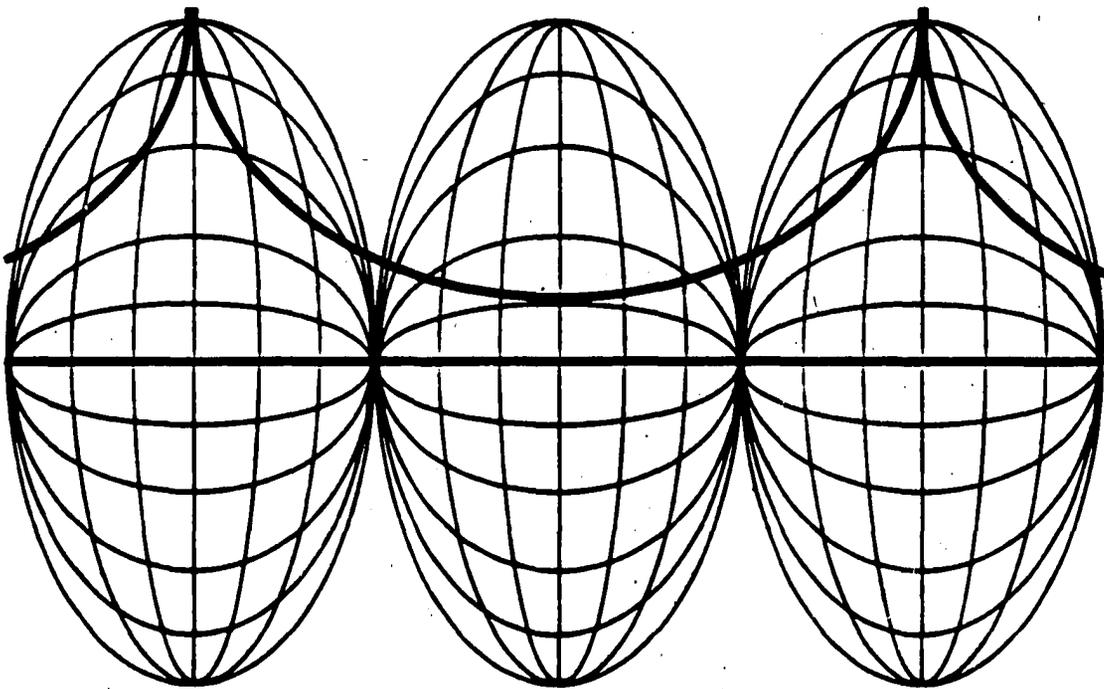


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**TEACHER CHARACTERISTICS AND STUDENT ACHIEVEMENT
IN MATH AND SCIENCE**

**Donald P. Warwick, Fernando Reimers and Noel McGinn
Harvard Institute for International Development**

Papers on Primary Education in Pakistan. Report # 5. 1989.

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PLEASE DO NOT QUOTE

**TEACHER CHARACTERISTICS AND STUDENT ACHIEVEMENT
IN MATH AND SCIENCE**

Donald P. Warwick, Fernando Reimers and Noel McGinn¹

Harvard Institute for International Development

A critical question in judging the effectiveness of primary schools is how much learning took place among their students. Learning can be evaluated in many ways, such as through essays indicating knowledge in a particular field, oral examinations, and standardized achievement tests. This paper reports findings on the relationship between the background and classroom practices of teachers and the performance of their students on achievement tests in Mathematics and Science.

The survey of 473 primary schools conducted by Project BRIDGES and the Academy for Educational Planning and Management (AEPAM) included interviews with over 900 teachers and achievement tests given to more than 11,000 students in Classes 4 and 5. The Mathematics and Science tests had been developed by the World Bank and the Primary and Non-Formal Education Wing of the federal Ministry of Education and used as a means of evaluating academic achievement in areas covered by World Bank

~~Project~~
The analysis will interpret relationships between

characteristics of teachers and their students in science and mathematics. The school survey was able to obtain information from the students tested about their teachers in those two subjects. By using a separate identification number for each teacher and assigning that same number to students he or she taught in science and mathematics, the survey has been able to link information provided by the teachers to the achievement test scores of their students. For example, teachers were asked about the level of formal education they had completed. The analysis will relate that information to the scores of the Class 4 and Class 5 students they have taught in science in mathematics. This approach differs from that taken in another BRIDGES paper which relates characteristics of schools to the average test scores for the whole school on mathematics and science.²

The average scores for each achievement test and the number of teachers who taught students in the respective classes are shown below:

<u>Test and class</u>	<u>Number of teachers</u>	<u>Average (mean) for teachers' students</u>
Math 4	495	11.7
Math 5	472	12.4
Science 4	493	13.8
Science 5	485	16.3

The averages are those obtained for students of a particular group of teachers, such as 11.7 for students of the 495 teachers who taught Math 4. Because most teachers in primary schools have more than one class, the same teachers are often responsible for

students taking two, three, or four tests.

