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Education and Employment

Population and Human Resources
Department
The World Bank
August 1988
WPS 71

School Effects on Student Achievement in Nigeria and Swaziland

Marlaine E. Lockheed
and
Andre Komenan

Student achievement is directly related to effective teaching practices, which differ from country to country. Conventional school and teacher quality variables are found less effective in boosting learning than teaching quality variables.

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Multi-level analyses showed that differences between schools accounted for substantial variance in eighth grade mathematics scores in Nigeria and Swaziland. However, conventional school and teacher quality variables, such as class size, length of school year, and teacher education and experience had no effect on student achievement.

The study — the first completely comparable cross-national comparison of school/classroom effects in Africa — shows that differences in achievement not attributable to student family background are largely due to differences in teaching quality (teacher's use of time for lecturing, testing, etc.).

This finding is important because little research has been conducted in developing countries to test the assumption that enhancing student achievement depends on the ability of teachers to manage the learning environment. The study indicates that the size, direction, and shape of the relationship between teaching time use and student achievement vary from one country to another.

In Nigeria, student time spent listening to the teacher lecture was positively associated with achievement, while time spent doing seat or blackboard work had a negative impact. In Swaziland, by comparison, seat and blackboard work had positive effects, but listening to lectures was unrelated to achievement.

Teaching time spent monitoring and evaluating student performance had good results in Swaziland, but no effects in Nigeria. In Swaziland, the use of published materials was negatively related to achievement, while in Nigeria the use of textbooks had a positive effect.

Teacher effectiveness depends on finding the appropriate mix of alternative uses of instructional time. Since this seems to differ according to the locale, more local research on teaching quality is needed.

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Table of Contents

INTRODUCTION

Near-universal enrollment in primary education has been attained by the vast majority of developing countries permitting policymakers to concentrate more intensively on improving education quality and efficiency. Of central concern to development specialists are measures to improve school and teacher effectiveness. This paper examines school and teacher effects on student mathematics achievement in two developing countries in Africa.

School effectiveness

The past decade has provided several important reviews of research on school-related factors affecting student achievement in developing countries (Avalos & Haddad, 1978; Fuller, 1986; Heyneman & Loxley, 1983; Husen, Saha & Noonan, 1978; Schiefelbein & Simmons, 1981; and Simmons & Alexander, 1978). Most reviews conclude that, controlling for student background, school characteristics have significant effects on achievement, and that in many cases the effects of school characteristics are <u>greater</u> than the effects of family background. For example, Heyneman and Loxley (1983) found that variance in student achievement explained by three family background variables averaged 8.6% across 17 developing countries, while variance explained by school characteristics amounted to nearly twice that (16%). Yet, overall, the amount of variance in student achievement explained by family background and school input variables in developing countries remains remarkably low in comparison with the results of similar studies conducted in developed countries. It has been argued strongly (Heyneman, 1986) that the failure of conventional models to explain variance in achievement is a consequence of poorly conducted research. An equally strong case can be made regarding the adequacy of the models and indicators employed.

Early models of educational achievement in developing countries reflected the educational production function perspective from which they were derived. As a result, school characteristics most frequently examined were indicators of material inputs: per-pupil expenditure, number of books, presence of library, teacher salaries and so forth.

More recently, research has changed in three important ways. First, complex organizational models of student achievement (e.g. Darling-Hammond, 1987, Rosenholtz, 1986) have begun to replace educational production function models. Second, research moved away from answering questions of whether and how much material material inputs affect student achievement to exploring other questions, including : (a) what are the relative effects on achievement of alternative inputs (see, for example, Armitage et al., 1986; Lockheed, Vail and Fuller, 1987), (b) what are the effects of nonmaterial inputs, such as teacher education and experience, organizational characteristics, or administrator training, and (c) what are the mechanisms (instructional processes, administrative practices) whereby material and non-material inputs affect student achievement? Third, research has begun to center on the classroom and classroom processes as important determinants of learning, with specific focusing on the role of teachers and administrators as managers of student learning. The underlying premise is that enhancing student achievement--that is, improving education effectiveness--depends crucially on administrative and teaching quality. (Much "effective schools" and "teacher effectiveness" research in developed countries has addressed these questions but little of this research has been undertaken in developing countries.)[1/] Teaching quality is particularly important in developing countries, since expenditures for teachers account for upwards of 70% of national education budgets; in sub-Saharan Africa, teacher emoluments account for approximately 90% of primary and 70% of secondary school recurrent expenditures. Therefore, understanding how teachers contribute to student achievement is key to improving both educational effectiveness and efficiency.

Teacher salary differences within countries typically reflect two teacher "quality" characteristics: (a) formal education and (b) experience. For example, by law, salary scales for primary teachers in Rwanda reward both education and experience. Salaries of "instituteurs" (highest certification level) are more than twice those of "Instituteur-Auxiliaires" (lowest certification level) and salaries of teachers at the highest step in the salary scale are two to three times those of teachers at the lowest step. The same pattern can be observed for secondary teachers (Presidential Act, 1985). Similarly, in Cote d'Ivoire, Komenan and Grootaert (1987) show that each additional year of education is associated with a 17% salary increase, while each aditional year of experience is worth a 7% salary increase. The result is that the most experienced and highly certified teachers are paid several times the salaries of the least experienced and least certified teachers. The question is, does teacher quality (as indicated by education and experience) imply teaching quality (as indicated by behaviors that enhance student achievement)?

Teacher quality

Teacher effectiveness research has examined the effects of both teacher background and quality (age, sex, education, experience) and teaching behavior (teaching quality) on student achievement, but has emphasized the former in developing countries.

Teacher education and student achievement. In developing countries a consistent positive relationship between the number of years of formal education received by teachers and the achievement of their students has been demonstrated (Avalos & Haddad, 1979; Husen, Saha & Noonan, 1980; Fuller, 1986). For example, of 60 studies examining the effects of teacher education and student achievement, 60% found positive relationships. Regional variations in effects were noted, however, and for eleven studies conducted in Africa the effects were less positive.

Formal educational attainment of teachers was positively related to student achievement in four studies (science in Uganda, Heyneman & Loxley, 1983; reading and mathematics in Botswana, Loxley, 1984; national exam in Ghana, Bibby & Peil, 1974; language and math in the Congo, Youdi, 1971). But negative results were found in seven others (national exam in Kenya, Thias & Carnoy, 1973; academic and vocational tests in Tanzania, Psacharopoulos & Loxley, 1986; comprehensive exam in Uganda, Silvey, 1972, and Somerset, 1968; comprehensive examination in Sierra Leone, Windham, 1970; national exam in Uganda, Heyneman, 1976). Unfortunately, these studies shed little light on why teacher formal education appears less effective (37%) in Africa than in other developing country regions.

