

# TIMSS 2007 International Mathematics Report 

Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades

Michael O. Martin
Ina V.S. Mullis
Pierre Foy
In collaboration with
John F. Olson
Corinna Preuschoff
Ebru Erberber
Alka Arora
Joseph Galia

Copyright © 2008 International Association for the Evaluation of Educational Achievement (IEA)
Published December 2008, Revised August 2009
TIMSS 2007 International Mathematics Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades

Ina V.S. Mullis, Michael O. Martin, Pierre Foy in collaboration with John F. Olson, Corinna Preuschoff, Ebru Erberber, Alka Arora, Joseph Galia

Publisher: TIMSS \& PIRLS International Study Center,
Lynch School of Education, Boston College

Library of Congress Catalog Card Number: 2008902434
ISBN: 1-889938-48-3

For more information about timss contact:
TIMSS \& PIRLS International Study Center
Lynch School of Education
Boston College
Chestnut Hill, MA 02467
United States
tel: +1-617-552-1600
fax: +1-617-552-1203
e-mail: timss@bc.edu
http://timssandpirls.bc.edu

Boston College is an equal opportunity, affirmative action employer.
Printed and bound in the United States.

## Contents

Foreword ..... 1
Executive Summary ..... 5
Introduction ..... 13
What Is TIMSS? ..... 14
Which Countries Participated in TIMSS 2007? ..... 15
Exhibit 1 Countries Participating in TIMSS 2007 ..... 16
Exhibit 2 Countries Participating in TIMSS 1995 Through 2007 ..... 20
Exhibit 3 Selected Characteristics of TIMSS 2007 Countries ..... 22
What Was the Nature of the TIMSS 2007 Mathematics Test? ..... 24
How Was Information Collected About the Contexts for Learning Mathematics? ..... 25
Who Conducts TIMSS? ..... 26
Chapter 1 ..... 31
International Student Achievement in Mathematics
How Do Countries Differ in Mathematics Achievement? ..... 31
Exhibit 1.1 TIMSS 2007 Distribution of Mathematics Achievement ..... 34
Exhibit 1.2 TIMSS 2007 Multiple Comparisons of Average Mathematics Achievement . ..... 36
How Has Mathematics Achievement Changed Since 1995, 1999, and 2003? ..... 43
Exhibit 1.3 Trends in Mathematics Achievement - 1995 Through 2007 ..... 44
Trends Across Grades: Fourth to Eighth Grade Cohort Analysis ..... 54
Exhibit 1.4 Cohort Comparison: 2003 Fourth Grade Students in Eighth Grade in 2007. ..... 55
What Are the Gender Differences in Mathematics Achievement? ..... 56
Exhibit 1.5 TIMSS 2007 Average Mathematics Achievement by Gender ..... 58
Exhibit 1.6 Trends in Average Mathematics Achievement by Gender - 1995 Through 2007 ..... 60
Chapter 2 ..... 65
Performance at the TIMSS 2007 International Benchmarks for Mathematics Achievement
How Do Countries Compare with the TIMSS 2007 International Benchmarks of Mathematics Achievement? ..... 66
Exhibit 2.1 TIMSS 2007 International Benchmarks of Mathematics Achievement ..... 68
Exhibit 2.2 Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Mathematics Achievement ..... 70
Exhibit 2.3 Trends in Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Mathematics Achievement ..... 76
Fourth Grade: Achievement at the Advanced International Benchmark ..... 80
Exhibit 2.4 Description of the TIMSS 2007 Advanced International Benchmark (625) of Mathematics Achievement ..... 81
Exhibit 2.5 TIMSS 2007 Advanced International Benchmark (625) of Mathematics Achievement - Example Item 1 ..... 83
Exhibit 2.6 TIMSS 2007 Advanced International Benchmark (625) of Mathematics Achievement - Example Item 2 ..... 84
Fourth Grade: Achievement at the High International Benchmark ..... 85
Exhibit 2.7 Description of the TIMSS 2007 High International Benchmark (550) of Mathematics Achievement ..... 86
Exhibit 2.8 TIMSS 2007 High International Benchmark (550) of Mathematics Achievement - Example Item 3. ..... 87
Exhibit 2.9 TIMSS 2007 High International Benchmark (550) of Mathematics Achievement - Example Item 4. ..... 88
Fourth Grade: Achievement at the Intermediate International Benchmark ..... 89
Exhibit 2.10 Description of the TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement ..... 90
Exhibit 2.11 TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement - Example Item 5. ..... 91
Exhibit 2.12 TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement - Example Item 6. ..... 93
Exhibit 2.13 TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement - Example Item 7 ..... 94
