ZJER

ZIMBABWE JOURNAL OF EDUCATIONAL RESEARCH

Volume 13 Number 2 July 2001

ISSN 1013-3445

Contents

Contents

Research on School Effectiveness on Pupils' Achievement in Developing Countries with Special Reference to Malawi: Some Methodological Issues

Chipo Kadzamira
Malawi National Examination Board

Abstract

Most previous research on the comparative effectiveness of schools in developing and developed countries, particularly the effect of school inputs and resources on academic achievement, have concluded that the effect of school quality on academic achievement is greater than that of pupil Socio-Economic Status (SES). However, the basis on which this conclusion is based is questionable. Of particular concern are the major methodological and conceptual weaknesses of most school effects research in both developed and developing countries. Most of the studies have heavily relied on production function models and as such very few process variables have been studied. In addition, the studies also suffer from conceptual limitations, especially in the way family socioeconomic status variables have been specified. Most studies have tended to use conventional social background measures appropriate to developed countries. On the methodological issues, the studies have suffered from over reliance on single-level models, particularly Ordinary Least Squares (OLS) regression models to analyse hierarchical data. This paper suggests that a deeper understanding of the process of schooling and the determinants of achievement in developing countries can be gained from applying multilevel models using socio-economic status background measures appropriate to developing countries. The paper also presents results of a study undertaken in Malawi which employed multilevel models in order to address in part, some of the methodological limitations leveled against school effectiveness research.

Introduction

Over the past two and half decades researchers mainly from the industrialized nations have been concerned with the question of the relative importance of school factors vis-à-vis non-school factors (particularly home background) as determinants of achievement. This growing concern has been in part a reaction to research reports which appeared in the 1960's in the U.S.A. (Coleman Report, 1966) and Britain (Plowden Report, 1967) which claimed that home background factors are more important than school factors in determining children's achievement.

The consequence of these claims was to lead researchers to the search for school effectiveness. This new quest for school effects in developed countries led to modification of earlier findings, with most studies generally concluding that schools make a difference in the kind of education received. Much more recently, refinements to earlier methodology have led to a more sophisticated understanding of the nature of school effectiveness and the process of schooling (Nyagura, 1992).

On the other hand, research on school effectiveness in developing countries has been more limited. Yet despite the fact that the literature on school effectiveness in the Third World is scanty, the findings are quite consistent. Most of the studies have consistently found that schools exert a more powerful influence on pupils' achievement in mathematics and languages than home background factors. This is in contrast with results obtained from Western countries, where family background characteristics have stronger effects on academic achievement than school related factors. This has led researchers from developing countries to propose a different paradigm for explaining the determinants of achievement (Riddell, 1988). These

studies have, therefore, challenged the widely held view that a different model of school effectiveness is applicable to the developing nations.

The effect of these claims has been to spark off a lively and heated debate in the literature (Riddell, 1988; Lockheed & Longford, 1989). Of particular concern are the conceptual and methodological limitations of most school effectiveness research in both developed and developing countries.

Literature Review

Three Paradigms of School Effectiveness Research

Review of literature on school effectiveness from developed countries reveals three different phases, each characterized by the dominance of particular research paradigms. These paradigms are:

1   The production function models,

2   The process models, and;

3   The multilevel models which cover inputs, processes and outcomes.

Production Function Models

This phase which began in the 1960's was dominated by the use of production function paradigms borrowed from economics (Coleman and Plowden Reports) and the major conclusion reached in this phase was that the effect of schooling on pupil achievement was insignificant. What mattered most was the child's socio-economic background in accounting for much of the variation in his/her achievement.

During this period researchers focused on the effects of various school inputs such as financial or physical resources, quality and quantity of teachers, and availability of textbooks on pupil outcomes such as academic achievement. These studies viewed schooling as a production process in which certain contributions of physical or functional inputs produced certain outputs (input-output models). Thus, they sought to find out which of the various economic and physical resources or inputs were important in determining pupils' achievement. However, these studies came under heavy criticisms for their methodological and conceptual weaknesses.

First, a lot of these studies took as a given base that family factors were determinant and went on to reinforce this paradigm. Furthermore, in some studies, the school was never measured at all even though they claimed that schools had little influence (Reynolds, 1985).

Second, most of the schools did not use appropriate measures of outcome variables (Riddell 1988). They used standardised achievement tests as indicators of academic achievement (Coleman [1966] used a verbal reasoning test). The problem with standardized tests is that they do not necessarily measure what is taught in schools and because they tend to measure general ability, they measure outcomes that are more dependent upon extra-school influences such as home background, rather than school specific learning outcomes. It can be argued, therefore, that the failure of these

early studies to find any significant school effects could be a consequence of the fact that school effects might have been confounded with pupils' background measures. These studies also concentrated on cognitive aspects of schooling (such as academic achievement) and as a result neglected the non-cognitive aspects such as attitudes and behaviour, which are equally important.

