Completing TIMSS and PIRLS 2011

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54th IEA General Assembly
October 2013, Lisbon
Progress Since Last General Assembly...

December 11, 2012

- TIMSS and PIRLS 2011 International Results released via web video
  - 90,000 visits to TIMSS & PIRLS International Study Center website on release day
  - 300 news articles in major media outlets around the world
TIMSS 2011 International Results in Mathematics and Science
Fourth and Eighth Grades

• Assessed 600,000 students in 63 countries and 14 states or regions

• Mathematics fourth and eighth grades – top performers included Singapore, Korea, Chinese Taipei, Hong Kong SAR, and Japan

• Science fourth and eighth grades – top performers included Singapore, Korea, Chinese Taipei, Japan, Finland, the Russian Federation
PIRLS 2011
Achievement Results
PIRLS 2011 International Results in Reading
Fourth Grade

- Assessed 300,000 students in 49 countries and 9 states or regions
- Top performing countries were Hong Kong SAR, Russian Federation, Finland, and Singapore
TIMSS 2011 Encyclopedia: Grades 4 and 8

69 individual country chapters

- Overview of education systems
- Mathematics curriculum
- Science curriculum
- Instruction in mathematics and science
- Teachers and teacher education
- Monitoring student progress in mathematics and science
- Impact of TIMSS
PIRLS 2011 Encyclopedia: Grade 4

56 individual country chapters

- Language and literacy environment
- Overview of education systems
- Language/reading curriculum
- Reading instruction
- Students with reading difficulties
- Teachers and teacher education
- Monitoring student progress in reading
- Impact of PIRLS
Methods and Procedures in TIMSS and PIRLS 2011 - Online

- Assessment framework and instrument development
- Sample design and implementation
- Translation and translation verification
- Operations and quality assurance
- Creating the international databases
- Creating and interpreting the achievement scales
- Creating and interpreting the context questionnaire scales
TIMSS 2011 International Database – January 17, 2013

- International Data
  - SAS and SPSS formats
- User Guide
- Released items with percent correct statistics
  - Mathematics
  - Science
PIRLS 2011 International Database – February 7, 2013

- International Data
  - SAS and SPSS formats
- User Guide
- Released items with percent correct statistics
TIMSS and PIRLS Together in 2011 – Capitalizing on the Opportunity

- Countries administered both TIMSS and PIRLS to the same students at fourth grade
- 34 countries and 3 benchmarking entities
- Comprehensive achievement data in three fundamental curricular areas
  - Reading, mathematics, science
- Array of background questionnaire data
  - Home, school, classroom contexts for learning
TIMSS and PIRLS Together in 2011 – Capitalizing on the Opportunity

Data on same fourth grade students in three core subject areas

• Possible to investigate important home and school characteristics that influence early learning
  – While controlling for extraneous factors

• Possible to apply a variety of modeling techniques to examine interrelationships
TIMSS and PIRLS 2011: Relationships among Reading, Mathematics, and Science Achievement at the Fourth Grade—Implications for Early Learning

Edited volume of four chapters

- Profiles of achievement across reading, mathematics, and science
- Impact of reading ability on TIMSS mathematics and science achievement
- Effective schools in reading, mathematics, and science
- Effects of home background on student achievement
TIMSS and PIRLS 2011 Fourth Grade Combined International Database – September 12, 2013

- Special international database including only fourth grade students assessed in all three subjects
- Primary value - countries conduct own in-depth research for school improvement
Profiles of Achievement Across Reading, Mathematics, and Science Achievement at the Fourth Grade

Ina V.S. Mullis
Profiles of Achievement

Are primary schools around the world providing students a solid foundation in core subjects – reading, mathematics, and science?

- Percentages of students reaching the TIMSS and PIRLS International Benchmarks

- **High** International Benchmark – proficient or competent level of achievement in each subject

- **Low** International Benchmark – basic level of understandings and skills in each subject
High International Benchmarks
Fourth Grade

**Reading:** Make and support inferences based on dense text and visual information; make generalizations across text

**Mathematics:** Solve a variety of problems involving place value, patterns, geometry, and tables and graphs

**Science:** Explain phenomena involving ecosystems and organisms, properties of matter, forces and motion, the solar system, and scientific inquiry
Low International Benchmarks
Fourth Grade

