



# TIMSS

## **TIMSS 2003 International Mathematics Report**

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



International Association  
for the Evaluation of  
Educational Achievement

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

© 2004 International Association for the Evaluation of Educational Achievement  
(IEA)

TIMSS 2003 International Mathematics Report / by Ina V.S. Mullis, Michael O. Martin, Eugenio J. Gonzalez, Steven J. Chrostowski.

Publisher:

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

Library of Congress Catalog Card Number: 2004111981

ISBN: 1-889938-34-3

For more information about TIMSS contact:

TIMSS & PIRLS International Study Center  
Lynch School of Education  
Manresa House  
Boston College  
Chestnut Hill, MA 02467  
United States

tel: +1-617-552-1600

fax: +1-617-552-1203

E-mail: [timss@bc.edu](mailto:timss@bc.edu)

URL: [timss.bc.edu](http://timss.bc.edu)

Boston College is an equal opportunity, affirmative action employer.

Printed and bound in the United States.

# Contents

## 3 Executive Summary

### 13 Introduction

13 What is TIMSS?

14 Who Conducts TIMSS?

15 Which Countries Participated in TIMSS 2003?

16 Exhibit 1  
Countries Participating in TIMSS

18 What Is the Comparability Across the Grades and Ages Tested?

20 Exhibit 2  
Information About the Grades Tested in TIMSS 2003

25 What Was the Nature of the Mathematics Test and Background Questionnaires?

26 How Do Country Characteristics Differ?

28 Exhibit 3  
Selected Characteristics of TIMSS 2003 Countries

## 31 Chapter 1

### *International Student Achievement in Mathematics*

31 How Do Countries Differ in Mathematics Achievement?

34 Exhibit 1.1  
Distribution of Mathematics Achievement

38 Exhibit 1.2  
Multiple Comparisons of Average Mathematics Achievement

41 How Has Mathematics Achievement Changed Since 1995 and 1999?

42 Exhibit 1.3  
Trends in Mathematics Achievement

47 What Are the Gender Differences in Mathematics Achievement?

48 Exhibit 1.4  
Average Mathematics Achievement by Gender

50 Exhibit 1.5  
Trends in Average Mathematics Achievement by Gender

## 55 Chapter 2

### *Performance at International Benchmarks*

55 How Do Countries Compare with International Benchmarks of Mathematics Achievement?

58 How Were the Benchmark Descriptions Developed?

59 How Should the Descriptions Be Interpreted?

61 Item Examples and Student Performance

62 Exhibit 2.1  
TIMSS 2003 International Benchmarks of Mathematics Achievement

64 Exhibit 2.2  
Percentages of Students Reaching TIMSS 2003 International Benchmarks of Mathematics Achievement

66 Exhibit 2.3  
Trends in Percentages of Students Reaching the TIMSS 2003 International Benchmarks of Mathematics Achievement in 1995, 1999, and 2003

68 Exhibit 2.4  
Trends in Percentages of Students Reaching the TIMSS 2003 International Benchmarks of Mathematics Achievement in 1995 and 2003

