

The Impact of Elementary School Related Factors on the Achievement of Montreal Francophone Children: Results from a Global Model

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The objective of this paper is to evaluate empirically the impact of elementary school related factors on the academic achievement of Montreal francophone children. Using a three-equation model we seek to explain simultaneously the level of achievement in mathematics and French and the self-concept of the students in our sample. The individual student is the basic unit of the model. The model includes numerous explanatory variables concerning personal characteristics of students, socioeconomic background of the student, and school-related factor variables. More specifically, school effects are defined in terms of not only structural components of the school setting but also teachers' and administrators' objective characteristics, specific educational interventions in a low-income area, and attitudinal variables. The data used in this paper originate from a two-year longitudinal sample concerning about 3,000 students. A logistic functional form is specified, and two-stage least square techniques are used for estimation.

Le but de ce texte est d'évaluer empiriquement l'impact des facteurs scolaires sur les résultats en français et en mathématiques d'élèves fréquentant le secteur français de la Commission des écoles catholiques de Montréal. Avec l'élève comme unité de base, notre modèle en est un d'équations simultanées incorporant les rendements scolaires et l'image de soi des élèves. Le modèle retient plusieurs variables explicatives concernant les caractéristiques personnelles de l'élève, des variables reliées à son milieu socio-économique et associées à son milieu scolaire. Plus spécifiquement, notre définition des facteurs scolaires inclut non seulement les composantes structurelles de l'école, mais aussi des informations sur les enseignants et administrateurs, des interventions scolaires spécifiques au milieu économiquement défavorisé et des variables d'attitude et de perception. Les données utilisées dans ce texte proviennent d'un échantillon longitudinal portant sur deux années et concernant près de 3,000 élèves. Une fonction logistique est spécifiée et les moindres carrés à deux étapes sont retenus pour l'estimation.

INTRODUCTION

The evaluation of educational interventions in low-income areas has been a primary research interest in North America for the past 20 years. The

present study grew out of the authors' evaluation of a major Québec program, *Opération Renouveau*, aimed at improving the educational opportunities of francophone students enrolled in Montreal inner city schools (Houle, Montmarquette, Crespo, & Mahseredjian, 1983). This program, under the responsibility of the Commission des écoles catholiques de Montréal (CECM), the largest single public school district in Canada, started in 1970 and had three basic objectives: improvement of students' performance in French and mathematics, enhancement of students' self-image, and betterment of students' general health condition.

Past evaluations of American educational programs in low-income areas have yielded polemic but inconclusive results about their real effectiveness. It seems, however, that the discovery by earlier evaluators of the nonlasting effects of educational interventions among disadvantaged children is now being questioned by more optimistic findings about longer term effects. Stickney (1981) has presented a good synthesis of these findings, and research continues on this subject (see, for example, Becker & Gersten, 1982). There does not seem to exist a similar review for Canada as a whole. For Québec, previous evaluations of *Opération Renouveau* are qualitative in nature.

The more general literature on school effectiveness is abundant and controversial. Studies by Coleman, Campbell, Hobson, McPortland, Mood, Weinfeld, & York (1966) and Jencks, Smith, Acland, Bane, Cohen, Gintis, Heyns, & Michelson (1972), showing the failure of school factors to account for variance in performance, and the British study *Fifteen Thousand Hours* (Rutter, Maughan, Mortimore, & Ouston, 1979), showing that some school-related factors do account for performance, delimit the many studies that address the question of school effectiveness.²

Some recent reviews of school effectiveness might be consulted with profit. Cuttance (1980), for instance, distinguishes between sociological aspects of schooling (selection, peer group formation and influence, and teachers' expectations) and pedagogic influences (teachers' characteristics, expenditures, and organizational factors – size of school and class) on students' achievement. He concludes that "schools are considered to be less influential than nonschool factors" (p. 275). He suggests, however, that students' attitudes and dispositions toward school and teachers' expectations might constitute fruitful lines of research. Finally, Centra and Potter (1980) propose a structural nonrecursive model to explore students' learning outcomes based on the idea that a global approach to education effectiveness seems preferable to a partial one based on selected sets of variables.

In this paper, the range of factors in the school setting that are regarded

as capable of influencing students' performance is very large. This approach contrasts with studies which analyze the impact of a limited set of factors.³ Thus, our definition of *school effect* includes not only *structural components* of the school setting (e.g., size and type of school) but also *teachers' and administrators' objective characteristics* (e.g., schooling, experience, and teaching methods), *educational interventions of Opération Renouveau* (e.g., pre-school, library, resource persons, and nutrition programs) and *attitudinal variables* (e.g., Pygmalion or Rosenthal effect, perceived school climate, pedagogical ideals, and self-concept).

