes obtained from the School Questionnaire items and students' expected achievement. Many of these items were related to school-level policies or school engagement with external parties (e.g., wider community, project networks). While these types of actions may be beneficial for environmental sustainability in broader contexts, they may not have a direct impact on students' environmental knowledge.

7. **Teachers' reported classroom practices that emphasize environmental sustainability appear to have limited relationships with students' environmental knowledge in both fourth and eighth grades.** Within-country results did not provide evidence for a strong relationship between the MG-LCA classes obtained from the Teacher Questionnaire items and students' expected achievement. It may be that teacher efforts to promote environmental sustainability relate to the development of other aspects of students' environmental literacy; however, such efforts do not appear to be directly related to environmental knowledge.

8. **Social desirability, response styles, and careless and insufficient effort responding may play a role in how people respond to questionnaire items related to environmentalism and sustainability.** Across the different groups of respondents, responses selected for the items related to environmentalism and sustainability were often overwhelmingly positive. It is important to consider the possibility that some respondents might have engaged in different response behaviors that bias the attitudinal and behavioral measurements of interest and obscure the relationships between contextual variables and students' achievement in environmental knowledge. Some respondents might have engaged in socially desirable responding,[26,27,28] selecting what they believed to be the "expected" response rather than the response most reflective of their attitudes or behaviors. Some respondents also may have engaged in careless and insufficient effort responding[29] such as straight lining, or may have shown response styles[30,31] such as the tendency to select only extreme response categories. Both careless and insufficient effort responding and response styles are response behaviors

considered unrelated to the actual attitudes and behaviors of interest, as respondents are assumed to respond without sufficient regard to the content of the items. There is some evidence for careless and insufficient effort responding to the Grade 8 Student Questionnaire items especially (e.g., high levels of agreement across classes that "nature exists to benefit humans regardless of the consequences").

Future Directions

The results of this TIMSS Insights report illuminate the relationships between environmental knowledge, attitudes, and behaviors and highlight characteristics of students with varying levels of environmental awareness. These findings can inform national education policy and reform, and support policymakers, researchers, and educators in identifying strategies to enhance educational outcomes related to environmental awareness. This would represent an important step toward strengthening students' environmental literacy nationally and globally.

The findings presented in this report also suggest areas for further research, such as exploration of the relationship between students' environmental knowledge and reported attitudes and behaviors, as well as how various contextual factors can contribute to the development of students' environmental awareness. This report suggests two general avenues for future research: 1) the relationships (or lack thereof) observed between variables related to environmental sustainability presented in this report, and 2) the potential of systematic response distortions in self-reports affecting questionnaire responses that may be due to social desirability or non-effortful responding, and ways to reduce these effects for future cycles of TIMSS.

Within the first avenue, there are multiple research questions that would benefit from further exploration within countries. For example, internationally there is no clear relationship between the geographic location of schools and students' environmental knowledge; however, there were clear patterns of higher or lower achievement in particular geographic areas within countries. Schools in different types of areas may have differential access to resources across countries, perhaps contributing to these patterns. Another potential area for further exploration is the relationship between different contextual variables related to the development of students' environmental literacy. For example, while teacher emphasis on environmental sustainability did not appear to have a strong direct relationship with students' environmental knowledge, future research could investigate whether there is an indirect relationship through the development of students' pro-environmental attitudes.

On the more technical side, these results suggest a need to study the prevalence of socially desirable or insufficient effort responding for context questionnaire items related to environmental sustainability. Such investigations could inform the development of improved data collection methods to reduce these effects and better measure environmental awareness in future cycles of TIMSS.

Appendix A: About TIMSS 2023

The 2023 cycle of the Trends in International Mathematics and Science Study (TIMSS 2023) aims to measure and compare the mathematics and science achievement of fourth- and eighth-grade students around the world. TIMSS provides valuable insights into mathematics and science achievement differences across and within countries and helps policymakers and educators understand factors contributing to student learning.

The data presented in this report are from the TIMSS 2023 science assessment, as well as the Student, Home, School, and Teacher Questionnaires. TIMSS 2023 also collected national policy-level data from National Research Coordinators from the participating countries and benchmarking entities.

Many resources are available for obtaining more information about TIMSS 2023, accessing TIMSS 2023 data, and conducting additional analyses, including:

- *TIMSS 2023 Assessment Frameworks*: provides information about the TIMSS 2023 mathematics and science assessments, context questionnaires, and assessment design. This includes a special supplement describing the measurement of environmental attitudes and behaviors in the TIMSS 2023 context questionnaires.

- *TIMSS 2023 International Results in Mathematics and Science*: summarizes fourth- and eighth-grade students' mathematics and science achievement and includes information about how contextual factors relate to students' achievement.

- *TIMSS 2023 Encyclopedia*: contains information about national contexts for countries participating in TIMSS 2023, including a chapter written by each country describing its educational system and responses to the TIMSS 2023 Curriculum Questionnaires.

- *TIMSS 2023 Technical Report: Methods and Procedures*: details instrument development, sample design and implementation, operations, and analytical procedures.

- *TIMSS 2023 Context Questionnaires*: the international versions of the contextual items to which students, parents, school principals, teachers, and National Research Coordinators responded.

- *TIMSS 2023 International Database*: includes data collected from the mathematics and science assessments and context questionnaires, and achievement and contextual scale estimates for the countries and benchmarking entities that participated in TIMSS 2023. The accompanying User Guide provides information about database contents and analysis resources.

- *TIMSS 2023 Insights Series*: a set of reports exploring different educational research areas using TIMSS 2023 data. Reports in the series provide an in-depth examination of particular topics beyond what can be covered in the International Results.

Appendix B: History of Environmental Awareness in TIMSS

TIMSS has historically measured topics within environmental knowledge as part of the science assessment at the fourth and eighth grades. These topics include environmental concepts within the life science and earth science domains, such as ecosystems and Earth's resources. In TIMSS 2019, science items that measured knowledge about the environment and environmental issues were identified to create the first TIMSS environmental knowledge subscale.[m] Thirty-three fourth-grade items and 41 eighth-grade items were identified as measuring environmental knowledge and were used to report on environmental awareness. For more information on environmental awareness in TIMSS 2019 and scaling the data, see Chapter 18 of the TIMSS 2019 Technical Report.