On the issue of methodology, the studies have been criticised for adopting a production function model which bore no resemblance to what went on in the schools. Most of these studies have focused on the effect of financial and physical factors such as availability of textbooks, quality of teachers, class size, and school buildings among others, on pupil achievement and in doing so they have failed to ask how these resources are utilized and organized in the classrooms and schools. These studies have been criticized for ignoring school processes and for failing to examine the effect of process variables (such as management practices and school ethos) on academic achievement. Burstein (1980) points out that a review of production function literature suggests that these studies failed to provide any consistent evidence for a relationship between school resources and outcomes such as achievement.

The second methodological limitation of the first phase studies is that most of them were cross-sectional in design and thus involved a snap view of pupils in schools at one point in time. The cross-sectional data collected did not include information on the pupils' initial attainments. As a result, these studies were unable to control for the differences in intakes to different schools and therefore were unable to isolate the effect of the schools.

The third methodological criticism of these studies was their use of aggregated data to analyse school effects (Goldstein, 1979; Burstein, 1980). A lot of these studies have aggregated data to the school level, but it is argued that, this may mask the differential effects for specific sub-groups of children. Aggregation bias can accelerate the estimated effects of pupil background on outcome relative to teacher/classroom/ school effects (Burstein, 1980). In addition, researchers have pointed out to the instability of results depending on level of analysis (i.e. whether it is individual (student) level or school level (Goldstein, 1987).

Finally, production function studies have also been criticized for their over-reliance on Ordinary Least Squares (OLS) regression analysis (Lockheed & Longford, 1989; Riddell, 1988). To this effect, studies (Coleman Report) regressed the outcome measure on a number of blocks of independent variables representing pupils' home background, school facilities and teacher characteristics, and the task was to determine the contribution of each of the blocks to the explanation of the achievement variance. The problem of using this method, however, is that it is more likely to produce unreliable estimates of the parameters involved and is also unsuitable for estimating the relative contribution of school and non-school inputs. More important is the fact that OLS regression models, being single-level models, were inappropriately used to analyse data which were clearly hierarchical. Thus these studies have not been able in reality to isolate the achievement variation attributable to pupils within schools from that attributable to schools as the OLS regression models failed to take into account the grouping of pupils within schools.

Refinements to the methodology of first phase school effects research and re-conceptualisation of certain variables led to a new phase of school effectiveness research.

Process Models

The second phase studies are usually put under the umbrella term process models because they viewed schools, not as production units, but as organisations or institutions which were linked closely into wider educational systems and other social systems (Cuttance, 1985). Thus greater emphasis, during this phase was placed on what went on in the classrooms and schools and some of the process variables studied were pupil motivation, attitudes, behaviours, management practices, school ethos, and also the social organizational and historical context of schools (Bennett, 1976; Reynolds, 1985). The major conclusion reached during this phase was that schools do make a difference with regard to the kind of education received and that schools are not interchangeable. This was major challenge to earlier studies which held a pessimistic view of the effect of schooling on achievement. Thus, modification of the methodology and re-conceptualisation of some concepts in response to criticisms leveled against production function models led to a challenge to earlier findings.

However, process models did not escape their share of criticisms. Though refinements to earlier models had been done (using curriculum sensitive tests, for example), a lot more problems still remained unresolved. For example, researchers still argued about the appropriate level of analysis to use in school effectiveness research, that is whether pupil level data should be used or these should be aggregated to school level in order to assess the importance of school level variables. Secondly, the studies during this phase still relied on single-level variables models (as no other alternative existed) to analyse a reality which was clearly hierarchical, and some studies (Bennett, 1976) still used nonrandom samples.

Multilevel Models

The third phase of school effects research, which is the most recent, is characterized by use of multilevel models. Multilevel models have been developed partly in response to methodological criticisms made against earlier studies.

Most social science and educational data have a hierarchical organization with units at one level being nested with units at a higher level. For example in education, pupils are nested in classrooms within schools and schools within districts or local education authorities. Since behaviour at one level (classroom or school) influences behaviour at another level (pupils), the statistical issue which arises is how to estimate these multilevel effects correctly (Inner London Education Authority, 1990). Until recently, researchers relied on single-level models such as OLS regression models to analyse multilevel effects (due to absence of appropriate analytic models and computer software). However, as Cronbach (1986) argued, this mismatch between the hierarchical character of much educational phenomena and traditional single-level analytic models has plagued educational research leading to many spurious inferences. Multilevel models on the other hand try to remain faithful to the hierarchical structure of the data. They are capable of analysing quantitative data at different levels of the hierarchy simultaneously, something which is not possible with single-level models. This has partly helped solve the controversy that existed amongst researchers regarding the appropriate level of analysis, (whether data should be analysed at the pupil or school level when estimating school effects). The controversy arose because different conclusions about the estimated effects of the school and importance of individual variables were reached depending on the level of analysis used (Lockheed & Longford, 1989).