Within this comprehensive definition of school factors, this paper will evaluate empirically the impact of elementary school related factors on the achievements of Montreal francophone students. This is done in the context of a global production function model of school achievement, and the study is designed to account for problems in data availability, estimation techniques, and functional forms encountered in previous studies.

After a brief introduction to some of the basic problems in previous literature, the second section of the paper discusses the data set and the specification of the model used to analyze these data. The third section describes the main findings of our model and emphasises an in-depth discussion of school effects and school interventions. In the fourth section, a synthesis of the principal results is presented, leading to policy and methodological recommendations.

THE DATA AND THE MODEL

In the literature, the problem of school effects has been analyzed with multiple regression techniques in the context of what has been familiarly called the *production function of education* or the *input-output model*. Those theoretical frameworks and statistical techniques, although largely accepted, are not however without conceptual or methodological difficulties. For example, what is the output of education? How does one differentiate between input and output variables in education? What is the meaning of statistical causality in education? In addition to these persistent difficulties, the literature has stressed three specific points with respect to the particular problem of school effects.

1. Some relevant variables are frequently omitted; such is the case with the measure of academic ability, in particular. This last omission tends to result in over- or underestimating the school effects (see Alexander, Pallas, & Cook, 1981).

2. A sample design suitable to the use of panel data and appropriate corresponding estimation techniques must be selected carefully to avoid obtaining biased coefficients estimates (see Boardman & Murnane, 1979).
3. The right specification of the functional form in determining the relationship between dependent and independent variables is crucial. If the model is misspecified, this could cast doubts on the validity of the findings (see Hauser, 1978; Sørensen & Hallinan, 1977).

The specific problem of selecting the appropriate sample design and statistical procedures was constantly singled out (see Rutter *et al.*, 1979; Tallmadge & Wood, 1978; Wingard, Smith, & Wan, 1981) when evaluating program impacts for students of low socioeconomic status. This study presents specific answers to these problems.

The Data

The data used in this paper originate from a two-year longitudinal sample (1979–80, 1980–81). The schools in the sample were chosen from a list of elementary schools ordered in a continuum from least-advantaged to most-advantaged according to a socioeconomic criteria (see Crespo, 1979). Thirty-six schools were chosen, 12 from each socioeconomic stratum: lower, middle, and higher. The rationale behind this strata selection is to permit a control reference group for an evaluation of *Opération Renouveau* compensatory programs which are mainly concentrated in schools of the lower socioeconomic group.

Once the schools were chosen, the different categories of persons to be tested or interviewed were identified: the students and their parents, home-room teachers, specialized teachers, professionals, and principals. All first, second, fourth, and fifth grade students from the chosen schools were included in the sample. More than 1,500 students at each grade level were involved.⁴

The self-concept measures were obtained from a French adaptation of McDaniel-Piers Younger Children's Scale for the students in first or second grades, while for those in fourth or fifth grades the self-concept was measured by Piers-Harris Children's Self-Concept Scale. The academic achievement in French and mathematics was measured by uniform grade-specific tests obtained from the school board records. Intellectual ability (IQ) was measured with a standardized test consisting of a number of subtests taken in kindergarten.

The other instruments – different questionnaires addressed to parents, home-room teachers, specialized teachers, professionals, and principals – were devised specifically for the study.⁵ Answers to these questionnaires

were then translated into more than 150 variables which could be divided into seven categories:⁶ personal characteristics of the student, socio-economic background of the student, school characteristics, peer group variables, perceptions and attitudes, interaction variables, and quadratic variables. Among the school characteristics, we considered a subcategory of variables called *school interventions* that included close to 50 variables mostly associated with the *Opération Renouveau* program. All this information was finally integrated into a unique vector associated with *each single student* in our sample.

The Model

The basic principle behind any modelling of an educational production function rests on the belief formulated by Hanushek that "education is a service which transforms fixed quantities of inputs [i.e., individuals] into individuals with different quality attributes" (1979, p. 355). Theory tells us about the importance of school structures, teachers' attributes and attitudes, the students' background knowledge and experience, and the role of socioeconomic factors and perceptions in this transformation. It also tells us that these factors interact in a very complex way, but unfortunately the theory falls short of specifying exactly those interactions and transformations. We propose a global educational production function model to deal with those interactions and transformations.