## Contents *(..Continued)*

- 69 Grade 8: Achievement at the Advanced International Benchmark**
- 71 Exhibit 2.5  
Description of TIMSS 2003 Advanced International Benchmark (625) of Mathematics Achievement
- 72 Exhibit 2.6  
TIMSS 2003 Advanced International Benchmark (625) of Mathematics Achievement – Example Item 1 (Part C)
- 73 Exhibit 2.7  
TIMSS 2003 Advanced International Benchmark (625) of Mathematics Achievement – Example Item 2
- 74 Grade 8: Achievement at the High International Benchmark**
- 75 Exhibit 2.8  
Description of TIMSS 2003 High International Benchmark (550) of Mathematics Achievement
- 76 Exhibit 2.9  
TIMSS 2003 High International Benchmark (550) of Mathematics Achievement – Example Item 3
- 77 Exhibit 2.10  
TIMSS 2003 High International Benchmark (550) of Mathematics Achievement – Example Item 4
- 78 Grade 8: Achievement at the Intermediate International Benchmark**
- 79 Exhibit 2.11  
TIMSS 2003 Intermediate International Benchmark (475) of Mathematics Achievement
- 80 Exhibit 2.12  
TIMSS 2003 Intermediate International Benchmark (475) of Mathematics Achievement – Example Item 5
- 81 Exhibit 2.13  
TIMSS 2003 Intermediate International Benchmark (475) of Mathematics Achievement – Example Item 6
- 82 Grade 8: Achievement at the Low International Benchmark**
- 83 Exhibit 2.14  
Description of TIMSS 2003 Low International Benchmark (400) of Mathematics Achievement
- 84 Exhibit 2.15  
TIMSS 2003 Low International Benchmark (400) of Mathematics Achievement – Example Item 7
- 85 Grade 4: Achievement at the Advanced International Benchmark**
- 86 Exhibit 2.16  
Description of TIMSS 2003 Advanced International Benchmark (625) of Mathematics Achievement
- 87 Exhibit 2.17  
TIMSS 2003 Advanced International Benchmark (625) of Mathematics Achievement – Example Item 1
- 88 Exhibit 2.18  
TIMSS 2003 Advanced International Benchmark (625) of Mathematics Achievement – Example Item 2
- 89 Grade 4: Achievement at the High International Benchmark**
- 90 Exhibit 2.19  
Description of TIMSS 2003 High International Benchmark (550) of Mathematics Achievement
- 91 Exhibit 2.20  
TIMSS 2003 High International Benchmark (550) of Mathematics Achievement – Example Item 3
- 92 Exhibit 2.21  
TIMSS 2003 High International Benchmark (550) of Mathematics Achievement – Example Item 4 (Part B)
- 93 Grade 4: Achievement at the Intermediate International Benchmark**
- 94 Exhibit 2.22  
Description of TIMSS 2003 Intermediate International Benchmark (475) of Mathematics Achievement
- 95 Exhibit 2.23  
TIMSS 2003 Intermediate International Benchmark (475) of Mathematics Achievement – Example Item 5
- 96 Exhibit 2.24  
TIMSS 2003 Intermediate International Benchmark (475) of Mathematics Achievement – Example Item 6

# Contents *(...Continued)*

- Benchmark (475) of Mathematics Achievement – Example Item 6
- 97 Grade 4: Achievement at the Low International Benchmark**
- 98 Exhibit 2.25  
Description of TIMSS 2003 Low International Benchmark (400) of Mathematics Achievement
- 99 Exhibit 2.26  
TIMSS 2003 Low International Benchmark (400) of Mathematics Achievement – Example Item 7
- 100 Exhibit 2.27  
TIMSS 2003 Low International Benchmark (400) of Mathematics Achievement – Example Item 8
- 101 What Issues Emerge from the Benchmark Descriptions?**
- 103 Chapter 3**  
*Average Achievement in the Mathematics Content Areas*
- 105 How Does Achievement Differ Across Mathematics Content Areas?**
- 106 Exhibit 3.1  
Average Achievement in Mathematics Content Areas
- 109 In Which Content Areas Are Countries Relatively Strong or Weak?**
- 110 Exhibit 3.2  
Profiles of Within-Country Relative Performance in Mathematics Content Areas
- 115 What Are the Gender Differences in Achievement for the Content Areas?**
- 116 Exhibit 3.3  
Average Achievement in Mathematics Content Areas by Gender
- 120 What Changes Have Occurred in Content Area Achievement?**
- 122 Exhibit 3.4  
Trends in Average Percent Correct in Mathematics Content Areas
- 125 Chapter 4**  
*Students' Backgrounds and Attitudes Towards Mathematics*
- 125 What Educational Resources Do Students Have in Their Homes?**
- 128 Exhibit 4.1  
Highest Level of Education of Either Parent
- 130 Exhibit 4.2  
Students' Educational Aspirations Relative to Parents' Educational Level
- 132 Exhibit 4.3  
Students Speak Language of the Test at Home
- 136 Exhibit 4.4  
Books in the Home
- 140 Exhibit 4.5  
Computer and Study Desk/Table in the Home
- 142 Exhibit 4.6  
Use of Computer
- 147 How Much of Their Out-of-School Time Do Students Spend on Homework During the School Week?**
- 148 Exhibit 4.7  
Index of Time Students Spend Doing Mathematics Homework (TMH) in a Normal School Week
- 150 Exhibit 4.8  
How Students Spend Their Leisure Time on a Normal School Day
- 152 How Confident Are Students in Their Ability to Learn Mathematics?**
- 154 Exhibit 4.9  
Index of Students' Self-Confidence in Learning Mathematics (SCM)
- 156 What Value Do Students Place on Mathematics?**
- 158 Exhibit 4.10  
Index of Students' Valuing Mathematics (SVM)
- 159 Exhibit 4.11  
Trends in "I Enjoy Learning Mathematics"

