

TIMSS and PIRLS 2011: A Cross-country Analysis of Relative School Effectiveness of Reading, Mathematics, and Science at the Fourth Grade

Ina V.S. Mullis and Michael O. Martin

Keynote Address

5th IEA International Research Conference

Singapore, June 26-28, 2013



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

Investigating Effective Schools in TIMSS/PIRLS 2011—Fourth Grade

In all schools, the aim is to have students learn

1. All schools have some resources to help students learn teachers, classrooms, learning materials, etc.
2. All schools have students ready to learn to some degree healthy, prior learning, positive attitude, etc.
3. Schools and students interact in the learning process



Investigating Effective Schools in TIMSS/PIRLS 2011- Fourth Grade

What is an effective school?

- The school with the highest achievement?
- The school with the most qualified teachers and best equipment?
- The school whose students make substantial gains in a year?
- The school that can have the most impact on achievement despite having a disadvantaged study body?



Investigating Effective Schools in TIMSS/PIRLS 2011- Fourth Grade

This study uses what is known as a school effectiveness approach to examine how school effectiveness factors 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

TIMSS/PIRLS 2011 unique resource for a school effective analysis

- Robust measures of achievement in three core school subject
- High quality data on school factors and home factors



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 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

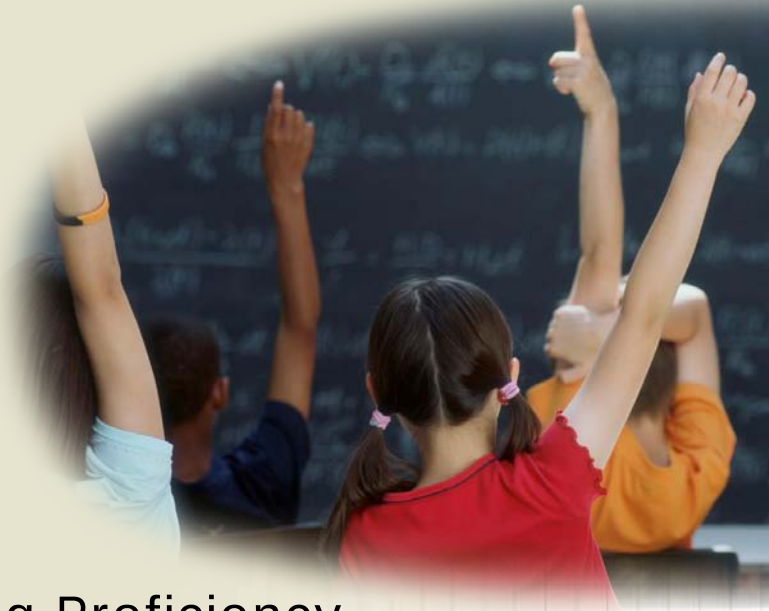
- Schools Are Safe Orderly
- Schools Support Academic Success
- Adequate Environment Resources

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



Considering Our Strong Conceptual Model

Safe and Orderly School

Description:

- Safe Neighborhood
- Violence not a problem
- Discipline is maintained
- Teachers are respected
- Bullying is minimal

TIMSS/PIRLS Data Excellent
Source for Data on this Factor



School Environment

Schools Are Safe and Orderly—Average Three Scales

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- School Discipline and Safety/Principals
- Safe and Orderly School/Teachers
- Students Bullied at School/Students



School Environment (Cont.)

School Discipline and Safety / Principals

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

To what degree is each of the following a problem among fourth grade students in your school?

	Not a problem	Minor problem	Moderate problem	Serious problem
1) Arriving late at school -----	☐	☐	☐	☐
2) Absenteeism (i.e., unjustified absences) -----	☐	☐	☐	☐
3) Classroom disturbance -----	☐	☐	☐	☐
4) Cheating -----	☐	☐	☐	☐
5) Profanity -----	☐	☐	☐	☐
6) Vandalism -----	☐	☐	☐	☐
7) Theft -----	☐	☐	☐	☐
8) Intimidation or verbal abuse among students (including texting, emailing, etc.) -----	☐	☐	☐	☐
9) Physical fights among students -----	☐	☐	☐	☐
10) Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.) -----	☐	☐	☐	☐



School Environment (Cont.)