In this model, the individual student is the basic unit of observation.⁷ We retain the idea that education produces multiple outputs by considering a three-equation model to explain *simultaneously* the level of achievement in mathematics and French and results on a self-concept test for the students in our sample. We also propose a *learning curve* by using a logistic function to relate each of these three output variables to the input variables. This functional form accounts for the limited range of values taken by the measures of school achievement and self-concept test.

We can illustrate this functional form in the case of achievement in French (AF) with the relation:

$$AF_i = \frac{1}{1 + \exp\left(-\sum_{l=1}^k \beta_l X_{il}\right)}$$

$$\text{or } \ln\left(\frac{AF_i}{1 - AF_i}\right) = \sum_{l=1}^k \beta_l X_{il}$$

where X_l is the l -th explanatory variable and β_l the corresponding parameter. This equation implies that $0\% < AF_i < 100\%$.

One interesting and striking feature of this functional form is that the effect of any explanatory variable on achievement in French, to keep the same example, varies in relation to the actual score obtained by the student. Moreover, it assumes that it is easier to modify the academic performance and self-concept of a low achiever relative to a high achiever. In other words, this specification enhances the probability of the school intervention variables affecting noticeably the overall performance of the low achievers in our sample. Those low achievers are concentrated in schools located in the lower socioeconomic sectors of the city, the target population concerned by the *Opération Renouveau* interventions.

Our model specification relies on about 150 variables regrouped in the various categories presented in the previous section. It is worthwhile to emphasize that many variables are included in both linear and square forms to account for potential nonlinear effects; also many interaction variables were defined particularly with respect to dummy variables identifying the socioeconomic background of the student. What is recognized here is the possibility that some variables such as, for example, the home-room teacher's experience, the students' IQ, attendance at kindergarten, the time spent in the school library, and so on might affect test scores differently according to the student's socioeconomic status (see Datcher, 1982).

EMPIRICAL RESULTS

Estimation procedure

Before proceeding with a *two-stage least squares estimation* of our empirical model, we had to deal with the problem of missing observations. With the large number of variables used in this study, it is not too surprising that the problem of missing data was encountered. Most of the time, to deal with this question, we estimated the missing data for a given variable by a regression procedure of this variable on variables related to it using a complete subset of observations. The final sample included between 732 and 925 observations, depending on the grade concerned.

The application of the two-stage least squares technique to our model proved to be difficult in view of anticipated multi-collinearity and numerical analysis problems with a large number of variables. Eventually, we had to drop most of the peer group variables from the model in order to perform the regression analysis.

The model yielded satisfactory $\bar{R}^2$ s (adjusted R^2 s) ranging from 0.39 to 0.48 for the French and mathematics equations and from 0.09 to 0.19 for the self-concept equation as it can be seen in Table 1.

TABLE 1
Measure of Model Fitness

<i>Schooling Years</i>	$\bar{R}^2$			<i>Number of variables/ Number of observations</i>
	<i>Self-concept</i>	<i>Achievement in French</i>	<i>Achievement in mathematics</i>	
First grade	0.19	0.48	0.41	142/860
Second grade	0.12	0.41	0.41	163/732
Fourth grade	0.13	0.47	0.47	136/887
Fifth grade	0.09	0.39	0.47	167/925

Space constraints preclude us from presenting descriptive statistics and detailed analysis of all the statistical results.⁸ Instead, the next section presents a synthesis of the most important results obtained for the four grade study of the academic achievement of children. These selected discussions of specific variables reflect their statistical importance and take into account also their numerical importance as determined by the computation of elasticities and effects on the dependent variables associated with a given change in the relevant independent variables.

Results for the simultaneity of the model

Before discussing the results for school effects, it is relevant to mention our findings concerning the simultaneity of the model because of the implications for policy analysis. Table 2 presents, in a synthetic form, the contribution of each explained variable (academic achievement in French and mathematics, and self-concept) to the explanation of the other two dependent variables.

The most noticeable feature of Table 2 is that, contrary to our expectations, there are few significant relationships between the three endogenous variables, the measures of school outputs. More specifically, achievement in the basic subjects does not affect positively self-concept, and, reciprocally, a positive self-image fosters high academic achievement only in Grade 1 mathematics and Grade 2 French. Some positive relationships do exist between achievement in the basic subjects, as shown by Grades 2 and 4 results; however, no generalization is possible.

These results have serious implications. First, the relationships among the school output variables considered are much weaker than expected when several explanatory variables are included in the model. So, second, in terms of policy design, it might be difficult to find intervention variables which could help to reach all school objectives simultaneously by their indirect effects.

