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The Determinants of School Achievement: A Review of the Research for Developing Countires

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This paper reviews results of twenty-six studies on
the determinants of student cognitive achievement in
developing countries. It describes the studies, reviews the
results for each of the major determinants of cognitive
student achievement - schooling characteristics, teachers'
attributes, and student traits - and concludes with the
implications for policy and research.

The manuscript was commissioned by the Research Review
and Advisory Group as part of a larger examination of
educational research as it relates to educational problems in
developing countries. It is intended that the information
gathered will be helpful to institutions in the developing
countries concerned with education policy, programmes, research
and training, and to international funding organizations.

CONTENTS

For many years a tradition of classroom research rooted in psychology and pedagogy dominated the field of educational research. With the availability of computers and with increasing interest and involvement in educational research by sociologists and economists, a "new" approach to studying influences on educational performance emerged in the 1960s and 1970s. This approach combines several features:

1) using national surveys to gather data about a wide range of possible influences on learning, including extra-school influences;

2) using multivariate or "systems" analysis to sort out the relative importance of a number of the possible "determinants"; and

3) applying the concept, taken from economics, of the "production function".

The literature abounds with previous reviews and critiques of studies adopting a systems approach to identifying determinants of school achievement. However, these reviews have been, with one dated exception,[1] of research done in the United States, the United Kingdom, or elsewhere in the developed world.[2] Meanwhile, determinants studies have proliferated in the developing world. It remained to pull together and interpret results, as has been done in the following pages.

The authors of this paper have assumed readers are familiar with standard critiques of studies using multiple regression techniques and based on an education production function model (EPF).[3] They have, moreover, taken a relatively cautious view in their own interpretation of the research results reviewed, drawing only from the statistically significant findings   suggestions for promising lines of experimentation. Their treatment of EPF studies may not be nearly cautious enough for some, however, who not only point to problems of definition, measurement, and method but who question   the very assumptions and concepts central to such research. For example:

> "A major deficiency in research on education-production
> functions... arises from the fact that (they) are based
> on the attempt to link statistically a list of inputs
> with a particular output, without the assistance of any
> theory... The (persisting) lack of theoretical

development...is likely to derive from the underlying
complexity of the phenomena that are being explored or
other obstacles that prevent the type of simplification
and reductionism that are necessary for the systematic
construction of a conceptual framework."[4]

Even the critics, however, admit that results of the EPF studies
have been consistent in at least two important respects, indicating
that (1) student backgrounds markedly affect their achievement, and
(2) the potential effects of providing additional or improved school
resources is greater for students from lower social status than for
higher. Providing textbooks, for instance, can improve performance for
students from lower SES backgrounds but does little for higher SES peers.
These two observations hold up in the work from developing countries, with
one difference -- that the combined "school effects" are generally more
pronounced and sometimes outweigh the non-school effects on achievement.
Indeed, the leeway for affecting performance by improving the condition
of schools and what goes on in them seems to be greater than in the more
homogeneous developed world.

In a related activity,[5] the Research Review and Advisory Group
sponsored, in May 1978, a meeting in Singapore at which national studies were
discussed. There, a point was made of the importance of treating results
from EPF research with care, and of complementing such research with
observational studies. However, a forceful case was made also for the
value of large-scale empirical studies of the type reviewed here as
devices for providing (1) descriptive data pointing to existing inequities in
participation and performance in national systems of education and (2) a new
vocabulary for policy-makers - one which includes social dimensions.

The authors have performed a valuable service in bringing together
these results and in pointing to particular variables that have emerged,
in their opinion, as promising for action and for further examination.
Their interpretations are their own, of course. To the extent their views
spark discussions, provoke experimentation with new programs and stimulate
research using complementary methods,[6] this publication will have served its
purpose.

Robert G. Myers

References

1 John Simmons and Leigh Alexander, "The Determinants of School Achievement:
   A Review of the Research", Economic Development and Cultural Change,
   Vol: XXVI, No. 2 (January, 1978), pp. 341-357.

2   See, for example: Harvey Averch, et al., How Effective is Schooling?
    Englewood Cliffs, N.J.: Educational Technology Publications, 1974; Eric
    Hanashek, "A Reader's Guide to Education Production Functions", Working
    Paper No. 798, Institution for Social and Policy Studies, Yale University,
    New Haven, Conn., 1977.

3   A production function analysis treats education, usually schooling, as a
    process in which labor and capital "inputs" (such as teachers, books,
    buildings) are combined to produce "outputs" (for instance, an increase
    in knowledge, or, more simply, graduates) in the most efficient manner.
    Both "inputs" and "outputs" are difficult to specify and measure. Strong
    intercorrelations among "determinants" make it difficult to sort out
    their unique effects: similarly schools produce simultaneously several
    outcomes but research usually deals only with cognitive achievement. The
    models used often assume (incorrectly?) linear relationships. Results are
    sensitive to the level of aggregation used. Often it is not additions to
    performance but level of performance that is used.

4   Henry M. Levin, "Educational Production Theory and Teacher Inputs",
    Revision of a paper prepared for a July 6-8 conference held at the
    Educational Finance and Productivity Center of the University of Chicago.
    Stanford University, August, 1978, p. 4 (mimeograph).

5   Susanne Mowat, Rapporteur. "The Genesis, Conduct and Utilisation of
    Educational Research: A Report on a Workshop Reviewing Four National
    Education Assessment Studies - Indonesia, Malaysia, the Philippines, and
    Thailand", Ottawa: International Development Research Centre. The
    Research Review and Advisory Group, 1978.

6   For an excellent discussion of concepts and methods associated with
    production function and classroom traditions of research, see: Rebecca
    Barr and Robert Dreeben, "Instruction in Classrooms", in Lee S. Shulman
    (ed.), Review of Research in Education 5, Itasca, Illinois: F.B. Peacock
    Publishers, Inc., forthcoming.

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INTRODUCTION AND SUMMARY

Research exploring why some children learn more in school than others
has revealed important issues for planners and educators in developing
countries.[1] The investigations have used the methods of anthropology,
psychology, sociology, economics, linguistics, and statistics. Some
studies have examined the effects of different curricula on student learning,
others have concentrated on studies of student and teacher interaction,
still others have described as fully as possible what happens in the
classroom and during homework. A separate group of studies has tried to
understand the learning process as a complex system of factors affecting
student achievement which includes the influence of family, the characteristics
of the student, other non-school experiences and the role of the school.
These system studies draw on all the disciplines and have been of particular
interest to planners and educators because they attempt to estimate the
relative effect of the inputs which, in theory, have an impact on student
achievement.