## Contents *(..Continued)*

### 163 Chapter 5

#### *The Mathematics Curriculum*

- 164 Which Countries Have a National Curriculum and Public Examinations in Mathematics?
- 166 Exhibit 5.1  
Intended Mathematics Curriculum
- 168 How Do Countries Support and Monitor Curriculum Implementation?
- 170 Exhibit 5.2  
Methods Used to Support or Monitor Implementation of the Intended Mathematics Curriculum
- 172 How Much Instructional Time is Intended for Mathematics?
- 173 Exhibit 5.3  
Percentage of Total Instructional Time Intended for Mathematics
- 174 Do Countries Differentiate the Intended Mathematics Curriculum for Students with Different Levels of Ability?
- 175 Exhibit 5.4  
The Way the Intended Mathematics Curriculum Addresses the Issue of Students with Different Levels of Ability
- 177 What Approaches and Processes Do Countries Emphasize in their Intended Mathematics Curriculum?
- 178 Exhibit 5.5  
Emphasis on Approaches and Processes in the Intended Mathematics Curriculum
- 180 Are the TIMSS Mathematics Topics Included in the Intended Curriculum?
- 184 Exhibit 5.6  
Summary of TIMSS Mathematics Topics in the Intended Curriculum

188 Are the TIMSS Mathematics Topics Taught in School?

- 190 Exhibit 5.7  
Summary of Students Taught the TIMSS Mathematics Topics

193 Which TIMSS Mathematics Topics Are in the Intended and Implemented Curriculum?

- 194 Exhibit 5.8  
Intended and Taught TIMSS Number Topics
- 198 Exhibit 5.9  
Intended and Taught TIMSS Algebra Topics
- 200 Exhibit 5.10  
Intended and Taught TIMSS Measurement Topics
- 202 Exhibit 5.11  
Intended and Taught TIMSS Geometry Topics
- 208 Exhibit 5.12  
Intended and Taught TIMSS Data Topics
- 210 Exhibit 5.13  
Intended and Taught TIMSS Number Topics
- 214 Exhibit 5.14  
Intended and Taught TIMSS Patterns and Relationships Topics
- 216 Exhibit 5.15  
Intended and Taught TIMSS Measurement Topics
- 218 Exhibit 5.16  
Intended and Taught TIMSS Geometry Topics
- 221 Exhibit 5.17  
Intended and Taught TIMSS Data Topics

### 225 Chapter 6

#### *Teachers of Mathematics*

226 What Are the Requirements for Being a Mathematics Teacher?

- 228 Exhibit 6.1  
Current Requirements for Being a Mathematics Teacher
- 230 Exhibit 6.2  
Licensing/Certification Authority for Mathematics Teachers