Teacher experience and student achievement. Teaching experience is also related to student achievement in developing countries, but the effects are less positive than for teacher formal education. Of 23 studies examining teacher experience effects on student achievement in developing countries, only 43% reported a positive effect. In Africa, the results are mixed, with two multivariate studies reporting positive effects (Kenya, Thias & Carnoy; Botswana, Loxley) and two reporting no effects (Uganda, Heyneman; Congo, Youdi).

Teaching quality

Research in developing countries has emphasized the effects of teacher quality on achievement, paying little attention to teaching quality. Yet identifying the mechanisms whereby teacher education and experience affect student achievement could yield particularly positive consequences for developing countries, by identifying effective practices that could be taught during pre-service or inservice training.

Use of material inputs. One way in which teacher education and experience could affect student achievement is through more effective use of material inputs, such as textbooks. However, one study (Lockheed, Vail and Fuller, 1986) demonstrated that, in Thailand, teacher education did not enhance textbook use, but rather that textbooks could substitute for additional years of teacher education, when educational levels were already comparatively high. Teacher education and experience could also contribute to the use of personally developed materials, which in turn could enhance student achievement; we are unaware of any research in which this relationship has been explored.

Opportunity to learn.[2] Another way that teacher education and experience could affect student achievement is by ensuring that more of the intended curriculum is actually taught during the course of the year.

Teaching processes. A third way that teacher education and experience could affect student achievement is through time: either enabling teachers to utilize more teaching time or to utilize teaching time more effectively. There is strong evidence from both developed and developing countries that instructional time is an important determining factor relative to student achievement; the more time that is available for learning, the more learning that occurs (Avalos and Haddad, 1978; Denham & Lieberman, 1980; Fuller, 1987) .

Teaching time can also be utilized in more or less effective ways. Three teaching processes widely agreed to promote student achievement are: (a) instructional tasks, (b) administrative tasks, and (c) monitoring and evaluation tasks. There is strong evidence from developed countries that each contributes positively to student achievement.

Instructional tasks appear to be most significant. For example, in their comprehensive review of teaching processes and student achievement in North America, Brophy and Good (1986) note that "the most consistently replicated findings link achievement to the quantity and pacing of instruction" (Brophy and Good, 1986, p. 360). Management, however, also finds support in research. Doyle (1986) notes that "the teacher's management task is primarily one of establishing and maintaining work systems for classroom groups, rather than spotting and punishing misbehavior, remediating behavioral disorders, or maximizing the engagement of individual students." (p 423). A third classroom process variable found strongly related to student achievement is teacher evaluation and feedback regarding student performance (Brookover, Beady, Flood, Schweitzer & Wisenbaker, 1979; Walberg, 1984; Bridge, Judd & Moock, 1979).

While evidence from industrialized countries points to the importance of each of these in improving student performance on tests of achievement, little research on achievement effects of teaching processes has been conducted in developing countries. A necessary step, therefore, is the conduct of such research. This will not only enable us to determine the degree to which processes identified as effective in developed countries are equally effective in one or more developing countries, but also to determine which teaching processes are effective in impoverished contexts. As Brophy and Good note, "what constitutes effective instruction varies with context." (Brophy and Good, 1986, p 370), and few educational contexts differ more widely than those of the richest and poorest countries.

A word of caution, however, is in order with respect to the implications of this research for policy. As Purkey and Smith note with respect to school effectiveness research, although it is possible to identify variables that seem responsible for higher levels of student achievement, it is "difficult to plant them in schools from without or to command them into existence by administrative fiat" (Purkey & Smith, 1983, p. 445). The same could be said of many conclusions drawn from the teacher effectiveness research.

This paper contributes to the literature on school/classroom effects on student achievement in three ways. First, it extends the evidence on the effects of teacher quality and teaching quality on achievement in developing countries by analyzing data from the Second International Mathematics Study (SIMS) conducted by the International Association for the Evaluation of Educational Achievement (IEA) in

Nigeria and Swaziland during the 1981-82 academic year. Second, it provides the first completely comparable cross-national comparison of school/classroom effects in Africa (Studies conducted in Uganda and Botswana and reported in Heyneman and Loxley (1983) did not employ equivalent instruments). Third, by utilizing a "fixed-effects" model with separate parameter estimates for schools/classrooms, it more accurately estimates the effects associated with enrollment in particular schools/classrooms. Finally, it identifies school and classroom factors, principally teacher quality and teaching quality, that contribute to student achievement.

MODEL

The general model for estimating school effects is multiple regression, with student achievement regressed on student background and school variables. Within this general framework, a number of different modelling procedures have been used, five principal ones of which are summarized by Aitkin and Longford (1986). These modelling procedures are used to (a) partition the variance in achievement into between and within-school components, (b) order schools and/or classrooms by level of effectiveness, and (c) identify school and individual student characteristics that account for observed differences.

This paper uses both random and fixed effects (ordinary least squares) methods to partition variance and order schools, and fixed effects methods to identify between-school characteristics that account for their comparatively greater effectiveness.[3/]

Partitioning variance

A central problem with ordinary least squares (OLS) estimates of school and classroom effectiveness[4/] is that within-class homogeneity leads to biased estimates of between-class effects (Aiken & Longford, 1986; Goldstein, 1987; Raudenbush & Bryk, 1986). Every classroom has its own idiosyncratic features that result from a complex of influences, including composition, teaching practices and management decisions. As a consequence, observations on students (e.g. achievement) are not statistically independent, not even after taking account of available explanatory variables. This invalidates the regression estimates obtained by OLS, particular in unbalanced designs. The main problem is not so much with the estimates themselves as with their standard errors.

Variance component models are an extension of ordinary regression models; the extension refers to more flexible modelling of the variation. Pupils are associated with (unexplained) variation, but hierarchy (pupils j within classrooms i):

(1) $y_{ij} = a + bX_{ij} + cZ_{ij} + \epsilon_{ij}$

where a, b, c are (unknown) regression parameters, x and z are explanatory variables, y the outcome measure and the random term ϵ is assumed to be a random sample from $N(0,\sigma^2)$. Variation among the classrooms can be accommodated in the "simple" variance component model

(2) $y_{ij} = a + bX_{ij} + cZ_{ij} + \alpha_i + \epsilon_{ij}$

where α is a random sample (i.i.d.) from $N(0,\tau^2)$ and the α's and the ϵ's are mutually independent. The covariance of two pupils' scores within a classroom is τ^2 (intraclass correlation $= \tau^2/[\tau^2 + \sigma^2]$). If we knew the α's we could use them to rank the classrooms. The model (2) has the form of ANOVA, with distributional assumptions imposed on the α's.