Multilevel models have also overcome some of the problems encountered when analyzing nonrandom data using single-level models. For example, one of the assumptions of OLS regression models is that the residuals (eij) are independent and their covariance is zero (e.g. cov eij, eik = 0). However, this stringent assumption is often violated in education because it is very difficult to conduct randomized experiment and usually intact classrooms or schools are used for analysis.

In education, we usually find that pupils from different communities and backgrounds are grouped together in classes that are located within schools in particular districts and regions. This means that pupils within one class or school share common experiences which tend to make them more homogenous in their attainments than pupils chosen randomly from different classes or schools. As a result, any measurements made on these pupils will not be independent, but correlated and, if this intra-unit correlation is high, it is likely that the standard error will be underestimated if single-level models are used and therefore more likely to overestimate the effect or estimates.

In multilevel models, this greater homogeneity (or intra-unit correlation) is modeled explicitly. In addition, multilevel models are interesting in school effects research because one is able to separate the variation due to school from that due to characteristics of the pupils. As a result, one is able to estimate the effect of the inclusion of different explanatory variables at each level (whether the inclusion of an explanatory variable in the fixed part of the model increases or decreases variation at the student and school levels).

One of the most promising approaches in multilevel modeling is the fact that the coefficients of the explanatory variables can be modeled as random terms (that is, can

be made to vary at a particular level; school or pupils level). For example, instead of assuming that the effect of socioeconomic status is constant in each school by modeling socioeconomic status (rather than the coefficient of this variable) at the school level, it can be assumed that the effect of this variable varies from school to school, which is more realistic and portrays the actual social educational reality. Thus multilevel models have the potential of providing more powerful interpretations and meaningful information than (OLS) regression models.

There is now a growing body of literature on school effectiveness research in industrialized nations which has employed multilevel models (Raudenbush & Bryk, 1989). These studies have provided quite illuminating evidence of the nature of school effectiveness. For example, multilevel re-analysis of previous research which used single-level models have produced results which are more conservative than earlier findings (Lockheed & Longford, 1989).

In summary, new studies using multilevel models have found significant effects after controlling for background factors (Inner London Education Authority, 1990). In addition, multilevel models have also demonstrated the multi-dimensionality of school effects (schools have differential effects on different types of pupils; some schools being particularly effective for high ability children).

Limitations of School Effectiveness Research in Developing Countries

Studies undertaken in developing countries have consistently found that unlike developed countries, schools exert a more powerful impact on academic achievement than background factors. However, this finding is undermined by various conceptual and methodological flaws in the research. Inner London

Education Authority (1990) for example, found that school factors explained small portions of variations in achievement in the developed countries whilst in developing countries the block of school factors explained significant portions of the variance in achievement. In this study, Heyneman (1980) found that school quality was a better predictor of achievement than family economic background in Malawi. Until very recently researchers from developing countries ignored the developments which were taking place in schools effectiveness research in Western countries.

Most research in developing countries (still responding to Coleman's findings) has continued to rely heavily on the production function models that compare the relative effectiveness of school and non-school resources on academic achievement (Heyneman & Loxley, 1983; Fuller, 1987). As a consequence, very few process variables have been studied. Thus though some studies have shown that textbook availability influences achievement, no one knows how this occurs and little is known about how such resource materials are organized in the classroom in the developing nations.

Another limitation of Third World studies is that they are usually cross-sectional in design and as such have failed to take into account prior achievement levels of the pupils which are known to confound effect of school and family characteristics. Very few longitudinal studies have been undertaken in this regard (Reynolds, 1985).

Critics (Inner London Education Authority, 1990) have argued that the failure of earlier studies to find stronger effects of family background can be attributed to the mis-specification of these variables in developing countries. As Lockheed, (1989) has pointed out, most of Third World research has tended to use attainment and occupation status which are more suitable to developed countries. The argument is

that the variation of conventional measures of social class may be constrained in many Third World countries and because of this, there is need to use more culturally relevant indicators of social background such as parents' demand for labour, status of home and material aspects of class. In a study of family effects on achievement in Thailand and Malawi, Lockheed, (1989) found that after using country specific measures of family background (parents demand for labour, status of houses, material aspects of class) in Malawi, family background characteristics had a more significant influence on achievement than the conventional Western measure of class. The issue here is that if family background has been mis-specified in earlier studies, then the importance of the school might have been over-exaggerated in the Third World.

Further, these studies continue to rely on single-level models and have tended to use R^2 (total variation explained) as a measure of importance of the variables, by comparing the proportion explained by school factors and that explained by family background factors). However, use of R^2 in this way is problematic, for R^2 is only a reflection of what one is able to measure; it does not measure relative importance of variables.