Our purpose is to highlight selected results from system studies carried
out by researchers in more than 20 developing countries. We will draw
policy implications from both the research methods and the findings, and
will suggest future research. Our review is limited to twenty-six studies
using multivariate analysis, the most rigorous of the statistical tools, and
includes twelve studies reported in the six years since the last review
was completed. We draw also upon recent reviews which have examined single
dimensions of the system like the effect of textbooks or class size on
student achievement.

Findings. We divided the possible determinants of student achievement
into three categories: school resources and processes, teacher attributes,
and student traits. It is important to note that these are determinants in
theory, but not necessarily in practice. We would expect them to have a
significant impact on student achievement, as measured by both statistical
estimations and classroom learning.

A)   Twenty-six studies provide evidence on thirteen dimensions within
the category of school resources and processes. We shall discuss these

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policy-related variables for which there are the most observations, including class size, the availability of textbooks, and expenditure per student.

1. The optimal number of students per class is an important policy issue because of its cost implications. In 9 of 14 studies relating the effects of class size to student achievement, larger class size was associated with higher performance or did not affect it. Relatedly, five of the eight studies examining the relationships between cost per student and student achievement found that higher expenditure per student is not associated with higher student achievement. The implication is that raising the class size 20 to 30 percent might not decrease student achievement. With this, and other findings, however, it is important to experiment with the suggested changes before policies are endorsed and implemented on a national scale. Increasing the class size for instance might cause negative reactions by some teachers and, as a result, lower scores. Or, implementation of new teaching methods may require a smaller class size.

2. Of 10 studies looking at the availability of textbooks and student achievement, 7 demonstrated a positive relationship. While this is a strong finding, one could ask why it is not stronger. Where results are negative the textbooks may not be well designed to teach what the students are being tested or teachers may not efficiently use the books that they have. It is also possible that oral or blackboard presentation of the information being tested is sufficient, and textbooks are not needed.

3. Students who have schoolwork to be done outside of school, i.e. "homework", tend to do better on the achievement tests in 6 of the 8 studies. None of the other school determinants of achievement have as high a proportion of significant findings. This is an interesting policy variable because it is virtually costless in money terms and seems to provide a high return.

B) The studies reviewed include information about 16 dimensions of teachers' characteristics. The dimensions for which there are the most observations are teacher certification, experience and training.

1. In 19 out of 32 studies, teachers without certificates in educational training had students who tested as well as those who had certificates. While additional information must be obtained to draw more meaningful conclusions from these studies,

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in the meantime it is possible to suggest that teacher certifi-
cation should be reviewed with caution as a way to increase
student achievement.

2. Years of teacher experience is a significant determinant of
   achievement in only 7 of 19 studies. Teacher experience might
   be related to cultural traditions, or administrative procedures.
   More experience might correspond with less exposure to new
   methods and approaches in education, or older teachers might
   be assigned to classes with higher performance.

3. More years of training is not related to higher student achievement
   in 5 out of 6 studies. If experimental work were to confirm this
   finding, it would have substantial implications for training
   requirements.

C)   Student traits are significant in the expected directions in 47 cases,
while no impact or an opposite result are found in only 17 cases. Results
are especially consistent across students for variables such as socioeconomic
status of parents (SES), repetition, malnutrition, health, and pre-primary
education.

1. SES is the variable most frequently studied in this set. Out of a
   total of 13 observations, SES is a significant predictor in 10.
   In several studies family background is the single most important
   determinant of school outcomes. It is usually a composite
   measure of parents occupation, incomes and education. Upper-
   income children may tend to learn the language skills and other
   behaviors rewarded by schools. They also have access to
   books, literate parents, toys and other conditions at home.
   Parent training of the poor could offset some of these
   advantages. Thus the design of new educational policies
   should pay attention to the possible effects of family
   background.

2. Malnutrition, body weight and health are significant predictors
   of scores in 8 of 11 cases, a surprisingly consistent finding
   across studies. The finding provides strong support for
   experiments to raise health levels as a form of educational
   investment. Nutrition or health are highly correlated with SES;
   thus it is uncertain in those studies where SES is not well
   measured whether these variables are important on their own, or
   only an indicator of the economic status of families.

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The data on health (mentioned above) indirectly suggests the role of parents in contributing to child health and student achievement, even when their socioeconomic status is controlled. Experiments on parent training and other pre-school factors could yield important policy results.

     3. Repetition studies have shown that the more repeating a student did, the lower the score, in 7 observations out of 8.

     4. Three of the 4 observations about kindergarten attendance indicate that it has a significant impact on student achievement measured 6 or 12 years later.

Data from the 33 studies are summarized in the table below (Table 1) From a total of 101 measures of school characteristics, 45 were statistically significant determinants of achievement.

TABLE 1: SUMMARY OF THE POSSIBLE DETERMINANTS
(number of observations)

	Significant	Other	Total	Percentage Significant [1]
School Attributes	47	51	98	48
Teacher Attributes	29	51	80	36
Student Attributes	47	17	64	75
TOTAL	123	119	242	51

1. Multiple regression coefficients are statistically significant at the .05 level or better.

Implications for Policy and Research: What policy and research implications can be drawn from these highlights? These studies have selected a small number of main determinants for pilot projects and experimental research from a large pool which were assumed to be significant. For policy planning, then, those variables that are labelled significant "determinants" should be considered as possible, but not certain, inputs to cognitive achievement as measured by school tests. This uncertainty is due to limitations of the cross-sectional regression analysis and of the data. The tests do not measure all aspects of cognitive achievement, nor do they measure any dimensions of students' affective development like co-operation, responsibility or leadership. Nevertheless, results should encourage policy planners to undertake pilot projects, for example, increasing class size, initiating homework, and improving early child development. Because these variables are themselves often linked casually,

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experiments should seek those combinations that will be most effective in improving overall performance of the system.

In short, we do not feel that additional national multivariate analyses should be given a high priority. However, studies which probe deeper into specific questions (for example.exploring the situation in rural or marginal areas), or periodic repetitions of the surveys to document changes in performance and distribution over time may be in order. And, in countries where experimentation is not feasible, then multivariate studies may be the only way to raise awareness about the possible determinants of achievement. If and when such additional surveys are done, attention should be given to non-cognitive as well as cognitive outcomes. To associate the desired outcomes of an educational system only with academic achievement is, of course, a narrow view. Surveys should be accompanied also by observational studies.

Reanalyses of the present data could be done within social or geographic groupings, with particular attention to determinants of achievement for low SES students.

In conclusion, the multivariate studies have provided important information for policy and research in developing countries by screening approximately ten variables for more than 500 for further examination. The next step is to undertake experimental studies assessing their impact as policy variables on achievement and other educational outcomes.