Safe and Orderly School/Teachers

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

Thinking about your current school, indicate the extent to which you agree or disagree with each of the following statements.

	Agree a lot	Agree a little	Disagree a little	Disagree a lot
1) This school is located in a safe neighborhood -----	☐	☐	☐	☐
2) I feel safe at this school -----	☐	☐	☐	☐
3) This school's security policies and practices are sufficient -----	☐	☐	☐	☐
4) The students behave in an orderly manner -----	☐	☐	☐	☐
5) The students are respectful of the teachers -----	☐	☐	☐	☐



School Environment (Cont.)

Students Bullied at School / Students

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

During this year, how often have any of the following things happened to you at school?

	Never	A few times a year	Once or twice a month	At least once a week
1) I was made fun of or called names -----	☐	☐	☐	☐
2) I was left out of games or activities by other students -----	☐	☐	☐	☐
3) Someone spread lies about me -----	☐	☐	☐	☐
4) Something was stolen from me -----	☐	☐	☐	☐
5) I was hit or hurt by other student(s) (e.g., shoving, hitting, kicking) -----	☐	☐	☐	☐
6) I was made to do things I didn't want to do by other students -----	☐	☐	☐	☐



Considering Our Strong Conceptual Model

Schools Support Academic Success

- School has rigorous academic goals
- Academic goals understood and supported by
 - Principals/Administrators
 - Teachers
 - Parents
 - Students
- All groups work to implement the goals
- All groups believe the goals can be attained



TIMSS/PIRLS Data Good Source for Data on this Factor



School Environment (Cont.)

Schools Support Academic Success—Average Two Scales

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- School Emphasis on Academic Success
 - Principals
 - Teachers



School Environment (Cont.)

*School Emphasis on Academic Success / **Principals***
*School Emphasis on Academic Success / **Teachers***

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

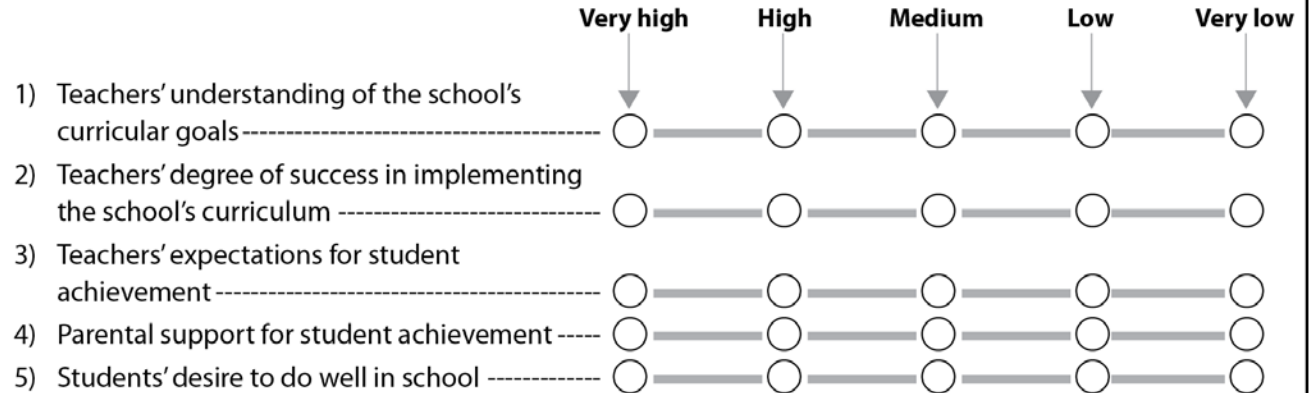
Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

How would you characterize each of the following within your school?



Considering Our Strong Conceptual Model

Adequate Environment and Resources

Description:

- School in good repair with good heating/cooling and lighting
- Well equipped with textbooks and supplies
- Not overcrowded
- Has a sizeable library
- Supports technology
- Has software, books, equipment, materials specific to reading, mathematics, and science instruction

TIMSS/PIRLS Data Excellent Source for Data on this Factor



School Environment (Cont.)