A few studies have appeared in the developing countries which have employed multilevel models (Lockheed, 1989; Riddell, 1988; Nyagura, 1992, 1995). These studies have, as expected, come up with different conclusions vis-à-vis earlier studies. Lockheed, and Longford (1989) in a re-analysis of IEA Mathematics data of Thailand found that schools in Thailand were much more uniform in their effects than previous research in developing countries would have suggested. A study of school effectiveness of Zimbabwean secondary schools found that the largest proportion of variation in "O" level achievement in English and Mathematics was

accounted for by the pupils' previous achievement and socioeconomic factors rather than factors specifically related to the classroom, teacher or school (Riddell, 1988). These results cast doubt on the prevailing wisdom existing in the Third World. Interestingly enough, using multilevel models and better measures of socio-economic background we begin to get similar results to those obtained from Western countries using multilevel models.

Determinants of School Achievement in Malawi's Secondary Schools: A Multilevel Approach

Methodology

The data used in the study (Tables 1 and 2) was obtained from the Malawi National Examinations Board (MANEB) and consisted of questionnaire data collected for an International Development Research Centre study carried out by MANEB and also examination scores for Malawi's School Certificate of Education (MSCE) and Junior Certificate (JC) Mathematics, English, and Chichewa extracted from MANEB and Ministry of Education and Culture respectively. The MSCE and JC are both of two-year duration. The JC is the lower level of secondary education while the MSCE is the upper level. The sample data comprised Form IV pupils (n = 1,095). They were drawn from a random sample of secondary schools (n = 24) in all the Northern, Central, and Southern regions of the country. This paper, however, presents analysis and results for Mathematics and Chichewa only.

The Measures

The measures included indicators of academic achievement, pupil demographic and school level variables. Public examination scores were used rather than standardised achievement tests as the former are more sensitive to what happens in the schools. The MSCE scores were used as outcome measures whilst the JC scores (JC examinations are taken at the end of junior secondary, Form 2) were used as a measure of intake knowledge before MSCE. The students' demographic variables were age, sex, and socioeconomic status. The study also looked at two school level variables, (1) school facilities in general and (2) resources available for a specific subject.

The Models

Multilevel models which take into account the hierarchical structure of the data (pupils within school) were used in the analysis. The models can be viewed as an extension of OLS regression models, the difference being that unlike the latter, they take into account more than one source of variation, (for example, a two-level has two random residual terms instead of one) first pupil level residual and second school level residual. The equations below demonstrate the difference between the two clearly:

$Yj = \$@ + \$_1X_1 + e_j$ OLS   Single-level regression equation

$Y_{ij} \$@ + + \$_1X1 + U_{ij} + e_{ij}$ Multilevel regression equation

A step-wise regression analysis was employed starting with the simplest models and building up to more complex models with deletion of variables which were found not to be important.

The package used to analyse the data was ML3-E software developed by the Multilevels Projects for the Institute of Education, University of London. Three models were fitted to the data and all these were two-level models (i.e. incorporated two random terms, level 1 = students and level 2 = schools).

The first model fitted was a basic variance components model and this was done in order to check whether there was any variability between school means. In the second model, explanatory variables were added to the first to control for previous achievement and then followed by pupils background variables, and lastly school characteristics. Model 3 was the random coefficient regression model which allows the coefficient (i.e. betas) of the explanatory variables to vary randomly at the school level.

Model 1: Simple Variance Components Model

In this model the JC and MSCE Mathematics and Chichewa scores were regressed on the constant term (coded 1 for every pupil) separately. In addition, the constant term was set at random at both the student and school levels. The aim of fitting this model was to estimate the overall mean achievement at both secondary school intake (JC level) and end of secondary schooling (MSCE) and also to check if there were any school differences in mean achievement. The intra-school correlation: proportion of the total variance that is due to school was also computed. The model fitted was:

$Y_{ij} = \$@_j X_{oij} + {}_{eoi}j X_{ij}$

With $\$@_j = {}^a{}_{oo} + \mu_{oj}$ (unconditional between school variation)

Where I = student

j = school

Y_{ij} =   student's JC or MSCE exam score

X_{oij} =   the intercept variable or constant term (1 for every student)

$Y_{ij}F_{oo}$ =   overall mean achievement

μ_{ij} =   school level residual

${}_{soij}$ =   student level residual

The following parameters were estimated:

F_{oo} =   overall average achievement across all schools

$F_{oe}{}^2$ =   between student within school variance

$F_{ou}{}^2$ =   between school variance

(Appendix 1 for assumptions about the random parameters of the model, (${}_{soij}$ and μ_{ij})

Table I shows the variation of JC and MSCE scores in Mathematics and Chichewa in relation to the different variables;

Table 1
Variation of JC and MSCE Scores (Standard Errors or Estimates in Brackets)

Explanatory Variables	JC Model 1A		MSCE Model 1B	
Variables	Mathematics	Chichewa	Mathematics	Chichewa
Fixed constant (β_0)	45.35 (1.68)	55.71 (1.06)	119.6 (5.25)	176.5 (2.18)
Random between schools (σ^2)	62.73 (19.4)	25.03 (7.68)	591.2 (7.68)	105.6 (32.97)
	185.3 (8.01)	61.21 (2.65)	2550.0 (11.2)	316.9 (31.69)
Intra school correlation	0.25	0.29	0.19	0.25

Source: Malawi National Examinations Board (1982-86), Sex differences in the performance of candidates in MSCE mathematics and humanities subjects at MSCE level. Zomba: MANEB.