In addition, some schools may be more "suitable" for pupils with certain background than others. This corresponds to variation in the within-school regressions of y on x and z, and this situation can be suitably modelled as

$$(3)\quad Y_{ij} = a + bX_{ij} + cZ_{ij} + \alpha_i + \beta_i X_{ij} + \gamma_i Z_{ij} + \epsilon_{ij}$$

The classroom-level random effects (α_i, β_i) are assumed to be a random sample from $N_2(0, \Sigma_2)$; here Σ_2 involves only 3 parameters: the variances of α and β and their covariance. Computationally efficient maximum likelihood estimation procedures for these models are now available.

In this paper we use HLM, a recently-developed empirical Bayes maximum likelihood estimation program (Raudenbush, Bryk, Seltzer & Congden, 1986) to estimate both between and within-class variance.

Ordering schools

Aiken & Longford (1986) have demonstrated that OLS and random effects models (such as HLM) provide similar results in terms of ordering schools according to effectiveness. For this analysis, therefore, we use OLS with "school" as a dummy variable. We do this first with no pupil level controls, and second with controls for pupil background. The first model is:

$$(4)\quad S_{ij} = a + dD_{ij} + e_{ij}$$

where $i = 1, \ldots, k$ schools,

$j = 1, \ldots, n$ students.

S represents individual student scores

D are dummy variables taking the value '1' if the student is enrolled in school j and '0' otherwise,

e is an error term, and

d is an estimated regression coefficient.

Since background characteristics of students can effect "school-level" performance, as a second step we introduce a set of student characteristics into the previous equation:

(5) $S_{ij} = a + bD_{ij} + cB_{ij} + dP_{ij} + e_{ij}$

where:

$i = 1,\ldots,k$ schools,

$j = 1,\ldots,n$ students,

S represents individual student scores,

D is as defined above,

B is a vector of student's background characteristics and other exogenous variables,

P is a vector of student's attitudes and motivations,

e is an error term,

and a, b, c and d are estimated regression coefficients.

Based on these two estimates, we divide the schools into three groups: schools with student performance one-third of a standard deviation or more below average (the "low" schools), schools with student performance one-third of a standard deviation or more above average (the "high" schools) and average schools.

Isolating school and classroom correlates of achievement

The next step in our analysis involved comparing above average, average and below average schools on a variety of indicators, using a simple analysis of variance design.

Finally, we use OLS to estimate (with nominal levels of significance) student achievement as a function of home-background, school, classroom and teacher characteristics. This final model is adapted from conventional educational production function models to include indicators of teaching quality as well as teacher quality. Theoretically, the production function is a frontier of potential attainment for predetermined input combinations. Therefore, its estimate requires that the school be an efficient producer of educational outputs. However, as Levin (1976) notes, the conditions for assuming that schools are managed efficiently are rarely--if ever--satisfied and hence policy prescriptions based on these "profit mazimixing" assumptions are misleading. In addition, conventional educational production functions rarely specify input variables that are widely believed to affect student achievement, such as classroom processes; these are included in our estimating equation:

(6) $S_{ij} = a + bB_{ij} + cP_{ij} + dSC_{ij} + fCC_{ij} + gTC_{ij} + hMI_{ij} + kCP_{ij} + e_{ij}$

where:

$i = 1,\ldots,k$ schools,

$j = 1,\ldots,n$ students,

S, B and P are as defined above,

SC is a vector of school characteristics (school enrollment, length of school year, school type)

CC is a vector of classroom characteristics (class size, peer characteristics)

TC is a vector of teacher's characteristics (education, experience, sex), MI is a vector of use of material inputs (purchased materials and personally created materials),

CP is a vector of classroom process variables (instructional, administrative and monitoring tasks),

e is an error term,

and a, b, c, d, f, g, h, and k are estimated regression coefficients.

Summary

In summary, in this paper we first partition the variance in student achievement into between and within-class components, using HLM. Next, we employ a fixed effects model that includes a specific intercept parameter for each school/classroom to rank order the schools in terms of performance. Third, we compare above average, average and below average schools on a variety of measures. Finally, we use OLS to regress student achievement on various combinations of student background, school, classroom, teacher and teacher practice variables in an attempt to identify the variables that account for the between school differences.

DATA

Sample

The research reported in this paper was conducted in the school year of 1980-81 in 29 countries, including two Sub-Saharan African nations: Nigeria and Swaziland.

Nigeria. Nigeria, a federation of 19 states, is one of the largest countries in Africa, with an area of 923,800 square kilometers and an estimated population of over 90 million. The education system is commensurately large, with approximately 15 million primary students and 3.5 million secondary students enrolled in 1983. It is estimated that, in 1982, 97% of the primary age group and 28% of the secondary age group were enrolled in school. Discrepancies between male and female secondary school enrollment rates are apparent, however, with only 14% of the 12-17 year old female age group enrolled, compared to 42% of same age males. Female students represented 43% of primary and 26% of secondary students (Unesco, 1986).

Until 1976, the formal education system consisted of nursery and preschool institutions, primary schools, secondary educational institutions of different kinds and duration, and a variety of different higher education institutions. Primary education was of six to seven years of duration, with entry age being 5 or 6. Basic secondary education lasted five years. The National Policy on Education adopted in 1976 introduced a uniform six-year primary education, followed by a three-year lower secondary and three-year upper secondary program. As these data were collected in 1980-81, students in Form 3 (grade 9) would have attended school under both old and new plans.

The IEA SIMS sample comprised 41 mathematics teachers in state-owned Secondary Grammar Schools which prepare students for the West African School Certificate Examination and their 1073 Form 3 students and was derived from a three-stage, stratified random sample. The primary sampling units were the ten southern states in Nigeria (The target population was originally intended to include students from all states; logistical and financial constraints caused this to be reduced to the 10 southern states, which include 90% of the country's school enrolments; of these, acceptable data were received from eight states). Within each state, a random sample of schools was selected, with probability proportional to the number of schools in the state. At the second stage, a random sample of one class per school was selected, and at the final stage, 30 students were randomly selected in each class.

Swaziland. The Kingdom of Swaziland is a landlocked country lying between the Republic of South Africa and Mozambique. With an area of 17,368 square kilometers and a population of about 520,000, it is among the smallest countries in Africa.

Since 1973, Swaziland's educational system has expanded rapidly, so that as of 1983 about 130,000 students, or 111% of the primary school age population, were in school (World Bank, 1987). Enrollment in secondary education, at 29,000, was equivalent to 43% of the relevant aged population in 1983. Participation of male and female students was approximately equal.

The formal education system in Swaziland consists of seven years of primary education, three years of lower secondary education, two years of upper secondary education and two to five years of higher education.

