

School Resources and Educational Outcomes in Developing Countries: A Review of the Literature from 1990 to 2010

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Introduction

There is a lot of evidence that education raises incomes and has other desirable outcomes.

Developing countries spend hundreds of billions of dollars each year on schools, educational materials and teachers, but...

...relatively little is known about how effective these expenditures are at increasing student learning and students' years of completed schooling.

This paper examines studies published between 1990 and 2010, in both the education and economics literatures, to investigate which specific school and teacher characteristics, if any, appear to have strong positive impacts on learning and time in school.

Background

Policymakers and aid agencies appear to be convinced of value of education, as seen by their higher financial commitments:

Table 1: Public Expenditures on Education in Developing Countries: 1980 to 2008
(millions of 2000 U.S. dollars)

<i>Region</i>	<i>1980</i>	<i>1996</i>	<i>2008</i>
East Asia and Pacific	74,887	197,309	409,106*
Latin American and Caribbean	52,017	70,176	100,694
Middle East and North Africa	25,541	40,475	69,389
South Asia	4,315	14,972	32,092
Sub-Saharan Africa	9,336	13,110	19,188*

Note: Asterisk indicates that data are for 2006, not 2008.

Source: World Bank (World Development Indicators, 1999, 2008, 2010)

**Table 2 Official Development Assistance for Education,
1980 to 2009**
(millions of constant 2008 U.S. dollars)

	<i>1980</i>	<i>1990</i>	<i>2000</i>	<i>2009</i>
All Donors	7,889	11,291	7,820	14,186
DAC (OECD Development Assistance Committee) Countries	7,889	8,914	5,642	9,492
Multilateral	--	2,377	2,178	4,445
Non-DAC Countries	--	--	--	248

Source: International Development Statistics, OECD (www.oecd.org/dac/stats/idsonline).

Increased spending appears to have paid off in terms of getting kids into school:

Table 3: Primary and Secondary Gross Enrollment Rates: 1980 to 2008

<i>Region</i>	<i>Primary</i>			<i>Secondary</i>		
	<i>1980</i>	<i>1995</i>	<i>2008</i>	<i>1980</i>	<i>1995</i>	<i>2008</i>
East Asia and Pacific	111	115	112	43	65	73
Latin American & Caribbean	106	111	117	42	53	88
Middle East and North Africa	87	97	106	42	64	72
South Asia	76	99	108	27	49	52
Sub-Saharan Africa	78	75	97	14	27	33

Source: World Bank (World Development Indicators, 1998, 2010)

Table 4: Primary School Completion Rates: 1980 to 2008

<i>Region</i>	<i>1991</i>	<i>2008</i>
East Asia and Pacific	100	100
Latin American and Caribbean	83	101
Middle East and North Africa	77	94
South Asia	76	79
Sub-Saharan Africa	50	62

Source: World Bank (World Development Indicators, 2002, 2010)

The good news is that almost all developing countries are doing a good job of getting most or all kids through primary school, and most countries are getting most kids into secondary school.

We also have some policies that we are fairly certain will increase enrollment further – recent research shows that enrollment increases when:

- The distance to the nearest school decreases
- School fees are reduced or eliminated (or become subsidies)
- School quality improves

The bad news is that:

- Children in most developed countries are not learning a lot
- At best, learning outcomes are increasing slowly over time
- We know much less about what can be done to increase learning

Table 5: Scores on International Comparable Tests (PISA), 2000 to 2009

<i>Country</i>	<i>READING</i>				<i>MATH</i>		
	<i>2000</i>	<i>2003</i>	<i>2006</i>	<i>2009</i>	<i>2003</i>	<i>2006</i>	<i>2009</i>
Argentina	418		374	398		381	388
Brazil	396	403	393	412	356	370	386
Chile	410		442	449		411	421
Colombia			385	413		470	481
Indonesia	371	382	393	402	360	381	371
Jordan			401	405		384	387
Mexico	422	400	410	425	385	406	419
Peru	327			370			
Thailand	431	420	417	421	417	417	419
Tunisia		375	380	404	359	365	371
Turkey		375	380	404	423	424	445
Uruguay		434	413	426	422	427	427

Objective of This Paper

Due to:

- Lack of clear research results on what school and teacher characteristics lead to improve test scores, and
- In many countries, disappointing results regarding little impact of increased expenditures per student

...many policymakers and researchers in both developed and developing countries have advocated changing the way that schools are run (e.g. changing teacher incentives and, more generally, changing the way that schools are organized).