Model 1A regresses JC scores on a constant term to obtain the overall mean achievement and the variability of the school means around this mean. The overall mean achievement is estimated to 45.35 for Maths and 55.71 for Chichewa. The variance of the school mean is estimated to be 62.72 and 25.03 for Maths and Chichewa, respectively and not larger than their standard errors supporting the view that the average levels of achievement differ across schools. The intra-school correlations are estimated to be 0.25 and 0.29 for Maths and Chichewa, suggesting that a substantial portion of variation in achievement in these five subjects is attributed to differences of some sort between schools.

Similarly, Model 1B regresses MSCE scores on a constant in order to get an idea about the overall variation between pupils and between schools. The variation between schools for MSCE scores is less than for JC scores (intra-school correlations

are lower for MSCE and JC (Table 1). However, it can still be argued that there is considerable variation in achievement which is due to differences between schools in achievement.

The magnitude of the intra-school correlations obtained are in the order often found with such kind of data and it is therefore useful to proceed with a multilevel analysis in order to explain this variation. Subsequent models try to do this.

Model 2: Variance Component Models

Model 1B is extended by the inclusion of explanatory variables measure at both pupil and school level in order to see if school differences still persist after controlling for pupil and school characteristics and also to find out which of these characteristics have significant effect on achievement at MSCE. (For statistical representations of model see Appendix 2).

First, JC scores, were added to the model as covariates and their effects in level 1 and 2 variation were analysed. The fixed effect of JC scores on both subjects were significant, suggesting that initial attainment had a significant effect on later performance (Table 2).

Table 2
Estimates for Various Models

Subject	Maths	Chichewa	Maths	Chichewa	Maths	Chichewa
Explanatory Variables						
Fixed Constant	-7.31 (3.98)	129.4 (3.95)	50.48 (13.93)	157.2 (7.67)	65.9 (14.76)	158.5 (8.16)
JC Score	2.8 (0.07)*	0.85 (0.06)*	2.71 (0.07)*	0.82 (0.06)	2.73 (0.15)*	0.82 (0.08)*
Age			-3.08 (0.60)	-1.64 (0.29)*	-2.99 (0.57)*	-1.66 (0.29)
Girl-Boys				0.7(1.89)	-6.72 (3.12)	
Non-manual				2.27 (1.14)*	4.99 (2.14)	2.97 (1.11)*
No illness				4.01 (1.11)*	5.68 (2.22)*	3.78 (1.1)*
No radio				-12.06 (5.3)*		
No fees problem		1.39 (1.56)	1.33 (1.56)	School face -15 (6.04)		
Random school Level	97.8 (36.21)	65.76 (21.09)	91.63 (33.88)	64.6 (20.5)	97.48 (36.14)	65.15 (21.03)
Covariance of Maths & Chichewa					5.06 (1.92)	-1.21 (0.74)
JC Score					0.38 (0.14)	0.06 (0.05)
Student (constant) level	1102 (47.61)	27.96 (11.88)	1059 (45.76)	258.2 (11.6)	987.1 (43.06)	255.6 (11.5)
Intra school correlation	0.08	0.19	0.08	0.20	0.10	0.20
Slope/intercept correlation					0.83	-0.61

* Statistically significant: estimates are larger than twice the standard error

Source: Malawi National Examinations Board (1982-86), Sex differences in the performance of candidates in MSCE mathematics and humanities subjects at MSCE level. Zomba: MANEB

Adjusting the MSCE scores for initial attainment also resulted in great reduction in variation at both student and school level. For example, in Mathematics Level 1 variation has been reduced by 57% and Level 2 by 84% whilst for Chichewa the reductions are lower, 13% for Level 1 and 38% for Level 2. This suggests that part of the variation in MSCE scores is accounted for by differences in intake. Thus, as Model 1A demonstrated, students differed markedly in their intake scores and once these differences are controlled for, variation at both student and school levels are greatly reduced. The intra-school correlation has also been reduced in this model, further confirming that a large amount of variation between schools is accounted for by initial attainment. This finding highlights an important design point in school effect studies; the need to control for initial attainment, because if not, it would confound results making it difficult to identify the factors contributing to later achievement.