In TIMSS 2023, efforts were made to develop and identify a greater number of science achievement items that measure environmental knowledge from the biology and earth science domains. The environmental knowledge subscale in TIMSS 2023 includes 44 fourth-grade items and 58 eighth-grade items. For more information about how the subscale was created, see Chapter 12 in the TIMSS 2023 Technical Report.

TIMSS 2023 is the first TIMSS cycle to incorporate measurement of pro-environmental attitudes and behaviors, providing a more complete evaluation of students' environmental awareness. In addition to items related to students' environmental attitudes and behaviors, TIMSS 2023 includes items related to environmental topics in the Home, School, and Teacher Questionnaires. These questionnaire development efforts involved a special expert group and are summarized in their accompanying framework. Further details are available in Chapter 2 of the TIMSS 2023 Technical Report.

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m The TIMSS 2019 environmental knowledge subscale was titled "Environmental Awareness." The name of the subscale was updated for TIMSS 2023 to better reflect theories of environmental literacy, acknowledging that environmental knowledge is only one component of this construct.

Appendix C: Technical Details

This appendix describes the technical details of the Multiple Group Latent Class Analyses (MG-LCAs) implemented in this study. While LCA can reveal subpopulations based on observed response patterns, its multiple-group variant, MG-LCA, was employed to maintain the same meaning and structure of the latent classes across countries, while allowing for country-specific differences in class prevalence.[32,33] The modeling was implemented in Mplus version 8.11 using maximum likelihood estimation with robust standard errors.[34] To reduce the chance of finding local (rather than global) maximum likelihood solutions, 100 random sets of starting values were used at the initial stage of parameter estimation. Of these starting values, the 10 sets associated with the highest log-likelihood were used for final-stage optimizations. The best loglikelihood values have been replicated for all selected solutions, providing evidence of convergence.

The analyses beyond the multiple-group LCA modeling were performed in R version 4.4.2,[35] with the "MplusAutomation" package used to extract outputs from Mplus.[36]

Data and Sample

The datasets used in this study are publicly available from the official TIMSS 2023 International Database website. All countries and benchmarking participants that administered contextual questionnaires were included in the analyses. Observations with fewer than two responses across selected items related to environmental awareness were excluded from the analyses. In other words, any record—regardless of whether it came from the Student, Home, School, or Teacher Questionnaire dataset—that included only a single response to the selected items was removed from the analyses.

To ensure consistency in the unit of analysis and interpretation, data from the Home, Teacher, and School Questionnaires were merged with the Student Questionnaire data. The specific items included for the analyses are listed in variable mapping documentation, and item descriptions are provided in the main body of the report.

All variables were recoded so that higher response categories reflected stronger agreement with the statements or greater frequency of the behaviors. For example, on four-point items, response category 1 consistently represented "disagree a lot" or "never or almost never," while response category 4 represented "agree a lot" or "every day." For binary items, response category 1 indicated "no" and response category 2 indicated "yes."

Sampling weights were applied throughout the analyses to account for the complex survey design. After merging all contextual data to the student level, the SENWGT weight was applied to data from the Student, Home, and School Questionnaires, and the SCIWGT weight was applied to data from the Teacher Questionnaire.

Multiple Group Latent Class Analysis

The general MG-LCA framework has the flexibility to allow both class prevalence and the measurement model to differ across groups. However, in this study, the MG-LCA model was constrained to assume measurement invariance across groups—in this case, countries. In other words, item response probabilities conditional on class membership were held equal across countries to ensure the comparability of latent constructs, while allowing class prevalences to vary by country. Model details are presented below.

Consider G groups indexed by $g = 1,2, \ldots , G$, where each group consists of N_g individuals who respond to the same set of J polytomous items. Each individual is uniquely identified by a tuple (i,g), where $i = 1,2, \ldots , N_g$ is the within-group index and $g = 1,2, \ldots , G$ is the group index. For item j with K_j response categories, the observed responses are denoted as $X_{ijk}^{(g)}$, where $X_{ijk}^{(g)}$ $=1$ if individual i in group g selects the k-th response category to the j-th item ($k=1, \ldots , k_j$), and 0 otherwise.

We assume C latent classes indexed by $c = 1,2, \ldots , C$. For each latent class c, p_{jck} denotes the probability of endorsing category k on item j in class c. This probability is held invariant across groups: $p_{ijk}^{(g)} = p_{jck}$, ensuring that the latent classes maintain a consistent interpretation across groups. In contrast, assuming that the latent class variable for individual i in group g is $C_i^{(g)}$, the proportions of individuals in each class $\pi_c^{(g)} = P\left(C_i^{(g)} = c\right)$ are allowed to vary across groups to capture differences in class distributions at the population level. The classes are mutually exclusive, which lead to $\sum_{c=1}^{C} \pi_c^{(g)} = 1$ for any group g.

As in any LCA, the MG-LCA model assumes conditional independence, meaning that the observed responses $X_{ijk}^{(g)}$ are statistically independent given latent class membership $C_i^{(g)} = c$. That is, the latent class variable accounts for all associations among observed responses, and within each class, the probability of observing a response pattern can be written as the product of individual item probabilities.

Given these assumptions, the probability of observing a response vector $X_i^{(g)}$ for individual i within group g can be expressed as:

$$P\left(X_i^{(g)} | \pi^{(g)}, p\right) = \sum_{c=1}^{C} \pi_c^{(g)} P\left(X_i^{(g)} | C_i^{(g)} = c\right) = \sum_{c=1}^{C} \pi_c^{(g)} \prod_{j=1}^{J} \prod_{k=1}^{K_j} \left(p_{jck}\right)^{X_{ijk}^{(g)}}. \tag{1}$$

where $\pi^{(g)}$ denotes the vector of class proportions for group g and p the collection of all item response probabilities conditional on class membership.

Accordingly, the log-likelihood for observing the responses for all individuals across all groups is given by:

$$\ln L = \sum_{g=1}^{G} \sum_{i=1}^{N_g} \ln \left(\sum_{c=1}^{C} \pi_c^{(g)} \prod_{j=1}^{J} \prod_{k=1}^{K_j} \left(p_{jck}\right)^{X_{ijk}^{(g)}} \right) \tag{2}$$

Equation (1) also implies local independence across groups, meaning that any observed differences between countries in item responses are fully mediated by differences in class proportions. Once latent class membership is accounted for, country-level grouping has no additional influence on response probabilities.