The IEA SIMS sample comprised 25 mathematics teachers in secondary schools and their 856 Form 2 students. The population in Swaziland included all students in Form 2, the grade level in which 13 year-old students would be found in they had entered school at age 5 and proceeded through without repetition; in fact, students in Form 2 ranged in age from under 12 to over 20. Form 2 is also the grade level for which the IEA mathematics test was judged most appropriate for the curriculum. The intended sampling plan called for random selection of 25 secondary schools from the 82 secondary schools then operating in Swaziland; in fact, volunteer participation was obtained from 27 schools, two of which were excluded. One class from each school was selected at random to be tested.

Method

Students were administered a mathematics test and a background questionnaire. Teachers completed several instruments, including a background questionnaire, general classroom process questionnaire, information about their teaching practices and characteristics of their randomly selected "target" class. Data about the school was provided by a school administrator.

Measures

The following sections describe the variables analyzed in this paper. Differences between variables as they are defined in Nigeria and Swaziland are noted in the text, and separate summary statistics are provided for each country in Table 1.

Mathematics achievement. The mathematics test used as the dependent variable in this study was the forty-item SIMS "core" test, which contained items covering five curriculum content areas (arithmetic, algebra, geometry, statistics and measurement). The test was developed to reflect the national mathematics curriculum, and part of the IEA survey assesses that match. McLean, Wolfe and Wahlstrom (1986, p.16) note that "How well the SIMS item pool matched a system's intended curriculum was measured by calculating the percentage of items in each topic subset that educators said were either highly appropriate or acceptable to that system." For Swaziland, the intended Form 3 curriculum included 80% of arithmetic items, 70% of algebra items, 60% of geometry items, 80% of statistics items and 80% of measurement items (McLean, Wolfe & Wahlstrom, 1986). No data are reported from Nigeria. Approximately 34% of the items tested computation skills, 32% tested comprehension skills, 28% were application items and 6% were analysis items (Garden, 1981). Because the core test contained relatively few items of each type, we were not able to analyze the results in greater detail. The score is total number of correct answers, with no adjustment for guessing. The mean score reported in this paper for students in Nigeria was 14.4 and for students in Swaziland was 12.9.

Student background Student background variables analyzed in this paper include both conventional indicators (sex, age, paternal occupation, and rural residence; for Nigeria, indicators for each state were also included) and indicators of student educational aspirations, motivation and parental support. Educational aspirations was indicated by the number of years more education the student expects to receive. In constructing indices of motiation and parental support, we first conducted exploratory principal component and varimax rotation factor analyses of a 9-item student survey of perceived parental attitudes and a 46-item student attitude survey. In both countries, two factors emerged from the perceived parental attitudes survey and five interpretable factors emerged from the student attitude survey. We then conducted confirmatory factor analyses and computed factor scores for each of the seven factors. This paper reports results from a subset of these nine factors.

In Nigeria, the two factors analyzed were perceived ability and perceived parental support. Perceived parental support (YPARSUP) was constructed from four items (e.g. "My parents are interested in helping me with mathematics") having factor loadings ranging from .64 to .79. Perceived ability (YPERCEV) was constructed from four items (e.g. "I could never be a good mathematician") having factor loadings ranging from .68 to .77.

In Swaziland, the two factors factors were perceived ability and student motivation. Perceived ability was constructed from four items, three of which were the same as in Nigeria, having factor having factor loadings ranging from .68 to .73.

School characteristics. Data on three school characteristics are analyzed in this paper: (a) school size, as indicated by the total number of students enrolled in the school, (b) length of the school year in days, and (c) single-sex or coeducational school type.

Classroom and peer characteristics. Two characteristics of the classroom are analyzed: (a) class size, and (b) percentage of students in class with father in professional occupation.

Teacher background. Two teacher background characteristics are analyzed: (a) teaching experience and (b) number of semesters of post-secondary mathematics education. We had no direct measure of inservice teacher training, and the indicator for preservice teacher education (number of semesters of mathematics methods and pedagogy included in teacher's post-secondary education) had unacceptable rates of missing data.

Teaching processes. Teaching processes analyzed here involve teacher use of time for administration, instruction and evaluation, and student time spent listening to whole class lectures and doing seat or blackboard work. These are self reports of time use, and no observation data are available for corroboration. Administrative time is defined as the number of minutes per week used for routine administration and for maintaining order in the classroom. Instructional time is defined as the number of weekly minutes for explaining new material and reviewing old material. Evaluation time is defined as the number of weekly minutes used for testing and grading student work. To test for non-linearity effects of time, we also employed quadratic terms for each of these.

Use of material inputs. Two indicators of use of material inputs are included in this paper: (a) and index of teacher use of commercially produced textbooks and workbooks, and (b) an index of teacher use of personally produced teaching materials.

Opportunity to learn. Opportunity to learn was defined as the number of items on the core mathematics test that the teacher claimed to have taught or reviewed during the year.

RESULTS

This section is devided into three sections: (a) partitioning the variance in achievement into between- and within-school components, (b) ordering schools by performance, and (c) identifying school and student characteristics that account for the observed difference. We first estimate between- and within-school variance components using HLM. Next, we employ OLS (using a specific intercept parameter for each school/classroom) to order schools according to effectiveness (net of student background characteristics), and classify them as "above average", "average" or "below average." We then regress student achievement on various combinations of student background, school, classroom, teacher and teacher practice variables in an attempt to identify factors accounting for differences.

Partitioning variance

The first step in the analysis involves fitting an unconditional or random regression coefficient model, using HLM, to partition the total variance in mathematics achievement into within and between-school components. The HLM program estimated the pooled within-school variance as 28.2 for Nigeria and 49.6 for Swaziland. the between-school variance was estimated as 9.01 for Nigeria and 9.3 for Swaziland. Thus, schools accounted for 24.2% of the total variance 9.01/9.01 + 28.20) in achievement in Nigeria, and 16% of the total variance in Swaziland. The intraclass correlation was .24 in Nigeria and .16 in Swaziland.

Within-class variance, by comparison, was responsible for over three-quarters of the variance in achievement observed.

The partitioning of variance using a random effects approach tells a substantially different story from that told by an OLS approach, which we ran for comparison purposes (Table 2). Here, we compare the variance explained by specific "dummy" variables for each school/classroom alone with that explained by specific "dummy" variables plus student background. First, we use OLS to estimate Equation (4) above. The total variance explained by school "dummy" variables for Nigeria was 21% and for Swaziland was 19%. Adding student background variables to each regression (Equation 5) increased the variance explained to 24% in both countries. Using OLS to estimate the contribution of schools versus student background to variance in student achievement would lead, therefore, to the (erroneous) conclusion that schools accounted for the bulk of the variance: 71-88% in Nigeria and 29-79% in Swaziland. In both countries, OLS estimates significantly overestimate between school effects and underestimate within school effects.