# Contents *(...Continued)*

- 232 **What Are the Background Characteristics of Mathematics Teachers?**
- 234 Exhibit 6.3  
Mathematics Teachers' Gender, Age, Certification, and Number of Years of Teaching
- 236 **What Preparation Do Teachers Have for Teaching Mathematics?**
- 238 Exhibit 6.4  
Highest Educational Level of Mathematics Teachers
- 240 Exhibit 6.5  
Preparation to Teach Mathematics
- 242 Exhibit 6.6  
Professional Development Opportunities for Teachers in Mathematics and Science
- 248 Exhibit 6.7  
Teachers' Participation in Professional Development in Mathematics
- 250 Exhibit 6.8  
Types of Interactions Among Mathematics Teachers
- 254 **How Ready Do Teachers Think They Are to Teach Mathematics?**
- 256 Exhibit 6.9  
Readiness to Teach Mathematics
- 263 Chapter 7**  
*Classroom Characteristics and Instruction*
- 264 **How Do the Characteristics of Mathematics Classrooms Impact Instruction?**
- 266 Exhibit 7.1  
Class Size for Mathematics Instruction
- 268 Exhibit 7.2  
Index of Teachers' Reports on Teaching Mathematics Classes with Few or No Limitations on Instruction Due to Student Factors (MCFL)
- 269 **How Much School Time Is Devoted to Mathematics Instruction?**
- 270 Exhibit 7.3  
Mathematics Instructional Time
- 272 Exhibit 7.4  
Percentage of Time in Mathematics Class Devoted to TIMSS Content Areas During the School Year
- 274 **What Activities Do Students Do in Their Mathematics Lessons?**
- 276 Exhibit 7.5  
Students' Reports on Mathematics Content Related Emphasis in Classroom Activities
- 278 Exhibit 7.6  
Teachers' Reports on Mathematics Content Related Emphasis in Students' Classroom Activities
- 281 Exhibit 7.7  
Students' Reports on Problem Solving Related Emphasis in Classroom Activities
- 282 Exhibit 7.8  
Teachers' Reports on Problem Solving Related Emphasis in Classroom Activities
- 283 **What Instructional Strategies Are Used in Mathematics Classes?**
- 284 Exhibit 7.9  
Textbook Use in Teaching Mathematics
- 286 Exhibit 7.10  
Percentage of Time in Mathematics Lessons Students Spend on Various Activities in a Typical Week
- 290 **How Are Calculators and Computers Used?**
- 292 Exhibit 7.11  
Emphasis on Calculators in Mathematics Class
- 294 Exhibit 7.12  
Computer Use in Mathematics Class

## Contents *(..Continued)*

- 296 What Are the Roles of Homework and Assessment?
- 298 Exhibit 7.13 Index of Teachers' Emphasis on Mathematics Homework (EMH)
- 300 Exhibit 7.14 Use of Mathematics Homework
- 301 Exhibit 7.15 Frequency of Mathematics Tests
- 302 Exhibit 7.16 Item Formats Used by Teachers in Mathematics Tests or Examinations
- 305 Chapter 8**  
*School Contexts for Learning and Instruction*
- 305 What Are the Schools' Demographic Characteristics?
- 307 Exhibit 8.1 Principals' Reports on the Percentages of Students in Their Schools Coming from Economically Disadvantaged Homes
- 309 What Is the Level of School-Home Involvement?
- 310 Exhibit 8.2 Schools' Expectations for Parents' Involvement
- 312 What School Resources Are Available to Support Mathematics Learning?
- 314 Exhibit 8.3 Trends in Index of Availability of School Resources for Mathematics Instruction (ASRMI)
- 317 What Are the Perceptions of School Climate?
- 318 Exhibit 8.4: Index of Principals' Perception of School Climate (PPSC)
- 320 Exhibit 8.5 Index of Mathematics Teachers' Perception of School Climate (TPSC)
- 323 How Serious Are School Attendance Problems?
- 324 Exhibit 8.6 Trends in Index of Good School and Class Attendance (GSCA)
- 326 How Safe and Orderly Are Schools?
- 328 Exhibit 8.7 Index of Mathematics Teachers' Perception of Safety in the Schools (TPSS)
- 330 Exhibit 8.8 Index of Students' Perception of Being Safe in the Schools (SPBSS)
- 333 Appendix A**  
*Overview of TIMSS Procedures for Assessing Mathematics*
- 333 History
- 334 Participants in TIMSS
- 336 Exhibit A.1 Countries Participating in TIMSS 2003, 1999, and 1995
- 338 Developing the TIMSS 2003 Mathematics Assessment
- 339 Exhibit A.2 The Content and the Cognitive Domains of the Mathematics Frameworks
- 342 Exhibit A.3 Distribution of Mathematics Items by Content Domain and Cognitive Domain
- 344 Exhibit A.4 Distribution of Score Points in TIMSS 2003 from Each Assessment Year by Mathematics Content Domain
- 345 TIMSS 2003 Assessment Design
- 346 Exhibit A.5 TIMSS 2003 Assessment Design
- 347 Background Questionnaires
- 348 Translation and Verification