Fourth Grade: Achievement at the Low International Benchmark ..... 95
Exhibit 2.14 Description of the TIMSS 2007 Low International Benchmark (400) of Mathematics Achievement ..... 96
Exhibit 2.15 TIMSS 2007 Low International Benchmark (400) of Mathematics Achievement - Example Item 8 ..... 97
Eighth Grade: Achievement at the Advanced International Benchmark ..... 98
Exhibit 2.16 Description of the TIMSS 2007 Advanced International Benchmark (625) of Mathematics Achievement ..... 100
Exhibit 2.17 TIMSS 2007 Advanced International Benchmark (625) of Mathematics Achievement - Example Item 1 ..... 102
Exhibit 2.18 TIMSS 2007 Advanced International Benchmark (625) of Mathematics Achievement - Example Item 2 ..... 103
Eighth Grade: Achievement at the High International Benchmark ..... 104
Exhibit 2.19 Description of the TIMSS 2007 High International Benchmark (550) of Mathematics Achievement ..... 105
Exhibit 2.20 TIMSS 2007 High International Benchmark (550) of Mathematics Achievement - Example Item 3. ..... 106
Exhibit 2.21 TIMSS 2007 High International Benchmark (550) of Mathematics Achievement - Example Item 4. ..... 107
Eighth Grade: Achievement at the Intermediate International Benchmark ..... 108
Exhibit 2.22 Description of the TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement ..... 109
Exhibit 2.23 TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement - Example Item 5 ..... 110
Exhibit 2.24 TIMSS 2007 Intermediate International Benchmark (475) of Mathematics Achievement - Example Item 6. ..... 111
Eighth Grade: Achievement at the Low International Benchmark. ..... 112
Exhibit 2.25 Description of the TIMSS 2007 Low International Benchmark (400) of Mathematics Achievement ..... 113
Exhibit 2.26 TIMSS 2007 Low International Benchmark (400) of Mathematics Achievement - Example Item 7 ..... 114
Exhibit 2.27 TIMSS 2007 Low International Benchmark (400) of Mathematics Achievement - Example Item 8. ..... 115
Chapter 3 ..... 117
Average Achievement in the Mathematics Content and Cognitive Domains
How Does Achievement Differ Across the TIMSS 2007 Mathematics Content and Cognitive Domains? ..... 118
Exhibit 3.1 Average Achievement in the Mathematics Content and Cognitive Domains. ..... 120
In Which Mathematics Content and Cognitive Domains Are Countries Relatively Strong or Weak? ..... 124
Exhibit 3.2 Profiles of Within-country Relative Performance in the Mathematics Content and Cognitive Domains ..... 126
What Are the Gender Differences in Achievement for the Mathematics Content and Cognitive Domains? ..... 136
Exhibit 3.3 Average Achievement in the Mathematics Content and Cognitive Domains by Gender ..... 138
Chapter 4 ..... 143
Students' Backgrounds And Attitudes Toward Mathematics
What Educational Resources Do Students Have in Their Homes? .....  143
Exhibit 4.1 Highest Level of Education of Either Parent. ..... 146
Exhibit 4.2 Students Speak the Language of the Test at Home with Trends ..... 148
Exhibit 4.3 Students' Parents Born in the Country with Trends ..... 152
Exhibit 4.4 Books in the Home with Trends ..... 156
Exhibit 4.5 Computer and Internet Connection in the Home ..... 162
Exhibit 4.6 Computer Use with Trends ..... 164
How Much of Their Out-of-school Time Do Students Spend on Homework During the School Week? ..... 169
Exhibit 4.7 Index of Time Students Spend Doing Mathematics Homework (TMH) in a Normal School Week ..... 170
What Are Students' Attitudes Toward Mathematics? ..... 173
Exhibit 4.8 Index of Students' Positive Affect Toward Mathematics (PATM) with Trends ..... 175
Exhibit 4.9 Index of Students' Valuing Mathematics (SVM) with Trends. ..... 179
Exhibit 4.10 Index of Students' Self-Confidence in Learning Mathematics (SCM) with Trends ..... 182
Exhibit 4.11 Index of Students'Self-Confidence in Learning Mathematics (SCM) by Gender ..... 184
Chapter 5 ..... 189
The Mathematics Curriculum
How Much Instructional Time Is Spent on Mathematics? ..... 190
Exhibit 5.1 Weekly Intended and Implemented Instructional Time for Mathematics with Trends ..... 192
Exhibit 5.2 Yearly Hours of Implemented Instructional Time for Mathematics with Trends ..... 194
Exhibit 5.3 Percentage of Time in Mathematics Class Devoted to TIMSS Content Domains During the School Year ..... 196
Are the TIMSS Mathematics Topics Included in the Intended Curriculum Taught in School?. ..... 198