THE STUDIES

This paper concentrates on presenting the results of the multivariate or "production function" studies of the effects of school, teacher, and student characteristics. We make comparisons across the African, Asian, and Latin American regions and explore the conclusions. Our analysis is limited to multivariate studies because they provide better insight than simple correlation studies for both policy planning and research design. Since a critique of the production function theory and estimation procedures can be found elsewhere, we have not replicated it here.[2] We were able to locate only 2 experimental studies.[3]

Twenty-six studies are represented in this review: 5 for Africa, 6 for Asia and 15 for Latin America. This compares with 14 studies available for review in 1974.[4] We include all multivariate studies covered in recent topical reviews. The studies are described by region in Table 2 on the following pages.[5]

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2   John Simmons and Leigh Alexander, "The Determinants of School Achievement:
    A Review of the Research", Economic Development and Cultural
    Change 26, No. 2 (January 1978) pp. 341-357. For reviews of specific
    determinants see Wadi Haddad, "Educational Effects of Class Size",
    (Washington, D.C.: World Bank Working Paper, No. 280, 1978); Institute
    of International Education, Stockholm University, "Teacher Training and
    Student Achievement in Less Developed Countries", mimeo (Washington,
    D.C.: World Bank, Education Department, 1978); Joseph P. Farrell,
    Manual A. Sepulveda-Stuardo and Stephen Heyneman, "Textbooks and Achievement:
    What We Know", mimeo (Toronto: Ontario Institute of Studies in Education,
    June 1978); and Beatrice Avalos and Wadi Haddad, "Teacher Effectiveness",
    mimeo (Ottawa: International Development Research Centre, 1978).

3   One is the Radio Mathematics Project in Nicaragua; the second is the Textbook
    Project in the Philippines. Both are randomly assigning schools to various
    treatment conditions involving high, low, or zero levels of school resources
    likely to be important in influencing achievement - radio and textbooks in
    Nicaragua, and radio, textbooks, and in-service teacher training in the
    Philippines. Both use multivariate methods, or production functions, to
    relate achievement to the experimentally assigned and other variables.

4   See Simmons and Alexander, 1978. See also L.J. Lair, "Educational
    Production Functions" in D. Windham (ed). Economic Perspectives in
    Education, forthcoming.

5   The reader should be aware - after reading Table 1 - that the studies
    differ in: size and the degree to which samples are representative;
    the definition and measurement of the dependent variable; and the
    number of and definitions of variables included as determinants.

Some studies present only one production function for the whole sample, while other studies present results for each subsample. For example, when the Thai study presented equations for 3 economic groups, each equation is presented as a separate observation. Finally each study examined several characteristics of each major determinant, like teacher motivation, and training of the teacher determinant. We have 102 observations on the school characteristics of achievement, 80 on teacher attributes, and 64 on student traits.[6]

We categorized in Annex I the determinants into those which were "statistically significant with the expected sign" and were "not statistically significant, or with the opposite sign".[7] Statistical significance may or may not signify policy significance; more research is needed to determine it. But it does help us to begin to sift through the more than 500 variables that have been studied for their possible importance in promoting student achievement. We grouped those determinants which were not significant with those which had a reversed sign into 1 rather than 2 categories to clarify the possible policy implications. The classificational system is also consistent with the earlier review, and makes comparison between them easier. It should be noted, however, that some studies of a determinant, like teacher certification, which were expected to have a positive impact on achievement in fact had a negative impact.[8]

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6 The important equations from many of the studies that we have used are available on request from the Educational Research Review and Advisory Group, IDRC. We hope that readers who are aware of studies we have omitted will send us copies including the equations.

7 A given variable may have several definitions, affecting the results. Also, the order in which variables are included in regressions may affect their significance.

8 Readers interested in these and other distinctions can request the equation in Annex II.

TABLE 2A: DESCRIPTION OF SYSTEMS STUDIES EXPLAINING STUDENT COGNITIVE ACHIEVEMENT IN AFRICA[1]

Author(s) and Publication Date	Country	Sample		R^2 Range	Measure of Student Academic Achievement
		Primary or Lower Secondary grade	Upper Secondary grade		
Youdi, 1971	Congo	-	1450 students in grade 11 and 12 randomly selected from 25 secondary schools	-	Individual scores on IEA multiple choice tests in French and mathematics.
Simmons, 1972	Tunisia	44 students from a village and 80 students from an urban suburb, grades 4-8	-	-	Individual scores on multiple choice tests in Arabic, French, and arithmetic.
Thias-Carnoy, 1973	Kenya	3405 rural grade 7 students in a random sample of 89 schools	-	-	Average student scores on Kenya Preliminary Examination for each school.
		-	Grade 11 students in 115 rural and urban schools	-	Average student scores on Cambridge School Certificate Examination for each school.
Carnoy-Thias, 1974	Tunisia	6195 students in grades 7-11 randomly selected from rural and urban secondary schools		-	Individual student grade point averages on school examinations.
Heyneman, et al. 1977 (data 1972) (Table 2)	Uganda	2293 grade 7 students in 67 schools	-	.35	Individual scores on Uganda school selection exams in English, mathematics, and general knowledge.

[1]The statistical procedures for these studies were all ordinary least squares procedures.

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TABLE 2B: DESCRIPTION OF SYSTEMS STUDIES EXPLAINING STUDENT COGNITIVE ACHIEVEMENT IN LATIN AMERICA

Author(s) and Data Collection Date	Country	Sample Primary or Lower Secondary grade	Upper Secondary grade	R^2 Range	Measure of Student Academic Achievement
M. Costa, 1977	Brazil	1658 eighth grade students Sao Paulo	-	.27 to .34	Individual scores on reading and math test.
L. Wolff, 1970		20120 first grades in Rio Grande do Soul	-	.04 to .16	Student grades in language as recorded by the teacher.
J. Mayo, R. Hornik and E. McAnany, 1969	El Salvador	1600 students of grades 7, 8, 9	-	.49 to .87	Individual scores on GTA developed general ability and reading test.
S. Schmelkes, 1972		161 students in 24 schools grades 1-4	-	-	Arithmetic, geometry and language test scores.
C. Munoz and J.T. Guzman, 1971	Mexico	519 students of grades 3,4,5 in Mexico City (private schools) for low SES sectors	-	.23	Individual scores on arithmetic and Spanish texts developed by Inst. Nac. de Pedagogia.
S. Klees, 1974	Mexico	-	1236 students in 58 telesecondaries		Math and language.
F. Swett, 1976	Ecuador	3146 students in grades 1, 4, 6	-	.16 to .92	Individual scores in verbal and math test.
E. Echart, J. Meier, R. Manuelli and M. Binimelis, 1976	Argentina	2130 students in grades 1, 4, 6	230 in Bachiller and technical education	-	Individual scores in verbal and math test.
D. Rivarola and G. Corvalan, 1976	Paraguay	3688 students of grades 4 and 6 and last course in secondary		.12 to .36	Individual scores on arithmetic and Spanish ELIEL adaption of IEA test.
Comber & Keeves, 1973	Chile	-	Final year in high school: 73 schools and 2052 students (IEA-IV); 81 & 1470 (I); 103 & 1311 (II)	-	
A.C. Purves, 1973	Chile		" "	-	IEA test on sciences.