TABLE 2
Synthesis of the Simultaneity of the Model

<i>Dependent variables</i>	<i>Self-concept SC</i>		<i>Achievement in French AF</i>		<i>Achievement in mathematics AM</i>	
	AF	AM	SC	AM	SC	AF
<i>Independent variables</i>						
<i>Schooling years</i>						
First grade	0.363 ^a	-0.581*	-0.505*	0.538*	0.310**	0.781**
Second grade			0.380*	0.609*	-0.297*	0.689**
Fourth grade				-0.908 ^a		
Fifth grade						

NOTE: ^aStatistic $t > 1$ or $t < -1$
 * $p < .10$
 *** $p < .025$

In the next sections, we will focus on the effects of independent variables on academic achievement. The lack of simultaneity in explaining academic achievement and self-concept provides some justification for analyzing school achievement independently.⁹

Results on school effects

Table 3 presents a list of all significant and important variables associated with the school effects in our model. All variables are not equally important, and a detailed presentation is offered in each subsection.

Characteristics of teachers and principals

The variable with the strongest positive effect on achievement in the basic subjects is *home-room teacher's education* in the first grade.

With respect to the role played by *home-room teacher's experience*, it is more difficult to reach a general conclusion. Most studies which have found that the teacher's experience had a positive effect on school achievement also found that the result held only for the first years of teaching (see Hanushek, 1981). In our sample, all the teachers have several years of experience; therefore, we did not expect to find a strong effect of general teaching experience. We find that the effect varies across grades and socioeconomic strata. Interestingly, teacher's experience has a significant effect on achievement in mathematics but not in French. A more specific form of experience, experience in the present school, has a positive effect in the fourth grade (for students from the low and high socioeconomic strata) and in the fifth grade (for students from the middle socioeconomic stratum). In Grade 2, students who come from single-parent (mother) families stand to gain in mathematics from having a more experienced teacher.

Contrary to our expectations, the number of noncompulsory training sessions attended by the home-room teacher affects academic achievement negatively (in the first and fourth grades). It is difficult to know if these unexpected results are a cause or an effect, i.e., whether teachers take courses to improve themselves because students are weak or whether the courses taken are inappropriate, time-consuming, and therefore prejudicial to the students' performance.

Absences on the part of the home-room teachers are in most cases negatively related with students' academic achievement, especially if they come from a middle socioeconomic environment. In Grades 4 and 5, students coming from single-parent (mother) families perform better if they have a male teacher. The variables concerning the characteristics of

TABLE 3
List of Significant Variables Related to School Effect

Characteristics of Teachers and Principals

Home-room teachers

Absences

Education (Education)²

Experience (Experience)²

Experience $\times$ student living with mother only

Experience in the present school

Male teacher $\times$ student living with mother only

Number of non-compulsory training sessions attended

Principals

Experience in a school affected by *Opération Renouveau*

Organizational Characteristics

Open space classrooms

Class size $\times$ number of students repeating their grade

Class size $\times$ number of immigrants

Class size $\times$ IQ

Attitudes and Perceptions of Teachers and Principals

Teachers

Perception of students' motivation

Evaluation of intellectual capacity of students

Pedagogical ideal concept

Exclusion of parents concept

Pygmalion effect concept

Perceived marginality of violence concept

School climate concept

Principals

Verbal aggressiveness against teachers

Vandalism in school

School climate concept

Leadership concept

Time spent in innovation, planning, evaluation and pedagogical supervision (%)

Time spent on relations with the community (%)

TABLE 3 (*concluded*)*Intervention Variables*

Private kindergarten (4-year-old)

Public kindergarten (5-year-old, part time)

Private kindergarten (5-year-old, part time)

Public kindergarten (5-year-old, full time)

Private kindergarten (5-year-old, full time)

Attendance of home-room teacher at training sessions of *Opération**Renouveau*

Information on nutrition for students

Information on nutrition for parents

Score on a test of knowledge on nutrition

Score on a test of nutrition habits

Time spent in school library

– less than an hour per week

– one hour or more per week

Educational outings (not integrated to classwork)

Outdoor classes integrated to classwork

Outdoor classes not integrated

Resource teachers (meeting hours)

Resource teachers (experience)

Remedial teachers (meeting hours with a group)

Remedial teachers (experience) (group meetings)

Remedial teachers (individual meeting hours)

Remedial teachers (experience) (individual meeting hours)

Social workers (group meetings)

Psychologists (group meetings)

Nurses (group meetings)

Social workers (experience) (group meetings)

Psychologists (individual meeting hours)

Nurses (individual meeting hours)

Resource-persons and resource-parents

Resource-parents only

the school principal do not have a consistently significant effect. One interesting result, however, given our preoccupation with the effectiveness of school attributes in improving the achievement of disadvantaged students, is that, in Grades 1 and 4, the experience that the principal has acquired in a school affected by *Opération Renouveau* positively influences French achievement of pupils from a lower socioeconomic environment.