Finally, the MG-LCA model assumes homogeneity within classes, meaning that the responses of all individuals assigned to a given latent class are drawn from the same response distribution. This assumption reinforces the idea that latent classes represent qualitatively distinct and internally consistent subpopulations.

The parameters are estimated by maximizing function (2) using the Expectation-Maximization algorithm[37], which iteratively computes posterior class membership probabilities and updates parameter estimates until convergence.

For each respondent i in group g, the posterior probability of belonging to each class c is computed using Bayes' rule:

$$P\left(C_i^{(g)} = c \mid X_i^{(g)}\right) = \frac{\pi_c^{(g)} \prod_{j=1}^{J} \prod_{k=1}^{K_j} \left(p_{jck}\right)^{X_{ijk}^{(g)}}}{\sum_{c=1}^{C} \pi_c^{(g)} \prod_{j=1}^{J} \prod_{k=1}^{K_j} \left(p_{jck}\right)^{X_{ijk}^{(g)}}}. \tag{3}$$

Procedures for Determining the Number of Classes

In this study, we fitted MG-LCA models with 2 to 5 latent classes separately for each grade and each set of items related to environmental awareness from the TIMSS 2023 Student, Home, School, and Teacher Questionnaires. That is, each grade–questionnaire combination was modeled independently.

There is no universally optimal method for determining the number of latent classes. Instead, it is recommended that researchers assess multiple statistical indicators in conjunction with considerations of substantive interpretability and practical usefulness.[38,39,40]

In this study, we drew on three broad categories of model evaluation criteria. First, we examined information criteria (IC), where lower values signify a better balance between model fit and complexity. Specifically, the Akaike Information Criterion (AIC),[41] Bayesian Information Criterion (BIC),[42] and sample-size-adjusted BIC (aBIC) were reported.[43]

Second, we evaluated how clearly the model distinguished between classes using classification separation metrics. Specifically, we examined the entropy statistic,[44,45] a global measure of classification quality, and the average posterior probability of correct classification, denoted $AvePP_c$, which provides class-specific information about the uncertainty of class assignment.[46,47,48]

Entropy ranges from 0 to 1, with higher values indicating clearer class distinctions. Although no definitive threshold exists, previous studies have considered entropy values above 0.80 indicative of good class separation.[49,50]

For a model with c classes, represents the average posterior probabilities for Class c across all individuals for whom Class c is the most likely class. In other words, $AvePP_c$ can be regarded as the proportion of individuals correctly classified into Class c. $AvePP_c$ values closer to 1 indicate higher classification accuracy, while values below 0.70 may indicate substantial classification error.[51]

Third, we evaluated the size of the smallest class. Classes with fewer than 50 members or comprising less than 5 percent of the population have been viewed as unreliable or too small to yield meaningful interpretations.[52,53]

In determining the final number of classes, this study sought a pragmatic balance between interpretability and parsimony. Beyond IC, we considered the added value of each additional class by inspecting shifts in conditional item response probabilities. When the inclusion of an additional class (from $c-1$ to c) yielded only marginal changes in conditional response probabilities with no clear interpretation, we selected the more parsimonious model. However, when the added class revealed a distinct, theoretically meaningful pattern in the contextual variables tied to environmental awareness, the more complex model was retained. We also factored in class separation and favored solutions in which all classes exceeded minimum size thresholds.

Model Comparison Results

Model evaluation indices for the 2- through 5-class models are summarized in Exhibits C.1 and C.2. IC values indicating the best model fit and the highest entropy values are highlighted in bold.

Across all combinations of grade and questionnaire type, IC values consistently declined with the inclusion of more classes, with the lowest values observed for the 5-class models. This trend indicates that the improvements in model fit from additional classes outweighed the costs associated with increased complexity.

All models exhibited a minimum $AvePP_c$ greater than 0.70, suggesting adequate classification accuracy across classes. The entropy statistic favored the 3-class models for the Home and Teacher questionnaire data at the fourth grade, while the 2-class models showed slightly higher entropy in the remaining datasets. However, the differences in entropy between the 2- and 3-class solutions were generally minor.

An examination of conditional item response probabilities revealed that the 3-class models captured a distinctive attitudinal or contextual profile not evident in the 2-class solutions. Furthermore, in the case of the Teacher Questionnaire data, the 4-class model identified an additional class that was characterized by a unique pattern of reported engagement in outdoor or experiential learning activities, which was conceptually meaningful and aligned with key dimensions of environmental education.

Potential concerns, such as any class having an $AvePP_c$ below 0.70, representing less than 5 percent of the population, or having fewer than 50 individuals, are italicized. Only one model— the 5-class solution for Grade 8 school data—produced a smallest class under 5 percent.

Taking all criteria into account, we ultimately selected the 4-class solution for the Teacher Questionnaire data and 3-class solutions for all other datasets. Although having the same number or structure of classes across grades was not an aim, the resulting class profiles for both grades were sufficiently similar to justify this choice. To enhance readability, rows for the selected solutions are shaded in Exhibits C.1 and C.2.

Exhibit C.1: Comparison of Statistical Indices Across Candidate Class Solutions (Grade 4)

Questionnaire	Classes	Log Likelihood	AIC	BIC	aBIC	Entropy	Min (AvePPc)	Smallest class relative size	Smallest class count
Student	2	-5,846,160	11,692,702	11,694,775	11,694,168	**0.78**	0.94	50%	189,314
	3	-5,752,626	11,505,826	11,508,941	11,508,029	0.76	0.86	23%	86,573
	4	-5,706,622	11,414,010	11,418,167	11,416,950	0.75	0.84	14%	53,354
	5	-5,674,383	**11,349,724**	**11,354,923**	**11,353,401**	0.74	0.79	8%	28,660
Home	2	-2,493,905	4,988,105	4,989,655	4,989,187	0.75	0.92	39%	109,573
	3	-2,452,354	4,905,150	4,907,480	4,906,778	**0.78**	0.88	11%	30,539
	4	-2,423,732	4,848,053	4,851,163	4,850,226	0.76	0.85	10%	27,024
	5	-2,407,041	**4,814,820**	**4,818,711**	**4,817,538**	0.74	0.79	9%	24,833
School	2	-3,278,134	6,556,615	6,558,477	6,557,927	**0.93**	0.98	42%	145,363
	3	-3,127,532	6,255,583	6,258,381	6,257,555	0.92	0.95	13%	44,069
	4	-3,054,691	6,110,076	6,113,810	6,112,707	0.89	0.92	12%	40,773
	5	-3,026,831	**6,054,529**	**6,059,199**	**6,057,820**	0.86	0.84	11%	39,609
Teacher	2	-3,475,995	6,952,317	6,954,073	6,953,555	0.86	0.95	39%	137,694
	3	-3,383,731	6,767,952	6,770,591	6,769,813	**0.87**	0.92	12%	43,079
	4	-3,348,386	6,697,425	6,700,948	6,699,909	0.84	0.84	12%	42,108
	5	-3,324,791	**6,650,399**	**6,654,806**	**6,653,506**	0.84	0.86	11%	39,708