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TABLE 2B. (Cont'd)

Author(s) and Data Collection Date	Country	Sample		R^2 Range	Measure of Student Academic Achievement
		Primary or Lower Secondary grade	Upper Secondary grade		
J.B. Carroll, 1973	Chile	-	1549 students in 60 schools (IEA-IV)	-	IEA test on French
Lewis & Massod, 1975	Chile	-	2314 students in 80 schools (IEA-IV)	-	IEA test on English
E. Schiefelbein and J. Farrell, 1973	Chile	3530 students in 8th grade in 1970	-	.30	Individual scores on national grade 8 test in Spanish and arithmetic.
E. Schiefelbein and C. Clavel, 1972 and 1974	Chile	-	162 high school students in their last year in 1972	.29 to .99	" " " "

TABLE 2C: DESCRIPTION OF SYSTEMS STUDIES EXPLAINING STUDENT COGNITIVE ACHIEVEMENT IN ASIA

Author(s) and Publication Date	Country	Sample		Statistical Procedure	R^2 Range	Measure of Student Academic Achievement
		Primary or lower Secondary grade	Upper Secondary grade			
Beebout, 1972	Malaysia	--	7674 students in grades 10-11 in a random sample of 89 secondary schools	OLS multiple regression using both a quadratic and linear functional form		An index of individual student performance relative to that of his peers; performance defined as the difference between secondary entrance and final examination scores
Comber-Keeves, 1973 Thorndike, 1973 (IEA Study)	India	2662 students age 10 in 176 schools and 2845 students age 14 in 155 schools	3040 students in terminal year of full-time secondary program in a sample of 127 secondary schools.	Stepwise OLS multiple regression		Individual scores on internationally developed multiple choice tests in science and native language reading comprehension
	Iran	1623 students age 10 in 53 schools and 1020 students age 14 in 33 schools	1051 students in terminal year of full-time secondary program in 40 schools	" "		" "
	Thailand	1822 students age 10 in 27 schools and 1924 students age 14 in 29 schools	723 students in terminal year of full-time secondary program in 15 schools	" "		" "
Haron, 1977 (data 1972)	Malaysia	6056 students of age 12 from a stratified random sample	--	OLS multiple regression		Individual scores on the "Standard Five Assessment Examination" commonly used in Malaysia
Fuller & NEC, 1977 (data 1973-74)	Thailand	23555 students from grade 3 in 987 schools	--	Stepwise OLS multiple regression	.09-.26	Individual scores on standardized achievement tests of Thai language and arithmetic administered at entrance and completion of grade 3

SCHOOL CHARACTERISTICS

We have reviewed studies providing evidence on 16 dimensions of
school resources and processes. These dimensions range from expenditure
per student and class size to the availability of textbooks, homework
assignments, curriculum and peer group effects. But in eight cases, there
are results for only one of the regions. This fact suggests the need
to explore these variables in the remaining regions. Table 3 below
summarizes the findings for each school variable on student achievement
by region.[9] Of the 98 observations of schooling and achievement, 47 had
statistically significant effects while 51 had either no impact or an
impact in the opposite direction than was expected.

The differences among the three regions and different aspects does
not appear significant.[10] For each, half of the variables have a significant
impact than have either no impact or a significant opposite impact. It
might be noted that there are more data on expenditures per student and
class size from Latin American than there are from Africa or Asia, while
the studies of textbook availability are predominantly from Asia. We
shall discuss the findings on the policy variables for which there are the
most observations, including average class size, the availability of
textbooks, homework and expenditure per student.

Class Size. The optimal number of students per class is an important
issue because of its cost implications. In 9 out of 14 studies testing
the effects of class size on student achievement, larger class size was
found to either improve or not affect performance. Five of the 8 studies
that examine the relationships between cost per student and student
achievement found that higher expenditure per student is not associated
with higher student achievement.[11] Some countries that were studied have an
average class size from 25 to 50 students. The implication is that raising

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9 Each study may include several measurements of school variables.

10 The comparison is limited by methodological problems mentioned above.

11 Higher expenditures may simply reflect inefficiencies in the deployment of
    resources or indivisibilities of some factors, neither of which affects
    learning. The Latin American schools seem to display great variation in
    inefficiency. See: Claudio Castro, et.al., "La Educacion en America
    Latina: Un Estudio Comparativo de Costos y Eficiencia", Rio de Janeiro,
    Programa de Estudios Conjuntos sobre Integracion Economica Latino
    Americana, 1978; p. 90

TABLE 3: SCHOOL ATTRIBUTES RANKED BY FREQUENCY OF STUDY

	AFRICA		LATIN AMERICA		ASIA		TOTAL		All
	Signif.	Other[2]	Signif.	Other	Signif.	Other	Signif.	Other	
Average class size	0	1	2	5	3	3	5	9	14
School facilities[2]	1	2	2	2	2	3	5	7	12
Textbook availability	1	0	2	0	4	3	7	3	10
School size	1	1	0	0	4	4	5	5	10
Expenditure per student	0	1	3	3	0	1	3	5	8
Homework assignment	1	0	2	2	3	0	6	2	8
Total years of science	0	0	0	0	4	4	4	4	8
Boarding at secondary	3	1	0	0	0	1	3	2	5
Double shifts	0	0	0	1	1	0	1	1	2
Student-made science observations & experiments	0	0	0	0	1	2	1	2	3
Distance to home	0	0	0	0	2	1	2	1	3
Coed student body	0	0	0	3	0	0	0	3	3
Percentage of teachers who teach science	0	0	0	0	0	3	0	3	3
Time devoted to science study & homework	0	0	0	0	1	2	1	2	3
Library utilization	0	0	0	2	0	0	0	2	2
School year length	0	0	2	0	0	0	2	0	2
Classroom peer group	1	0	0	0	0	0	1	0	1
Extracurricular activities	0	0	1	0	0	0	1	0	1
TOTAL	8	6	14	18	25	27	47	51	98

1. Other includes non-significant results and results of opposite sign than expected.
2. Includes labs, libraries, farms, electricity, and workshops.
Source: See Annex I for a description of the individual studies.

the national average class size 20 to 30 percent might not decrease student achievement.[12] The magnitude of this estate is based on the regression coefficient and standard deviation of class size. However, increasing the class size might cause negative reactions by some teachers and, as a result, lower scores, or, implementation of new teaching methods might require a smaller class size. Thus, it is important to experiment with the critical changes before policies are endorsed and implemented on a national scale.[13]

Textbooks. Ten studies looked at the relationship between the availability of textbooks and student achievement, of which seven demonstrated a positive relationship.[14] Based on the central role that textbooks could play in most classrooms, it may be surprising to some observers that the number is not higher. It is possible that the textbooks are not well-designed to teach what the students are being tested or that the teachers do not efficiently use the books that they have. It is also possible, for certain educational goals, that oral or blackboard presentation of the information being tested is sufficient, and the textbooks are not needed. Finally, it may be that textbooks are only useful for rote learning and are not sufficient (without changes in the role of the teacher) for achieving higher levels of skills - making inferences or judgements, for example.