Organizational characteristics

As expected from the findings of previous studies, the physical characteristics of the school do not significantly influence academic achievement. However, two variables concerning school organization do have a significant effect. Open space classrooms are negatively linked to achievement, except in mathematics for Grade 5 students from underprivileged backgrounds. The number of students, particularly in a classroom with a large proportion of immigrants or students repeating their grade, has a negative effect on the French and mathematics test scores of Grade 1 students.

Attitudes and perceptions of teachers and principals

Some of the more recent literature on the production function in education has stressed the importance of considering attitudinal variables (e.g., Link & Ratledge, 1979), not only the more traditional school variables mentioned above. We included several measures of teachers' and principals' attitudes and perceptions. The results are rather difficult to summarize: for most variables, the direction of the effect differs from one grade to another and from one socioeconomic stratum to another. We were particularly interested in testing the existence of the Pygmalion effect since it had been suggested that the poorer results for students from low-income areas could be explained by their reaction to teachers' and administrators' expectations. Although some significant coefficients pointed to the existence of a Pygmalion effect, there were too many significant coefficients pointing to the opposite effects to draw a firm conclusion.

The *pedagogical ideal (goal) of the teacher* has significant effects on achievement in the basic subjects in the first two grades.¹⁰ In Grade 1, a more traditional pedagogical ideal is associated with higher school achievement in privileged areas. In Grade 2, it influences positively achievement in French for students from low socioeconomic backgrounds, but it influences negatively the achievement in mathematics for the same students. As for the variables related to school climate or perceived violence, their effect is ambiguous.

For the second and fifth grades, we had some information on the leadership of the principal and the allocation of his time. The importance of those factors was underlined in the Phi Delta Kappa study (1980). We did not obtain strong evidence that the leadership of the principal or a higher proportion of time spent on innovation, planning, evaluation, and supervision had a positive effect on students' school achievement.

Our findings concerning attitude and perception variables may indicate that these variables lose importance when the model includes several personal, socioeconomic, and school attributes. But they may also arise from the difficulty of measuring attitudes and perceptions adequately.

Results on educational intervention variables

The intervention variables hold a special interest because they are, to a larger extent than other variables, control or policy variables. Many of those interventions are part of the *Opération Renouveau* program in the underprivileged areas. For example, a relatively large share of the *Opération Renouveau* budget was allocated to public kindergartens (for 4-year-olds and, to a lesser degree, 5-year-olds). Public kindergarten attendance does not have a significant effect on academic achievement for students in underprivileged areas. Some positive effects are observed for those students in the fourth grade with respect to *private* kindergarten attendance. In the first grade, having attended kindergarten is related negatively to achievement in French and positively to achievement in mathematics for students from a privileged environment. Although we cannot rule out the possibility of a positive influence of public kindergarten attendance in later years (see Hodgkinson, 1982, on Headstart), this intervention does not seem to affect students' academic achievement in our sample.

The group of intervention variables linked to the nutrition program (results from tests of nutritional knowledge and habits¹¹ and information sessions for students and for parents) are related to school achievement positively. The effects, however, are rather small.

The findings linking the number of hours spent in the school library and performance in French are positive for first graders from privileged areas. For children from low socioeconomic environments, time spent in the school library, even when it is less than one hour per week has a negative influence on performance in French. There is reason to wonder whether this finding is linked to the different pre-school educations that children from different environments receive. Time spent in the library has a positive effect on French achievement for students from middle and high socioeconomic strata in Grade 2, while it has no significant effect in Grades 4 and 5.

We were unable to find a systematic effect associated with educational outings and open air classes regardless of whether they were part of the academic program. Besides, the few positive or negative effects observed are weak. Similarly, for the category of resource teachers,¹² in terms of number of hours of contact with the children or years of experience,

no systematic effect is observed. Sessions with a remedial teacher in a group or on a one-to-one basis have a positive effect on the students' performance. The most significant effects are positive, and the most noteworthy are in mathematics. It should be noted that no information was available for sessions held on an individual basis for Grades 1 and 4. Time spent meeting social workers or nurses on a group basis has a positive and significant influence on performance in French for first graders. With regard to certain professionals and specialists, we found several examples of a negative effect on student performance. This could reflect the cause of the intervention rather than the effect. In fact, a student's poor performance may cause increased meetings with professionals (or specialists), so that, while in the short term our regression analyses find that this is the direction of the relationship, in the medium or longer term we might hope to capture the relationship in the other direction, i.e., that of the effect of the input on the student's achievement. A typical example is the significant relationship between exposure to social workers in the previous year and performance in mathematics for Grade 5 students. However, this hypothesis is not confirmed in the case of psychologists and nurses for the fifth graders.