The discussion will now show the relationships found between characteristics of teachers and the four achievement tests. The categories of analysis are the same as those used in a related paper called "A Profile of Primary School Teachers in Pakistan." Differences among categories of teachers will usually be discussed only if they are statistically significant.³

1. PERSONAL BACKGROUND AND LIVING CONDITIONS

How much of the differences in achievement test scores can be explained by the personal background and living conditions of teachers, such as their age, sex, and the literacy of their parents?⁴ The gender of the teachers is related to student scores on Math 4 and Math 5 but not to scores on either of the science tests. Students of male teachers have an average (mean) score of 12.9 on Math 4 compared to 10 for students of female teachers. On Math 5 students of male teachers score 13.9 while those of female teachers average 10.4. On the tests in science, by contrast, the average scores for Class 4 are identical for men and women and for Class 5 only slightly different. Further analysis will be necessary to determine if the differences on the mathematics tests are explained by gender alone or by other conditions related to gender.

The age of teachers makes a difference only for Math 5, with the students of older teachers showing higher scores. Whether a teacher's father can read or write has no significant relationship to any of the test results. The literacy of the

teacher's mother is associated only with scores on Science 4. Students of teachers whose mothers can read and write have higher test scores than of those whose mothers cannot. Overall, age and the literacy of parents are weak predictors of student achievement.

The school survey contained one question about the quality of construction of the teachers' homes and 9 others about facilities and services available in those homes. The question about quality asked teachers to indicate whether their home was built of mud and straw (kaccha) or of more permanent materials, such as brick (pacca). Their responses to this item were not related to any of the achievement test scores.

An index of services and facilities available in teachers' homes was constructed by summing positive responses about the following items: electricity, a sewing machine, piped water, a radio, a television set, a washing machine, a refrigerator, gas, and a motorbike. The survey findings showed that this index was significantly related to student achievement on Science 4 and 5. In both cases the students of teachers with more services and facilities scored higher on the test. Later analysis will determine whether these relationships hold up for teachers who live in urban and rural areas, or whether they are an indirect reflection of living conditions in rural areas.

Teachers were also asked how far they lived from school (coded in kilometers) and how long it took them to travel to school (coded in minutes). The results were the same with each

question. The further teachers lived from the school and the more time it took them to travel there, the lower the average scores of their students in Math 5 and Science 5. The most plausible explanation is that teachers who must travel more than 10 kilometers and spend more than an hour en route to school are more fatigued, more frustrated with teaching, or both than those who live closer. For example, on the results for Math 5, where the average test score for the sample is 11.5, no teacher travelling more than an hour each way to school had any student score above 18, while among those living closer there were many students with scores between 20 and 38.

2. EDUCATION AND PREPARATION FOR TEACHING

In interviews before and during the survey of schools provincial officials often complained that the level of formal education and professional qualifications of their teachers was below that needed for effective teaching. Two District Education Officers in Baluchistan stated that, because of the low attractiveness of teaching as a profession in Pakistan, they were often left with candidates who were simply not qualified to handle even a primary school curriculum. In light of such comments, and a broad body of literature emphasizing the importance of education and training for teachers, the survey probed this area in some depth.

The first question is whether the formal education of teachers is related to the achievement test scores of their students. In fact, it is one of the best single predictors of

achievement found in the entire survey. Table 1 shows that for all 4 achievement tests the average scores rise with the teacher's level of education. All of the differences reported in the table are statistically significant. On Math 4 students of teachers with primary education score 3.9, those with middle 9.7, matric 11.2, FA or FSc 13.5, and those with higher levels 13.8. On Math 5 the scores range from 7.6 for primary to 14.6 for the highest category, on Science 4 from 3.7 to 16.6, and on Science 5 from 10.8 to 17.7. With every test scores rise as the level of formal education increases. These findings confirm the comments of education officials about the importance of adequate education for student achievement.