**Reading:** Locate and retrieve explicitly stated information

**Mathematics:** Basic mathematical knowledge of addition and subtraction, geometric shapes, simple bar graphs and tables

**Science:** Elementary knowledge of life, physical, and earth sciences, e.g., human health, characteristics of animals, physical properties of matter, simple diagrams
Strength

High Benchmark

Mathematics – 78%
Science – 68%
Reading – 62%

High Benchmark All Three – 54%
• Only country >50%

Low Benchmark All Three – 95%
Strength

High Benchmark

Mathematics – 82%
Reading – 67%
Science – 46%

High Benchmark All Three – 39%

Low Benchmark All Three – 97%
Strengths

High Benchmark
Science – 65%
Reading – 63%
Mathematics – 50%

High Benchmark All Three - 39%

Low Benchmark All Three - 97%
### Strengths

**High Benchmark**
- **Reading** – 48%
- **Science** – 46%
- **Mathematics** – 37%

**High Benchmark All Three** – 28%

**Low Benchmark All Three** – 88%
Strength

High Benchmark

Reading – 54%
Mathematics – 41%
Science – 35%

High Benchmark All Three - 25%

Low Benchmark All Three - 90%
Well Balanced
High Benchmark
Reading – 46%
Science – 39%
Mathematics – 37%

High Benchmark All Three – 23%

Low Benchmark All Three – 94%
Strength

High Benchmark
Reading – 47%
Mathematics – 40%
Science – 36%

High Benchmark All Three - 23%

Low Benchmark All Three - 93%
Strengths

High Benchmark
**Reading** – 50%
**Science** – 45%
**Mathematics** – 30%

High Benchmark All Three - 21%

Low Benchmark All Three - 92%
Strengths

High Benchmark

**Reading** – 47%

**Science** – 44%

Mathematics – 25%

High Benchmark All Three - 18%

Low Benchmark All Three - 91%
Well Balanced
High Benchmark
Reading – 25%
Mathematics – 21%
Science – 19%

High Benchmark All Three - 8%

Low Benchmark All Three - 86%
Well Balanced
High Benchmark
Reading – 14%
Science – 12%
Mathematics – 14%

High Benchmark All Three – 6%

Low Benchmark All Three – 48%
The Impact of Reading Ability on TIMSS Mathematics and Science Achievement at the Fourth Grade: An Analysis by Item Reading Demands

Ina V.S. Mullis, Michael O. Martin, and Pierre Foy
TIMSS/PIRLS 2011 Relationships Report

Impact of Reading Ability on TIMSS

How does reading ability impact mathematics and science achievement?

- Doing mathematics and science involve considerable reading and communication – reflected in the TIMSS Framework and assessment items

- TIMSS fourth grade items span a range of mathematics reading or science reading demands, from minimal to more demanding
  - None involve reading of any length or complexity
  - Greater range at eighth grade
Hypotheses

• Students with high reading ability would not be impacted by item reading demands
  – Would score similarly on TIMSS items with varying levels of reading demands

• Students with lower reading ability would perform relatively better on items with less reading
  – Would score better on low reading demand items, and less well on high reading demand items
Study Approach

Phase 1
Sort the TIMSS fourth grade mathematics items (175) and science items (172) according to **three** levels of reading demands

Phase 2
Look at the relationship between students’ reading ability (measured by PIRLS) and their performance on TIMSS items at the three levels of reading demands
Phase 1: Categorizing the Items by Reading Demands

- Considered literature about dimensions of reading difficulty – in TIMSS context

- Holistic scoring to separate items into three reading demands categories – high, medium, low

- Developed and applied detailed coding guide to each item

- Validated holistic categories through quantitative analysis (discriminant function analysis)
Major Indicators of Reading Demands

- Number of words (anywhere in the item)
- Number of different symbols (e.g., numerals, operators)
- Number of different specialized vocabulary words
- Total number of elements (density) in the visual displays
Example TIMSS 4th Grade Mathematics Item - Low Reading Demands

23 \times 19 =

Answer: ___________
Some of the materials below will burn and some will not. Put an X in the box next to the materials that will burn.

(You may put an X in more than one box.)

☐ water
☐ wood
☐ sand
☐ gasoline
☐ air
The graph shows the number of students at each grade in the Pine School.

In the Pine School there is room in each grade for 30 students. How many more students could be in the school?