But...

...before abandoning all hope of finding out whether certain school or teacher characteristics have a causal impact on students' educational outcomes it also seems useful review the literature, because:

- Prior reviews cover studies only through the early 1990s
- Many new studies, including many with stronger research designs, have now appeared.

This paper examines both the economics literature and education literature published in the last two decades to assess the extent to which specific school and teacher characteristics have a causal impact on student learning and enrollment.

More specifically, this paper reviews the literature that attempts to estimate the impact on student learning and time in school of:

1. **School infrastructure and pedagogical materials** (electricity, roof/wall/floor, desks/tables/chairs, blackboard, textbooks, library, computers, etc.)
2. **Teacher and principal characteristics** (education, training, experience, sex, subject knowledge, and ethnicity)
3. **School organization** (pupil-teacher ratio, teaching methods, teacher absence, homework assignment, student assessment methods, teacher contract, expenditure per pupil, etc.)

Interpreting the Research on Basic Education Inputs

The underlying conceptual framework we use considers schools to be “factories” that produce “learning” using various school and teacher characteristics as “inputs”. This is the **production function approach**.

Intuitively, the process by which cognitive skills are learned is determined by many different factors, and production functions are expressions, in simple terms, of this process.

In this sense, an education production function always exists, although its existence does not guarantee that one can estimate it.

Relationships of Interest

It is useful to step back to consider what relationships are of interest that one wants to estimate when examining the impact of school and teacher characteristics on educational outcomes, and how those relationships interact with households' behavior.

Start with the production function for learning (a structural relationship), which can be depicted as:

$$A = a(\mathbf{S}, \mathbf{Q}, \mathbf{C}, \mathbf{H}, \mathbf{I}) \quad (1)$$

A is skills learned (*achievement*)

S is years of schooling

Q is a vector of school and teacher characteristics (*quality*)

C and H are vectors of child and household characteristics

I is school inputs that parents control, e.g. child attendance

Assume that parents, by optimizing their utility, have well defined demand functions for years of schooling and educational inputs:

$$S = f(\mathbf{Q}, \mathbf{C}, \mathbf{H}, \mathbf{P}) \quad (2)$$

$$I = g(\mathbf{Q}, \mathbf{C}, \mathbf{H}, \mathbf{P}) \quad (3)$$

where prices related to schooling are denoted by the vector \mathbf{P} .

Inserting (2) and (3) into (1) gives the reduced form equation for (A):

$$A = h(\mathbf{Q}, \mathbf{C}, \mathbf{H}, \mathbf{P}) \quad (4)$$

This reduced form equation is a causal relationship, but it is not a textbook production function because it reflects household preferences and includes prices among its arguments.

This presentation focuses on attempts to estimate equation (1), the production function for cognitive skills. But in fact some of the studies we examine may be closer to estimates of equation (4), e.g. if they include the price of schooling or distance to schooling. Thus far we have not had time (or maybe the motivation) to classify studies but what they are estimating.

For now, simply note that the impacts of school and teacher variables (\mathbf{Q}) on student learning are **not** the same in equations (1) and (4). In particular, consider a change in one element of \mathbf{Q} , call it Q_i . Equation (1) shows how changes in Q_i affect A holding all other explanatory variable constant (a *partial* derivative), while equation (4) provides the *total* derivative of A with respect to Q_i since it allows S and \mathbf{I} to change in response to the change in Q_i .

For example, parents may respond to better teaching by changing their provision of educational inputs such as textbooks.

Estimation Problems

It is not easy to estimate equation (1).