Adequate Environment and Resources—Average Two Scales

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- Teacher Working Conditions
- Instruction Affected by Resources Shortages/
Principal
 - General
 - Mathematics
 - Science
 - Reading



School Environment (Cont.)

Teacher Working Conditions

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

In your current school, how severe is each problem?

	Not a problem	Minor problem	Moderate problem	Serious problem
1) The school building needs significant repair-----	☐	☐	☐	☐
2) Classrooms are overcrowded-----	☐	☐	☐	☐
3) Teachers have too many teaching hours-----	☐	☐	☐	☐
4) Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students) -----	☐	☐	☐	☐
5) Teachers do not have adequate instructional materials and supplies -----	☐	☐	☐	☐



School Environment (Cont.)

Instruction Affected by Resources Shortages/Principals

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?

	Not at all	A little	Some	A lot
A. General School Resources				
1) Instructional materials (e.g., textbooks)-----	☐	☐	☐	☐
2) Supplies (e.g., papers, pencils)-----	☐	☐	☐	☐
3) School buildings and grounds-----	☐	☐	☐	☐
4) Heating/cooling and lighting systems-----	☐	☐	☐	☐
5) Instructional space (e.g., classrooms)-----	☐	☐	☐	☐
6) Technologically competent staff-----	☐	☐	☐	☐
7) Computers for instruction-----	☐	☐	☐	☐
B. Resources for Mathematics Instruction				
1) Teachers with a specialization in mathematics-----	☐	☐	☐	☐
2) Computer software for mathematics instruction-----	☐	☐	☐	☐
3) Library materials relevant to mathematics instruction-----	☐	☐	☐	☐
4) Audio-visual resources for mathematics instruction--	☐	☐	☐	☐
5) Calculators for mathematics instruction-----	☐	☐	☐	☐



School Environment (Cont.)

Instruction Affected by Resources Shortages/Principals (Cont.)

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?

Not at all

A little

Some

A lot

C. Resources for Science Instruction

- | | Not at all | A little | Some | A lot |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| 1) Teachers with a specialization in science ----- | ☐ | ☐ | ☐ | ☐ |
| 2) Computer software for science instruction ----- | ☐ | ☐ | ☐ | ☐ |
| 3) Library materials relevant to science instruction----- | ☐ | ☐ | ☐ | ☐ |
| 4) Audio-visual resources for science instruction ----- | ☐ | ☐ | ☐ | ☐ |
| 5) Science equipment and materials ----- | ☐ | ☐ | ☐ | ☐ |

D. Resources for Reading Instruction

- | | | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| 1) Teachers with a specialization in reading----- | ☐ | ☐ | ☐ | ☐ |
| 2) Computer software for reading instruction ----- | ☐ | ☐ | ☐ | ☐ |
| 3) Library books----- | ☐ | ☐ | ☐ | ☐ |
| 4) Audio-visual resources for reading instruction----- | ☐ | ☐ | ☐ | ☐ |



Considering Our Strong Conceptual Model

Instruction

- Rigorous Curriculum
 - Students taught difficult TIMSS and PIRLS topics
- Are staffed with well-prepared teachers
 - Solid mastery of content to be taught
 - Repertoire of pedagogical approaches
- Have well-resourced classrooms
 - Classroom library, computers/calculators, science equipment
- Provide effective instruction
 - Adequate instructional time
 - Students engaged in their lessons



TIMSS/PIRLS Data Good Source for Data on this Factor



School Instruction

Emphasis in Early Grades on Reading Proficiency— One Scale

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- Emphasis in Early Grades on Reading Skills and Strategies/Principals



School Instruction (Cont.)

Emphasis in Early Grades on Reading Proficiency

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

At which grade do the following reading skills and strategies first receive a major emphasis in instruction in your school?