A 20
B 25
C 30
D 35
Mathematics and Science

Cognitive Domain by Reading Demands

**Mathematics**

- **Knowing**: 40% (61% Low, 21% Medium, 17% High, 70 items)
- **Applying**: 40% (45% Low, 24% Medium, 31% High, 71 items)
- **Reasoning**: 20% (35% Low, 6% Medium, 34 items)

**Science**

- **Knowing**: 40% (56% Low, 32% Medium, 76% High, 68 items)
- **Applying**: 40% (52% Low, 30% Medium, 71 items)
- **Reasoning**: 20% (30% Low, 18% Medium, 29 items)
Generalizability of Item Categorizations Across Languages

NRCs from 17 countries used holistic process and submitted categorizations

- High level of agreement, on average, between countries and the TIMSS & PIRLS International Study Center for both mathematics and science items
  - 71% exact agreement
  - 98% adjacent agreement

- Some items (15%) with exact agreement below 50%
  - Often had complicated graphics
Reading Demands Study

Analysis

- Average percent correct on items with high, medium, and low reading demands
- For each of three levels of reading ability on PIRLS

Expected

- Best readers would perform similarly on high, medium, and low demand items
- Poor readers would perform relatively better on low demand items, and less well on high demand items
Mathematics Achievement – Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demand

Russian Federation

- Low Reading Demand Items
  - Upper Reading Tercile: 75
  - Middle Reading Tercile: 63
  - Lower Reading Tercile: 49
  - Average Percent Correct: 62

- Medium Reading Demand Items
  - Upper Reading Tercile: 74
  - Middle Reading Tercile: 61
  - Lower Reading Tercile: 44
  - Average Percent Correct: 60

- High Reading Demand Items
  - Upper Reading Tercile: 75
  - Middle Reading Tercile: 61
  - Lower Reading Tercile: 42
  - Average Percent Correct: 58

TIMSS & PIRLS 2011

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College
Mathematics Achievement – Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Mathematics Items Grouped by Three Levels of Reading Demand

TIMSS & PIRLS 2011

Sweden

Low Reading Demand Items

Medium Reading Demand Items

High Reading Demand Items

Average Percent Correct

24

68

29*

Upper Reading Tercile

Middle Reading Tercile

Lower Reading Tercile
Science Achievement Across Countries – Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demand

- Low Reading Demand Items
- Medium Reading Demand Items
- High Reading Demand Items

Average Percent Correct

- Upper Reading Tercile
- Middle Reading Tercile
- Lower Reading Tercile

*Results for each tercile averaged across countries*
Science Achievement – Fourth Grade

Average Percent Correct for Students at Three Levels of PIRLS Reading Ability on Science Items Grouped by Three Levels of Reading Demand

Georgia

Low Reading Demand Items

Medium Reading Demand Items

High Reading Demand Items

Average Percent Correct

Upper Reading Tercile

Middle Reading Tercile

Lower Reading Tercile

TIMSS & PIRLS

2011
Reading Demands Study Results

- In mathematics, hypotheses supported in most countries (31/37)
- In science, hypotheses supported in just over half the countries (21/37)

Students are likely to be at a disadvantage in mathematics and science if they lack reading skills

  - For example, the traditional gender gap in reading may impact performance in other content areas
Effective Schools in Reading, Mathematics, and Science at the Fourth Grade

Michael O. Martin, Pierre Foy, Ina V.S. Mullis, and Laura O’Dwyer
Investigating Effective Schools in TIMSS/PIRLS 2011- Fourth Grade

This study uses a “school effectiveness” approach to examine how indicators of effective schools operate across countries and school subjects.

- In this approach, an effective school is one that has an effect on student achievement over and above home influence.
- Thus, effective schools research attempts to examine school factors, while controlling for home background influence.
Universally Relevant Characteristics of Effective Schools

Strong Conceptual Model

Strongly supported by research, we have a firm conviction that effective schools

• Are safe and orderly
• Have adequate facilities and equipment
• Support academic success
• Rigorous Curriculum
• Are staffed with well-prepared teachers
• Have well-resourced classrooms
• Provide effective instruction
Investigating Effective Schools in TIMSS/PIRLS 2011- Fourth Grade

Summary of Analysis:

Across 34 countries and 3 benchmarking participants:

1. Given the factors that are known to contribute to school effectiveness

2. Given that the students in schools have been adjusted (statistically) to all have the same backgrounds
   - Which school factors will have the most influence across countries?
   - Will there be a difference across school subjects?

