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Relationships Among Student-body Composition, School Process, and Mathematics Achievement in Argentina's High Schools

Relaciones entre Composition estudiantil, proceso escolar y el logro en matemáticas en la educación secundaria en Argentina

Rubén Cervini Iturre
racervin@infovia.com.ar
Departamento de Ciencias Sociales
Universidad Nacional de Quilmes

Salguero 2460, 5º Piso
Buenos Aires, Argentina

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Abstract

This is a study of the relationships between the student-body composition of the school, some characteristics of the scholastic process—*culture and school climate*—according to learners' perceptions, and the mathematics achievement of students in the last year of high school in Argentina. The data used came from the 1998 National Census of High School Completion, carried out by the nation's Ministry of Culture and Education. The file contains data for 135,000 students of 2,708 schools in 25 states. Multilevel linear modeling with three levels (student, school and state) was applied. A strong relationship was detected between mathematics achievement and the variables *student-body composition* and *school process*. When both variables acted together, the effect of other variables experienced a pronounced descent. Although reduced, the variables of the

process influenced the student's achievement. There was identified for future works a reference model which would evaluate other institutional learning factors.

Key words: Scholastic achievement, high school education, institutional factors, school climate, scholastic culture.

Resumen

En este estudio se investigan las relaciones entre la composición estudiantil de la escuela, algunas características del proceso escolar —*cultura y clima*— según percepciones del alumno, y el rendimiento en matemáticas de los alumnos del último año de secundaria en Argentina. Se utilizan los datos del Censo Nacional de Finalización del Nivel Secundario de 1998, que fue realizado por el Ministerio de Cultura y Educación de la nación. El archivo es de 135 mil alumnos en 2,708 escuelas de 25 estados. Se aplica la técnica de *análisis estadístico multinivel* con tres niveles: alumnos, escuela y estado. Se detectó una estrecha relación entre el rendimiento en matemáticas y las variables *composición* y *proceso escolar*. Cuando ambas variables actúan conjuntamente, el efecto de otras variables experimenta un descenso pronunciado. Aunque reducido, las variables del proceso influyen en el logro del alumno. Se identificó un modelo de referencia para futuros trabajos que evalúen otros factores institucionales del aprendizaje.

Palabras clave: Logro escolar, educación secundaria, factores institucionales, clima escolar, cultura escolar.

Introduction

Recently, several studies have questioned the validity of the conclusions of a great part of the research on scholastic effectivity (Angus, 1993; Coe and Taylor, 1998; Gerwitz, 1998; Gibson and Asthana, 1998; Hatcher, 1998, cited by Thrupp, 2001b; Slee, Weiner and Tomlinson, 1998; Thrupp, 2001a; 2001b), and have generated, in turn, reactions of some of the most visible of this type of study (Daly and Ainley, 2000; Goldstein, 1998; Teddlie and Reynolds, 2001). Up for grabs in the debate is the credibility of the messages that endorse scholastic efficacy and identify factors of institutional effectiveness. In connection with the studies on the "determination of the existence and magnitude of school effects" (Teddlie, 1994b, p. 89)[*] through regression analysis, which are different from the case studies whose interest is to determine the characteristics or processes belonging to singular, effective schools, three methodological topics have acquired relevance in this debate. These are the inclusion of contextual variables, the conceptualization and measurement of the culture and institutional climate as aspects of the scholastic process, and the technique used to analyze the data.

The results of investigations will undoubtedly vary according to the treatment given these three aspects. This study is guided by the idea that to demonstrate the

[*] Translator's note: Not having access to the original English version of English-language works quoted in this paper, I have been obliged to use the technique of back-translation, for which I extend my most humble apologies.

effectiveness of any characteristic of the schooling process (policy, organization, teaching practice), there is required a reference model (control or adjustment). This must include not only measures of individual student background (social origin, gender, academic history), but also and principally, many different indicators of the school's composition; and measurements of the culture and school climate based on attitudes, expectations and perceptions of the school's own students. In addition, the data must be analyzed with the technique of hierarchical linear models—the only means available for overcoming the technical problems of traditional methods of regression.

In this paper my aim is to illustrate these criteria and to identify the model of reference for secondary education in Argentina, as based on the 1998 National Census of High School Completion, conducted by the nation's Ministry of Culture and Education. To this end, we have explored the relationships between the students' achievement in mathematics, the composition of the student body, and some characteristics of the culture and the school climate, according to the perceptions of the students themselves. The results obtained will serve for future studies oriented toward evaluating the measurements concerning the school's institutional life, according to the information provided by school principals.