To be concrete, consider a simple linear specification of (1):

$$A = \beta_0 + \beta_1 S + \beta_{Q1} Q_1 + \beta_{Q2} Q_2 + \dots + \beta_{C1} C_1 + \beta_{C2} C_2 + \dots \quad (1') \\ + \beta_{H1} H_1 + \beta_{H2} H_2 + \dots + \beta_{I1} I_1 + \beta_{I2} I_2 + \dots + u_A$$

where each variable in **Q**, **C**, **H** and **I** is shown explicitly. Note that the “error term”, u_A , accounts for:

1. All variables in (1) that are not in the data
2. Differences between (1) and its linear approximation in (1')
3. Measurement error in A
4. Measurement error in the the right hand side variables

Unfortunately, u_A is very likely to be correlated with the right hand side variables in (1'), for (at least) four reasons:

1. ***Omitted Variable Bias***. Difficult to observe variables include: teachers' motivation (a **Q** variable), school principals' management skills (**Q**), children's ability and motivation (**C**), and parents' willingness and capacity to help (**H**), and the time they spend helping (**I**), their children with schoolwork. Also, "high quality" schools are usually better in many dimensions, both observed and unobserved.
2. ***Selection and Attrition Bias***. School and teacher characteristics (**Q**) often affect which children attend school, and which school they attend. For example, improved schools could attract less prepared students who would otherwise drop out, reducing average test scores.

3. ***Endogenous Program Placement Bias***. Governments may raise school quality in areas with bad education outcomes, in an attempt to assist disadvantaged groups. On the other hand they may raise school quality in areas with good education outcomes, if those areas have political influence. The former causes underestimation of school quality variables' impacts on learning, while the latter causes overestimation.

4. ***Measurement Error Bias***. Anyone who has directly observed household or school survey data collection in developing countries understands that even the best data contain many errors. Random measurement error typically causes underestimation of true impacts, while nonrandom errors could cause underestimation or overestimation.

Potential Solutions

The above estimation problems are very hard to solve.

Perhaps the most obvious approach for addressing problems of omitted variable bias is to collect data on the omitted variables.

Similarly, to eliminate or minimize measurement error bias one should improve data collection to reduce measurement error.

Yet even the best efforts to collect comprehensive and accurate data fall short. Thus we briefly review **five methods** that can be used **to avoid or minimize bias** when estimating equation (1).

A common feature of these methods, **however**, is that **they may be difficult to apply**, and they often rely upon additional assumptions, special circumstances or unique opportunities.

1. **Instrumental Variable (IV) Methods** can be used to address omitted variable bias & measurement error bias. Unfortunately, it is frequently difficult to find plausible instruments.
2. **Panel Data** can be used to estimate the impact of changes (over time) in observed variables on changes in test scores, and more generally to apply value added methods. But many unobserved variables could change over time, and “differencing” may exacerbate measurement error bias.
3. **Regression Discontinuity Design** methods take advantage of thresholds in “smooth” variables that lead to sharp changes in school conditions. The main disadvantage of this method is that such opportunities are relatively rare, and so in most cases it cannot be applied.

4. Matching methods can be used to ensure that comparisons of students in different types of schools are based only on comparisons of students who are “well matched”, at least in terms of observed characteristics. However, these methods do not ensure that students are similar in terms of unobserved characteristics.

5. Randomized control trials (RCTs) have become increasingly popular since the mid 1990s. In principle, they remove bias because they randomly assign a policy (which could be as simple as a change in one school or teacher characteristic) to a set of randomly selected schools, and those not randomly selected serve as controls. However, they often have the following limitations: the control schools must be treated within 1-2 years; it may not be clear “why” a policy works or doesn’t work; and compliance may be a problem.

Review Methodology

First, the **scope of this review** is limited to:

1. Studies published from 1990 to 2010 (and working papers since 2005)
2. Primary and secondary schools (thus it excludes pre-primary, vocational or post-secondary education).
3. Studies of “traditional” school and teacher characteristics; thus it does not examine school policies related to incentives for students & parents (Behrman et al.), school organization and management (Galiani & Perez-Truglia), relative performance of private and public schools (MacLeod & Urquiola) and issues of child health (Alderman & Bleakley).