   - Reading
   - Mathematics
   - Science

Hierarchical Linear Modeling (HLM) takes into account nesting of students within schools—Analyses conducted separately for each country
Variables Included in the School Effectiveness Analysis

**School Environment**

- Schools Are Safe Orderly
- Schools Support Academic Success
- Adequate Environment Resources

**School Instruction**

- Emphasis in Early Grades on Reading Proficiency
- Students Engaged in Their Classroom Lessons

**Home Background Variables**

- Home Resources for Learning
- Students Could Do Literacy/Numeracy Tasks When Started School
TIMSS/PIRLS 2011 Analytic Approach

Country by country:

1. Examine relationship between school variables and achievement – explanatory model, without controls

2. Introduce controls for students’ home background

3. Reexamine school variable relationships with achievement, after controlling (statistically) for home background
Controlling for Home Background

Home background influences operate...

• At the individual student level
  – Each individual student comes to school with certain advantages and disadvantages
  – These can help or hinder the student

• At the school level (compositional effect)
  – Composition of the student body can have an additional effect – attending a school with lots of advantaged students vs. lots of disadvantaged students
Some Challenges

Analytic approach depends on analyzing between-school variation in cross-sectional data – “naturally occurring variation”

However, school systems carefully managed

• Some countries have little variation between schools

• Some countries have little variation in particular factors
  – Instructional time for a subject may be a national policy
  – In affluent countries, schools may be equally well resourced
Method of Analysis

• Hierarchical linear modeling (multilevel modeling)
  – School effects on student achievement
  – Explicitly models the nesting of students within schools

• Two-level analysis – schools and students

• Separate analysis for each country

• Series of models
  – Each stage of the analysis
Models for Analysis

1. Baseline model
   - Achievement differences between schools

2. Explanatory model
   - School Environment and Instruction effects, ignoring student home background

3. Home background control Model
   - Home Background, between and within schools

4. Explanatory with control model
   - School Environment and Instruction effects, controlling for student home background
Results - %Variance Between Schools

Upper limit on impact of school variables

- 5-50% range
- Lowest in Slovenia, Finland, Norway
- Highest in Honduras, UAE, Qatar, Azerbaijan
- Reading, mathematics, and science similar, but a little less for reading
## Results
### Example Country - Australia

<table>
<thead>
<tr>
<th>Subject</th>
<th>Variance between Schools (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>23%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>28%</td>
</tr>
<tr>
<td>Science</td>
<td>28%</td>
</tr>
</tbody>
</table>
## School Explanatory Variables

### School Environment

<table>
<thead>
<tr>
<th>Variables</th>
<th>REA</th>
<th>MAT</th>
<th>SCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Schools Are Safe and Orderly</strong></td>
<td>.55</td>
<td>.54</td>
<td>.54</td>
</tr>
<tr>
<td></td>
<td>21 (3.5)</td>
<td>21 (4.1)</td>
<td>20 (3.5)</td>
</tr>
<tr>
<td><strong>Schools Support Academic Success</strong></td>
<td>.44</td>
<td>.43</td>
<td>.44</td>
</tr>
<tr>
<td></td>
<td>6 (2.1)</td>
<td>6 (2.4)</td>
<td>6 (2.0)</td>
</tr>
<tr>
<td><strong>Adequate Environment and Resources</strong></td>
<td>.28</td>
<td>.28</td>
<td>.28</td>
</tr>
<tr>
<td></td>
<td>2 (2.5)</td>
<td>3 (2.5)</td>
<td>2 (2.5)</td>
</tr>
</tbody>
</table>

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*Australia*
### Variables

<table>
<thead>
<tr>
<th>School Instruction</th>
<th>REA</th>
<th>MAT</th>
<th>SCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Emphasis on Reading Skills</td>
<td>.03</td>
<td>.04</td>
<td>.02</td>
</tr>
<tr>
<td>Students Engaged in Reading, Mathematics, and Science Lessons</td>
<td>.21</td>
<td>.21</td>
<td>.21</td>
</tr>
</tbody>
</table>