I. Background

The hypothesis that school climate relates to educational results has a long history (Scheerens and Bosker, 1997). Much research has been concentrated on the effects of the classroom's social climate on students' cognitive and affective development (Angell, 1991; Dunn and Harris, 1998; Fraser, 1989, Waxman and Ellett, 1992). Other studies, no less numerous, have focused on the effects of institutional climate or culture (Anderson, 1982; Purkey and Smith, 1983). Recent critiques of the studies on effectiveness have questioned the validity of a great part of this background research. At least three methodological aspects could be considered to assess such validity in the correlational studies: (1) measurement of context or composition of the student body, (2) concept and measurement of culture or institutional climate and (3) technique used to analyze data.

1.1. Composition of the student body

One of the main criticisms of the tradition of scholastic effectiveness studies is that it has not given enough attention to the effect of the school's social context, giving the impression that the school acts independently of such determination (Slee, Weiner, and Tomlinson, 1998; Thrupp, 2001b).

On the other hand, Teddlie and Reynolds (2001), believe that since very early (Coleman Report) school effectiveness studies have addressed the impact of social class on student achievement, distinguishing between "the individual socioeconomic level of the student, and the effect of the group of students" (p. 53), and have never claimed that school effectiveness was independent of the student body's composition (p. 56). In fact, the hallmark of the authors of school

effectiveness is believing that schools can have an impact beyond that of social class, rather than being obsessed with the relationship between social class and student achievement (p. 54).

A decade ago, Kreft (1993) indicated the existence of two alternative theoretical focuses regarding the causes of effective school climate, that is, leading to improved scholastic achievement. The first approach argues that the climate is the result of the institution's organization and policies (type of school) and that, moreover, it molds the behavior and the attitudes and expectations (scholastic ethos) of the student, immediate conditioners of their level of scholastic achievement (school climate hypothesis); in other words, the joint effort of principal, teachers and parents—who agree on policies and standards of education—creates an effective school climate.

According to the second focus, however, school climate, like other institutional variables, is the result of the composition of the school's student body, a product of institutional selectivity (school composition hypothesis). The students' attitudes and individual behavior depend on the type of student attracted to or selected by the school, which molds its composition and determines the student climate. Then, higher expectations of achievement and an environment of ordered learning are the result of the makeup of the student body, and not of polices or directed institutional interventions. In summary, neither of the two theories questions the association between institutional climate and scholastic achievement, but while the first says that the climate models the attitudes and behavior (ethos) of the student, the second considers this to be a result of these last two variables and student-body composition. The students create their own school climate.

This dilemma appears in the analysis of any aggregation of the educational system (classroom, school, district, state, etc.), although its individual components change. In the classroom, the specific element is the instructor's teaching practice. For the focus of educational effectiveness, "successful schools are those that can achieve effective classrooms (Creemers, 1994, p. 201), and ultimately, teachers are the crucial factor for education in the classroom" (p. 203). Through his/her pedagogical practice, the teacher can generate an atmosphere tranquil, orderly, and oriented toward learning. A prolific history of research has identified many different behaviors of the teacher, both concerning classroom management and teaching itself, supposedly effective in achieving that objective. There have also been proposed theoretical models that incorporate and synthesize part of those empirical findings, frequently based on the key concepts of Carroll's model (1963) (Creemers, 1994; Slavin, 1996), or that integrate the classroom level with upper strata of grouping (Scheerens y Creemers, 1989; Teddlie, 1994a). Regarding the latter, the review of several studies leads us to conclude that, by means of various mechanisms, "teachers in the most effective schools conduct the classroom with a more positive climate and with higher expectations for learning than do teachers in less-effective schools (Tedlie, 1994b, p.128). A recent study by Yasumoto, Uekawa and Bidwell (2001) confirms the argument for integration of different levels—department (or subject area) and classroom—in the high school.

According to their data, the authors conclude that through the interactions of teachers in the same department in each school, there is created a pedagogical culture of "the effective way to teach and manage the classroom" (p. 183), producing greater pedagogical consistency, and intensifying its effect on students' learning.

In the alternative focus, by contrast the composition of the makeup of the group of students in the classroom influences the teacher's style, whether because teaching practice (quality and quantity) varies according to his/her expectations about the group's learning ability, conditioned in turn by its aptitudinal composition (Barr and Dreben, 1983; Gamoran, 1987); because of the processes of group reference; or because of both factors (Hallinan, 1988).

While correlational studies can hardly resolve in conclusive form, the impasse between school climate and student-body composition, at least there is consensus around the idea that the validity of the conclusions of any study depends on the inclusion of good and various measurements of the school's socio-economic context. In reality, it is of little interest that "for every school-impact study that has indicated weak 'compositional', 'contextual', or 'peer group' effects' on students' achievements, there has been another that indicates a much stronger impact of student-body composition" (Thrupp, 2001b, p. 24). Nor is it of interest to scrutinize the impact of the context of scholastic achievement, if this is interpreted by means of an organizational or sociological theory, such as Bourdieu's theory of cultural reproduction (Thrupp, 2001b, pp. 27). From the methodological point of view, the problem can be reduced to the following question: has the data analysis included good measurements of the school's social context, in addition to the individual student's social background? That is, are the estimates of the scholastic effect "adjusted" by the student's social background and the school's socioeconomic composition? Do these measurements capture diverse aspects of the students' socioeconomic background? The theme continues to be valid for the existence of recent studies where this condition is not fulfilled. In brief, all research on scholastic factors should reflect the face-off between the effect of student-body composition and scholastic effect.