	First grade or earlier	Second grade	Third grade	Fourth grade	Not in these grades
1) Reading isolated sentences -----	☐	☐	☐	☐	☐
2) Reading connected text -----	☐	☐	☐	☐	☐
3) Locating information within the text-----	☐	☐	☐	☐	☐
4) Identifying the main idea of a text -----	☐	☐	☐	☐	☐
5) Explaining or supporting understanding of a text -----	☐	☐	☐	☐	☐
6) Comparing a text with personal experience --	☐	☐	☐	☐	☐
7) Comparing different texts -----	☐	☐	☐	☐	☐
8) Making predictions about what will happen next in a text -----	☐	☐	☐	☐	☐
9) Making generalizations and drawing inferences based on a text -----	☐	☐	☐	☐	☐
10) Describing the style or structure of a text -----	☐	☐	☐	☐	☐
11) Determining the author's perspective or intention -----	☐	☐	☐	☐	☐



School Instruction (Cont.)

Students Engaged in Reading, Mathematics, and Science Lessons—Average Three Scales

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- Students Engaged in Reading Lessons/Students
- Students Engaged in Mathematics Lessons/Students
- Students Engaged in Science Lessons/Students



School Instruction (Cont.)

Students Engaged in Reading / Students

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

Think about the reading you do for school. How much do you agree with these statements about your reading lessons?

	Agree a lot	Agree a little	Disagree a little	Disagree a lot
1) I like what I read about in school -----	☐	☐	☐	☐
2) My teacher gives me interesting things to read -----	☐	☐	☐	☐
3) I know what my teacher expects me to do -----	☐	☐	☐	☐
4) I think of things not related to the lesson* -----	☐	☐	☐	☐
5) My teacher is easy to understand -----	☐	☐	☐	☐
6) I am interested in what my teacher says -----	☐	☐	☐	☐
7) My teacher gives me interesting things to do -----	☐	☐	☐	☐

* Reverse coded



School Instruction (Cont.)

*Students Engaged in **Mathematics** / Students Engaged in **Science** / Students*

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

How much do you agree with these statements about your mathematics lessons?

	Agree a lot	Agree a little	Disagree a little	Disagree a lot
1) I know what my teacher expects me to do -----	☐	☐	☐	☐
2) I think of things not related to the lesson*-----	☐	☐	☐	☐
3) My teacher is easy to understand -----	☐	☐	☐	☐
4) I am interested in what my teacher says -----	☐	☐	☐	☐
5) My teacher gives me interesting things to do -----	☐	☐	☐	☐

* Reverse coded



Home Background Variables

“Learning to Read Survey” completed by students’ parents and caregivers

- Home Resources for Learning Scale
- Students Have Prerequisite Skills for Learning

TIMSS/PIRLS Data
Excellent Source for
Data on this Factor



Home Resources for Learning— *Composite Scale*

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- Number of Books in the Home/Students
- Number of Home Study Supports/Students
- Number of Children's Books in the Home/Parents
- Highest Level of Education of Either Parent/Parents
- Highest Level of Occupation of Either Parent/Parents



Home Resources for Learning (Cont.)

Students and Parents

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

Number of books in the home (students):

- 1) 0-10
- 2) 11-25
- 3) 26-100
- 4) 101-200
- 5) More than 200

Number of home study supports (students):

- 1) None
- 2) Internet connection or own room
- 3) Both

Number of children's books in the home (parents):

- 1) 0-10
- 2) 11-25
- 3) 26-50
- 4) 51-100
- 5) More than 100

Highest level of education of either parent (parents):

- 1) Finished some primary or lower secondary or did not go to school
- 2) Finished lower secondary
- 3) Finished upper secondary
- 4) Finished post-secondary education
- 5) Finished university or higher

Highest level of occupation of either parent (parents):

- 1) Has never worked outside home for pay, general laborer, or semi-professional (skilled agricultural or fishery worker, craft or trade worker, plant or machine operator)
- 2) Clerical (clerk or service or sales worker)
- 3) Small business owner
- 4) Professional (corporate manager or senior official, professional, or technician or associate professional)

Many
Resources

Some
Resources

Few
Resources



Home Resources for Learning (Cont.)

Early Literacy/Numeracy Tasks—Average Two Scales

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

- Could Do Early Literacy Tasks When Began Primary School/Parents
- Could Do Early Numeracy Tasks When Began Primary School/Parents



Home Resources for Learning (Cont.)