Australia

TIMSS & PIRLS
International Study Center
Lynch School of Education, Boston College
<table>
<thead>
<tr>
<th>Variables</th>
<th>Home Background Control Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home Background Control Variables</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Students within Schools</strong></td>
<td></td>
</tr>
<tr>
<td>Home Resources for Learning</td>
<td>REA 0.31 12 (1.3)  ▲</td>
</tr>
<tr>
<td></td>
<td>MAT 0.32 12 (1.4)  ▲</td>
</tr>
<tr>
<td></td>
<td>SCI 0.36 13 (1.1)  ▲</td>
</tr>
<tr>
<td>Early Literacy/Numeracy Tasks</td>
<td>REA 0.17 11 (1.3)  ▲</td>
</tr>
<tr>
<td></td>
<td>MAT 0.23 15 (1.4)  ▲</td>
</tr>
<tr>
<td></td>
<td>SCI 0.20 12 (1.2)  ▲</td>
</tr>
<tr>
<td><strong>Between Schools</strong></td>
<td></td>
</tr>
<tr>
<td>School Average of</td>
<td>REA 0.70 49 (3.7)  ▲</td>
</tr>
<tr>
<td>Home Resources for Learning</td>
<td>MAT 0.70 56 (4.0)  ▲</td>
</tr>
<tr>
<td></td>
<td>SCI 0.72 49 (3.4)  ▲</td>
</tr>
<tr>
<td>School Average of</td>
<td>REA 0.22 19 (6.8)  ▲</td>
</tr>
<tr>
<td>Early Literacy/Numeracy Tasks</td>
<td>MAT 0.27 23 (8.4)  ▲</td>
</tr>
<tr>
<td></td>
<td>SCI 0.25 21 (6.0)  ▲</td>
</tr>
<tr>
<td>Variables</td>
<td>School Environment and Instruction</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td><strong>School Explanatory Variables</strong></td>
<td></td>
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<tr>
<td><strong>School Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Schools Are Safe and Orderly</td>
<td>REA 20 (3.5)</td>
</tr>
<tr>
<td></td>
<td>MAT 21 (4.1)</td>
</tr>
<tr>
<td></td>
<td>SCI 19 (3.5)</td>
</tr>
<tr>
<td>Schools Support Academic Success</td>
<td>REA 6 (2.1)</td>
</tr>
<tr>
<td></td>
<td>MAT 7 (2.4)</td>
</tr>
<tr>
<td></td>
<td>SCI 6 (2.0)</td>
</tr>
<tr>
<td>Adequate Environment and Resources</td>
<td>REA 2 (2.5)</td>
</tr>
<tr>
<td></td>
<td>MAT 3 (2.5)</td>
</tr>
<tr>
<td></td>
<td>SCI 2 (2.5)</td>
</tr>
<tr>
<td><strong>School Instruction</strong></td>
<td></td>
</tr>
<tr>
<td>Early Emphasis on Reading Skills</td>
<td>REA 2 (1.5)</td>
</tr>
<tr>
<td></td>
<td>MAT 2 (1.7)</td>
</tr>
<tr>
<td></td>
<td>SCI 2 (1.5)</td>
</tr>
<tr>
<td>Students Engaged in Reading, Mathematics, and</td>
<td>REA 6 (4.2)</td>
</tr>
<tr>
<td>Science Lessons</td>
<td>MAT 6 (4.3)</td>
</tr>
<tr>
<td></td>
<td>SCI 5 (4.2)</td>
</tr>
<tr>
<td>Source of Variance</td>
<td>Percentage of Variance Explained</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>School Explanatory Model</td>
</tr>
<tr>
<td></td>
<td>School Environment and Instruction</td>
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<tr>
<td></td>
<td>Home Background Control Model</td>
</tr>
<tr>
<td></td>
<td>School Explanatory Model with the Control Model</td>
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<tr>
<td></td>
<td>School Environment and Instruction</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td></td>
</tr>
<tr>
<td>Between Schools (23%)</td>
<td>44</td>
</tr>
<tr>
<td><strong>Mathematics</strong></td>
<td></td>
</tr>
<tr>
<td>Between Schools (28%)</td>
<td>43</td>
</tr>
<tr>
<td><strong>Science</strong></td>
<td></td>
</tr>
<tr>
<td>Between Schools (28%)</td>
<td>43</td>
</tr>
</tbody>
</table>
### Summary

**Number of Countries with Significant Predictors AFTER Controlling for Home Background**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>At Least One Subject</th>
<th>All three Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools safe and orderly</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Support academic success</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Adequate environment/resources</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Emphasis on reading</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Students engaged in lessons</td>
<td>13</td>
<td>5</td>
</tr>
</tbody>
</table>
Safe and Orderly School

- Maintains discipline and safety
- Is safe and orderly
- Reduces the frequency of bullying among students
Schools Support Academic Success

*Working together* to ensure success

- Teachers understand curricular goals
- Teachers are successful in implementing curriculum
- Teachers expect student high achievement
- Parents support student achievement
- Students desire to do well
Students Engaged in Lessons

- Students know what they are expected to do
- Students like what they read
- Teachers are easy to understand
- Teachers present content in interesting ways
- Teachers give students interesting things to do
What Have We Learned?