Exhibit C.2: Comparison of Statistical Indices Across Candidate Class Solutions (Grade 8)

Questionnaire	Classes	Log Likelihood	AIC	BIC	aBIC	Entropy	Min (AvePPc)	Smallest class relative size	Smallest class count
Student	2	-6,236,695	12,473,756	12,475,706	12,475,124	**0.82**	0.95	49%	153,638
	3	-6,111,860	12,224,270	12,227,200	12,226,326	0.81	0.90	22%	68,195
	4	-6,047,439	12,095,611	12,099,521	12,098,354	0.81	0.86	14%	44,813
	5	-5,997,112	**11,995,143**	**12,000,032**	**11,998,574**	0.78	0.82	11%	34,791
School	2	-2,646,058	5,292,398	5,293,888	5,293,440	**0.93**	0.97	43%	122,388
	3	-2,517,396	5,035,216	5,037,456	5,036,782	0.92	0.95	12%	34,886
	4	-2,452,707	4,905,980	4,908,970	4,908,070	0.89	0.92	10%	29,778
	5	-2,430,214	**4,861,136**	**4,864,876**	**4,863,751**	0.90	0.91	2%	5,359
Teacher	2	-4,787,018	9,574,297	9,575,747	9,575,331	**0.85**	0.95	44%	206,571
	3	-4,645,058	9,290,510	9,292,691	9,292,065	0.85	0.91	20%	96,125
	4	-4,596,212	9,192,950	9,195,861	9,195,025	0.81	0.87	18%	85,702
	5	-4,557,024	**9,114,706**	**9,118,348**	**9,117,303**	0.78	0.82	19%	90,572

Item Response Probabilities Conditional on Class Membership

While the main text presents plots of item response probabilities conditional on class membership, this section provides corresponding tables with the specific conditional item response probabilities and their standard error estimates.

Grade 4

Exhibit: C.3: Grade 4 Student Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ASBG11A	Protection of plants and animals	0.085	(0.002)	0.118	(0.002)	0.396	(0.003)	0.401	(0.003)
ASBG11B	Sad when nature destroyed	0.134	(0.003)	0.216	(0.003)	0.391	(0.004)	0.259	(0.003)
ASBG11C	Enjoy learning about plants and animals	0.180	(0.003)	0.279	(0.002)	0.299	(0.004)	0.242	(0.003)
ASBG11D	Enjoy being in nature	0.126	(0.002)	0.168	(0.002)	0.332	(0.003)	0.374	(0.003)
ASBG11E	Climate change priority	0.168	(0.003)	0.231	(0.002)	0.343	(0.004)	0.257	(0.002)
ASBG12A	Reuse things	0.197	(0.003)	0.483	(0.003)	0.173	(0.002)	0.147	(0.002)
ASBG12B	Save resources	0.251	(0.003)	0.425	(0.004)	0.197	(0.002)	0.127	(0.002)
ASBG12C	Talk about environment	0.425	(0.005)	0.413	(0.005)	0.103	(0.002)	0.060	(0.002)
ASBG12D	Learn about environment	0.417	(0.005)	0.424	(0.005)	0.102	(0.002)	0.057	(0.002)
ASBG12E	Participate in activities	0.486	(0.004)	0.350	(0.004)	0.100	(0.002)	0.064	(0.002)
ASBG12F	Tell when friends do harm	0.378	(0.004)	0.405	(0.004)	0.127	(0.002)	0.091	(0.002)

Exhibit: C.3: Grade 4 Student Questionnaire Conditional Item Response Probabilities (Continued)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ASBG11A	Protection of plants and animals	0.005	(0.000)	0.014	(0.001)	0.220	(0.003)	0.762	(0.003)
ASBG11B	Sad when nature destroyed	0.014	(0.001)	0.033	(0.001)	0.292	(0.004)	0.662	(0.004)
ASBG11C	Enjoy learning about plants and animals	0.006	(0.000)	0.070	(0.002)	0.376	(0.003)	0.548	(0.004)
ASBG11D	Enjoy being in nature	0.006	(0.001)	0.041	(0.001)	0.260	(0.003)	0.694	(0.003)
ASBG11E	Climate change priority	0.020	(0.001)	0.090	(0.001)	0.413	(0.002)	0.478	(0.003)
ASBG12A	Reuse things	0.022	(0.001)	0.370	(0.004)	0.407	(0.002)	0.201	(0.003)
ASBG12B	Save resources	0.056	(0.001)	0.337	(0.004)	0.398	(0.002)	0.210	(0.003)
ASBG12C	Talk about environment	0.048	(0.002)	0.535	(0.005)	0.314	(0.003)	0.103	(0.003)
ASBG12D	Learn about environment	0.048	(0.001)	0.473	(0.005)	0.351	(0.003)	0.128	(0.003)
ASBG12E	Participate in activities	0.145	(0.003)	0.486	(0.003)	0.264	(0.003)	0.105	(0.003)
ASBG12F	Tell when friends do harm	0.074	(0.001)	0.365	(0.004)	0.340	(0.002)	0.221	(0.004)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ASBG11A	Protection of plants and animals	0.020	(0.001)	0.012	(0.000)	0.071	(0.001)	0.897	(0.001)
ASBG11B	Sad when nature destroyed	0.051	(0.001)	0.023	(0.001)	0.101	(0.001)	0.824	(0.002)
ASBG11C	Enjoy learning about plants and animals	0.021	(0.001)	0.023	(0.001)	0.120	(0.002)	0.836	(0.002)
ASBG11D	Enjoy being in nature	0.022	(0.001)	0.021	(0.001)	0.099	(0.001)	0.859	(0.002)
ASBG11E	Climate change priority	0.058	(0.001)	0.049	(0.001)	0.213	(0.002)	0.680	(0.002)
ASBG12A	Reuse things	0.064	(0.001)	0.147	(0.002)	0.209	(0.002)	0.580	(0.003)
ASBG12B	Save resources	0.078	(0.001)	0.099	(0.001)	0.202	(0.002)	0.620	(0.003)
ASBG12C	Talk about environment	0.029	(0.001)	0.081	(0.002)	0.188	(0.003)	0.702	(0.004)
ASBG12D	Learn about environment	0.040	(0.001)	0.074	(0.002)	0.186	(0.003)	0.699	(0.004)
ASBG12E	Participate in activities	0.039	(0.001)	0.106	(0.002)	0.162	(0.002)	0.692	(0.004)
ASBG12F	Tell when friends do harm	0.058	(0.001)	0.069	(0.001)	0.143	(0.002)	0.730	(0.003)