Table 1. Average achievement of students by level of formal education of the teacher.

	Math 4	Math 5	Science 4	Science 5
Primary	3.85	7.55	3.67	10.82
Middle	9.72	9.36	11.55	12.15
Matric	11.19	12.51	13.39	16.56
FA or FSc	13.47	12.33	15.26	17.12
BA or Higher	13.84	14.55	16.19	17.74
Total	11.79	12.54	11.79	16.56

Similar, though less dramatic, findings emerge when student achievement is related to the professional qualifications of their teachers. Table 2 shows that across all 4 tests students of teachers with no professional qualifications score lower than those holding the Primary Teaching Certificate (PTC). On Math 4 and Math 5 scores rise from those with no qualifications through the PTC, the JV, SV, CV, or OT, and teachers with a B Ed. or higher. On Science 4 and Science 5 there is a clear difference

between the top and the bottom levels, but students of teachers with the PTC score higher than those with the JV,SV, CT, and OT. Taken together, these findings strongly support the importance of the teachers' formal education for student achievement and show the limitations of no qualifications as well as the benefits of a BEd. or higher for learning in mathematics and science.

Table 2. Average achievement of students by professional qualification of the teacher.

	Math 4	Math 5	Science 4	Science 5
None	10.21	9.82	13.02	14.68
PTC	11.84	12.69	14.09	16.72
JV-SV-CT-OT	12.11	13.03	12.98	16.13
BEd or Higher	15.33	17.04	18.98	21.28
Total	11.77	12.53	13.90	16.49

Advocates of improved teaching in Pakistan have also emphasized the need for supervised practice teaching and in-service training for teachers already hired. To judge from the results of the achievement tests, the case for extending current practices in either area is not convincing. The scores of students whose teachers had practice teaching are no different from those teachers who did not. Those who reported having had the experience of practice teaching were asked if it was supervised or not. For this group, which numbered between 123 and 135 teachers depending on the test used, the students of those who said they were supervised had lower test scores on Math 4 and Science 4 than in the case of teachers who were not supervised.

Teachers were asked if they had received any in-service training and, if so, how many courses they had completed. Neither

item was related to the achievement test scores.

When student achievement in mathematics and science is taken as a criterion of schooling effectiveness, the main conclusion about the preparation of teachers is the importance of formal education and, to a lesser extent, of professional credentials for teaching. This survey indicates that about 60% of Pakistan's teachers are educated to the matric level. The results on academic achievement show that students of teachers with primary and middle education have lower scores than those with matric, and those with teachers holding the FA or FScM and above have higher scores. Practice teaching and in-service training make no difference for achievement and supervised practice teaching is associated with lower student scores on two tests.

3. TEACHING EXPERIENCE AND ABSENCES

One possibility in explaining student achievement is that it is brought about by the experience gained by teachers in their work. By this logic the students of teachers with many years of teaching experience should do better than those who are new to the profession. The same idea could be applied to teachers' experiences in their present school. The longer they remain there, the more they know the students, their families, and local conditions, including language, bearing on achievement. The experience of the headmaster or headmistress in that school might have the same impact on learning.

The survey asked teachers how long they had been teaching and how long they had been in their present school. The responses

showed no relationship to any of the tests taken by their students in science and mathematics. The years of experience in the school by the headmaster or headmistress likewise did not predict achievement by their students. Teaching experience is thus of no consequence in explaining the results of the achievement tests used in this study.

Another possibility is that student learning is affected by the number of different classes (U. S. equivalent is grades) taught by teachers. For those who teach mathematics and science the range is from 1 to 5 classes with an average (mean) of about 2.5. The hypothesis in this case is that the larger the number of classes taught, the smaller the amount of time available for preparing and teaching any one class. Student learning in math and science may suffer because teachers have to deal with different age groups and several textbooks.

The results show that the larger the number of classes taught, the lower the achievement test scores on Math 4, Math 5, and Science 5. The findings are in the same direction for Science 4, but fall just short of statistical significance. Later analysis will explore whether this pattern holds up when controls are added for other conditions that may affect achievement, such as urban and rural locations.

The study further explored the possibility of a relationship between teacher absences and student achievement in math and science. One measure of teacher absences was whether they were at school on the day of the survey. Through questions to students it

was possible to identify the math and science teachers of the 10th who were absent that day. The survey results show that students of teachers who were present obtained somewhat higher scores than those of teachers who were absent, but the results were not statistically significant.