Model 2B: Controlling for Other Student Background Variables (Variance Components Regression Model)

Model 2B is a further extension of Model 2A, in which student background characteristics are added to the model as fixed effects. These variables were age, gender (a dummy variable representing girls minus boys differences), non-manual and dummy variables representing social class (i.e. non-manual contrasted with manual), no illness (another dummy variable representing the difference between students who were not prevented to attend classes regularly because of illness and those who were), no radio: a dummy variable representing the difference in achievement between students who experienced problems in paying fees and those who did not. Like Model 2A only intercept term was allowed to vary at both student

and school level. The aim of fitting this model was to determine whether students' background characteristics had any effect controlling for these variables.

Results

The results in Table 2 show that school differences still exist even after controlling for pupil background variables and these differences are significant in both subjects. The school level variances have been moderately reduced by the inclusion of these background characteristics. In Chichewa, for example, the reduction in school level variance (between Models 2A and 2B) is only about 2%, suggesting that pupils' background characteristics explain only about 2% of the school variance after controlling for initial achievement whilst in Maths they explain about 6% of the school variance. These findings suggest that prior achievement explain a lot more variation at school level and it can be argued that it is a much more important variable than student background characteristics. But it is highly probable that these students' background characteristics are confounded with initial achievement, thus variation of these factors were going to explain any more variation in the MSCE scores.

For Model 2B the age factor had a significant effect on achievement in Maths and Chichewa, with younger pupils doing better than older students. Prior achievement had also significant effects on later achievement.

In Maths, boys had higher mean scores than girls whilst in Chichewa no sex differences were observed, a finding which confirms earlier reports (Kadzamira, 1987, 1988). Pupils coming from non-manual background (that is, higher status) had also higher achievement levels than students from manual backgrounds, a finding which claimed that social background had no significant effect on achievement. As

expected, healthy pupils also outperformed those who missed classes regularly due to illness. No significant effects on social background measures (that is, possession of radio) in home and no fees problem variable were found.

Model 3: Random Coefficients Regression Model (Appendix 2b for Statistical Representation of this Model)

In Model 3, group level variation is modeled by the inclusion for the coefficients (betas) for JC scores as random variables. That is the coefficients of the term (intercept) and the JC course were allowed to vary at the school level. The results of fitting this model are presented in Table 2. In Maths, we note that there is considerable variation between schools in achievement. The slope intercept correlation is 0.83 which suggests that there is a very high tendency for the greatest progress to occur in schools with high achievement means. Figure 1 (Appendix 3) shows a plot of fitted MSCE Maths scores against JC Maths scores with school regression lines. We note that in Maths, most of the schools were less effective for low ability students and they also differed in the amount of progress made for these type of students. School 9 is the major exception: it seems particularly ineffective for high ability students as entry to senior secondary school (Form 3).

For Chichewa a different picture is obtained. The results in Table 2 show that there was no statistically significant variation of the school means. Figure 2 (Appendix 4) shows that the school varied a lot in the progress they made for their low ability students at intake but varied less for high ability students. The major exceptions being School 1 which was relatively effective for students with low intake scores in

comparison to other schools but was not particularly effective for higher ability students. School 16 on the other hand is effective for high ability students but less effective for low ability students.

Discussion

School Effects on Achievement

The variance due to school for Chichewa is 20% and that for Maths is 10% (Table 2). From this finding, we can conclude that the school made a substantial contribution in accounting for variations in student achievement in Chichewa whilst for Maths the effects were more homogeneous. This finding is in line with what other studies have found, for instance, in a study of Zimbabwean schools Riddell (1988) found greater variation between schools in English Language and English Literature than in Maths.

Differential School Effectiveness

Another important question which can be raised in this multilevel analysis is whether schools have the same effects for different types of pupils (boys and girls, different age groups, high and low ability students, and students from different socio-economic status). Because of the small sample of school used in this study (which made the estimates unreliable and poorly estimated) only one variable slope (coefficient of JC scores) was fitted to the model. Studying variable slopes is of importance because it provides a deeper understanding of school effects. For example, some schools may relatively be more successful in teaching students with certain background characteristics and they may either exaggerate or reduce the differences between students at entry. This study found that school had differential effects on students with

different intake scores, with some schools being more effective for students with high intake scores and others for low intake scores. Several multilevel studies have come up with similar findings (Inner London Education Authority, 1990).

Contribution of School Versus Student Background Characteristics and Relative Importance of Variables

By far the largest proportion of variation in achievement lies between students (over 80% of total variation is at student level in both subjects).

Secondly, initial attainment explains the largest proportion of variation in students' outcomes both at school and student levels than any other or the variables fitted. In Maths, for example, 67% of the total variation is explained by prior achievement (84% of variation at school level and 57% at student level). In Chichewa initial attainment explains 20% of the total variation (39% at school level and 13% at student level). Thus, the results show that initial attainment is strongly related to subsequent achievement, and therefore the need to control for prior achievement needs to be heavily emphasized in school effects study. This entails the need for longitudinal designs, something which has been lacking in most previous studies done in developing countries.