Exhibit: C.4: Home Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ASBH09A	Discuss problems	0.526	(0.008)	0.451	(0.008)	0.012	(0.001)	0.010	(0.001)
ASBH09B	Read/watch information	0.656	(0.008)	0.314	(0.008)	0.019	(0.002)	0.011	(0.001)
ASBH09C	Save resources	0.256	(0.005)	0.494	(0.005)	0.134	(0.003)	0.116	(0.004)
ASBH09D	Time in nature	0.209	(0.004)	0.642	(0.005)	0.100	(0.003)	0.049	(0.002)
ASBH09E	Encourage action	0.306	(0.005)	0.527	(0.006)	0.089	(0.003)	0.078	(0.003)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ASBH09A	Discuss problems	0.010	(0.001)	0.889	(0.002)	0.096	(0.002)	0.005	(0.000)
ASBH09B	Read/watch information	0.050	(0.001)	0.906	(0.002)	0.044	(0.001)	0.001	(0.000)
ASBH09C	Save resources	0.012	(0.000)	0.489	(0.003)	0.411	(0.002)	0.088	(0.002)
ASBH09D	Time in nature	0.012	(0.001)	0.698	(0.002)	0.254	(0.002)	0.036	(0.001)
ASBH09E	Encourage action	0.012	(0.001)	0.573	(0.003)	0.345	(0.002)	0.071	(0.002)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ASBH09A	Discuss problems	0.011	(0.001)	0.267	(0.004)	0.468	(0.003)	0.254	(0.003)
ASBH09B	Read/watch information	0.013	(0.001)	0.353	(0.004)	0.427	(0.003)	0.207	(0.003)
ASBH09C	Save resources	0.003	(0.000)	0.074	(0.002)	0.341	(0.003)	0.582	(0.003)
ASBH09D	Time in nature	0.015	(0.001)	0.341	(0.003)	0.340	(0.002)	0.305	(0.003)
ASBH09E	Encourage action	0.006	(0.000)	0.082	(0.002)	0.360	(0.003)	0.552	(0.003)

Exhibit: C.5: Grade 4 School Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ACBG13A	Shared vision	0.074	(0.002)	0.400	(0.003)	0.490	(0.004)	0.037	(0.001)
ACBG13B	Review sustainability practices	0.094	(0.002)	0.552	(0.003)	0.341	(0.004)	0.013	(0.001)
ACBG13C	Schoolwide approach	0.125	(0.002)	0.601	(0.003)	0.266	(0.004)	0.008	(0.001)
ACBG13D	Teach students to appreciate	0.017	(0.001)	0.166	(0.002)	0.668	(0.003)	0.149	(0.003)
ACBG13E	Teach students how to take action	0.029	(0.001)	0.235	(0.003)	0.658	(0.003)	0.078	(0.002)
ACBG13F	Encourage teachers' learning	0.096	(0.002)	0.531	(0.003)	0.365	(0.004)	0.008	(0.001)
ACBG13G	Promotes within community	0.149	(0.002)	0.529	(0.003)	0.318	(0.003)	0.003	(0.000)
ACBG13H	Participation in networks/projects	0.148	(0.002)	0.531	(0.003)	0.299	(0.003)	0.023	(0.001)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ACBG13A	Shared vision	0.002	(0.000)	0.013	(0.000)	0.698	(0.002)	0.286	(0.002)
ACBG13B	Review sustainability practices	0.002	(0.000)	0.042	(0.001)	0.779	(0.002)	0.178	(0.002)
ACBG13C	Schoolwide approach	0.001	(0.000)	0.057	(0.001)	0.811	(0.002)	0.131	(0.002)
ACBG13D	Teach students to appreciate	0.000	(0.000)	0.002	(0.000)	0.502	(0.003)	0.495	(0.003)
ACBG13E	Teach students how to take action	0.000	(0.000)	0.002	(0.000)	0.588	(0.003)	0.410	(0.003)
ACBG13F	Encourage teachers' learning	0.001	(0.000)	0.034	(0.001)	0.747	(0.002)	0.218	(0.002)
ACBG13G	Promotes within community	0.002	(0.000)	0.077	(0.001)	0.767	(0.002)	0.154	(0.002)
ACBG13H	Participation in networks/projects	0.005	(0.000)	0.111	(0.001)	0.700	(0.002)	0.183	(0.002)

Exhibit: C.5: Grade 4 School Questionnaire Conditional Item Response Probabilities (Continued)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ACBG13A	Shared vision	0.000	(0.000)	0.002	(0.000)	0.074	(0.001)	0.925	(0.001)
ACBG13B	Review sustainability practices	0.004	(0.000)	0.004	(0.000)	0.118	(0.002)	0.874	(0.002)
ACBG13C	Schoolwide approach	0.000	(0.000)	0.002	(0.000)	0.130	(0.002)	0.868	(0.002)
ACBG13D	Teach students to appreciate	0.000	(0.000)	0.000	(0.000)	0.017	(0.001)	0.983	(0.001)
ACBG13E	Teach students how to take action	0.000	(0.000)	0.000	(0.000)	0.025	(0.001)	0.975	(0.001)
ACBG13F	Encourage teachers' learning	0.000	(0.000)	0.002	(0.000)	0.085	(0.001)	0.913	(0.001)
ACBG13G	Promotes within community	0.000	(0.000)	0.004	(0.000)	0.135	(0.001)	0.861	(0.001)
ACBG13H	Participation in networks/projects	0.000	(0.000)	0.006	(0.000)	0.165	(0.001)	0.829	(0.001)