Exhibit 5.4 Summary of TIMSS Mathematics Topics in the Intended Curriculum ..... 200
Exhibit 5.5 Summary of Students Taught the TIMSS Mathematics Topics ..... 204
Fourth Grade: Which TIMSS Mathematics Topics Are in the Intended and Implemented Curriculum? .....  206
Exhibit 5.6 Intended and Taught TIMSS Number Topics ..... 208
Exhibit 5.7 Intended and Taught TIMSS Geometric Shapes and Measures Topics ..... 216
Exhibit 5.8 Intended and Taught TIMSS Data Display Topics ..... 220
Eighth Grade: Which TIMSS Mathematics Topics Are in the Intended and Implemented Curriculum? .....  222
Exhibit 5.9 Intended and Taught TIMSS Number Topics ..... 224
Exhibit 5.10 Intended and Taught TIMSS Algebra Topics. ..... 228
Exhibit 5.11 Intended and Taught TIMSS Geometry Topics ..... 232
Exhibit 5.12 Intended and Taught TIMSS Data and Chance Topics ..... 238
Chapter 6 ..... 243
Teachers of Mathematics
What Are the Background Characteristics of Mathematics Teachers? ..... 243
Exhibit 6.1 Mathematics Teachers' Gender, Age, and Number of Years Teaching with Trends ..... 244
What Education and Training Do Teachers Have for Teaching Mathematics? ..... 246
Exhibit 6.2 Highest Educational Level of Mathematics Teachers ..... 248
Exhibit 6.3 Teachers'Educational Emphasis on Mathematics and Teaching ..... 250
Exhibit 6.4 Teachers' Participation in Professional Development in Mathematics ..... 252
Exhibit 6.5 Frequency of Collaboration Among Mathematics Teachers with Trends. ..... 255
How Well Prepared Do Teachers Feel They Are to Teach Mathematics? ..... 257
Exhibit 6.6 Summary of Students Whose Teachers Feel "Very Well" Prepared to Teach the TIMSS Mathematics Topics ..... 258
Exhibit 6.7 Students Whose Teachers Feel "Very Well" Prepared to Teach the TIMSS Mathematics Topics. ..... 260
Chapter 7 ..... 267
Classroom Characteristics and Instruction
How Do the Characteristics of Mathematics Classrooms Impact Instruction? .....  267
Exhibit 7.1 Class Size for Mathematics Instruction with Trends ..... 268
Exhibit 7.2 Achievement and Class Size for Mathematics Instruction ..... 274
Exhibit 7.3 Index of Teachers' Reports on Teaching Mathematics Classes with Few or No Limitations on Instruction Due to Student Factors (MCFL) ..... 276
What Activities Do Students Do in Their Mathematics Lessons? ..... 278
Exhibit 7.4 Students' Reports on Mathematics Content-related Emphasis in Classroom Activities ..... 280
Exhibit 7.5 Teachers' Reports on Mathematics Content-related Emphasis in Students' Classroom Activities ..... 282
Exhibit 7.6 Students' Reports on Learning Activities in Mathematics Lessons ..... 284
Exhibit 7.7 Teachers' Reports on Learning Activities in Mathematics Lessons. ..... 286
What Instructional Strategies Are Used in Mathematics Classes? .....  288
Exhibit 7.8 Textbook Use in Teaching Mathematics with Trends ..... 290
Exhibit 7.9 Percentage of Time in Mathematics Lessons Students Spend on Various Activities in a Typical Week ..... 292
How Are Calculators and Computers Used? .....  296
Exhibit 7.10 Calculator Use in Mathematics Class with Trends ..... 298
Exhibit 7.11 Computer Use in Mathematics Class with Trends ..... 300
What is the Role of Homework?. .....  302
Exhibit 7.12 Index of Teachers'Emphasis on Mathematics Homework (EMH) with Trends. ..... 304
Exhibit 7.13 Use of Mathematics Homework ..... 306
Exhibit 7.14 Types of Mathematics Homework with Trends, ..... 307
What Types of Assessments Are Used in Mathematics Classes? ..... 308
Exhibit 7.15 Emphasis on Sources to Monitor Students' Progress in Mathematics. ..... 309
Exhibit 7.16 Frequency of Teachers Giving Mathematics Tests with Trends ..... 310
Exhibit 7.17 Item Formats Used by Teachers in Mathematics Tests or Examinations with Trends ..... 312
Exhibit 7.18 Types of Questions on Mathematics Tests. ..... 314
Chapter 8 ..... 317
School Contexts for Mathematics Learning and Instruction
What Are the Characteristics of the Schools' Student Population? ..... 317
Exhibit 8.1 Principals' Reports on the Percentages of Students in Their Schools Coming from Economically Disadvantaged Homes with Trends ..... 320
Exhibit 8.2 Principals' Reports on the Percentages of Students Having the Language of the Test as Their Native Language with Trends ..... 324
Exhibit 8.3 Index of Good Attendance at School (GAS) ..... 328