Teachers available to be interviewed were asked to indicate the number of days they had been absent during the present school year for reasons of health, collection of pay or dealing with other administrative matters, training programs, personal matters, such as a death in the family, lack of transportation, or other reasons. Relationships with achievement were sought between specific kinds of absences as well as the total number of days the teachers reported they were absent for any reason. The information on absences proved to be a poor predictor of academic achievement. There was no relationship between the total number of absences and the results of any achievement test. Among the 30 possible relationships between specific forms of absence and the two tests in mathematics and science, only one was significant, that between absences for pay or administrative matters and the results of Math 4. As absences increased, student scores declined. This single finding is overshadowed by the lack of association in 29 other cases as well as with the summary indicator of absences.

The main conclusion about teacher experience and absences is that test performance in both math and science is related to the number of different classes (grades) taught by teachers. Years of

experience in teaching and at the teacher's current school, absence from the school on the day of the survey, and, among those present, total days absent as well as days absent for specific reasons explain little or nothing of student performance on the tests used.

5. TEACHING PRACTICES AND RESOURCES

Of direct relevance to an analysis of the quality of primary education in Pakistan are the practices of teachers in their schools and the resources available to them for teaching. For this reason the BRIDGES-AEPAM survey included several questions to investigate what happens in classrooms. This section examines the contribution of the most prominent of those conditions to student achievement.

Instructional time

Current literature on schooling effectiveness suggests that the time spent in instruction has a strong influence in student achievement. The school survey asked about the amount of time teachers spent on the subjects in which achievement was tested and about how they handled groups for whom they were responsible but whom they were not able to teach at a given time.

On time of instruction, teachers were questioned about three areas of their instruction in math and science: how many periods a week were given to that subject, how many minutes a week were spent on the subject, and how many exercises in the textbook for math or science they had completed by the date of the interview.

The number of periods per week in math and science were not

significantly related to student achievement. The number of minutes per week in math were significantly related to achievement in math 5 and science 5. The number of minutes per week in science was not significantly related to any of the tests.

One of the best predictors of achievement in the entire study was the number of exercises covered in math. This teaching practice was significantly related to all four of the achievement tests. The number of exercises in science was positively related to science 4 and science 5 and of borderline significance with math 5. In both cases teachers with more exercises had students with higher scores on the achievement tests.

Another way of considering instructional time is to ask teachers of more than one class what they do with the class that they are not teaching. Teachers in Pakistan use two approaches in this situation: assigning tasks to the class that is not being taught, and using student monitors with that group. Although over three quarters of the teachers report assigning tasks, this practice is significantly related only to achievement in math 5. Students of those who assign tasks have lower scores than students of those who do not. The use of monitors is consistently associated with lower achievement among students, though none of the differences is significant. The number of hours per week that monitors handle classes is significantly related to math and science achievement in math and science 5, but not to tests in class 4. The larger the number of hours, the lower the average

scores in class 5.

The simplest interpretation of these two sets of findings is that student achievement rises when teachers spend time with students and give them exercises that they read. Assigning tasks and using monitors may be unavoidable in some schools, but they are negatively related with student achievement.

Lesson plans

Among the teachers covered by the survey 87% report making lesson plans. Perhaps because there are so few who do not prepare these plans, there is no significant relationship between this teaching practice and student achievement.

Homework.

Because 99% of the teachers reported that they assigned homework to their students, it was not possible to consider the relationship between this practice and achievement. However, the teachers were asked whether they had assigned their students homework on the day before the interview. The mean achievement of all classes is higher when the teacher gave homework on that day, but none of the differences is statistically significant.

Teachers were also asked how many days in a week they assigned homework in math and science. There is no relationship between achievement and the number of days of homework in math. However, there are significant relationships between days of homework in science and achievement on all four tests. The more days of homework the higher the achievement scores.

There is great variability in what teachers do with the

homework once they receive it. Some read it, some read it and grade it, some grade it but also discuss it with the students. Interviewers asked teachers how often they discussed homework with students and examined the relationship of their responses to student achievement. The teachers who discuss the homework often have classes with higher achievement scores than teachers who discuss assignments less frequently with their students. However, this relationship is significant only for achievement in science 4.

Testing.