A generally positive but weak effect is observed when the school benefits from the presence of resource parents and persons.

Results on personal attributes and socioeconomic variables

The previous discussion of empirical results concerned only school effects. However, one must remember that the model included variables measuring the personal attributes of the students, the socioeconomic characteristics of their environment, and the attitudes and perceptions of their parents. The inclusion of those variables allows us to better isolate the *school effects* in the context of a global explanation of students' achievement. Table 4 lists the significant variables of this group found in our model.

As expected, IQ as measured in kindergarten¹³ has a strong and persistent impact on achievement in French and mathematics. Moreover, from the regression results, we know that this variable has a greater direct effect on achievement in a privileged socioeconomic environment than in an underprivileged environment with respect to Grades 2, 4, and 5, the reverse being true with respect to Grade 1.

The number of times a student is late or absent and the number of schools attended are, for the most significant cases, detrimental to the students' achievement, but in varying degrees according to the grade and socioeconomic environment. On the other hand, the average number of

TABLE 4
List of Significant Variables Related to Student Personal Characteristics and Socioeconomic Background

<i>Personal characteristics</i>
Sex (male)
Age
IQ
Latenesses
Schools attended
Absences
Hours spent watching TV
(Hours spent watching TV) ²
<i>Socioeconomic background</i>
Father's education
Mother's education
Mother's education presence × presence of resource parents
Mother works full time
Living with mother only
Single parent (mother) × home-room teacher's experience
Language spoken by parents at home (French)
<i>Parental perceptions</i>
Parents think child is successful in school
Parents think child has problems in school because he (she) is not talented
Parents think child has problems in school because of teaching methods

hours per week spent watching television has no negative influence on academic achievement except with respect to achievement in mathematics for Grade 5 students. Finally, boys do better in mathematics in Grades 4 and 5 and in French in Grade 5.

The results for the socioeconomic variables of the model reveal some important trends. The mother's level of education has a positive influence on the performance in mathematics of students from all backgrounds. The father's level of education has a positive and significant influence on performance in the basic subjects of Grade 5 students from middle and privileged backgrounds. No systematic influence was noted on the test scores of children whose mother works full time. A student in Grades 1¹⁴ and 2 coming from a single-parent (mother) family does less well in mathematics than a student from a traditional two-parent family. Finally,

better achievement in mathematics for students with parents whose first language is not French, compared to students with francophone parents, is a very clear and constant result found in our study.

Concerning parental perceptions, the two most important variables are *evaluation of student's success* and *attributing problems in class to intellectual deficiencies*. Both variables have the effects we would expect. One perception variable among parents that has an effect differentiated by socioeconomic background associates students' classroom problems with low intellectual ability: if the cause of classroom problems is attributed to this weakness, the values of the dependent variables in our study decrease significantly. Students whose parents think that their problems in school stem from the teaching methods have lower test scores. However, the effects only begin to show in Grade 4 and affect only the achievement in mathematics.

When trying to design policies to improve the effectiveness of urban schools or to equalize educational opportunities, it is crucial to know the role of personal characteristics and socioeconomic variables in determining academic achievement. If these variables (beyond the control of school authorities) were mostly responsible for the level of achievement, the school authorities would face an almost insurmountable problem. We ran simulations to evaluate the extent of reduction of inter-socioeconomic strata differences in performance if the mean value of the personal characteristics and socioeconomic variables observed in the two lower strata were replaced by the mean value observed in the highest stratum. All the personal characteristics and socioeconomic variables were considered in the simulations regardless of whether their estimated coefficients were statistically significant.

Our simulations indicate that the personal characteristics variables explain an important aspect of the mean performance differences observed between backgrounds. We note an increase in the mean results for each of the four elementary grades studies ranging from 1.15 to 4.06 points in French and from 0.62 to 3.46 points in mathematics, with the highest gains registered in the low economic stratum. With respect to the proportions of the observed differences explained by our simulations, we note that the explained proportions are between 8 and 51% in French and 12 and 87% in mathematics.¹⁵ We wish to observe that in these simulations the students' IQ is the most important personal characteristic.