Exhibit: C.6: Grade 4 Teacher Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ATBS04A	Develop positive attitudes	0.041	(0.001)	0.464	(0.003)	0.358	(0.003)	0.138	(0.003)
ATBS04B	Encourage save resources	0.077	(0.002)	0.642	(0.004)	0.219	(0.003)	0.063	(0.002)
ATBS04C	Discuss actions	0.084	(0.002)	0.792	(0.003)	0.114	(0.003)	0.010	(0.001)
ATBS04D	Discuss problems	0.101	(0.002)	0.803	(0.003)	0.087	(0.002)	0.009	(0.001)
ATBS05A	Visit natural areas	0.629	(0.003)	0.371	(0.003)				
ATBS05B	Responsible activities	0.427	(0.003)	0.573	(0.003)				
ATBS05C	Research topics	0.621	(0.003)	0.379	(0.003)				
ATBS05D	Outdoor programs	0.712	(0.003)	0.288	(0.003)				
ATBS06	Opinion on priority	0.011	(0.001)	0.063	(0.002)	0.473	(0.003)	0.453	(0.003)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ATBS04A	Develop positive attitudes	0.000	(0.000)	0.036	(0.001)	0.487	(0.002)	0.476	(0.002)
ATBS04B	Encourage save resources	0.003	(0.000)	0.055	(0.001)	0.631	(0.002)	0.311	(0.002)
ATBS04C	Discuss actions	0.000	(0.000)	0.056	(0.002)	0.810	(0.002)	0.135	(0.002)
ATBS04D	Discuss problems	0.000	(0.000)	0.174	(0.002)	0.765	(0.002)	0.061	(0.001)
ATBS05A	Visit natural areas	0.453	(0.003)	0.547	(0.003)				
ATBS05B	Responsible activities	0.200	(0.002)	0.800	(0.002)				
ATBS05C	Research topics	0.355	(0.002)	0.645	(0.002)				
ATBS05D	Outdoor programs	0.537	(0.002)	0.463	(0.002)				
ATBS06	Opinion on priority	0.002	(0.000)	0.011	(0.000)	0.280	(0.002)	0.706	(0.002)

Exhibit: C.6: Grade 4 Teacher Questionnaire Conditional Item Response Probabilities (Continued)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ATBS04A	Develop positive attitudes	0.001	(0.000)	0.016	(0.001)	0.096	(0.003)	0.887	(0.003)
ATBS04B	Encourage save resources	0.004	(0.001)	0.005	(0.001)	0.128	(0.003)	0.863	(0.003)
ATBS04C	Discuss actions	0.001	(0.000)	0.001	(0.000)	0.094	(0.004)	0.904	(0.004)
ATBS04D	Discuss problems	0.001	(0.000)	0.027	(0.001)	0.264	(0.005)	0.708	(0.006)
ATBS05A	Visit natural areas	0.995	(0.004)	0.005	(0.004)				
ATBS05B	Responsible activities	0.176	(0.004)	0.824	(0.004)				
ATBS05C	Research topics	0.214	(0.004)	0.786	(0.004)				
ATBS05D	Outdoor programs	0.605	(0.008)	0.395	(0.008)				
ATBS06	Opinion on priority	0.002	(0.000)	0.006	(0.000)	0.113	(0.002)	0.879	(0.002)

Class 4

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
ATBS04A	Develop positive attitudes	0.000	(0.000)	0.004	(0.000)	0.038	(0.001)	0.958	(0.001)
ATBS04B	Encourage save resources	0.009	(0.000)	0.002	(0.000)	0.067	(0.001)	0.922	(0.001)
ATBS04C	Discuss actions	0.000	(0.000)	0.001	(0.000)	0.043	(0.001)	0.955	(0.001)
ATBS04D	Discuss problems	0.000	(0.000)	0.012	(0.000)	0.155	(0.002)	0.833	(0.002)
ATBS05A	Visit natural areas	0.102	(0.007)	0.898	(0.007)				
ATBS05B	Responsible activities	0.043	(0.001)	0.957	(0.001)				
ATBS05C	Research topics	0.118	(0.002)	0.882	(0.002)				
ATBS05D	Outdoor programs	0.192	(0.002)	0.808	(0.002)				
ATBS06	Opinion on priority	0.001	(0.000)	0.006	(0.000)	0.104	(0.001)	0.888	(0.001)

Exhibit: C.7: Grade 8 Student Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BSBG14A	Protection of plants and animals	0.102	(0.002)	0.174	(0.002)	0.501	(0.003)	0.222	(0.003)
BSBG14B	Nature benefits humans	0.139	(0.002)	0.249	(0.002)	0.375	(0.003)	0.237	(0.003)
BSBG14C	Protect nature for enjoyment	0.148	(0.002)	0.289	(0.003)	0.367	(0.003)	0.196	(0.003)
BSBG14D	Confidence in sci and tech solve	0.145	(0.002)	0.311	(0.003)	0.362	(0.003)	0.182	(0.003)
BSBG14E	Sad when nature destroyed	0.151	(0.003)	0.274	(0.003)	0.407	(0.004)	0.168	(0.003)
BSBG14F	Enjoy learning about plants and animals	0.308	(0.004)	0.360	(0.003)	0.235	(0.003)	0.096	(0.002)
BSBG14G	Enjoy being in nature	0.140	(0.002)	0.211	(0.002)	0.396	(0.003)	0.252	(0.003)
BSBG14H	Protecting nature more important	0.158	(0.003)	0.357	(0.003)	0.377	(0.004)	0.108	(0.002)
BSBG14I	Climate change priority	0.110	(0.002)	0.196	(0.002)	0.419	(0.003)	0.275	(0.003)
BSBG15A	Reuse things	0.215	(0.003)	0.480	(0.003)	0.198	(0.003)	0.106	(0.002)
BSBG15B	Save resources	0.296	(0.004)	0.464	(0.003)	0.159	(0.002)	0.081	(0.002)
BSBG15C	Talk about environment	0.614	(0.006)	0.324	(0.006)	0.042	(0.001)	0.021	(0.001)
BSBG15D	Learn about environment	0.557	(0.006)	0.390	(0.006)	0.037	(0.001)	0.016	(0.001)
BSBG15E	Participate in activities	0.749	(0.004)	0.206	(0.004)	0.029	(0.001)	0.016	(0.001)
BSBG15F	Tell when friends do harm	0.522	(0.005)	0.387	(0.005)	0.057	(0.002)	0.035	(0.001)