Could Do Early Literacy Tasks When Began Primary School/Parents

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

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

	Very well	Moderately well	Not very well	Not at all
1) Recognize most of the letters of the alphabet -----	☐	☐	☐	☐
2) Read some words -----	☐	☐	☐	☐
3) Read sentences -----	☐	☐	☐	☐
4) Write letters of the alphabet -----	☐	☐	☐	☐
5) Write some words -----	☐	☐	☐	☐



Home Resources for Learning (Cont.)

Could Do Early Numeracy Tasks When Began Primary School/Parents

School Environment

Schools Are Safe and Orderly

Schools Support Academic Success

Adequate Environment and Resources

School Instruction

Early Emphasis on Reading Skills

Students Engaged in Reading,
Mathematics and Science Lessons

Student Home Background

Home Resources for Learning

Early Literacy/Numeracy Tasks

Could your child do the following when he/she began primary/elementary school?

	Up to 100 or higher	Up to 20	Up to 10	Not at all
1) Count by himself/herself -----	☐	☐	☐	☐
2) Recognize different shapes (e.g., square, triangle, circle) -----	More than 4 shapes ☐	3-4 shapes ☐	1-2 shapes ☐	None ☐
3) Recognize the written numbers from 1-10 -----	All 10 numbers ☐	5-9 numbers ☐	1-4 numbers ☐	None ☐
4) Write the numbers from 1-10 -----	☐	☐	☐	☐
5) Do simple addition -----	Yes ☐		No ☐	
6) Do simple subtraction -----	☐		☐	



Investigating Effective Schools in TIMSS/PIRLS 2011

Goal to examine the TIMSS/PIRLS data from a school effectiveness perspective

Relative effect on reading, mathematics, and science of:

- School Environment
- School Instruction

Before and **after** controlling for Home Background



TIMSS/PIRLS 2011 Analytic Approach

Country by country:

1. Examine relationship between school variables and achievement – explanatory model, no 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
 - School and student level



Models for Analysis

- “Null” model (baseline)
 - Achievement differences between schools
- Explanatory model
 - School Environment and Instruction effects, **ignoring** student home background
- Home background control Model
 - Home Background, between and within schools
- Explanatory with control model
 - School Environment and Instruction effects, **controlling for** student home background



Models for Analysis

“Null” Model

- Contains only a between-school effect – no predictor variables
- Purpose is to estimate how much student achievement varies from school to school

$$\text{Student : } Y_{ij} = \beta_{oj} + r_{ij}$$

$$\text{School : } \beta_{oj} = \gamma_{00} + u_{0j}$$



Models for Analysis

Explanatory Model (No Controls)

- Adds School Environment and Instruction variables (W_{sj}) at school level
- Purpose is to estimate the relationship between these variables and student achievement

$$\text{Student : } Y_{ij} = \beta_{oj} + r_{ij}$$

$$\text{School : } \beta_{oj} = \gamma_{00} + \gamma_{0s} W_{sj} + u_{0j}$$



Models for Analysis

Home Background Control Model

- Student and school levels
 - Student: difference between student's home background and school mean
- School: school mean on home background variables

$$(X_{ij} - \bar{X}_{\bullet j})_K$$

$$(\bar{X}_{\bullet j})_K$$



Models for Analysis

Home Background Control Model

- Purpose is to estimate relationship between
 - Student home background (in terms of difference from school mean) and student achievement
 - School mean home background and student achievement (school composition)

$$\text{Student : } Y_{ij} = \beta_{0j} + \beta_{Kj} (X_{ij} - \bar{X}_{\bullet j})_K + r_{ij}$$

$$\text{School : } \beta_{0j} = \gamma_{00} + \gamma_{0K} (\bar{X}_{\bullet j})_K + u_{0j}$$



Models for Analysis

Explanatory Model with Controls

- Includes School Environment and Instruction variables (W_{sj}) at school level
- **Also** includes Home Background control variables (X_{ij}) at student and school level
- Purpose is to estimate the relationship between the school environment and instruction and student achievement **after** controlling for home background