The objective of the review process was to identify as many relevant, high-quality papers as possible. The strategy used was to search a wide variety of sources, then systematically eliminate individual papers that do not meet a series of criteria for relevance and quality. The specific steps taken were:

1. Search for journal articles published between 1990 and 2010 using two search engines: EconLit and the Education Resources Information Center (ERIC). Searched for papers that listed both “education” as a key word, and any one of a list of 72 educational inputs as keyword. The search was limited to papers that also included the name of at least one developing country or the term “developing country” or “developing countries” in the abstract. This search yielded a total of **about 9,000 articles**.

2. Reviewed the abstracts of each of the 9,000 articles, selecting those that looked potentially relevant. Eliminated papers that were not focused on developing countries (dropped most ERIC papers), or that did not estimate the impact of a school-level (or teacher-level) variable on students' educational outcomes (dropped most papers in Econlit). This reduced the total number of papers to **307**.
3. The authors also searched several prominent series of working papers in economics: NBER; World Bank Policy Research working papers; Institute for the Study of Labor (IZA); Center for Economic and Policy Research (CEPR); Ifo Institute for Economic Research (CESifo). and Poverty Action Lab (J-PAL). Working papers issued before 2005 were excluded (assumed that “good” working papers written before 2005 should be published by 2010). Selected 29 working papers.

4. All four authors reviewed the abstracts the 307 published papers and 29 working papers. This narrowed the sample to **253** by eliminating duplicate papers and papers that did not analyze the impacts on students' educational outcomes of: school infrastructure and pedagogical supplies; teacher and principal characteristics; or school organization (including pedagogical practices).

5. All 253 papers were read by at least one author, which eliminated papers for one of three reasons: a) Paper did not focus on a developing country; b) Paper focused on an education policy unrelated to school infrastructure and pedagogical supplies; teacher and principal characteristics; or school organization; and c) Paper did not include quantitative analysis. More than half of these 253 papers were eliminated, which reduced the studies considered to **112**.

6. The remaining 112 papers were reviewed for quality, both econometric methodology and covariates included. Papers were retained if they used any of the following methods: RCTs; difference in differences (DD) regression, regression discontinuity design (RDD), or matching methods. Also, papers using simpler quantitative methods (e.g. OLS) *and* including at least one general family background variable (e.g. parental schooling or household income) and school expenditure per pupil, or one family background variable, one teacher variable, and at least one additional school variable, were kept. Excluding papers that did not meet these restrictions reduce the number of papers to **79**.
7. Finally, papers that applied OLS to cross-sectional without using any more sophisticated methodology were also eliminated. This gave a final total of **43** articles (see Table 6).

Table 6: Steps Used to Select Papers Used in Literature Review

Step	Number of Papers
Search EconLit and ERIC databases	~5,500
Review abstracts of all results	307
Add working papers published after 2004	336
Review abstracts again, eliminate duplicate papers and papers beyond scope of the review	253
Read entire papers, eliminating those that lack relevance or quantitative analysis	112
Eliminate papers based on methodology and/or lack of basic covariates	79
Final set of “high quality” papers	43

RESULTS!

Note:

1. Many studies present multiple estimates of the impact of the same variable. In general, different estimation methods or estimations based on different subgroups (for example boys and girls, or different grades) were counted as separate estimates, but adding or removing a few variables for the same estimation method (or a similarly minor change) was not.
2. When an author presents multiple estimations, but argues that one is the most reliable, only that preferred estimate is used.