Rank ordering schools

In this section, we identify the most and least effective schools/classrooms, which we define as schools/classrooms performing at least one-third of a standard deviation above average (N = 8 in both countries) or below average (N = 13 in Nigeria and 7 in Swaziland), when intake variables are statistically controlled. As the first row in Table 3 shows, average scores for students in these three types of schools/classrooms are substantially different, with performance in "high" schools/ classrooms approximately twice that in "low" schools/classrooms. To estimate the actual size of the school/classroom effect, an average of the absolute size of coefficients for the school indicator variables was computed (see Heyneman & Jamison, 1980, for a rationale for this procedure). The effect is pronounced. On average, being in a good or bad school/classroom can, with student background characteristics statistically controlled, affect achievement by 4.31 points in Nigeria and 2.9 points in Swaziland. This is equivalent to .74 and .40 of a standard deviation, respectively, which is substantial.

Explaining the differences

The next logical question to ask is if and how school, classroom and teacher characteristic or practices account for this effect. This leads us to inquire about differences between high and low performing schools/classrooms. Are there characteristics that differentiate high performing schools/classrooms from low performing schools/classrooms, and is the effect stable cross-nationally? An examination of mean differences between schools/classrooms at different levels of performance can inform judgments about effective practices and inputs. In this analysis we simply use analysis of variance to test for differences between the three school types.

Patterns of differences between high and low performing schools are quite similar for Nigeria and Swaziland, with high performing schools in both countries appearing to share certain advantages (Table 3). The schools are neither too large nor too small, being among the smaller in Nigeria and the larger in Swaziland. In both countries teachers are more experienced and have classes that average 36 students. Students are more likely to have fathers with professional occupations, and girls are more likely to attend single-sex schools.

Teacher instructional practices also are similar cross-nationally. In both countries, students in high performing schools/classrooms spend substantially less time listening to whole class lectures and less time doing seat and board work than students in low performing classes, and their teachers spend less time at administrative tasks. Also, teachers of high-performing classes use more personally developed instructional materials than do teachers of low performing classes. In both countries high and low performing classes differ little in teacher instructional time and use of published materials. There are also some between-country differences. In Nigeria, teachers in high performing schools spend more time at monitoring and evaluating tasks and cover more of the intended curriculum (OTL), while in Swaziland, teachers of students in high performing schools spend less time monitoring and evaluating.

The picture that emerges from this comparison between high, average and low performing schools/classes is one of substantial differences between students, teachers and teaching practices; the patterns of differences are remarkably stable across the two countries.

Determinants of achievement

To further address the independent effects of these factors on student achievement, we conducted a series of multiple regression (OLS) analyses, which indicate that many of the features that differentiate high performing schools from low performing schools are in fact correlated with achievement. First, we examine student background effects. Then we examine each school, classroom, teacher background and teaching process variable independently, controlling for student background. Second, we examine the mix of inputs. Tables 4 and 5 present the results of these analyses.

<u>Student background effect.</u> (a) Exogenous variables. Consistent with previous research conducted in developing countries, exogenous student background variables--sex, age, father's occupation and rural residence--accounted for little variance in individual achievement (4% in Nigeria and 9% in Swaziland). In both countries, girls performed less well than did boys on the mathematics test (one-third of a point less in Nigeria and 1.7 points less in Swaziland; the difference was significant only for Swaziland), older children performed less well than did younger children, and children having professionally employed fathers outperformed children of fathers in other occupations; this effect was statistically significant in Swaziland only, however. Rural residence had a different effect in the two countries; in Nigeria, rural residence was associated with higher performance, while in Swaziland, it was associated with lower performance; in both cases, the effects were statistically significant.

Adding dummy variables for states into the equation for Nigeria added 11% to the percent variance in achievement explained. We explored reasons for the "state effect" in Nigeria by examining economic and education indicators for the states, but found no consistent pattern. Table 6 presents our findings. The state effect, therefore, is unlikely to have resulted from differences in resources or commitment to education at the state level, but may have been due to differences in sampling, survey administration, cultural conditions, or the school and classroom characteristics we examine in the following sections.

(b) Attitudes and perceptions. In both countries, student self perceptions of ability (YPERCEV) and educational aspirations (YMOREED) were associated with higher achievement (the negative coefficient on YPERCEV reflects its reversed direction). The effect of educational aspirations was statistically significant in Swaziland only, however. Parental support (YPARSUP) was related to achievement in Nigeria, and self-reported motivation (YMOTIV) was related to achievement in Swaziland. Including these motivation-related variables in the equations increased the explained variance by 2% in Nigeria and 8% in Swaziland.

All together, student background accounted for 17% of the variance in achievement in both countries (7% in Nigeria <u>without</u> state indicators).

<u>Independent school/classroom effects on achievement</u>

In this analysis, we ran simple OLS regressions of achievement on student background plus each of the school and classroom variables taken separately (Table 7). Six of the ten variables operated consistently in both Nigeria and Swaziland, net of student background effects. Teaching experience and use of personally developed teaching materials were positively related to student achievement in both countries, while teacher use of published materials, student time spent listening to teacher lectures, and teacher time spent at administrative and instructional tasks were all negatively related to achievement. The levels of significance for these effects differed for the two countries, but the direction of effect was the same in all cases.

Four other variables, however, operated in different directions in the two countries. The effects of teacher education and student time spent at seat or blackboard work were *positive* with respect to achievement in Swaziland but *negative* in Nigeria. The reverse was true for curriculum coverage and monitoring and evaluating.

These findings suggest that some elements of effective teaching are common cross-culturally, while others may be culture specific.

Effect of input mix. In this section, we conduct OLS analyses of school, classroom, teacher background, teacher process inputs and their joint effects on student achievement. The results are presented in Table 8 for Nigeria and Table 9 for Swaziland. In the following sections we discuss school, classroom, teacher and teacher process effects.

School effects. Four school level effects were examined: school size, length of school year and type of school. School size effects on achievement differed between Swaziland and Nigeria, being positively associated with achievement in Swaziland and unrelated to achievement in Nigeria. In part, this difference may be accounted for by the differences in average school size between the two countries, with average school size in Nigeria nearly three times that of in Swaziland. For the other school-level characteristics, little between country differences were observed. In neither country was the length of the school year related to levels of achievement, which in part was due to the minimal variation in school year length in both countries. And, although all-female schools were rare in both countries, enrolling 10 percent of students in Nigeria and 14 percent of students in Swaziland, students in these schools performed significantly better than students in coeducational schools in both countries. In

Swaziland, boys in all-male schools perform significantly less well than students in coeducational schools.

Class and peer effects. Class size was unrelated to achievement in both countries; however in both countries the average class size was outside the range for which marginal changes in class size has been observed to have significant effects (Glass, McGaw and Smith, 1981). Peer effects, as indicated by the average percent of student having fathers with professional occupations, were significant in both countries.