Models for Analysis

Explanatory Model with Controls

$$\text{Student : } Y_{ij} = \beta_{0j} + \beta_{kj} (X_{ij} - \bar{X}_{\bullet j})_K + r_{ij}$$

$$\text{School : } \beta_{0j} = \gamma_{00} + \gamma_{0K} (\bar{X}_{\bullet j})_K + \gamma_{0S} (W_{Sj}) + u_{0j}$$



Analysis Notes

In all models:

- Appropriate sampling weights were applied
- Missing data for predictors imputed using maximum likelihood
- All five plausible values were used and results combined



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

Subject	Variance between Schools (%)
Reading	23%
Mathematics	28%
Science	28%



Variables

School
Environment

School Explanatory Variables

School Environment

Schools Are Safe and Orderly	REA	.55	21 (3.5)	▲
	MAT	.54	21 (4.1)	▲
	SCI	.54	20 (3.5)	▲
Schools Support Academic Success	REA	.44	6 (2.1)	▲
	MAT	.43	6 (2.4)	▲
	SCI	.44	6 (2.0)	▲
Adequate Environment and Resources	REA	.28	2 (2.5)	
	MAT	.28	3 (2.5)	
	SCI	.28	2 (2.5)	

Australia



Variables

School
Instruction

School Instruction

Early Emphasis on Reading Skills

REA

.03 0 (1.8)

MAT

.04 1 (1.9)

SCI

.02 0 (1.7)

Students Engaged in Reading, Mathematics,
and Science Lessons

REA

.21 15 (5.2) ▲

MAT

.21 16 (5.6) ▲

SCI

.21 14 (5.2) ▲

Australia



Variables		Home Background Control Model		
<i>Home Background Control Variables</i>				
Students within Schools				
Home Resources for Learning	REA	.31	12 (1.3)	▲
	MAT	.32	12 (1.4)	▲
	SCI	.36	13 (1.1)	▲
Early Literacy/Numeracy Tasks	REA	.17	11 (1.3)	▲
	MAT	.23	15 (1.4)	▲
	SCI	.20	12 (1.2)	▲
Between Schools				
School Average of Home Resources for Learning	REA	.70	49 (3.7)	▲
	MAT	.70	56 (4.0)	▲
	SCI	.72	49 (3.4)	▲
School Average of Early Literacy/Numeracy Tasks	REA	.22	19 (6.8)	▲
	MAT	.27	23 (8.4)	▲
	SCI	.25	21 (6.0)	▲

Australia



Variables		School Environment and Instruction	School Environment and Instruction (With Home Background Controls)
<i>School Explanatory Variables</i>			
School Environment			
Schools Are Safe and Orderly	REA	20 (3.5) ▲	10 (3.5) ▲
	MAT	21 (4.1) ▲	11 (4.0) ▲
	SCI	19 (3.5) ▲	8 (3.3) ▲
Schools Support Academic Success	REA	6 (2.1) ▲	3 (1.8)
	MAT	7 (2.4) ▲	3 (2.1)
	SCI	6 (2.0) ▲	3 (1.6)
Adequate Environment and Resources	REA	2 (2.5)	1 (1.9)
	MAT	3 (2.5)	1 (2.0)
	SCI	2 (2.5)	1 (1.8)
School Instruction			
Early Emphasis on Reading Skills	REA	2 (1.5)	1 (1.3)
	MAT	2 (1.7)	2 (1.4)
	SCI	2 (1.5)	1 (1.2)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	6 (4.2)	4 (3.6)
	MAT	6 (4.3)	3 (3.6)
	SCI	5 (4.2)	3 (3.2)

Australia



Source of Variance	Percentage of Variance Explained		
	School Explanatory Model	Home Background Control Model	School Explanatory Model with the Control Model
	School Environment and Instruction		School Environment and Instruction
Reading			
Between Schools (23%)	44	58	67
Mathematics			
Between Schools (28%)	43	58	67
Science			
Between Schools (28%)	43	61	69