Tests are an opportunity for children to show how much they have learned, and to receive feedback from their teachers about their performance. Teachers were asked whether they had given students a written test during the month before the interview. Students whose teachers had tested them had higher achievement scores than students who were not tested, but the results were not statistically significant.

What happened after the students took the test? Most teachers (93%) said that they discuss the test results with students. Probably because there were few cases where the test was not discussed, this condition was not related to achievement. The length of time spent on the discussion of test results was related to achievement only for math 5. The longer the discussion, the higher the test scores.

Teaching Kit

In most schools in Pakistan, the resources that teachers

have to aid their teaching are very limited. The teaching kit was an attempt to provide the teacher with some materials that could enrich the learning resources of teachers and students. Another report in this series describes the history of the teaching kit in detail and analyzes some of the obstacles faced in its implementation.⁵

Students of teachers who have a teaching kit attain higher scores on all four achievement tests. However, these differences are significant only for math 5 and of borderline significance for math 4.

Interviews carried out before this survey showed that teachers sometimes had teaching kits that were not kept in the school. In the school survey 20% of the teachers reported this situation with the kits given to their schools. The results showed that students do better when the teaching kit is in the school than when it is not. However, these relationships are statistically significant only in Math 4 and borderline in Science 5.

In its original design, the teaching kit was supposed to contain self-training manuals to help the teacher use the materials contained in the kit. When BRIDGES and AEPAM staff visited schools, however, they found that many of these manuals were missing from the kits. According to the survey, 34% of the teachers reported that the training manuals were not in the kit. As shown in Table 3, students have higher test scores when the training manuals are in the teaching kit. The differences are

statistically significant for math 4 and 5 and for science 5.

Table 3. Average achievement of students when their teachers have teaching kits with and without training manuals.

	Math 4	Math 5	Science 4	Science 5
T.K. with manuals	13.17	14.19	14.41	17.67
T.K. no manuals	11.38	11.66	13.95	15.71

Interviewers also asked teachers if the teaching kits were complete, as they had been delivered by the Education Department, or if some parts were missing. Only 21% of the teachers replied that the kit had all its parts. The analysis showed that students do better when the kits have all their parts than when some of the parts are broken or missing. These differences are significant for achievement in science 4 and borderline significant in math 4.

When asked if the government repaired the teaching kits that were broken or had some parts missing, 80% of the teachers replied that it did not. Students have higher achievement scores when the government repairs the broken kits than when it does not, but this difference is significant only for science 4.

Teachers were asked if they had ever used the teaching kit, to which a little over half of the teachers replied yes. Although students had higher achievement test scores when the teachers used the teaching kits, the results are not statistically significant.

Another question asked in how many lessons the teacher had used the kit. The number of lessons is significantly related to achievement in Science 4. The more the lessons, the higher the

scores.

Other questions asked if the teacher had any problems with the kit and if he or she had been trained to use it. Neither condition was significantly related to the achievement test scores.

In short, the presence, completeness, and actual use of the teaching kit show some positive relationships with achievement test scores in science and math. All of the relationships suggest that the teaching kit benefits student achievement. However, the total pattern of findings suggests that these conditions are of only moderate importance for achievement. The best single predictor is whether the kits contain the original manuals for self-training.

Textbooks

The survey had questions about how many of the students had textbooks that they could use at the beginning of the school year in each of the subjects. In schools where few of the students had math and science textbooks, average achievement in those subjects is lower than in schools where more students had textbooks. These differences are significant only for the relationship between achievement in Math 5 and the presence of Math textbooks.

Language of Instruction

A number of questions inquired about the language used by the teacher and students in the school.⁶ This discussion will consider only the use of translation in the classroom.

Interviewers asked teachers if they had students translate for

one another while they were explaining material in the classroom. The results show that when teachers ask students to translate for other students, their classes have higher scores on all four achievement tests. The differences are statistically significant for all tests except science 5 (see Table 4).

Table 4. Average achievement of students for teachers who ask and do not ask other students to translate.

	Math 4	Math 5	Science 4	Science 5
Students translate	12.41	13.24	14.38	16.54
Don't translate	10.85	11.49	13.27	16.52

Punishment

Visits to schools by BRIDGES and AEPAM staff showed that many teachers used physical punishment with their students. It was not unusual to see teachers carrying a stick and using it or their bare hands to hit children. The survey showed that 52% of the teachers used physical punishment. When these reports were related to achievement in math and science, there were no significant relationships.