Teacher quality. In neither country did teacher experience or teacher education have a direct effect on student achievement, controlling for student background, school and other classroom effects. The lack of effect for teacher experience when student average social class background is included in the equation, in comparison with its positive effect when average social class background was excluded, suggests that more experienced teachers may have been assigned (or selected by parents of) students having a more advantaged background.

Material inputs and opportunity to learn. Holding constant school, classroom characteristics and teacher background, the effects of material inputs were surprising. In Nigeria, use of published materials was positively related to achievement, but use of teacher-made materials was negatively related to achievement; both effects were statistically significant. In Swaziland, however, material inputs were unrelated to student achievement, presumably due to restricted variation in this variable, rather than to genuine ineffectiveness of materials. In both countries, opportunity to learn was unrelated to student achievement once other characteristics of students, classes, and schools were hold constant.

Teaching quality. While the effects of specific teaching practices differed between the two countries, in both countries it was possible to identify teaching practices that were significantly related to student achievement. The best model for Nigeria included student listening time, student seatwork time, teacher instructional time and interactions between these variables. The best model for Swaziland also included student listening and seatwork time, but teacher monitoring and evaluation time was more important than instructional time, and interaction terms were insignificant. In both countries the effects of time were non-linear, and in both countries the inclusion of teaching process variables substantially increased the explained variance in student achievement, from 20% to 24%, after controlling for student background, school, teacher quality and material inputs.

The size, direction and shape of the relationship between teaching time use and student achievement were not the same for the two countries. In Nigeria, student time spent listening to the teacher give whole class lectures was positively associated with achievement, and time spent doing seat or blackboard work was negatively associated with achievement; the positive sign on the quadratic term, however, indicates that after a certain length of time (computed from the coefficients reported in Table 8 to be 135 minutes) seatwork contributed to learning. Teacher instructional time was also positively associated with achievement, but the negative sign on the quadratic term indicated that after 167 minutes of instruction, student achievement declined. For both seatwork and instruction, computed maximal times for learning were far from the mean learning time as reported by the teachers. For example, the minimal time for effective seatwork was computed as over two hours weekly, but students received, on average, only about 42 minutes weekly. Similarly, the maximal learning time for instruction was computed as nearly three hours weekly, but students received less than two hours weekly.

In Swaziland, by comparison, time spent by students listening to the teacher, doing seatwork and being monitored and evaluated by the teacher were all positively associated with achievement. As in the case of instructional time in Nigeria, the negative coefficient for the quadratic terms indicates a diminishing return after a certain length of time, computed as 44 minutes of listening, 78 minutes of seatwork, and 127 minutes of monitoring and evaluation. In Swaziland, however, significant discrepancies between computed maximal learning times and average times actually spent at the same activities were found only for seatwork (78 minutes vs. 58 minutes). For both listening and monitoring and evaluation, the computed maximal learning times (44 and 127 minutes, respectively) differed little from the average times (36 and 138 minutes, respectively).
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CONCLUSIONS

This paper provides evidence regarding the effects of schools, teachers and teaching processes on enhancing eighth grade mathematics achievement in Nigeria and Swaziland.

A principal conclusion is that the achievement of students in both countries was significantly affected by the school/classroom in which they were enrolled, once effects of family characteristics were controlled. However, the specific school and classroom level variables accounting for these differences were not the same in both countries. Explanations for these between country differences could be both methodological or substantive.

From a methodological point of view, differences in sampling, data quality and reliability could account for differences between the models. That sampling may have had an important effect on the results is suggested by the strong between state differences found for Nigeria. Between state differences in achievement could result from differences in economic, educational or cultural conditions, but the available evidence here does not support the first two of these three explanations, and we were unable to locate information that would shed light on the third. In Swaziland, the intended national sample was not achieved, and instead a volunteer sample was used; this undoubtedly reduced the variation among school and may have affected the significance of certain school and class-level variables. In addition, data quality in both countries was poor, with missing or out-of-range data resulting in the loss of over 30% of the original cases. Replication of the study with better quality data could shed light on the degree to which the differences in models are attributable to methodological shortcomings.

Substantively, effective teaching practices in one country setting could be entirely ineffective in another one. For example, in Nigeria, Bajah (1985) found that parents, teachers and students concurred that science was an accumulation of knowledge and facts to be memorized. Effective teaching under these conditions might involve more whole-class lecturing in comparison with other types of instruction, whereas memorization could be quite ineffective in a system that emphasized inquiry skills.

In the present study, students in Nigerian mathematics classes who spent more time listening to the teacher introduce and review mathematics outperformed those who were less exposed to "direct instruction"; the same result was not found for Swaziland. However, teaching time spent monitoring and evaluating student performance was positively associated with achievement in Swaziland, while it had no effect on achievement in Nigeria.

In part, this may be due to the presence of an external examination system in Nigeria at the time of the study. The last year of the "old" education system in Nigeria was 1981-82; in 1982-83 10 states began the "new" system of three years of junior secondary education, followed by three years of senior secondary education, followed by a new National Examination (Federal Ministry of Education Science and Technology Planning Section/ Unesco Planning Team, 1985). Thus, all students in the IEA study were expecting to sit the West African School Completion (WASC) Examination at the end of five years of secondary school. Under these conditions, teacher monitoring and evaluation would have less of an impact on student motivation and performance than under a system in which teacher grades were significant determinants of school completion.

Nevertheless, holding student background (and in Nigeria, state) constant, a number of classroom teaching practice variables were correlated with student achievement.

The findings of this study also provide support for the notion that <u>teaching</u> quality--actual teaching practices--is more important than <u>teacher</u> quality--education, experience and certification--in determining student outcomes. Neither teacher education nor teacher experience were associated with student achievement in either African country, once student background characteristics were statistically controlled.

Teaching quality, however, was manifest in several dimensions. The use of published and teacher made instructional materials, coverage of the curriculum, and uses of instructional time all appear to contribute to student achievement (although not always in the direction predicted). Finding the appropriate mix of alternative uses of instructional time appears to characterize the effective teacher, and this differs from country setting to country setting. To better inform local policymakers, within-country research capacity will need to be enhanced and the appropriate mix of inputs identified through local research efforts.