There are other problems with the analysis of this variable. If textbooks are bought by the student, they may be a proxy of socioeconomic status (SES). If students do not have textbooks because the teacher does not ask the students to buy them, the variable becomes a proxy of teaching methods. Only when students lack the textbooks required by their teachers is it possible to identify a possible impact on achievement. The data do not enable us to say if textbooks may be more important for improving reading rather than arithmetic.[15]

Homework. Students who have homework tend to do better on the achievement tests in six of the eight studies. Few of the other school determinants of achievement have as high a proportion of significant findings. This is an interesting policy variable. Since it is virtually costless in money terms, it could provide a high return. Homework,

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12 Increasing the average does not mean all classes would be larger and could be consistent with a policy to reduce the size of the largest classes.

13 For a full discussion of class size and related issues see Wadi Haddad, op.cit.

14 The three cases correspond to the Thailand study. There are more studies examining the issues of textbook impact but using simple correlations. See J. Farrell, M. Sepulveda and S. Heyneman, op.cit.

15 For a full discussion of class size and related issues see Wadi Haddad, op.cit.

however, may be a proxy for the length of time a student spends studying, teacher training, careful supervision, or teacher motivation. If children have no books, light or quiet, then the homework might not be too effective. Again experimentation would be essential for any country wishing to explore such a policy since its actual introduction might have adverse effects among students, parents or teachers. For example, some students that have to work may not have free time for doing homework, or teachers may start using their classroom time for checking homework.

Table 4 presents a summary of studies of teachers' characteristics.
Of the 80 observations, 29 have statistically significant impact in the
opposite direction than hypothesized.[16] In each of the regions, only
one-third of the cases show a statistically significant relationship with
the expected sign.[17] In all regions, studies have focussed on teacher
education and experience, as well as on some indicators that might be
proxies of quality. African studies include variables such as salary,
tenure or English proficiency, while Latin American studies tend to
emphasize teacher upgrading, authoritanianism, and innovations in teaching
methods. Asian studies include both attitudinal variables like motivation
or preparation of lessons and personal characteristics like sex or age.[18]

   Teacher Certification, Training and Upgrading. Thirty-two of the
80 observations about teaching attributes concern whether or not the
teachers were certified. While half of the studies are statistically
significant in Latin America, and in Asia, only one fourth are in
Africa. The differences may reflect the educational contexts of each
region. In 13 studies the presence of certified teachers in the classroom
significantly affected student scores, and in 19 they did not. In the
6 studies which investigated the impact of the amount of teacher training
on student test scores, only one was significant. A related finding
concerns the upgrading of teachers; in the four studies undertaken, none
showed that teacher upgrading improves the scores of students. Additional
information must be obtained from each source to draw more meaningful
conclusions from these studies. In the meantime, it is possible to
suggest that present methods and duration of teacher training and
upgrading should be reviewed with caution as a way to increase student
achievement.

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16 U-shaped relationships may also be included as "nonsignificant". For
   example, dependence may be positive up to a certain point, beyond which
   it is negative.

17 Teachers characteristics may be related to output in non-linear ways and
   may operate in interaction with other variables. For example, low SES
   teachers may have to solve language problems and, therefore, may obtain
   better results when using the mother tongue with low SES children facing
   similar problems. Linear regression models used in the studies did not
   incorporate interactive terms. This is an aspect that may be further
   investigated.

18 For a detailed discussion of determinants of teacher effectiveness, see
   Beatrice Avalos and Wadi Haddad, op.cit.

TABLE 4: TEACHER ATTRIBUTES RANKED BY FREQUENCY OF STUDY [1]

	AFRICA		LATIN AMERICA		ASIA		TOTAL		
	Signif.	Other[2]	Signif.	Other	Signif.	Other	Signif.	Other	All
Educational certification	1	3	8	8	3	3	12	14	26
Experience	1	4	4	8	2	0	7	12	19
Teacher training	0	0	0	0	1	5	1	5	6
Authoritarianism	0	0	2	3	0	0	2	3	5
Upgrading	0	0	0	4	0	0	0	4	4
Sex	1	2	0	0	1	0	2	2	4
Preparation of lessons	0	0	0	0	0	3	0	3	3
Illness	0	0	0	0	0	3	0	3	3
Turnover	0	0	1	0	1	0	2	0	2
Age	0	0	0	0	0	2	0	2	2
Motivation	0	0	0	0	1	0	1	0	1
Innovation in methods	0	0	0	1	0	0	0	1	1
Tenure	0	1	0	0	0	0	0	1	1
English proficiency	1	0	0	0	0	0	1	0	1
Salary	1	0	0	0	0	0	1	0	1
Education of parents	0	1	0	0	0	0	0	1	1
TOTAL	5	11	15	24	9	16	29	51	80

1. Source: See Annex I for description of the individual studies.
2. Other includes non-significant results and results of opposite sign than expected.

26

Teacher Experience. The years of experience which teachers had in the classroom was examined in 19 observations. In about one-third (7 of 19) of the cases significant results with the expected sign have been obtained. The only two Asian cases are both significant, while only half are in Latin America and one-fifth are in Africa. The length of teacher experience might be related to cultural traditions, or administrative procedures and incentives. A good supervisor might be associated with positive effects of a teacher's experience or with sharing of experience among teachers. If this hypothesis is true, urban teachers' experience might be more significant than the rural teachers' because of greater contact with supervisors. However, more experience might correspond with less willingness to use new methods and approaches in education. Also, older teachers with more seniority might be assigned to better schools and classes with higher performance. As before, experimentation is needed before results can be applied in decision-making.

Teacher Turnover. The rate of teacher turnover is another variable for further exploration. The two studies which have been done both found significant effects: the higher the turnover, the lower the score. It is not demonstrated, however, whether it is the change of the teacher or the time that students remain without classes because of hiring delays which affects students' performance. Turnover might also be a proxy for administrative red tape. The main source of problems must be identified before these results can be utilized.

Results for this group of variables are significant in 73 percent
of the observations (48 out of 65), as shown in Table 5. There are
slight differences by region - from 61 percent significant in Asia to
83 percent in Africa. Results are especially consistent for variables
such as socio-economic status (SES), repetition, malnutrition, and pre-
primary education.