# Contents *(...Continued)*

- 349 Population Definition and Sampling
- 352 Exhibit A.6 Coverage of TIMSS 2003 Target Population
- 354 Exhibit A.7 School Sample Sizes
- 356 Exhibit A.8 Student Sample Sizes
- 358 Exhibit A.9 Participation Rates (Weighted)
- 360 Data Collection
- 361 Scoring the Constructed-Response Items
- 362 Exhibit A.10 TIMSS 2003 Within-Country Scoring Reliability for the Constructed-Response Mathematics Items
- 364 Exhibit A.11 TIMSS 2003 Trend Scoring Reliability (1999–2003) for the Constructed-Response Mathematics Items
- 365 Exhibit A.12 TIMSS 2003 Cross-Country Scoring Reliability for the Constructed-Response Mathematics Items
- 367 Test Reliability
- 368 Exhibit A.13 Cronbach's Alpha Reliability Coefficient – TIMSS 2003 Mathematics Test
- 369 Data Processing
- 370 IRT Scaling and Data Analysis
- 372 Estimating Sampling Error
- 373 Assessing Statistical Significance
- 373 Setting International Benchmarks of Student Achievement
- 374 Calculator Use in the TIMSS 2003 Mathematics Assessment
- 375 Exhibit A.14 Students' Reports on the Frequency of Calculator Use During the TIMSS 2003 Test
- 379 Appendix B**  
*Multiple Comparisons of Average Achievement in Mathematics Content Areas*
- 380 Exhibit B.1 Multiple Comparisons of Average Achievement in Number
- 382 Exhibit B.2 Multiple Comparisons of Average Achievement in Algebra
- 384 Exhibit B.3 Multiple Comparisons of Average Achievement in Measurement
- 386 Exhibit B.4 Multiple Comparisons of Average Achievement in Geometry
- 388 Exhibit B.5 Multiple Comparisons of Average Achievement in Data
- 390 Exhibit B.6 Multiple Comparisons of Average Achievement in Number
- 391 Exhibit B.7 Multiple Comparisons of Average Achievement in Patterns and Relationships
- 392 Exhibit B.8 Multiple Comparisons of Average Achievement in Measurement
- 393 Exhibit B.9 Multiple Comparisons of Average Achievement in Geometry
- 394 Exhibit B.10 Multiple Comparisons of Average Achievement in Data

## **Contents** (...Continued)

### **397 Appendix C**

*The Test-Curriculum Matching Analysis: Mathematics*

- 400 Exhibit C.1  
Average Percent Correct for Test-Curriculum Matching Analysis – Mathematics
- 404 Exhibit C.2  
Standard Errors for the Test-Curriculum Matching Analysis – Mathematics

### **409 Appendix D**

*Percentiles and Standard Deviations of Mathematics Achievement*

- 410 Exhibit D.1  
Percentiles of Achievement in Mathematics
- 412 Exhibit D.2  
Standard Deviations of Achievement in Mathematics

### **415 Appendix E**

*Descriptions of Mathematics Items at Each Benchmark*

- 416 Exhibit E.1  
Descriptions of Mathematics Items at Each International Benchmark
- 424 Exhibit E.2  
Descriptions of Mathematics Items at Each International Benchmark

### **433 Appendix F**

*Syrian Arab Republic and Yemen - Mathematics Achievement*

- 434 Exhibit F.1  
Syrian Arab Republic – Selected Mathematics Achievement Results
- 435 Exhibit F.2  
Yemen – Selected Mathematics Achievement Results

### **437 Appendix G**

*Acknowledgements*