The other student background characteristics explained much less variation once the effect of initial achievement had been controlled for in the model. In both subjects students' background characteristics explained a further 5% of the total variation only. Thus, it can be concluded that initial attainment is a more important determinant (predictor) of later achievement in Malawi secondary schools than social class,

gender and age. The possibility of these being confounded with initial attainment, however, should not be ruled out.

Factors Affecting Achievement at MSCE Level

From this analysis it can be concluded that prior achievement, age and social background are the factors found to affect achievement at MSCE level. Younger students do better than older students in both Chichewa and Maths. This has policy implications on repetition at primary level (standard eight) and subsequently selection procedures to secondary schools.

Gender is also another important factor determining achievement with boys out-performing girls in Maths, though no sex differences were observed for Chichewa. Students from non-manual backgrounds also did better in Chichewa than those from manual backgrounds, but no social background effects were observed for Maths.

Conclusion

School effects research in developing countries has been beset by conceptual and methodological limitations. Researchers have now begun to address these problems and a lively debate in the literature is now focusing on how best to solve these problems. On the conceptual side, critics have lamented the way family background has been measured and use of appropriate measures of these variables have led researchers to call for policy makers in the Third World to include programmes that take into account students' background characteristics (Lockheed, 1989). On the methodological issues much of the debate has centred on the appropriate statistical designs to use and researchers are now turning to multilevel models. These models

are appealing because they have the potential of providing far more powerful and meaningful information than single-level models such as OLS regression models. They closely model the reality of educational data because they are capable of analyzing data at different levels of hierarchy simultaneously. With these models, one is able to study the way in which group differences vary from school to school or within schools (between boys and girls) and can also provide a deeper understanding of the process of schooling and the determinants of achievement (Goldstein, 1987). However, multilevel models should not be viewed as a panacea for all educational research methodology problems. They are of course powerful but they have their own limitations. As Goldstein (1987) pointed out, there still remains one problem which multilevel models have not yet addressed, for example, how to obtain estimates when the data are not strictly random. In addition, measurement problems still remain, particularly model mis-specification. Alternative models with different explanatory variables can yield different estimates and conclusion. Thus researchers need to be wary about choice of explanatory variables and have to ensure that they have included all possible variables in their models. This problem of model mis-specification is not confined to multilevel models alone, but it plagues all other statistical models such as OLS regression analysis of variance. As Lockheed and Longford (1989) point out, use of OLS regression methods and variance components (multilevel) analysis allows improved description but does not provide inference about causal relationships between variables.

References

Bennet, S. N. (1976). *Teaching styles and pupils progress.* London: Open Books.

Burstein, L. (1980). The analysis of multilevel data in educational research and evaluation. In D. C. Berliner (Ed.) *Reviews of Research in Education,* 8. Washington DC: American Education Research Association.

Coleman Report, (1966). London: HMSO.

Cronbach, L. J. (1976). *Research on Classroom and Schools: Formulation of Questions, Design and Analysis.* An occasional paper. Standford, California: Standford Evaluation Consortium.

Cuttance, P. F. (1985). Framework for Research on The Effectiveness of Schooling. In D. Reynolds (Ed.), *Studying School Effectiveness.* London: The Falmer Press.

Goldstein, H. (1979). *The Design and Analysis of Longitudinal Studies.* London: Academic Press.

Goldstein, H. (1987). *Multilevel Models in Educational and Social Research.* London: Charles Griffin & Company.

Good, T. L. & Brophy, J. E. (1986). School Effect. In M. C. Wittrock (Ed) *Handbook of research on teaching* (3rd ed.) New York: MacMillan Publishing Co.

Heyneman, S. P. (1980). *The Evaluation of Human Capital in Malawi.* Washington D.C.: The World Bank.

Inner London Education Authority. (1990). *Differences in Execution Performance.* London: Research and Statistics Branch.

Kadzamira, E. C. (1987). *Sex Differences in the Performance of Candidates in MSCE Mathematics and Science Subject at MSCE Level 1982-1986.* Zomba: MANEB.

Kadzamira, E. C. (1987). *Sex Differences in the Performance of Candidates in Languages and Humanities Subjects at Msce Level 1982-1986.* Zomba: MANEB.

Lockheed, M. E. & Longford, N. T. (1989). *A Multilevel Model of School Effectiveness in a Developing Country.* Washington D.C.: World Bank.

Lockheed, M. E., Fuller, B. & Nyirongo, R. (1989). Family Effects on Students Achievement in Thailand and Malawi. *Sociology of Education, 63.*

Nyagura, L. M. (1992). Multilevel Methodology in Studying the Quality of Education with an Application to Mathematics Education in Zimbabwe Primary Schools. *Zimbabwe Journal of Educational Research, 4,* 1, pp. 49-70.