Socioeconomic Status of Parents. SES is the variable most frequently
studied in this set. It is measured in several ways for example, by
occupational scales, by educational levels, or by more complex scales.
Out of a total of 13 observations, SES is a significant predictor in 10.
The exception is 3 observations from a study in Ecuador.[19]

Malnutrition and Health. Malnutrition, body weight or height[20] and
health are significant predictors of standard scores in 8 of 11 cases,
a surprisingly consistent finding across studies. The finding provides
strong support for experiments to raise health levels as a form of
educational investment. Nutrition and health are highly correlated with
SES and thus it is uncertain in those studies where nutrition and health
are measured and SES is not, whether these variables are important on their
own, or only an indicator of the economic status of families.

Repetition of Grade. Repetition has been studied in the three regions
and showed that the more repeating a student did, the lower the score, in
7 observations out of 8. Repeating could be a proxy of student ability or
teacher perception. Repeating could also be classified as a school
attribute.[21]

Television Outside School. All 5 observations in the Latin American
region on the effects of access to TV on achievement gave significant
results. However, results are not consistent with those obtained from
other studies.[22] Again, this variable may be a proxy for SES in developing
countries.

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19 Separate equations, however, were computed for each of six different types
   of schools (public urban, public rural, county urban, county rural, private
   religious, private other), so parts of the SES are controlled in the
   design of the equations.
20 Measured as deviations from weight or height tables by sex and age.
21 Repeating may be studied as an output as well as a determinant.
22 Robert C. Hornik, "Television Access and the Slowing of Cognitive Growth"
   in American Educational Research Journal, Winter 1978, Vol. 15, No. 1
   pp 1-15.

TABLE 5: STUDENT ATTRIBUTES RANKED BY FREQUENCY OF STUDY [1]

	AFRICA		LATIN AMERICA		ASIA		TOTAL		
	Signif.	Other[2]	Signif.	Other	Signif.	Other	Signif.	Other	All
SES	1	0	7	3	1	0	10	3	13
Repetition	4	1	2	0	3	1	9	2	11
Malnutrition & weight	2	0	1	0	2	1	5	1	6
Television outside school	0	0	6	0	0	0	6	0	6
Family size	1	0	1	3	0	0	2	3	5
Health [3]	3	2	0	0	0	0	3	2	5
Student age	1	0	0	0	0	3	1	3	4
Absences	0	0	0	0	3	1	3	1	4
Kindergarten	0	0	1	0	2	1	3	1	4
Educational aspirations	0	0	1	1	0	0	1	1	2
Sex	1	0	0	0	0	0	1	0	1
IQ	1	0	0	0	0	0	1	0	1
Self concept	1	0	0	0	0	0	1	0	1
Free reading at home	0	0	1	0	0	0	1	0	1
All pupils same ethnic group	0	0	0	0	1	0	1	0	1
TOTAL	15	3	20	7	12	7	48	17	65

1. Source: See Annex I for a description of the individual studies.

2. Other includes non-significant results and results of opposite sign than expected.

3. Includes total medical problems, blood with stool, and hospital experience.

Early Child Development. A major debate is under way in an increasing number of countries about the importance of early child development, between birth and school entry. Unfortunately, the studies say nothing directly about the effect of parenting on later learning in school. Three of the 4 observations about kindergarten attendance,however, indicate that it has a significant impact on student achievement when achievement is measured 6 to 12 years later.[23] The data on health discussed above indirectly suggest the important role of parents in contributing to child health, even when their socioeconomic status is controlled. Experiments on parent training and other pre-school factors could yield important policy results.

In short, pre-school attendance, health, repetition, and access to TV might be important policy variables. Country efforts to reduce repetition rates should be carried out, provided that the effects should be assessed. Experiments with pre-primary education should be controlled for SES and for specific social groups with special access to that level of education. In many countries, industrial workers obtain pre-primary education for their children.

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23 IDRC is sponsoring an experimental project on the relationships between primary training and first grade outcomes in four Latin American countries.

IMPLICATIONS FOR POLICY AND RESEARCH

What policy and research implications can be drawn from the data we
have presented? For policy planning, those variables that are labelled
statistically significant "determinants" should be considered to be
possible, but not certain, inputs to cognitive achievement as measured
by school tests. This uncertainty is due to both the limitations of the
cross section regression analysis and the data. The tests do not measure
all aspects of cognitive achievement, nor do they measure any dimension of stu-
dents' affective or interpersonal development like discipline, co-operation, and
responsibility of leadership. And it may be these traits which schools can
foster through the curriculum that may have a greater impact on the earnings
and satisfaction of adults, than their cognitive skills.[24] The results,
however, should encourage planners and educators to undertake pilot
projects (to study the effects in their own countries of increasing class
size, initiating homework, and improving early child development, for
example).

In brief, our review indicates that a small number of determinants
should have priority for experimental research compared to the large pool
which were assumed to be equally important when the review was undertaken.
The experiments should use the students, the classroom and the school as
the unit of observation to capture effects which may have been omitted or
under-estimated in earlier studies. We should also note that some
attributes like intelligence, self-concept, teacher motivation and parent
education for early child development have not been widely studied in
their relation to student achievement, thus they should not be out of
consideration for future research for this reason.

About half of the observations (12 out of 242) reported in Table 1
are statistically significant determinants of school achievement.[25] Within
the 123, however, variables related to student characteristics seem to
provide more consistent results than either teacher or school characteristics.
While 73% of the observations are significant in the expected direction for

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24 The relationship between affective and interpersonal traits fostered by
   schools and their impact on earnings, productivity and satisfaction has
   been ignored in the empirical research for developing countries. For a
   review of American data see Herbert Gintis, "Technology, Work and Education",
   American Economic Review, April 1972.

25 Nearly all studies include at least one variable in each of the three attributes.

student characteristics, only 48% of the school characteristics and 36% of
teachers' characteristics are significant. While these results suggest that
school effects may be less important than we expected, the main result is
the selection of a small but important set of variables that are most
promising for further examination.

The set of student characteristics present particular problems for
generating a suitable change, since they are not easily affected by
education policy. Relationships between SES and the rest of the indicators
must be more clearly defined before support for specific actions can be
obtained from the studies. They are not,however, promising variables to
be affected by policy instruments either to increase achievement or
reduce costs. In the other two sets of characteristics, most of the
variables are related to policy decisions. The results, however, are
mixed and in several cases the variables might act as proxies of other
dimensions of the educational process, rather than being important
themselves. The results of each study must be examined in terms of the
context of each country.

We have compared the results of the review in 1974 and 1978 in
Table 6. In 1974, there were a total of 61 observations, in 1978, there
were 242. The percentage of both school and teacher attributes which
were significant has declined. This discouraging result, however,
does not reflect changes in what is happening in the schools. Rather,
because the later review is a larger sample, it is a more accurate
picture of what has been taking place all along. The 1978 review is
still an imperfect sample of schools in developing countries. Traditions,
attitudes, teachers' prestige, expectations created by educational
certification, student and parental aspirations and many other variables
affect the impact of the variables. Subjective judgment of the results
in each country must supplement direct experimentation.