• TIMSS and PIRLS 4th grade data a valuable resource for school effectiveness research
  – Comprehensive achievement data on reading, mathematics, and science
  – Wide range of home, school, and predictor variables

• Cross country perspective crucial
  – No one country give complete picture
    • Challenges of statistical modeling cross-sectional data
  – Takes all of the countries together to show the conceptual model in action in the data
Effects of Home Background on Student Achievement in Reading, Mathematics, and Science at the Fourth Grade

Jan-Eric Gustafsson, Kajsa Yang Hansen, and Monica Rosén
University of Gothenburg
How Does Home Background Influence Student Achievement?

• Takes as starting point the well-established relationship between home background and achievement

• Examines the extent to which literacy and numeracy resources and activities are the mechanism through which parental education and gender influence fourth grade students’ achievement in reading, mathematics, and science
The Model

Effect of parental education and gender on achievement mediated via

• Availability of home resources
• Early literacy and numeracy activities
• Literacy and numeracy skills when beginning school
• Achievement in reading, mathematics, and science at the fourth grade

Structural equation modeling approach
# Early Literacy Activities

**Items in the Early Literacy Activities Before Beginning Primary School Scale**

Before your child began primary/elementary school, how often did you or someone else in your home do the following activities with him or her?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Often</th>
<th>Sometimes</th>
<th>Never or almost never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Read books</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2) Tell stories</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3) Sing songs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4) Play with alphabet toys (e.g., blocks with letters of the alphabet)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5) Talk about things you had done</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6) Talk about what you had read</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7) Play word games</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>8) Write letters or words</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>9) Read aloud signs and labels</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
# Early Numeracy Activities

*Items in the Early Numeracy Activities Before Beginning Primary School Scale*

Before your child began primary/elementary school, how often did you or someone else in your home do the following activities with him or her?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Often</th>
<th>Sometimes</th>
<th>Never or almost never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Say counting rhymes or sing counting songs</td>
<td>🗝</td>
<td>🗝️</td>
<td>🗝️</td>
</tr>
<tr>
<td>2) Play with number toys (e.g., blocks with numbers)</td>
<td>✗</td>
<td>🗝️</td>
<td>🗝️</td>
</tr>
<tr>
<td>3) Count different things</td>
<td>✗</td>
<td>🗝️</td>
<td>🗝️</td>
</tr>
<tr>
<td>4) Play games involving shapes (e.g., shape sorting toys, puzzles)</td>
<td>✗</td>
<td>🗝️</td>
<td>🗝️</td>
</tr>
<tr>
<td>5) Play with building blocks or construction toys</td>
<td>✗</td>
<td>🗝️</td>
<td>🗝️</td>
</tr>
<tr>
<td>6) Play board games or card games</td>
<td>✗</td>
<td>🗝️</td>
<td>🗝️</td>
</tr>
</tbody>
</table>
Literacy Skills When Beginning School

Items in the Could Do Early Literacy Tasks When Began Primary School Scale

How well could your child do the following when he/she began primary/elementary school?

<table>
<thead>
<tr>
<th>Task</th>
<th>Very well</th>
<th>Moderately well</th>
<th>Not very well</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Recognize most of the letters of the alphabet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Read some words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Read sentences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Write letters of the alphabet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) Write some words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Numeracy Skills When Beginning School

#### Items in the Could Do Early Numeracy Tasks When Began Primary School Scale

<table>
<thead>
<tr>
<th>Could your child do the following when he/she began primary/elementary school?</th>
<th>Up to 100 or higher</th>
<th>Up to 20</th>
<th>Up to 10</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Count by himself/herself</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Recognize different shapes (e.g., square, triangle, circle)</td>
<td>More than 4 shapes</td>
<td>3–4 shapes</td>
<td>1–2 shapes</td>
<td>None</td>
</tr>
<tr>
<td>3) Recognize the written numbers from 1–10</td>
<td>All 10 numbers</td>
<td>5–9 numbers</td>
<td>1–4 numbers</td>
<td>None</td>
</tr>
<tr>
<td>4) Write the numbers from 1–10</td>
<td>Yes</td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>5) Do simple addition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6) Do simple subtraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Educationally Oriented Activities in the Home