The same simulations applied to the socioeconomic variables of the model lead to the conclusion that these variables are less important in explaining the differences in mean results observed between backgrounds. However, certain variables sometimes have an important effect, as we

mentioned for mother's education, which reaches a higher level in upper socioeconomic backgrounds, explaining some differences observed.¹⁶

CONCLUSION

This study dealt with the problem of estimating school effects in an urban context. In this empirical research, the credibility of the findings regarding school effectiveness depends on the ability of the model to explain the students' results in academic achievement tests. The model estimated provides a very good explanation (statistically speaking) of the students' test scores in French and mathematics. Moreover, the reliability of the explanation of the model is invariant with students' socioeconomic background. However, the model slightly overestimates the results of the students who scored highest in the IQ tests. We can summarize our empirical findings as follows.

A *first result* of our research which we judge important concerns the simultaneous nature of our model. We found that, once several explanatory variables are taken into account, there exists no systematic link (positive or negative) between self-concept and academic achievement in the basic subjects. Furthermore, although the results in one basic subject sometimes contribute significantly to explaining the results in the other basic subject, this effect is far less frequent across grades than expected. This implies a difficulty in designing intervention formulae which will improve simultaneously and significantly students' achievement in French and mathematics and self-concept.

The second result we wish to comment upon concerns the role of variables beyond the control of school authorities: personal attributes, socioeconomic variables, and parental perceptions.

The kindergarten IQ test score contributes strongly to the explanation of academic achievement. In relative terms, it is the most important explanatory variable among the set of personal attributes and socioeconomic characteristics. The effect of the variable differs from one socioeconomic stratum to the other. It is stronger for students from underprivileged areas in Grade 1 while the reverse is true in Grades 2, 4, and 5. When they start school, more "gifted" students from underprivileged areas can somehow make up for the lack of certain resources in their environment. But, as school years pass, the combinations of school, family, and larger environment resources are such that "natural ability" has greater positive effect on achievement for students from relatively more privileged areas. Although the process by which this happens remains unknown, this empirical finding merits future research.

Among socioeconomic variables, mother's education has the most persistently significant effect, especially on achievement in mathematics. Students who belong to a single-parent (mother) family perform less well on average in the first years of schooling than children belonging to a two-parent family. A positive parental perception of the child's intellectual ability is related positively to the child's academic achievement.

Although several other personal characteristics and socioeconomic variables significantly affect academic achievement, sometimes in French or mathematics, sometimes in only one grade or socioeconomic stratum, the variables above emerge as having the overall most significant impact.

A *third result* of our study is that, among the school variables traditionally considered, the most influential variable in the first elementary grade is the home-room teacher's education. Several other variables also have a significant impact: the teacher's absences, certain forms of the teacher's and principal's experience, and the size of the class.

The *fourth result* pertains to educators' and administrators' attitudes and perceptions. In our study, we note the lack of consistent results for the various agents and the various grades. The one exception is the effect of the teacher's pedagogical ideal (goal). Such a traditional goal is associated with higher school achievement in Grade 1 in privileged areas. In Grade 2 for students in underprivileged areas it influences achievement positively in French but negatively in mathematics.

Although the absence of confirmation of our hypotheses about the effect of attitudes and perceptions might lead us to conclude that the role of such variables has been exaggerated, it should be noted that the lack of significant and consistent results may come from the difficulty of measuring these concepts.

The *final result* is related to the effect of what we called school interventions. Our regression results indicate the *Opération Renouveau* type of interventions do not exert a large positive influence on academic achievement. Some interventions even have negative effects. However, there are interventions with significant positive effects, and these are worth mentioning. The nutrition program, the presence of remedial teachers, and the intervention of professionals (social workers and nurses) have a positive effect. Still other interventions have no significant positive effect, contrary to our hypotheses. Such variables are public kindergarten attendance for underprivileged children, meetings with professionals, time spent in the school library, resource teaching personnel, educational outings, and open air classes.

In conclusion, we did find some significant school effects after considering personal attributes of the students and socioeconomic characteristics. However, even with elements that distinguish our study

from previous ones, such as a large number of explanatory variables, a simultaneous equation model applied to disaggregated data, and appropriate functional form and estimation techniques, we could not reach a conclusive answer to the question of school effectiveness. Additional methodological issues (for example, the multi-collinearity problem) arise when we enlarge the educational production functional model. Therefore, the design of further research concerning school effects must consider the trade-off between a complex modelling of the reality and the limits of available statistical techniques.