Table 7: Summary of Impacts on Test Scores of School Infrastructure and Pedagogical Supplies (All 79 Studies)

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
Textbooks/Workbooks	4 (3)	13 (8)	7 (5)	10 (7)	26 (10)	21
Desks/Tables/Chairs	0 (0)	0 (0)	13 (1)	7 (5)	8 (4)	8
Computers/Elec. game	1 (1)	9 (5)	1 (1)	8 (3)	7 (4)	8
Electricity	0 (0)	3 (2)	0 (0)	6 (5)	6 (2)	6
School infrastr. index	0 (0)	1 (1)	7 (1)	1 (1)	13 (4)	6
Blackboard/flip chart	0 (0)	2 (2)	13 (1)	3 (3)	7 (3)	6
Library	1 (1)	3 (2)	7 (1)	1 (1)	10 (5)	6
Roof/wall/floor	0 (0)	1 (1)	0 (0)	3 (2)	2 (1)	4

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

**Table 8: Summary of Impacts on Test Scores of Teacher
and Principal Characteristics
(All 79 Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign.	Positive, Insignificant	Positive, Significant	Total Studies
Teacher educat. level	4 (3)	11 (9)	11 (3)	22 (11)	24 (11)	24
Teacher experience	3 (3)	16 (11)	1 (1)	26 (13)	17 (7)	20
Tchr knowledge (test)	2 (2)	2 (2)	0 (0)	11 (5)	18 (7)	9
Female teachers	6 (4)	7 (5)	2 (1)	12 (7)	12 (5)	11
Tchr training (in serv.)	1(1)	10 (6)	0 (0)	7 (5)	11 (6)	11
Teacher quality index	0 (0)	0 (0)	8 (1)	0 (0)	6 (2)	2
Teaching degree	0 (0)	2 (1)	2 (1)	0 (0)	2 (1)	2
Principal experience	0 (0)	1 (1)	0 (0)	3 (2)	2 (2)	2
Principal education	2 (1)	1 (1)	1 (1)	1 (1)	1 (1)	2

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

**Table 9: Summary of Impacts on Test Scores of School Organization
(All 79 Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign.	Positive, Insignificant	Positive, Significant	Total Studies
Pupil-teacher ratio	30 (13)	29 (13)	3 (2)	24 (12)	15 (9)	29
Teacher absenteeism	7 (4)	6 (3)	2 (1)	0 (0)	0 (0)	5
Tchr assign homework	0 (0)	4 (2)	0 (0)	0 (0)	12 (3)	5
School provides meals	4 (1)	3 (2)	0 (0)	0 (0)	6 (3)	4
Multi-grade teaching	4 (1)	0 (0)	10 (1)	5 (2)	2 (2)	4
Hours of school day	1 (1)	1 (1)	0 (0)	2 (1)	4 (2)	4
Tutoring	1 (1)	0 (0)	0 (0)	2 (1)	2 (1)	3
Salaried teacher	0 (0)	0 (0)	0 (0)	4 (1)	2 (2)	3
Contract teacher	1 (1)	0 (0)	0 (0)	1 (1)	4 (1)	2
Expenditure/pupil	2 (2)	0 (0)	0 (0)	0 (0)	1 (1)	2
Cost of attending	1 (1)	1 (1)	0 (0)	4 (2)	0 (0)	2
Total schl enrollment	2 (1)	0 (0)	2 (1)	1 (1)	1 (1)	2
Group work	0 (0)	4 (1)	0 (0)	5 (1)	4 (2)	2
Tchr gives examples	2 (1)	0 (0)	0 (0)	2 (1)	3 (1)	2
Student attendance	0 (0)	0 (0)	0 (0)	0 (0)	8 (2)	2

**Table 10A: Summary of Impacts on Test Scores of School Infrastructure
and Pedagogical Supplies
(43 High Quality Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
Textbooks/Workbooks	1 (1)	8 (4)	3 (1)	6 (4)	3 (2)	8
Desks/Tables/Chairs	0 (0)	0 (0)	0 (0)	4 (3)	3 (2)	4
Computers/Elec. game	1 (1)	9 (5)	0 (0)	8 (3)	4 (3)	6
Electricity	0 (0)	3 (2)	0 (0)	3 (2)	0 (0)	3
Blackboard/flip chart	0 (0)	2 (2)	0 (0)	2 (2)	2 (1)	3
Library	0 (0)	1 (1)	0 (0)	1 (1)	4 (2)	3
Roof/wall/floor	0 (0)	1 (1)	0 (0)	3 (2)	2 (1)	4