Australia



Results

Example Country - Botswana

Subject	Variance between Schools (%)
Reading	38%
Mathematics	31%
Science	35%



Variables		School Environment		
<i>School Explanatory Variables</i>				
School Environment				
Schools Are Safe and Orderly	REA	.46	15 (4.8)	▲
	MAT	.49	15 (3.7)	▲
	SCI	.47	20 (5.7)	▲
Schools Support Academic Success	REA	.62	19 (2.4)	▲
	MAT	.61	14 (2.1)	▲
	SCI	.61	22 (2.8)	▲
Adequate Environment and Resources	REA	.22	2 (3.3)	
	MAT	.23	1 (2.7)	
	SCI	.22	2 (4.1)	

Botswana



Variables

School
Instruction

School Instruction

Early Emphasis on Reading Skills

REA

.02 0 (2.2)

MAT

.03 0 (1.7)

SCI

.03 0 (2.5)

Students Engaged in Reading, Mathematics,
and Science Lessons

REA

.59 55 (7.6) ▲

MAT

.58 47 (5.9) ▲

SCI

.64 75 (8.5) ▲

Botswana



Variables		Home Background Control Model		
<i>Home Background Control Variables</i>				
Students within Schools				
Home Resources for Learning	REA	.38	6 (1.0)	▲
	MAT	.30	3 (0.9)	▲
	SCI	.34	6 (1.2)	▲
Early Literacy/Numeracy Tasks	REA	.34	10 (0.9)	▲
	MAT	.31	9 (1.0)	▲
	SCI	.34	14 (1.1)	▲
Between Schools				
School Average of Home Resources for Learning	REA	.78	37 (4.8)	▲
	MAT	.70	26 (4.9)	▲
	SCI	.74	39 (6.4)	▲
School Average of Early Literacy/Numeracy Tasks	REA	.64	9 (6.7)	
	MAT	.58	9 (6.4)	
	SCI	.63	19 (8.8)	▲

Botswana



Variables		School Environment and Instruction	School Environment and Instruction With Home Background Controls
<i>School Explanatory Variables</i>			
School Environment			
Schools Are Safe and Orderly	REA	7 (4.7)	7 (3.3) ▲
	MAT	8 (3.6) ▲	8 (3.1) ▲
	SCI	9 (5.4)	9 (4.1) ▲
Schools Support Academic Success	REA	15 (2.6) ▲	5 (1.9) ▲
	MAT	11 (2.1) ▲	5 (1.9) ▲
	SCI	17 (2.9) ▲	7 (2.3) ▲
Adequate Environment and Resources	REA	3 (2.6)	2 (1.9)
	MAT	3 (1.9)	2 (1.9)
	SCI	4 (2.9)	3 (2.5)
School Instruction			
Early Emphasis on Reading Skills	REA	0 (1.9)	2 (1.2)
	MAT	0 (1.5)	1 (1.1)
	SCI	0 (2.2)	2 (1.5)
Students Engaged in Reading, Mathematics, and Science Lessons	REA	37 (6.5) ▲	28 (4.8) ▲
	MAT	32 (5.0) ▲	27 (4.1) ▲
	SCI	54 (7.6) ▲	44 (5.6) ▲

Botswana



Source of Variance	Percentage of Variance Explained		
	School Explanatory Model	Home Background Control Model	School Explanatory Model with the Control Model
	School Environment and Instruction		School Environment and Instruction
Reading			
Between Schools (38%)	58	68	84
Mathematics			
Between Schools (31%)	62	56	80
Science			
Between Schools (35%)	63	62	84

Botswana



Summary

Number of Countries with Significant Predictors AFTER Controlling for Home Background

Predictor	At Least One Subject	All three Subjects
Schools safe and orderly	16	7
Support academic success	10	2
Adequate environment /resources	3	1
Emphasis on reading	1	1
Students engaged in lessons	13	5



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



TIMSS and PIRLS 2011: A Cross-country Analysis of Relative School Effectiveness of Reading, Mathematics, and Science at the Fourth Grade

Ina V.S. Mullis and Michael O. Martin

Keynote Address

5th IEA International Research Conference

Singapore, June 26-28, 2013



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