5. SUPERVISION

Among those who supervise and sometimes help primary school teachers are the District Education Officer (DEO), Sub-District Education Officer (SDEO), Assistant Education Officer (AEO), Learning Coordinator (LC) or supervisor, and Headmaster of a center school. The last individual was found only in areas participating in an experimental program in which a primary school was linked to a center school that was given

responsibility for its improvement. In the present sample there were 139 center schools, 125 or 90% of which were in Punjab. All of these officials are under the provincial departments of education. Except in the federal district and other special cases, such as military schools, federal officials are not directly involved in supervising primary school teachers.

It has often been argued in Pakistan that one way of improving the quality of teaching is to have supervisors who do more than check attendance and handle records and other administrative matters at the school. The Learning Coordinator, introduced in 1979 by the World Bank and the Government of Pakistan, was an innovation directed specifically at using supervision to promote better teaching. In interviews with BRIDGES and AEPAM staff before the survey of schools, many federal and provincial officials pointed out that the standard system of supervision led to few and sometimes no visits by those responsible and had a negligible effect on the quality of teaching.

To explore the impact of supervision on student learning the survey asked teachers the same set of questions about the DEO, SDEO, AEO, LC, and other supervisors. The questions were:

- number of visits this year?
- did the supervisor observe teaching?
- when was the most recent visit (coded in days)?
- how long did the person observe (coded in minutes)?
- did the supervisor make comments about the respondent's teaching?

In schools with Learning Coordinators or supervisors, interviewers questioned teachers about the effects those

individuals had on their teaching, how they had helped, and what problems they had created. The information provided by teachers about supervisors was then related to the test scores of their students in math and science.

There were some significant findings in these data, but overall the behavior of supervisors was not a strong predictor of achievement test scores. Out of 116 possible relationships only 12 were statistically significant. With the DEO there was one significant association among 20 possibilities: between the time since the last visit to the school and scores on Science 5. The longer the time, the lower the test scores. Findings for the SDEO showed associations for three of the five possibilities on Math 4 and two of five on Science 4. Student scores on Math 5 increased when the SDEO observed and made comments on teaching and rose with the time spent observing teachers. On Science 4 scores also increased with the time the SDEO spent observing teachers and when comments were made on teaching. No significant associations were seen with the AEO. Though the findings were not statistically significant, test scores on Science 4 increased when the SDEO observed teaching and with the recency of his or her most recent visit. Scores on Science 5 increased with the length of time the SDEO spent observing teaching, but the findings were again not statistically significant.

With the LC or supervisor there were significant findings in just two of 36 cases. Scores on Math 4 rose when these officials made comments on teaching. Scores on Science 5 were higher when

teachers reported that they had learned new methods of teaching from visits by the LC or supervisor. The headmasters of the center schools, most of whom were in Punjab, showed significant results in 4 of 20 possibilities and had two others of borderline significance. Scores in Science 5 increased with the number of visits by the headmaster when he observed teaching. Test results were also related to the recency of the headmaster's last visit, with more recent visits associated with better performance. Scores on Math 5 likewise increased with the frequency of visits. Though not statistically significant, the same finding was seen with Science 4. Scores on Math 4 were higher when the headmaster was reported to have observed teaching, but that relationship was not statistically significant.

Overall, the supervisors whose behaviors were most closely associated with test scores were the SDEO and the headmasters of the center school, most of whom were in Punjab. It is surprising that the results for the group including LCs were not stronger. To judge from these findings, LCs have some influence on performance in math and science, but less than SDEOs and headmasters of center schools.

6. CONCLUSIONS

One question remaining is how well one can predict student achievement in math and science by combining different types of teacher characteristics. The statistical technique commonly used for calculating such joint relationships is multiple regression

analysis. The use of this method proceeded as follows.

First, a decision was made about which of the many teacher characteristics would enter this analysis. The choice was made on the basis of two criteria: the characteristic in question had shown significant relationships with two or more the achievement tests in the material just reported; and among those items would be chosen to represent the personal background and living condition of teachers; teacher education; teacher experience, specifically the number of different classes taught by teachers; and teaching practices and resources. Because the items on supervision were weak predictors of achievement, none were included in the present analysis.

The items used as predictors were the following: the sex of the teacher; the time it took the teacher to reach school; the teacher's formal education; whether the teacher taught more than one class; the number of exercises assigned in mathematics; whether the teacher asked students to translate for others in the class; and whether the teacher had a teaching kit. These variables in turn were relatively independent of each other, as shown by the low correlation coefficients of all independent variables with each other which were never higher than 0.20 (Pearson correlation coefficient).