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

**Table 10B: Summary of Impacts on Test Scores of Teacher Characteristics
(43 High Quality Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
Teacher educat. level	1 (1)	5 (5)	0 (0)	5 (4)	2 (1)	6
Teacher experience	1 (1)	10 (6)	0 (0)	12 (7)	5 (2)	9
Tchr knowledge (test)	0 (0)	0 (0)	0 (0)	7 (3)	13 (4)	5
Female teachers	1 (1)	1 (1)	0 (0)	5 (2)	1 (1)	2
Tchr training (in serv.)	0 (0)	3 (3)	0 (0)	0 (0)	3 (2)	3

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

**Table 10C: Summary of Impacts on Test Scores of School Organization
(43 High Quality Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
Pupil-teacher ratio	14 (5)	18 (9)	1 (1)	10 (6)	3 (3)	14
Teacher absenteeism	4 (2)	2 (2)	0 (0)	0 (0)	0 (0)	2
School provides meals	0 (0)	1 (1)	0 (0)	0 (0)	2 (1)	2
Multi-grade teaching	4 (1)	0 (0)	0 (0)	5 (2)	1 (1)	2
Hours of school day	0 (0)	0 (0)	0 (0)	0 (0)	4 (2)	2
Tutoring	0 (0)	0 (0)	0 (0)	2 (1)	2 (1)	2
Contract teacher	1 (1)	0 (0)	0 (0)	1 (1)	4 (1)	2

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

**Table 11: Summary of Impacts on Test Scores of School Variables
(13 RCT Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
Textbooks/workbooks	0 (0)	1 (1)	3 (1)	0 (0)	0 (0)	2
Computers/Elec. game	1 (1)	7 (4)	0 (0)	8 (3)	4 (3)	5
Blackboard/flip chart	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	1
Pupil-teacher ratio	3 (1)	2 (1)	0 (0)	0 (0)	0 (0)	1
School provides meals	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	1
Tutoring	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	1
Contract teachers	0 (0)	0 (0)	0 (0)	0 (0)	4 (1)	1
Comm. inform. campgn.	0 (0)	4 (1)	5 (1)	4 (1)	1 (1)	1
Merit-based scholarship	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)	1

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

**Table 12: Impacts of School and Teacher Variables on Time in School
(All 79 Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
<i>School Infrastructure</i>						
Textbooks/workbooks	0 (0)	2 (2)	1 (1)	2 (1)	2 (2)	4
Library	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	2
Roof/wall/floor	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)	2
Building new schools	0 (0)	0 (0)	0 (0)	1 (1)	4 (3)	3
School quality index	0 (0)	0 (0)	0 (0)	1 (1)	4 (2)	2
<i>Teacher Characteristics</i>						
Teacher educat. level	0 (0)	2 (2)	0 (0)	2 (2)	1 (1)	4
Teacher experience	1 (1)	0 (0)	0 (0)	4 (3)	2 (2)	5
Tchr training (in serv.)	1 (1)	2 (2)	0 (0)	0 (0)	0 (0)	2
<i>School Organization</i>						
Pupil-teacher ratio	0 (0)	3 (2)	0 (0)	2 (1)	2 (1)	3
Cost of attending	0 (0)	5 (3)	0 (0)	1 (1)	0 (0)	4
Merit based scholarship	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	2

**Table 13: Impacts of School and Teacher Variables on Time in School
(43 High Quality Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
<i>School Infrastructure</i>						
Textbooks/workbooks	0 (0)	2 (2)	1 (1)	2 (1)	2 (2)	4
Roof/wall/floor	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)	2
Building new schools	0 (0)	0 (0)	0 (0)	1 (1)	4 (3)	3
<i>Teacher Characteristics</i>						
Teacher educat. level	0 (0)	2 (2)	0 (0)	2 (2)	1 (1)	4
Teacher experience	1 (1)	0 (0)	0 (0)	4 (3)	1 (1)	4
Tchr training (in serv.)	1 (1)	2 (2)	0 (0)	0 (0)	0 (0)	2
<i>School Organization</i>						
Pupil-teacher ratio	0 (0)	3 (2)	0 (0)	2 (1)	2 (1)	3
Cost of attending	0 (0)	5 (3)	0 (0)	1 (1)	0 (0)	4
Merit based scholarship	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	2