Exhibit: C.7: Grade 8 Student Questionnaire Conditional Item Response Probabilities (Continued)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BSBG14A	Protection of plants and animals	0.007	(0.000)	0.035	(0.001)	0.369	(0.003)	0.589	(0.004)
BSBG14B	Nature benefits humans	0.119	(0.001)	0.154	(0.002)	0.327	(0.002)	0.399	(0.004)
BSBG14C	Protect nature for enjoyment	0.104	(0.001)	0.220	(0.002)	0.352	(0.002)	0.324	(0.003)
BSBG14D	Confidence in sci and tech solve	0.057	(0.001)	0.232	(0.002)	0.457	(0.002)	0.253	(0.003)
BSBG14E	Sad when nature destroyed	0.017	(0.001)	0.054	(0.001)	0.337	(0.004)	0.591	(0.004)
BSBG14F	Enjoy learning about plants and animals	0.024	(0.001)	0.166	(0.003)	0.435	(0.002)	0.374	(0.005)
BSBG14G	Enjoy being in nature	0.014	(0.001)	0.073	(0.001)	0.340	(0.003)	0.573	(0.004)
BSBG14H	Protecting nature more important	0.016	(0.001)	0.138	(0.002)	0.526	(0.003)	0.320	(0.004)
BSBG14I	Climate change priority	0.014	(0.001)	0.074	(0.001)	0.395	(0.003)	0.517	(0.003)
BSBG15A	Reuse things	0.039	(0.001)	0.404	(0.002)	0.358	(0.002)	0.199	(0.002)
BSBG15B	Save resources	0.078	(0.001)	0.405	(0.003)	0.351	(0.002)	0.166	(0.002)
BSBG15C	Talk about environment	0.082	(0.002)	0.621	(0.003)	0.239	(0.003)	0.059	(0.002)
BSBG15D	Learn about environment	0.068	(0.001)	0.595	(0.004)	0.273	(0.003)	0.064	(0.002)
BSBG15E	Participate in activities	0.256	(0.003)	0.551	(0.002)	0.162	(0.002)	0.030	(0.001)
BSBG15F	Tell when friends do harm	0.092	(0.002)	0.484	(0.004)	0.296	(0.002)	0.129	(0.003)

Exhibit: C.7: Grade 8 Student Questionnaire Conditional Item Response Probabilities (Continued)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BSBG14A	Protection of plants and animals	0.022	(0.001)	0.019	(0.001)	0.126	(0.002)	0.832	(0.002)
BSBG14B	Nature benefits humans	0.066	(0.001)	0.053	(0.001)	0.174	(0.002)	0.706	(0.003)
BSBG14C	Protect nature for enjoyment	0.068	(0.001)	0.089	(0.001)	0.184	(0.002)	0.658	(0.003)
BSBG14D	Confidence in sci and tech solve	0.052	(0.001)	0.093	(0.002)	0.252	(0.002)	0.602	(0.003)
BSBG14E	Sad when nature destroyed	0.033	(0.001)	0.028	(0.001)	0.098	(0.002)	0.841	(0.002)
BSBG14F	Enjoy learning about plants and animals	0.021	(0.001)	0.036	(0.001)	0.157	(0.002)	0.787	(0.003)
BSBG14G	Enjoy being in nature	0.021	(0.001)	0.030	(0.001)	0.118	(0.002)	0.832	(0.002)
BSBG14H	Protecting nature more important	0.028	(0.001)	0.055	(0.001)	0.237	(0.003)	0.680	(0.003)
BSBG14I	Climate change priority	0.028	(0.001)	0.042	(0.001)	0.189	(0.002)	0.741	(0.003)
BSBG15A	Reuse things	0.070	(0.001)	0.208	(0.003)	0.244	(0.002)	0.478	(0.004)
BSBG15B	Save resources	0.071	(0.001)	0.133	(0.002)	0.252	(0.002)	0.544	(0.004)
BSBG15C	Talk about environment	0.031	(0.001)	0.129	(0.004)	0.239	(0.003)	0.601	(0.006)
BSBG15D	Learn about environment	0.040	(0.001)	0.119	(0.003)	0.253	(0.003)	0.588	(0.006)
BSBG15E	Participate in activities	0.062	(0.002)	0.197	(0.004)	0.214	(0.002)	0.527	(0.006)
BSBG15F	Tell when friends do harm	0.045	(0.001)	0.096	(0.003)	0.196	(0.003)	0.662	(0.005)

Exhibit C.8: Grade 8 School Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BCBG14A	Shared vision	0.077	(0.002)	0.395	(0.004)	0.490	(0.004)	0.038	(0.001)
BCBG14B	Review sustainability practices	0.100	(0.002)	0.517	(0.004)	0.370	(0.004)	0.013	(0.001)
BCBG14C	Schoolwide approach	0.126	(0.002)	0.619	(0.003)	0.250	(0.004)	0.005	(0.001)
BCBG14D	Teach students to appreciate	0.036	(0.001)	0.261	(0.003)	0.644	(0.004)	0.059	(0.002)
BCBG14E	Teach students how to take action	0.041	(0.001)	0.331	(0.004)	0.589	(0.004)	0.039	(0.001)
BCBG14F	Encourage teachers' learning	0.100	(0.002)	0.572	(0.004)	0.312	(0.004)	0.015	(0.001)
BCBG14G	Promotes within community	0.117	(0.002)	0.589	(0.004)	0.284	(0.004)	0.010	(0.001)
BCBG14H	Participation in networks/projects	0.147	(0.003)	0.530	(0.003)	0.307	(0.004)	0.016	(0.001)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BCBG14A	Shared vision	0.000	(0.000)	0.015	(0.001)	0.703	(0.002)	0.282	(0.003)
BCBG14B	Review sustainability practices	0.001	(0.000)	0.045	(0.001)	0.768	(0.002)	0.186	(0.002)
BCBG14C	Schoolwide approach	0.002	(0.000)	0.070	(0.001)	0.817	(0.002)	0.111	(0.002)
BCBG14D	Teach students to appreciate	0.000	(0.000)	0.007	(0.000)	0.623	(0.003)	0.370	(0.003)
BCBG14E	Teach students how to take action	0.000	(0.000)	0.009	(0.000)	0.681	(0.003)	0.309	(0.003)
BCBG14F	Encourage teachers' learning	0.001	(0.000)	0.040	(0.001)	0.763	(0.002)	0.196	(0.002)
BCBG14G	Promotes within community	0.002	(0.000)	0.071	(0.001)	0.804	(0.002)	0.123	(0.002)
BCBG14H	Participation in networks/projects	0.011	(0.000)	0.106	(0.002)	0.702	(0.002)	0.181	(0.002)