NOTES

- ¹ This is a condensed report of a more extensive study recently completed by the authors for the Commission des écoles catholiques de Montréal, Montreal, 1983. The research assistance of Luc Monty, François Coupal, Yves Geoffrion, Monique Bélanger, Catherine Lombardo and the comments of Françoise Coulombe, Gilles Goulet, Guy Huot, and Richard Laferrière on an earlier version of the text were greatly appreciated. Remarks and suggestions from referees and the editor of the *Canadian Journal of Education* were helpful in revising the paper. Some of the findings were presented at the American Educational Research Association meeting in Montreal in 1983.
- ² In the economics of education literature, one should mention Boardman, Davis and Lloyd (1974), Henderson, Mieszkowski and Sauvageau (1976), Hanushek (1971, 1979, 1981), Link and Ratledge (1979), Summers and Wolfe (1977) and Walberg (1981).
- ³ One interesting exception is McDonald and Elias (1976).
- ⁴ In 1979–80, information on the first and fourth graders was obtained. The following academic year information on the same students then in second and fifth grades was compiled.
- ⁵ The rate of responses to the questionnaires and other instruments for the various categories of people involved was high. See Houle, Montmarquette, Crespo, and Mahseredjian (1983) for details.
- ⁶ Justification for the choice of those variables are detailed in Houle and Montmarquette (1978) and Houle, Crespo and Montmarquette (1979) and can be found in the above mentioned literature.
- ⁷ Incidentally, Cuttance (1980, p. 277) suggests that the individual student should be the proper unit for analysis.
- ⁸ A set of complete results from the regression analyses (including the self-concept equation) and descriptive statistics are available from the authors.
- ⁹ This does not mean, however, that the estimated coefficients are identical to those we would obtain in a two-equation instead of a three-equation model.
- ¹⁰ "Concepts" were constructed from several variables using factor analysis. For more details, see Houle, Montmarquette, Crespo, and Mahseredjian (1983).
- ¹¹ Those tests were not taken in 1979–80.
- ¹² These teachers were assigned to schools in underprivileged areas to help the regular staff. Their tasks varied from one school to the other.

- ¹³ When available. If not, the kindergarten IQ test score was estimated from the first grade IQ test score.
- ¹⁴ For Grade 1, the coefficient of the interaction variable "home-room teacher's experience $\times$ single-parent (mother) family" is statistically significant.
- ¹⁵ Note that, in mathematics, the last proportion (87%) does not correspond to the highest gain in points (3.46).
- ¹⁶ Part of the influence of the socioeconomic variables on the differences in test scores passes through the effects differentiated by environment (coefficients of the variables of interaction between the explanatory variables of the model and the environmental variables). Our simulations do not pick up that influence.

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Das Ziel dieser Abhandlung ist die empirische Prüfung der Auswirkung von grundschulbezogenen Faktoren auf die akademische Leistung von französischsprachigen Schülern in Montreal. Unser Modell enthält drei Gleichungen welche gleichzeitig die Leistungsebene der Schüler dieser Probe in Mathematik, Französisch und Selbstschätzung erklären sollen. Der einzelne Schüler ist die Grundeinheit dieses Modells. Das Modell enthält zahlreiche erklärende Variable die sich mit den persönlichen Eigenschaften und der sozial-wirtschaftlichen Lage des Schülers und mit schul-bezogenen Faktoren befassen. Im Einzelnen enthält die Definition der Schulauswirkungen nicht nur die strukturellen Komponente der Schulsituation sondern auch die objektiven Eigenschaften der Lehrer und

Verwalter, die Lehreinflüsse einer Nachbarschaft niedriger Einkünfte und die Variablen des Verhaltens. Die Daten dieser Abhandlung stammen von einer zweijährigen, fortlaufenden Untersuchung die ungefähr 3 000 Schüler umfasste. Ein logistische Funktionsform wurde bestimmt und zur Schätzung wurden minimum-quadrat Techniken angewendet.

El objetivo de este artículo es evaluar empíricamente el efecto de factores relacionados a la escuela primaria sobre los resultados académicos de niños de habla francesa de Montreal. Nuestro modelo es un modelo de tres ecuaciones que trata de explicar, simultáneamente, el nivel de resultados en matemáticas y en francés y la idea que los estudiantes de nuestra muestra tienen de sí mismos. El estudiante individual es la unidad básica del modelo. El modelo incluye numerosas variables explicativas relativas a las características personales de los estudiantes, a los antecedentes socio-económicos de los estudiantes y a las variables del factor relacionado a la escuela. De manera más específica, nuestra definición de efectos de la escuela incluye no solamente componentes estructurales del ambiente escolar, sino también las características objetivas de los maestros y administradores, intervenciones educacionales específicas en áreas de rentas bajas, y variables de actitudes. Los datos usados en esta investigación provienen de una muestra longitudinal de dos años de 3.000 estudiantes. Se especifica una forma logística funcional y se usaron técnicas de estimación.

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