Parents’ responses reflected general level of activity, rather than early literacy and numeracy activities separately

Bi-factor approach

• One general activity variable including both literacy and numeracy - **Activity**

• One variable representing the balance between literacy and numeracy activities - **NumLitAct**
Skills when Beginning School

Similar bi-factor approach

• One general ability variable including parents’ reports of how well the child could do both literacy and numeracy tasks - **Ability**

• One variable representing the contrast between how well the child could do literacy compared to numeracy tasks - **NumLitAb**
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Activity</th>
<th>NumLitAct</th>
<th>Ability</th>
<th>NumLitAb</th>
<th>Books</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beta</td>
<td>t-value</td>
<td>Beta</td>
<td>t-value</td>
<td>Beta</td>
</tr>
<tr>
<td>LITACT1</td>
<td>0.78</td>
<td>95.69</td>
<td>0.23</td>
<td>56.97</td>
<td></td>
</tr>
<tr>
<td>LITACT2</td>
<td>0.78</td>
<td>99.35</td>
<td>0.22</td>
<td>52.95</td>
<td></td>
</tr>
<tr>
<td>NUMACT1</td>
<td>0.78</td>
<td>82.01</td>
<td>-0.20</td>
<td>-57.63</td>
<td></td>
</tr>
<tr>
<td>NUMACT2</td>
<td>0.77</td>
<td>100.88</td>
<td>-0.19</td>
<td>-47.87</td>
<td></td>
</tr>
<tr>
<td>LITAB1</td>
<td></td>
<td></td>
<td>0.90</td>
<td>234.47</td>
<td>0.29</td>
</tr>
<tr>
<td>LITAB2</td>
<td></td>
<td></td>
<td>0.88</td>
<td>169.87</td>
<td>0.28</td>
</tr>
<tr>
<td>NUMAB1</td>
<td></td>
<td></td>
<td>0.75</td>
<td>79.62</td>
<td>-0.47</td>
</tr>
<tr>
<td>NUMAB2</td>
<td></td>
<td></td>
<td>0.74</td>
<td>73.67</td>
<td>-0.43</td>
</tr>
<tr>
<td>NBOOK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>NCBOOK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
</tbody>
</table>
Structural Model

• Overall model – pooled data from all countries
• Parental education and gender unrelated
  – Can be presented separately
• Separate models for each country
Path Diagram for Relations between Parental Education and Achievement (All Participants, Pooled Data)
The Main Path for Parental Education

- **Main path** theoretically and empirically important – all links in chain fairly strong

- Books (total and children’s books) an important mediating variable – represents valuing and investing in education

- Engaging in early literacy and numeracy activities strongly influences the child’s skills when beginning school

- Second important path directly from parental education to activity, circumventing books
Literacy/Numeracy Emphasis

- Homes reporting stronger emphasis on literacy than numeracy activities also reported higher level of ability in general, leading to positive effect on achievement in all three subjects
  - An emphasis on literacy activities may have a positive effect on development of both literacy and numeracy skills
  - Numeracy skills at beginning of primary school tend to involve both reading and writing
Path Diagram for Relations between Gender and Achievement
(All Participants, Pooled Data)
Gender

• Substantial gender effect in favor of girls with regard to reading

• Essentially no gender effects for mathematics or science

• Only a small part of the gender effect was mediated by the variables in the model

• For girls, activities in the home more oriented toward literacy than numeracy
  
  – Accentuates the Ability-Achievement path for girls
Conclusions

For nearly all countries,

- Effects of parental education on achievement at fourth grade were mediated via books, activities, and abilities (Main Path)

- There were substantial effects of number of books in the home on achievement
Conclusions (cont.)

• Another mechanism is that a stronger emphasis on literacy than numeracy activities influences the level of both literacy and numeracy skills when beginning primary school, which influences achievement.

• It is more common for girls than for boys to have such an emphasis.

• In many countries, homes with a larger number of books put more emphasis on literacy than on numeracy activities.
Thank You!

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