Table 1: Variable names, descriptions, means and standard deviations (in parentheses) for Nigeria and Swaziland

Variable	Description	Nigeria	Swaziland
SCORE	Student's core test score	14.36 (5.80)	12.92 (6.94)
Background			
YSEX	Student's sex (0=male; 1=female)	.24 (5.80)	.58 (6.94)
YAGE	Student's age in months	196.20 (20.84)	185.83 (20.30)
YFPROF	1=Father has professional occupation	.21 (.41)	.13 (.34)
YPERCEV	Student's self-perception of math ability	3.18 (1.19)	3.91 (1.30)
YMOREED	Years more education expected	3.64 (1.00)	3.26 (.99)
YMOTIV	Motivation to work hard and do well in math	n.a.	4.18 (1.52)
YPARSUP	Perceived parental support	3.66 (1.53)	n.a.
RURAL	1=School in rural area	.22 (.41)	.31 (.46)
School			
ISENROL	School size (number of students enrolled in the school)	1054.2 (354.5)	374.23 (139.86)
ISDAYSYR	Length of school year in days	188.03 (14.04)	191.02 (.72)
SINGMALE	1=All male school	.41 (.49)	.03 (.18)
SINGFEM	1=All female school	.10 (.30)	.14 (.35)
Teacher/Class			
TNSTUDS	Class size (Number of students enrolled in class)	34.92 (15.05)	38.15 (6.73)

Variable	Description	Nigeria	Swaziland
TEXPTCH	Teacher's experience (in years)	8.04 (9.10)	4.78 (4.73)
TEDMATH	Semesters post-secondary mathematics education	3.61 (1.44)	2.97 (2.75)
AVYFPROF	Percentage of professional fathers in each class	.21 (.17)	.12 (.12)
Teaching process			
TADMNTASK	Weekly minutes for routine administration and maintaining order	70.46 (63.68)	30.60 (28.15)
TINSTASK	Weekly minutes for explaining new material and reviewing old material	117.22 (106.36)	78.38 (45.19)
TMONEVAT	Weekly minutes for testing and grading	162.04 (115.22)	138.21 (39.14)
TLISTL	Weekly minutes students spent listening to whole class lectures	37.70 (33.60)	36.17 (27.47)
TSEATL	Weekly minutes students spent at seat or blackboard	42.28 (38.03)	57.79 (44.59)
TPERSMAT	Use of personally produced teaching materials	5.51 (.84	4.55 (1.14)
TPUBMAT	Use of commercially published teaching material	8.76 (1.66)	9.57 (1.68)
OTL	Opportunity to learn (Number of test questions covered by teacher during current academic year)	11.40 (10.95)	10.41 (5.38)
N		700	587

Table 2: Percent variance in Grade 8 mathematics achievement explained by between and within school indicators, Nigeria and Swaziland, 1981-82.

Source of Variance[a]	Nigeria HLM	Nigeria OLS	Swaziland HLM	Swaziland OLS
Total variance	.37	.24	.59	.24
% variance between school	.09	.21	.09	.19
as % of total variance	24%	88%[b]	16%	79%[d]
% variance within school	.28	.07	.50	.17
as % of total variance	76%	29%[c]	84%	71%[e]

Note:

a/ For OLS only, colinearity between-school and within-school variables (selection effect) leads to the underestimation of the contribution of each when both are included in estimation equations and overestimation when they are treated separately. This yields a range of explained variance, for which the upper limit is reported.

b/ The range is 71-88%
c/ The range is 13-29%
d/ The range is 29-79%
e/ The range is 21-71%

Table 3: Differences between schools having above average, average and below average scores on mathematics achievement in Nigeria and Swaziland, 1980-81.

Variable	Nigeria			Swaziland		
	Average School Achievement			Average School Achievement		
	High	Medium	Low	High	Medium	Low
SCORE	18.8	15.0	11.4	15.9	12.3	7.3
ISDAYSYR	188.6	189.8	91.41	190.9	191.2	191.1
ISENROL[a/]	986.0	964.4	1178.0	451.22	342.1	320.6
TNSTUDS	36.6	31.6	32.4	36.7	37.9	40.2
AFYFPROF(%)	32.2	18.8	17.5	21.4	6.7	6.5
SINGMALE(%)	33.9	40.6	51.5	12.4	0	0
SINGFEM(%)	33.3	4.8	0	25.2	10.4	0
TEXPTCH	12.5	6.7	7.2	6.1	4.2	3.5
TEDMATH	2.8	3.2	4.1	3.1	3.5	2.3
TADMINTASK	46.6	73.9	68.1	22.4	26.2	33.4
TINSTASK	125.7	122.6	119.2	71.3	73.2	73.4
TMONEVTA	173.1	170.3	149.9	118.3	144.7	145.1
TLISTL	31.9	35.7	57.2	33.8	36.3	64.0
TSEATL	34.7	43.8	53.7	69.8	70.2	72.9
TPERSMAT	6.0	5.3	5.4	5.5	43.8	4.2
TPUBMAT	9.0	8.4	9.3	9.7	9.4	10.0
OTL	16.7	9.9	8.1	9.3	11.1	11.5
N	164	443	286	290	278	254

Note: a/ N = 901 for Nigeria.

Table 4: Family Background Effects on Grade 8 Mathematics Achievement in Nigeria, 1981-82

Variables	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat	(3) Coeff.	(3) t-stat
YSEX	-.37	-.73	-.08	-.16	.19	.36
YAGE	-.04	-3.83***	-.04	-3.53***	-.04	-3.50***
YPROF	.80	1.48	.37	.72	.61	1.17
RURAL	2.29	4.29***	2.70	5.20***	2.52	4.89***
OYO			4.37	4.46***	4.53	4.67***
KWARA			6.06	8.02***	5.88	7.79***
BENDEL			2.45	2.71**	2.56	2.85**
ONDO			2.31	2.98**	2.29	2.98**
LAGOS			6.33	7.23***	6.36	7.35***
RIVERS			4.09	5.21***	3.96	5.08***
ANAMBRA			2.47	3.10**	2.55	3.24**
YPERCEV					-.60	-3.52***
YMOREED					.09	.44
YPARSUP					.41	3.01**
C	21.93		17.60		17.50	
Adj R^2	.04		.15		.17	
N	700		700		700	

** $p < .01$, *** $p < .001$

Table 5: Family Background Effects on Grade 8 Mathematics Achievement in Swaziland, 1981-82

Variables	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat
YSEX	-1.68	-2.98**	-1.47	-2.72**
YAGE	-.08	-5.61***	-.07	-4.94***
YPROF	3.04	3.53***	2.12	2.55*
RURAL	-.90	-1.49***	-1.01	-1.74
YPERCEV			-1.02	-4.83***
YMOREED			.94	3.40***
YMOTIV			.58	2.32*
C	28.38		23.90	
R^2	.09		.17	
N	593		593	

*p < .05, ** p < .01, *** p < .001

Table 6: Education indicators by state in Nigeria, for 8 states participating in IEA study, 1981-82.