TABLE 6:   COMPARISON OF 1974 AND 1978 REVIEWS

	Percentage Significant		Number of Observations	
	1974	1978	1974	1978
School Attributes	59	48	27	98
Teacher Attributes	54	36	28	80
Student Attributes	100	73	6[1]	64

Sources: For the 1974 review, Simmons and Alexander's Table 2, p. 350,
          op.cit., and for the 1978 review, tables 2, 3, & 4 above.

1. The Simmons and Alexander review focusses on the School and Teacher
   Attributes in each study; thus 6 is not an accurate account of the
   number of student attributes actually measured in those studies.

Two lines of future work are needed for the selection of the more important variables for policymaking. First, the most strongly supported relationships among the school characteristics are the most promising in terms of either increasing achievement or reducing costs. Their real influence should be assessed through carefully designed pilot projects and controlled experiments.[26] Two illustrations of promising experiments are under way in Nicaragua and the Philippines to examine the effects of radio and textbooks on achievement.[27] Second, available data on some of the studies should be reanalyzed to obtain more meaningful comparisons. For example, the classroom as a unit of analyzing seems to be more suitable than the student for testing teacher effects, if the teacher is dealing with the class group as a whole. Attention to factors affecting achievement of low SES students should be a priority, given the evidence from Thailand for example, which suggests substantive differences between effects of variables on different SES levels. This is supported by analysis of United States and Latin American data. Rural and urban differences should also be explored. Work is also needed to standardize the definitions used for similar variables, as well as to discuss the policy implications of the statistical methods, like path analysis and longitudinal data sets used for estimating parameters. Finally, cross tabulation and residuals might be computed for studies with large samples to study high performing schools for non-linearities or threshold effects.

In conclusion, multivariate studies have provided major ideas for policy and research in developing countries by initiating a screening process. Approximately ten variables from more than 500 have been identified for further examination. The next step is to undertake experimental studies assessing their impact as policy variables on cognitive achievement and other educational outcomes like affective and interpersonal development.

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26 In order to carry out experiments, a previous step might be useful. For most relationships, other types of approaches have been implemented. For example, teacher-student interactions have been analyzed from many points of view and the same has happened for reading or writing. Available knowledge in developing countries related to the variables selected for experiments should be summarized for use in the design of the experiments.

27 World Bank Education Loan V to the Philippines, 1977, and Dean T. Jamison "Radio and Student Repetition in Nicaragua", in P. Suppes, B. Searle, J. Friend, Eds., The Nicaragua Radio Mathematics Project, 1975-76 (Stanford, Ca: Institute for Mathematical Studies, 1978).

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TABLE 1: DETERMINANTS OF SCHOOL ACHIEVEMENT: AFRICA

Variable	Expected Sign	Stat. Signif.	Not Signif. or Opposite Sign
SCHOOL ATTRIBUTES			
1) Per pupil expenditures on school facilities or teachers	(+)		Thias-Carnoy (gr.7)
2) School facilities			
Availability and use of library	(+)		Heyneman et al.
School electricity	(+)		Heyneman et al.
School farm	(+)	Heyneman et al.	
3) Textbook availability at primary grades	(+)	Heyneman et al.	
4) Size of school enrollment at upper secondary grades	(+)	Thias-Carnoy	Youdi (gr.11)
5) Average class size or pupil/teacher ratio	(-)		Thias-Carnoy (gr.7)
6) Homework and free reading at home	(+)	Simmons	
7) Performance and attitudes of classroom peer groups	(+)	Carnoy-Thias	
8) Boarding at secondary grade	(+)	Thias-Carnoy (gr.11) Carnoy-Thias Youdi	
Boarding at gr.7	(+)		Heyneman et al.
TOTAL		8	6
TEACHER ATTRIBUTES			
1) Teacher certificate and academic qualification at primary and lower secondary grades	(+)		Thias-Carnoy (gr.7) Heyneman et al.
Teacher certification and academic qualification at upper secondary grades	(+)	Youdi	

TABLE 1. (Cont'd)

Variable	Expected Sign	Stat. Signif.	Not Signif. or Opposite Sign
2) Teacher experience at primary & lower secondary grades	(+)		Carnoy-Thias Youdi
3) Teacher sex-males at primary & lower secondary grades; females at upper secondary levels	(+)	Carnoy-Thias	Thias-Carnoy (gr.7) Youdi
4) Teacher contract (tenure) at upper secondary grades	(+)		Carnoy-Thias
5) Teacher's English	(+)	Heyneman et al.	
6) Teacher salary grade	(+)	Heyneman et al.	
7) Education of teacher's parents	(+)		Heyneman et al.
TOTAL		5	11

STUDENT ATTRIBUTES

Variable	Expected Sign	Stat. Signif.	Not Signif. or Opposite Sign
1) SES	(+)	Heyneman et al.	
2) Grade repetition	(−)	Thias-Carnoy (gr.7) Simmons Youdi Heyneman et al.	
No. years dropped out of school	(−)		Heyneman et al.
3) Malnutrition	(−)	Heyneman et al.	
Amount of breakfast eaten	(+)	Heyneman et al.	
4) Age	(−)	Heyneman et al.	
5) Health	(+)	Heyneman et al.	
Pupil hosp. experience	(−)	Heyneman et al.	
Blood with stool	(−)	Heyneman et al.	

TABLE 1. (Cont'd)

Variable	Expected Sign	Stat. Signif.	Not Signif. or Opposite Sign
Total medical problems	(-)		Heyneman et al.
Disease	(-)		Heyneman et al.
6) Sex	(+)	Heyneman et al.	
7) Intelligence	(+)	Heyneman et al.	
8) Pupil self-concept	(+)	Heyneman et al.	
9) Position in family (family size)	(+)	Heyneman et al.	
TOTAL		15	3