Exhibit C.8: Grade 8 School Questionnaire Conditional Item Response Probabilities (Continued)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BCBG14A	Shared vision	0.000	(0.000)	0.001	(0.000)	0.074	(0.001)	0.925	(0.001)
BCBG14B	Review sustainability practices	0.002	(0.000)	0.003	(0.000)	0.127	(0.001)	0.868	(0.001)
BCBG14C	Schoolwide approach	0.000	(0.000)	0.003	(0.000)	0.165	(0.002)	0.833	(0.002)
BCBG14D	Teach students to appreciate	0.000	(0.000)	0.000	(0.000)	0.032	(0.001)	0.968	(0.001)
BCBG14E	Teach students how to take action	0.000	(0.000)	0.000	(0.000)	0.038	(0.001)	0.962	(0.001)
BCBG14F	Encourage teachers' learning	0.000	(0.000)	0.001	(0.000)	0.101	(0.001)	0.897	(0.001)
BCBG14G	Promotes within community	0.001	(0.000)	0.003	(0.000)	0.140	(0.001)	0.856	(0.002)
BCBG14H	Participation in networks/projects	0.005	(0.000)	0.007	(0.000)	0.146	(0.001)	0.842	(0.001)

Exhibit C.9: Grade 8 Teacher Questionnaire Conditional Item Response Probabilities

Class 1

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BTBS17A	Develop positive attitudes	0.032	(0.001)	0.471	(0.002)	0.382	(0.002)	0.114	(0.002)
BTBS17B	Encourage save resources	0.093	(0.001)	0.713	(0.002)	0.174	(0.002)	0.020	(0.001)
BTBS17C	Discuss actions	0.093	(0.001)	0.801	(0.002)	0.100	(0.002)	0.006	(0.000)
BTBS17D	Discuss problems	0.094	(0.001)	0.762	(0.002)	0.137	(0.002)	0.007	(0.000)
BTBS18A	Visit natural areas	0.817	(0.002)	0.183	(0.002)				
BTBS18B	Responsible activities	0.604	(0.002)	0.396	(0.002)				
BTBS18C	Research topics	0.534	(0.002)	0.466	(0.002)				
BTBS18D	Outdoor programs	0.759	(0.002)	0.241	(0.002)				
BTBS19	Opinion on priority	0.014	(0.000)	0.057	(0.001)	0.439	(0.002)	0.490	(0.002)

Class 2

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BTBS17A	Develop positive attitudes	0.001	(0.000)	0.037	(0.001)	0.516	(0.002)	0.447	(0.002)
BTBS17B	Encourage save resources	0.006	(0.000)	0.093	(0.001)	0.693	(0.002)	0.208	(0.002)
BTBS17C	Discuss actions	0.000	(0.000)	0.097	(0.002)	0.814	(0.002)	0.090	(0.002)
BTBS17D	Discuss problems	0.005	(0.000)	0.182	(0.002)	0.740	(0.002)	0.074	(0.001)
BTBS18A	Visit natural areas	0.684	(0.002)	0.316	(0.002)				
BTBS18B	Responsible activities	0.335	(0.002)	0.665	(0.002)				
BTBS18C	Research topics	0.265	(0.002)	0.735	(0.002)				
BTBS18D	Outdoor programs	0.551	(0.002)	0.449	(0.002)				
BTBS19	Opinion on priority	0.002	(0.000)	0.017	(0.000)	0.271	(0.001)	0.710	(0.002)

Exhibit C.9: Grade 8 Teacher Questionnaire Conditional Item Response Probabilities (Continued)

Class 3

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BTBS17A	Develop positive attitudes	0.001	(0.000)	0.019	(0.001)	0.103	(0.002)	0.877	(0.002)
BTBS17B	Encourage save resources	0.003	(0.000)	0.007	(0.001)	0.120	(0.003)	0.870	(0.003)
BTBS17C	Discuss actions	0.001	(0.000)	0.003	(0.000)	0.086	(0.003)	0.910	(0.003)
BTBS17D	Discuss problems	0.004	(0.000)	0.024	(0.001)	0.232	(0.004)	0.741	(0.004)
BTBS18A	Visit natural areas	0.824	(0.002)	0.176	(0.002)				
BTBS18B	Responsible activities	0.305	(0.003)	0.695	(0.003)				
BTBS18C	Research topics	0.254	(0.002)	0.746	(0.002)				
BTBS18D	Outdoor programs	0.703	(0.004)	0.297	(0.004)				
BTBS19	Opinion on priority	0.004	(0.000)	0.013	(0.001)	0.142	(0.002)	0.841	(0.002)

Class 4

Variable	Label	P Response=1	(S.E.)	P Response=2	(S.E.)	P Response=3	(S.E.)	P Response=4	(S.E.)
BTBS17A	Develop positive attitudes	0.000	(0.000)	0.006	(0.000)	0.081	(0.001)	0.913	(0.001)
BTBS17B	Encourage save resources	0.011	(0.001)	0.009	(0.000)	0.125	(0.002)	0.856	(0.002)
BTBS17C	Discuss actions	0.001	(0.000)	0.003	(0.000)	0.134	(0.002)	0.863	(0.002)
BTBS17D	Discuss problems	0.000	(0.000)	0.016	(0.001)	0.183	(0.002)	0.801	(0.003)
BTBS18A	Visit natural areas	0.263	(0.002)	0.737	(0.002)				
BTBS18B	Responsible activities	0.028	(0.001)	0.972	(0.001)				
BTBS18C	Research topics	0.023	(0.001)	0.977	(0.001)				
BTBS18D	Outdoor programs	0.018	(0.001)	0.982	(0.001)				
BTBS19	Opinion on priority	0.002	(0.000)	0.002	(0.000)	0.120	(0.001)	0.876	(0.001)

Estimating Class Sizes and Expected Achievement

Proportions of individuals in each latent class by country were obtained by calculating the sampling-weighted average of posterior class probabilities. To derive expected *Environmental Knowledge* achievement scores by class, we calculated the weighted average of student achievement Boston scores for each class, where the weights were the product of their sampling weight and posterior class probability. Standard errors were estimated following the procedures outlined in Chapter 13 of the TIMSS 2023 Technical Report.

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