State	Raw Score	% of State Govt. Revenue Coming From Federal Sources[a]	Ed. exp. as % of total state exp.[a]	Enroll. in 1st yr post-primary 1982/83[b]	Gross Enrollment rate in Primary Education[b]
Lagos	16.74	37	23.4	62,502	122%
Kwara	16.53	93	24.8	36,623	161%
Oyo	15.77	53	38.4	116,604	127%
Anambra	14.31	83	15.8	41,236	74%
Rivers	14.15	66	20.3	41,772	69%
Bendel	13.40	93	28.7	95,988	113%
Ondo	13.31	68	33.0	71,145	87%
Ogun	10.55	62	30.1	41,651	92%
All States in Nigeria		63	23.8	956,918	85%

Notes:

a/ These percentages are, respectively, indicators of State's dependence on federal funds, and their financial commitments to education. Source: Onabamiro, S. (1982).

b/ These figures indicate the level of school coverage in the different States. Source: Fed. Ministry of Education, Sc. and Techn./Unesco Planning Team (1985).

Table 7: Teacher quality and teaching quality effects on student Grade 8 mathematics achievement, Swaziland and Nigeria, 1981-82[a/]

Variables	Nigeria		Swaziland	
	Coeff.	t-stat.	Coeff.	t-stat.
TEXPTCH	.0088	.379	.1435	2.468*
TEDMATH	- .5028	-4.524***	.0747	.781
TPUBMAT	-.3437	-3.034**	-.0802	-.513
TPERSMAT	.1019	.401	.7257	2.906**
OTL	.0372	2.008*	-.0047	-.096
TSEATL	-.0150	-2.885**	.0073	1.715
TLISTL	-.0304	-5.156***	-.0061	-1.166
TMONEVTA	.0013	.686	-.0127	-1.932
TADMTASK	-7.356	-2.312*	-.0193	-1.803
TINSTASK	-2.230	-1.313	-.0079	-1.313

Note: a/ Student background is held constant, and each teacher variable is assessed individually.

$*p < .05$ $**p < .01$ $***p < .001$

Table 8: School and classroom determinants of Grade 8 mathematics achievement in Nigeria, 1981-82 (family background held constant)

Variables	Alternative specifications (1)	(2)	(3)	(4)	(5)
ISDAYSYR	.03	.04	.05	.05	.10
	(.96)	(1.42)	(1.38)	(1.40)	(1.87)
ISENROL	.07	-.01	.00	.13	.23
(IN 100'S)	(.78)	(-.03)	(.35)	(1.20)	(1.50)
SINGMALE	1.24	.59	.05	-.65	-.26
	(1.80)	(.80)	(.06)	(-.74)	(-.19)
SINGFEM	5.47***	4.44***	4.60***	6.89***	-1.48
	(5.15)	(3.92)	(3.68)	(4.18)	(-.79)
TNSTUDS		.01	.01	.01	.05
		(.43)	(.50)	(.33)	(1.79)
AVYFPROF		4.85**	3.74	4.91*	8.50**
		(2.58)	(1.84)	(2.04)	(2.85)
TEDMATH			.13	.44	-.02
			(.65)	(1.88)	(-.05)
TEXPTCH			.04	.03	.04
			(1.19)	(.86)	(.66)
TPUBMAT				.37*	.71**
				(1.93)	(2.60)
TPERSMAT				-.96*	.58
				(-1.92)	(.61)
OTL				-.03	-.20**
				(-.65)	(-2.44)
TLISTL					.12
					(1.65)
TLISTLSQ					.00
					(.62)
TSEATL					-.35**
					(-3.19)
TSEATLSQ					.00**
					(2.42)
TINSTASK					.11*
					(2.30)
TINSTSQ					-.00*
					(-2.22)
TINSLIST					-.00*
					(-2.26)
TINSSEAT					.00**
					(2.52)
C	10.31	7.07	4.82	3.44	-15.47
Adj. R^2	.20	.20	.20	.21	.24
N	700	700	700	700	700

Note: Numbers are unstandardized OLS coefficients, with t-statistics in parentheses.
*p < .05, **p < .01, ***p <.001

Table 9: School and classroom determinants of Grade 8 mathematics achievement in Swaziland, 1981-82 (family background held constant)

Variables	Alternative specifications (1)	(2)	(3)	(4)	(5)
ISDAYSYR	-.68	-.83*	-.78	-.26	-.24
	(-1.73)	(-2.11)	(-1.82)	(-.38)	(-.25)
ISENROL	.78**	.24	.21	.01	.22
(IN 100'S)	(3.19)	(.88)	(.71)	(.14)	(.35)
SINGMALE	1.73*	-3.53*	-3.63*	-2.15	-2.25
	(2.11)	(-2.04)	(-2.04)	(-1.03)	(-.49)
SINGFEM	1.73*	.25	.17	1.23	4.45
	(2.11)	(.28)	(.17)	(.93)	(1.02)
TNSTUDS		.02	.03	.04	.18*
		(.51)	(.60)	(.92)	(2.56)
AVYFPROF		12.76***	13.16***	11.72*	-1.86
		(4.16)	(3.50)	(2.48)	(-.15)
TEDMATH			.04	.14	.38*
			(.34)	(1.02)	(2.20)
TEXPTCH			-.01	.00	.14
			(-.07)	(.02)	(1.07)
TPUBMAT				-.02	-.56*
				(.12)	(-2.19)
TPERSMAT				.22	.74
				(.46)	(1.37)
OTL				.13	.22
				(1.47)	(.88)
TLISTL					.13
					(1.76)
TLISTLSQ					-1.45*
					(-2.15)
TSEATL					.13*
					(2.33)
TSEATLSQ					-.00
					(-1.69)
MONEVTA					.30*
					(2.52)
MONEVTASQ					-1.20**
					(-2.82)
C	152.80	178.63	168.97	67.32	35.85
Adj. R^2	.18	.20	.20	.20	.24
N	587	587	587	587	587

Note: Numbers are unstandardized OLS coefficients, with t-statistics in parentheses.
*p < .05, **p < .01, ***p <.001

FOOTNOTES

1/ Effective schools research has received criticism for inadequacy of methodology and content (Aitkin & Longford, 1986; Cuttance, 1985; Goldstein, 1984; Madaus, Kellaghan, Rakow & King, 1979; Raudenbush & Bryk, 1986; Sirotnik & Burstein, 1985). This criticism can apply equally well to research on teacher effectiveness.

2/ In IEA studies, the term "opportunity to learn" has been used to describe the number of items on the achievement test that are included in objectives of national curricula and/or taught by classroom teachers. It does not refer to the actual process of teaching, which could include memorization by students without any genuine understanding.

3/ In fact, we tried a random effects approach with the data from but were unsuccessful in identifying any between unit characteristic that could explain the variance accounted for in the base model.

4/ By "school-level" effects, in this paper we refer to both school characteristics and classroom characteristics, since each school is represented by one classroom.

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