TABLE 2: DETERMINANTS OF SCHOOL ACHIEVEMENT: LATIN AMERICA

Variables and Expected Sign of their Relationships to Students Performance	Statistically Significant with Expected Sign	Not Statistically Significant, or with Opposite Sign
TEACHER VARIABLES		
1) Teacher certification (+) (education)	Rivarola (4th & 6th grades) Echart et al. (secondary) Costa (R&M) Purves (11-Lit) Klees (74) Comber (IV Se)	Rivarola (secondary) Echart et al. (4th & 6th) Wolff (70) Munoz (71) Schiefelbein-Farrell (70) Purves (V-Lit); Carroll (IV French)
2) Teacher experience (+)	Swett (6th grade) Rivarola (4th & 6th grades) Costa (M)	Swett (1st & 4th grades) Rivarola (Secondary) Echart et al. (all) Klees (74); Carroll (IV-French)
3) Teacher turnover (-)	Wolff (70)	
4) Teacher upgrading (+)		Echart et al. (all) Schief-Farrell (70)
5) Teacher authoritarianism	Rivarola (6th grade) Swett (6th grade)	Rivarola (4th grade) Swett (1st & 4th grades)
6) Innovation in teaching methods (+)		Echart et al. (all)
TOTAL	15	24
SCHOOL VARIABLES		
1) Average class size (-) (pupil: teacher ratio)	Swett (4th & 6th grades)	Swett (1st grade) Schief. & Farrell (69) Echart et al. Schief. & Farrell (70)
2) School facilities availability (+)	Echart et al. (6th grade) Munoz (71)	Echart et al. (4th grade & secondary)
3) School year length (+)	Schief. and Clavel (72-74)	
4) Double sessions (-) (double shifts)		Schief. & Farrell (70)
5) Coed. student body (+)		Schief. & Clavel (72-74) Schief. & Farrell (70)

TABLE 2. (Cont'd)

Variables and Expected Sign of their Relationships to Students Performance	Statistically Significant with Expected Sign	Not Statistically Significant, or with with Opposite Sign
6) Extracurricular activities (+)	Munoz (71)	
7) Study at home (+)	Costa (m); Comber & Keeves (IV)	Comber & Keeves (I & II)
8) Textbook availability (+)	Wolff (70) Schief. & Farrell (70)	
9) Expenditure per pupil (+)	Swett (1st, 4th & 6th)	Swett (1st, 4th & 6th)
10) Library utilization (+)		Costa (R&M)
TOTAL	14	18

STUDENT ATTRIBUTES

1) Free reading at home	Schief. & Farrell (70)	
2) Kindergarten (+)	Wolff (70)	
3) T.V. (+)	Costa (R&M) Schief. & Farrell (70) Schief. & Clavel (72-74) Costaneda et al.	
4) SES (+)	Costa (R&M); Swett (4th & 6th) Schief. & Farrell (70) Schief. & Clavel (72-74)	Swett (1st, 4th & 6th)
5) Family size (-)	Costa (R)	Costa (M) Schief. & Clavel (72-74)
6) Repetitions (-)	Costa (R&M)	
7) Education aspirations (+)	Costa (M)	Costa (R)
8) Malnutrition (-)	Schief. & Farrell (70)	
TOTAL	20	7

TABLE 3: DETERMINANTS OF SCHOOL ACHIEVEMENT: ASIA

Variables and Expected Sign of their Relationships to Students Performance	Statistically Significant with Expected Sign	Not Statistically Significant, or with Opposite Sign
TEACHER ATTRIBUTES		
1) Teacher education (+) (amount of post-secondary for IEA)	IEA India (Pop. II Science)	Fuller & NEC (students from low, middle and upper income families)
		IEA Thailand (Pop. IV Science)
		IEA Iran (Pop. IV Science)
2) Teacher experience (+)	Beebout; Haron	
3) Teacher motivation (+)	Ryan	
4) Teacher qualification (+)	Fuller & NEC (low income) Beebout; Haron	Fuller & NEC (middle and upper income) Ryan
5) Teacher preparation of lessons (+)		IEA India (Pop. IV Science) IEA Iran (Pop. IV Science) IEA Thailand (Pop. IV Science)
6) Transfer rate of teachers (+)	Haron	
7) Teacher age (+)		Fuller & NEC (middle and upper income)
8) Teacher absence (-)		Fuller & NEC (low, middle and upper income)
9) Teacher sex (+) (males at primary and lower secondary, females at upper secondary)	Beebout	
TOTAL	12	13
SCHOOL ATTRIBUTES		
1) Pupil:teacher ratio (-)	Beebout; Ryan; Haron	Fuller & NEC (lower, middle and upper income students)

TABLE 3. (Cont'd)

Variables and Expected Sign of their Relationships to Students Performance	Statistically Significant with Expected Sign	Not statistically Significant, or with Opposite Sign
2) Distance time to school (-)	Fuller & NEC (low & middle income)	Fuller & NEC (upper income)
3) Total time devoted to science study and homework (+)	IEA India (Pop. IV)	IEA Thailand, (Pop. IV) IEA Iran, (Pop. IV)
4) Total years study of science (+)	IEA India (Pop. IV Science) IEA Iran (Pop. IV Science) IEA India (Pop. II Science) IEA Thailand (Pop. II Science)	IEA Thailand (Pop. Science) IEA Thailand (Pop. IV Science) IEA India (Pop. II Science) IEA Iran (Pop. II Science)
5) School size (+)	Fuller & NEC (low, middle and upper income) IEA Iran, (Pop. IV)	Beebout; IEA India (Pop. IV) IEA Thailand (Pop. IV) Haron
6) Boarding at secondary (+)		Beebout
7) Double sessions (-)	Beebout	
8) Space per pupil in classroom (+)		Fuller & NEC (lower, middle and upper income)
9) Availability of textbooks (+)	IEA India (Pop. I Science) IEA Iran (Pop. I Science) Fuller & NEC (lower, middle and upper income) Beebout; Haron	
10) Hours of homework per week (+)	IEA India (Pop. II Science) IEA Thailand (Pop. II Science) IEA Iran (Pop. II Science)	
11) Per student experience (+)		Beebout
12) Availability & use of library (+)	Beebout; Haron	
13) Percent of teachers of science (+)		IEA India (Pop. II Science) IEA Thailand (Pop. II Science) IEA Iran (Pop. II Science)

41

(Cont'd)

TABLE 3. (Cont'd)

Variables and Expected Sign of their Relationships to Student Performance	Statistically Significant with Expected Sign	Not statistically Significant, or with Opposite Sign
14) Student-made science observations & experiments (+)	IEA Iran (Pop. I Science)	IEA India (Pop. I Science) IEA Thailand (Pop. I Science)
TOTAL	25	33
PUPIL ATTRIBUTES		
1) Student age (+)		Fuller & NEC (lower, middle and upper income)
2) Repeated grade (+)	Fuller & NEC (lower, middle and upper income)	Beebout
3) Attended kindergarten (+)	Fuller & NEC (middle and upper income)	Fuller & NEC (lower income)
4) Weight (+)	Fuller & NEC (low and middle income)	Fuller & NEC (upper income)
5) Pupil absence record (-)	Fuller & NEC (low and middle income) Haron	Fuller & NEC (upper income)
6) 100% pupils same ethnicity (-)	Haron	
7) SES[1]	Fuller & NEC (pooled data)	
TOTAL	12	7

[1]The IEA studies don't report their SES findings in regression form. See p. 196 of Comber and Keeves for example.

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