**Table 14: Impacts of Teacher and School Variables on Time in School
(13 RCT Studies)**

	Negative, Significant	Negative, Insignificant	Zero, or insign. & no sign given	Positive, Insignificant	Positive, Significant	Total Studies
Textbooks/workbooks	0 (0)	0 (0)	1 (1)	0 (0)	2 (2)	2
Building new schools	0 (0)	0 (0)	0 (0)	1 (1)	3 (2)	2
School provides meals	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	1
Merit based scholarship	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	1

1. Figures are number of estimates; figures in parentheses are number of papers/studies.
2. Includes all school infrastructure characteristics with at least two separate papers/studies.

Table 15: Summary of Impacts in Tables 7-11 (Number of studies in parentheses)

Teacher/School Variable	All 79 Studies	43 High Quality Studies	RCTs
<i>School Infrastructure</i>			
Textbooks/workbooks	Mostly positive (21)	Inconclusive (8)	No signif. effect (2)
Desks/Tables/Chairs	Almost all positive (11)	All positive (4)	--
Computers/Elec. game	Mostly positive (8)	Positive?/Ambig. (6)	Inconclusive (5)
Electricity	Mostly positive (6)	No signif. effect (3)	--
School infrastr. index	Mostly positive (6)	--	--
Blackboard/flip chart	Mostly positive (6)	Positive?/Ambig. (3)	No signif. effect (1)
Library	Mostly positive (6)	Mostly positive (3)	--
Roof/wall/floor	Mostly positive (4)	Mostly positive (4)	--
<i>Teacher Characteristics</i>			
Teacher educat. level	Mostly positive (24)	Inconclusive (6)	--
Teacher experience	Positive?/Ambig. (20)	Positive?/Ambig. (9)	--
Tchr knowledge (test)	Mostly positive (9)	All positive (5)	--
Female teachers	Inconclusive (11)	Inconclusive (2)	--
Tchr training (in serv.)	Mostly positive (11)	Positive?/Ambig. (3)	--
Teacher quality index	Mostly positive (2)	--	--
Teaching degree	Positive?/Ambig. (2)	--	--
Principal experience	Mostly positive (2)	--	--
Principal education	Inconclusive	--	--

<i>School Organization</i>			
Pupil-teacher ratio	Negative?/Ambig. (29)	Negative?/Ambig. (14)	Negative (1)
Teacher absenteeism	Almost all negative (5)	All negative (2)	--
Tchr assigns homework	Mostly positive (5)	--	--
School provides meals	Positive?/Ambig. (4)	Positive?/Ambig. (2)	No signif. effect (1)
Multi-grade teaching	Inconclusive (4)	Inconclusive (2)	--
Hours of school day	Positive?/Ambig. (4)	All positive (2)	--
Tutoring	Positive?/Ambig. (3)	All positive (2)	Positive (1)
Teacher salary	Almost all positive (3)	--	--
Contract teacher	Positive?/Ambig. (2)	Positive?/Ambig. (2)	Positive (1)
Expenditure/pupil	Inconclusive (2)	--	--
Cost of attending	Inconclusive (2)	--	--
Total schl enrollment	Inconclusive (2)	--	--
Group work	Mostly positive (2)	--	--
Tchr gives examples	Inconclusive (2)	--	--
Student attendance	All positive (2)	--	--
Parent follow up	Mostly positive (2)	--	--
Commun. Inform. Camp.	--	--	Positive?/Ambig. (1)
Merit-based scholarship	--	--	Positive (1)

Table 16: Summary of Impacts in Tables 12-14 (Number of studies in parentheses)