Exhibit 8.4 High Index of Good Attendance at School (GAS) with Trends ..... 330
What Is the Role of the School Principal? ..... 332
Exhibit 8.5 Principals'Time Spent on Various School-related Activities with Trends ..... 334
Do Schools Encourage Home Involvement? .....  338
Exhibit 8.6 Schools'Encouragement of Parental Involvement ..... 340
What School Resources Are Available to Support School Learning? ..... 342
Exhibit 8.7 Index of Availability of School Resources for Mathematics Instruction (ASRMI) ..... 344
Exhibit 8.8 High Index of Availability of School Resources for Mathematics Instruction (ASRMI) with Trends ..... 346
Exhibit 8.9 Index of Teachers' Adequate Working Conditions (TAWC). ..... 350
Exhibit 8.10 Schools' Reports on Teachers' Mathematics and Science Professional Development in the Past 2 Years. ..... 352
What Are the Perceptions of School Climate? ..... 355
Exhibit 8.11 Index of Principals' Perception of School Climate (PPSC) with Trends ..... 358
Exhibit 8.12 Index of Mathematics Teachers' Perception of School Climate (TPSC) with Trends ..... 360
How Safe and Orderly Are Schools? ..... 362
Exhibit 8.13 Index of Mathematics Teachers' Perception of Safety in School (TPSS) with Trends. ..... 364
Exhibit 8.14 Index of Students' Perception of Being Safe in School (SPBSS) with Trends. ..... 366
Appendix A ..... 371
Supporting Documentation
TIMSS 2007 Mathematics Framework ..... 371
Exhibit A. 1 Overview of TIMSS 2007 Mathematics Framework ..... 372
Number of Items by Mathematics Content and Cognitive Domains ..... 373
Exhibit A. 2 Distribution of Mathematics Items by Content Domain and Cognitive Domain ..... 374
Grades and Ages Assessed ..... 376
Exhibit A. 3 Information About the Grades and Ages of Students Tested in TIMSS 2007 ..... 378
Sample Implementation and Participation Rates ..... 382
Exhibit A. 4 Coverage of TIMSS 2007 Target Population ..... 384
Exhibit A. 5 School Sample Sizes ..... 388
Exhibit A. 6 Student Sample Sizes ..... 390
Exhibit A. 7 Participation Rates (Weighted) ..... 392
Exhibit A. 8 Trends in Student Populations ..... 395
Translation and Layout Verification ..... 398
Survey Operations for Data Collection ..... 399
Scoring the Constructed-response Items ..... 399
Test Reliability ..... 401
Scaling the Achievement Data ..... 401
Exhibit A. 9 Average Percent Correct in the Mathematics Content and Cognitive Domains ..... 405
Scale Anchoring Analysis ..... 407
Estimating Standard Errors ..... 409
Appendix B. ..... 411
Multiple Comparisons of Average Achievement in Mathematics Content And Cognitive Domains
Exhibit B. 1 Multiple Comparisons of Average Achievement in Number ..... 412
Exhibit B. 2 Multiple Comparisons of Average Achievement in Geometric Shapes and Measures ..... 414
Exhibit B. 3 Multiple Comparisons of Average Achievement in Data Display ..... 416
Exhibit B. 4 Multiple Comparisons of Average Achievement in Knowing ..... 418
Exhibit B. 5 Multiple Comparisons of Average Achievement in Applying ..... 420
Exhibit B. 6 Multiple Comparisons of Average Achievement in Reasoning ..... 422
Exhibit B. 7 Multiple Comparisons of Average Achievement in Number ..... 424
Exhibit B. 8 Multiple Comparisons of Average Achievement in Algebra ..... 426
Exhibit B. 9 Multiple Comparisons of Average Achievement in Geometry ..... 428
Exhibit B. 10 Multiple Comparisons of Average Achievement in Data and Chance ..... 430
Exhibit B. 11 Multiple Comparisons of Average Achievement in Knowing ..... 432
Exhibit B. 12 Multiple Comparisons of Average Achievement in Applying ..... 434
Exhibit B. 13 Multiple Comparisons of Average Achievement in Reasoning ..... 436
Appendix C ..... 439
The Test-Curriculum Matching Analysis: Mathematics
Exhibit C. 1 Average Percent Correct for Test-Curriculum Matching Analysis - Mathematics ..... 444
Exhibit C. 2 Standard Errors for the Test-Curriculum Matching Analysis - Mathematics ..... 448
Appendix D ..... 453
Percentiles and Standard Deviations of Mathematics Achievement
Exhibit D. 1 Percentiles of Achievement in Mathematics ..... 454
Exhibit D. 2 Standard Deviations of Achievement in Mathematics ..... 456
Appendix E ..... 459
Mongolia-Mathematics Achievement
Exhibit E. 1 Mongolia - Selected Mathematics Achievement Results ..... 460
Appendix F ..... 463
Organizations and Individuals Responsible for TIMSS 2007