Plowden Report (1967). *Children and their Primary Schools.* London: HMSO.

Raudenbush, S. & Bryk, A. S. (1989). Quantitative Models for Estimating Teacher and School Effectiveness. In D. Bock (Ed.). *Multilevel Analysis of Educational Data.* New York: Academic Press.

Reynolds, D. (1985). Introduction: Ten Years On: A Decade of Research and Activity in School Effectiveness. In D. Reynolds (Ed.), *Studying School Analysis.* London: The Falmer Press.

Riddell, A. R. (1988). *School Effectiveness in Secondary Education in Zimbabwe: A Multilevel Analysis.* PhD Thesis, Institute of Education, University of London.

Appendix I

Assumptions

The models make the following assumptions about the random parameters $,_{ij}$ and μ_j.

It is assumed that the $,_{ij}$'s and μ_j's are each randomly distributed with zero mean and a constant variance and that the residuals are uncorrelated both between and within each level. i.e..

$E(,_{ij})$	$= 0$	$E(\mu j) =$	0
$Var(,_{ij})$	$= @^2@e$	$Var(\mu j) =$	$@^2@u$
$Cov(,_{ij}, ,_{ik})$	$= 0$	$Cor(\mu_j, \mu_k)=$	0

$$,_{ij} \sim N(0,o^2 0e) \qquad \mu_j \sim N(O,o^2 ou)$$

$$Cov(\mu_j, ,_{ij}) = 0$$

The intra-school correlation is given by the formula:

$$D \quad = \quad o^2_{ou}(o^2_{ou} + o^2_{oe})$$

This correlation measures the proportion of the total variation that is due to schools and also the degree of homogeneity within a school. The larger the value of D the greater the clustering and the more important it is to use a multilevel analysis (Goldstein, 1987).

Appendix 2

Model 2 is represented by the equation:

$$Y_{ij} = \$_{oij}X_{oij} + \$1^{x}_{\ lij} + \dots + \$_{k}X_{kij}$$

With $\$_{oij} = $**   **$\$o + F_{oij} + e_{oij}$

Where   i   =   student

       j   =   school

      Y_{ij} =   **response variables (MSCE Chichewa & Maths scores)**

      $Y_{lij}\dots X_{kij} =$ **student level explanatory variables**

      F_{oj} =   **school level random residual**

      e_{oij} =   **student level random residual**

      $\$^{o}$ =   **constant (intercept) term**

      $\$_{1}\dots\$_{k}$ =   **structural regression coefficients**

The same assumptions are made about the random terms as in model 1.

Appendix 2b

Model 3 is represented by the equation:

$$Y_{ij} \quad = \quad \$_{oij}X_{oij} + \$_{ij}X_{1ij} + \$_{2}X_{2}i_{j} + \ldots + \$_{k}X_{kij}$$

$$\text{Where} \quad \$_{oij} \quad = \quad \$_{o} + F_{oj} + e_{oij}$$

$$\$_{Lj} \quad = \quad \$_{1} + F_{1j} \text{ (complex level 2 variation)}$$

In this model schools not only vary in their intercepts but also their slopes. $\$_{1}$ here represents the coefficient of the JC scores and each school has its own $\$_{1}$ and these are allowed to vary across schools.

Two variance and one covariance are estimated here at the school level and these are:

$$o^2_{ou} \quad = \quad \text{the variance of the school means (constant)}$$

$$o^2_{olu} \quad = \quad \text{the variance of the school slope (JC scores)}$$

$$o^2_{olu} \quad = \quad \text{the slope-intercept covariance}$$
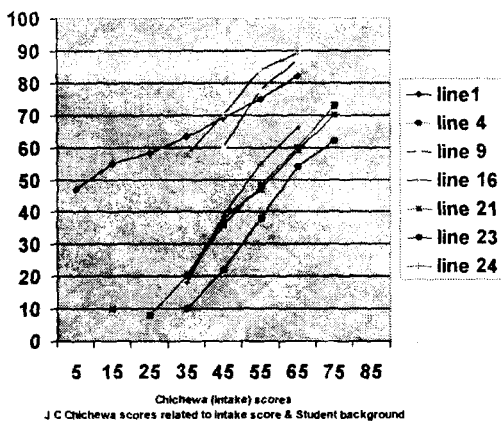
Total level 2 variation then becomes

$$o^2_{ou} + o^2_{1u} + 2o^2_{olu}$$

In addition one variance term (o^2_{oe}) is estimated at level 1. i.e. student level.

Appendix 3

JC Chichewa Intake Scores

Legend: line 1, line 4, line 9, line 16, line 21, line 23, Line 7, Line 8, Line 9

Appendix 4

Chichewa (intake) scores
J C Chichewa scores related to intake score & Student background

Legend: line1, line 4, line 9, line 16, line 21, line 23, line 24