Teacher/School Variable	All 79 Studies	43 High Quality Studies	RCTs
<i>School Infrastructure</i>			
Textbooks/workbooks	Positive?/Ambig. (3)	Positive?/Ambig. (3)	Positive (1)
Library	Positive (2)	--	--
Roof/wall/floor	Positive?/Ambig. (2)	Positive?/Ambig. (2)	--
Building New Schools	Positive (3)	Positive (3)	Positive?/Ambig. (2)
School quality index	Positive (2)	--	
<i>Teacher Characteristics</i>			
Teacher education level	Positive?/Ambig. (4)	Positive?/Ambig. (4)	--
Teacher experience	Positive?/Ambig. (5)	Positive?/Ambig. (4)	--
Tchr training (in serv.)	Mostly negative (2)	Mostly negative (2)	--
<i>School Organization</i>			
Pupil-teacher ratio	Inconclusive (3)	Inconclusive (3)	--
School provides meals	--	--	Inconclusive (1)
Cost of attending	Negative?/Ambig (4)	Negative?/Ambig (4)	--
Merit-based scholarship	Inconclusive (2)	Inconclusive (2)	Inconclusive (1)

Summary

1. Can't draw definite conclusions about **pupil teacher ratio**, but it is unlikely to have a strong negative impact on learning; the 79 and 43 studies are rather inconclusive, and we have only 1 RCT (and that confounds pupil-teacher ratio with contract teacher).
2. The evidence suggests electrification has little effect (surprising?).
3. Some evidence that fixing walls/roofs/floors will have positive effects, but this is based on only 4 high quality studies.
4. Little evidence in favor of provision of school meals and community information campaigns.
5. Textbooks/workbooks unlikely to have big effects; the Kenya paper shows how something that should work can go wrong.

6. Desks/tables/chairs seem promising, though based on only 4 high quality studies (and no RCTs).
7. Blackboards/flipcharts are not very promising.
8. Libraries seem to be promising,
9. Introduction of computers, internet etc. has mixed results at best, which casts doubt on this now popular and expensive policy.
10. Teacher education, experience, female teachers and in service training have mixed effects; little reason to push in these directions.
11. In contrast, teacher knowledge of subjects they teach seems very important, as one would expect.

12. Little evidence (& no high quality studies) of principal characterist.
13. Not enough evidence on (formal) teaching degree or teacher salary.
14. Multigrade teaching maybe not so bad, but just 2 high qual. studies
15. While the evidence is limited, teacher absenteeism is likely to have a major negative impact on learning, which is quite intuitive.
16. Student time in school (longer school days and higher attendance) increase learning (would be surprising if they didn't!)
17. Some pedagogical techniques show promise (group work, teacher assigns homework, meetings with parents), others don't (teacher uses examples in class), but none has been examined in a high quality study or an RCT. Can they be clearly defined?
18. Tutoring seems to hold promise.

Future Research Implications

1. Little need for more studies on things that have been examined a lot and have at best mixed results, in particular pupil teacher ratio, textbooks/workbooks, and teacher education and experience.
2. Also little need to study teacher knowledge, student time in school, and teacher attendance since it is pretty clear (either from studies or common sense) that all three work.
3. Perhaps more studies on things that appear most promising: desks/tables/chairs, library, contract teachers and tutoring.
4. More studies of computers. internet, etc. are needed given their popularity and the mixed findings thus far.

5. Maybe more studies on what, if any, principal characteristics lead to higher test scores. But principals are hard to study (U.S. work).

6. Maybe more studies on impact of teaching degree and/or teacher salary (latter gets into area of teacher incentives). For salaries it is very important to distinguish between level and form/distribution of salaries across teachers.

7. Maybe some RCTs on pedagogical methods? (Eric is skeptical)

8. Would be useful to have RCTs of aid organizations projects, hundreds of findings could turn up some useful regularities.

10. **Big question:** Is there a role for researchers to do more studies of school and teacher characteristics? I think so. If schools and teachers go in for expensive laptops or I-pads for every kid, maybe we need some good studies of them to see if this makes sense.