Second, these 7 characteristics were used as the basis for regression analysis against each of the four achievement tests. These calculations were made several different ways, all of which led to about the same results. The findings reported in Table 5

come from a procedure in which each of the characteristics was entered into the analysis in the order in which they are listed above. Thus the sex of teachers was entered first and the availability of a teaching kit last. The figures on significance levels indicate whether a given characteristic was related to achievement test scores at a level above that expected by chance. Figures of .05 or less (.01 or .00) mean that the characteristic had a significant association with the test scores in a particular regression analysis.

The results show that three characteristics of teachers are significant predictors of achievement on all 4 tests. These are the teacher's formal education, whether the teacher teaches more than one class, and the number of exercises assigned in mathematics. The sex of the teacher is a relatively strong predictor of student achievement in math but not in science. Students of female teachers have lower scores than those of male teachers. The time required to reach school is significantly related only to scores in Science 5. Asking students to translate for others is significantly related to achievement just in Math 5.

A useful summary indicator of the predictive power of these characteristics is R^2 , the square of the multiple correlation coefficient. This is interpreted as the percentage of the variation on the test scores that is predicted by the set of teacher characteristics used in the analysis. The characteristics predict most strongly in the case of Math 5, where the multiple

correlation is .24. This means that by knowing these seven teacher characteristics, one can predict about a quarter of the differences found on the test score. The comparable figures for Math 4, Science 4, and Science 5 are 17%, 14%, and 14%.

The main conclusion from this analysis is that student achievement on objective tests of achievement in math and science are related to how well educated teachers are, what they do in the classroom, and, in the case of the two mathematics tests, the gender of the teachers. Achievement in math will rise when teachers are men, with the amount of formal education the teachers have had, when teachers teach only 1 class, and with the number of exercises assigned in mathematics. With Math 5 achievement also rises when teachers ask their students to translate for others. With Science 4 and 5 the best predictors are teacher education, teaching only 1 class, and the number of exercises in math. In Science 5 achievement also rises when teachers do not have to spend a long time travelling to school.

Table 5. Summary of impact of various teaching variables on student achievement using a multiple regression where all variables are entered.

Variable	Math 4		Math 5		Science 4		Science 5	
	Slope	signf	Slope	signf	Slope	signf	Slope	signf
Sex	2.37	0.00	3.19	0.00	-0.39	0.52	0.54	0.43
Time to reach sch.	-0.02	0.13	-0.01	0.26	-0.01	0.22	-0.04	0.00
Teacher Education	1.30	0.01	1.11	0.01	1.78	0.00	1.26	0.00
Teach more 1 class	-1.83	0.01	-2.68	0.00	-2.45	0.00	-0.26	0.00
Exercise # Math	0.15	0.00	0.08	0.01	0.04	0.01	0.04	0.01
Ask students trans.	1.00	0.15	1.29	0.03	1.20	0.06	0.71	0.32
Have teaching kit?	0.26	0.70	1.05	0.08	0.23	0.71	0.46	0.50
R	0.41		0.49		0.38		0.38	
r ²	0.17		0.24		0.14		0.14	
significance of F	0.0000		0.0000		0.0000		.0000	

1. The research reported in this paper was carried out as part of the BRIDGES Project, a Cooperative Agreement between the Harvard Institute for International Development and the Office of Education, Bureau of Science and Technology, United States Agency for International Development. Comments made in this paper are the responsibility of the authors and not of USAID.

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2. The title of this paper is "Do Differences Between Schools and Between School Administrators in Pakistan Contribute to Differences in Student Achievement?"

3. The criterion of statistical significance used in this paper is that the probability of differences between or among groups occurring by chance is less than 5 in 100. In the tables the figures for significance levels refer to this probability. A level of .05 means that there are 5 chances in 100 that the finding could be a random occurrence, .01 means 1 chance in 100, and .0000 less than 1 chance in 1000.

4. Descriptive information for all items about teachers discussed in this paper can be found in a companion essay entitled "A Profile of Primary School Teachers in Pakistan."

5. This paper is called "The Implementation of Educational Innovations in Primary Education in Pakistan."

6. A thorough discussion of language usage in the school can be found in another report in this series: "The impact of language of instruction on student achievement in Pakistan."