Other conclusions related with the above also seem to have a certain consensus: (a) in the more developed countries, the differences in scholastic achievement explainable by the school (*interschool* variance) is notably less than those attributable to the extra-scholastic factors (*intra-school* variance) (Teddlie and Reynolds, 2001, p. 54; Thrupp, 2001a, p. 448). (b) At the same time, the effect of context variables is always greater than the individual; and (c) the factors of effectiveness can vary according to the socioeconomic context (Teddlie and Reynolds, 2001, p. 59; Thrupp, 2001b, p. 24). It seems appropriate, therefore, always to include the analysis of interaction with contextual measurements. Finally, there are numerous studies which support the hypothesis of an effect relevant and significant for *Intellectual Composition* or *Composition by Background Achievement* (Teddlie and Reynolds, 2000) regarding scholastic achievement in

primary-school education (Leiter, 1983) and high school (Resh and Dar, 1992; Opdenakker and Van Damme, 2001).

1.2. Culture and school climate

The classical focus defines *school culture* as systems of attitudes, values, norms and meaning shared by the members of a school (Tagiuri, 1968). However, the postmodern critique of the idea of a unique culture, static, as opposed to a dynamic and heterogeneous concept with different cultures competing, confronting each other, and negotiating (McLaren, 1991; Quantz, 1988) has revealed the importance of considering all the "voices" existing in the institutional environment, including the student body. In this regard, Thrupp (2001b) has observed that school effectiveness studies tend to use "notions of school culture that emphasize the organizational, administrative (management), and instructional dimensions of the school at the expense of the student and community culture", when in reality, the school culture should be visualized as the result of a "negotiation with the students on the basis of levels of docility, motivation and aptitude according to social class, which in turn, is related to the vision of the student regarding the school and his/her probable occupational future (Thrupp, 2001b, p. 26). In this perspective, "school cultures are the product of the interaction between the *official* culture and that of the students" (Hatcher, 1998, cited by Thrupp, 2001b, p. 27).

When it comes to teaching practice, the predominant tendency is to lay the concept of culture exclusively on the shoulders of the teachers. During the last two decades, numerous studies have promoted the idea that the teaching culture is the result of the teachers' interactions in school (Angelides and Ainscow, 2000), and consistent with this idea, it has been judged to be of instrumental origin. The culture through which the actors define present reality "is often a function of problems inherited from the past" (Hargreaves, 1995, p. 25). A recent study mentioned above (Yasumoto, Uekawa and Bidwell, 2001) is a paradigmatic example. The authors investigated the effect of the *pedagogical culture* of high school mathematics and science teachers regarding students' achievement. It is assumed that teaching will make various and sometimes contradictory goal demands, while at the same time it is technically imprecise (Rowan, 1990; Weick, 1976). As a result, teachers seek to solve problems endemic to the classroom through informal day-to-day interactions with colleagues, supposedly focused on the everyday work of teaching. These *clusters of interaction* generate a convergence of teachers on the diagnosis of problems and how to solve them, that is, the effective way to teach and manage the classroom in that particular school. If in a department (or disciplinary area) there exist these *interactive clusters* it is more probable that a local culture will be generated—"a variety of social capital that will sustain vigorously normative discourses on good teaching practice, achievement of goals, procedures and teaching standards" (Yasumoto, Uekawa y Bidwell, 2001, p. 183), producing a greater collective consistency in the teachers' pedagogical practice, and consequently intensifying the effect of this on the students' achievement progress. In sum, the authors conclude that when teachers have close communication (social relationships), they share intense critiques of the

teaching process (*ethos*), and are consistent in the way they teach (behaviors, teaching processes). The effects of their pedagogical practices on the progress of student achievement are intensified. However, in many other studies, no measurements of the *sociodemographic composition* were included, much less those for *student culture*, although there was information about the student's personal characteristics (social origin, ethnicity, gender, and previous achievements) which could have been added to create variables of composition. Consequently, it is impossible to know how much of the effect of the *teacher's culture* is superimposed on the student-body composition, or if it is an indirect effect of that composition, or how much is simply the adaptation of the teacher to the cultural ethos of his/her students.

Beyond the theoretical relevance of disputing the various voices or cultural perceptions, the imperative for including the student's perceptions is based on two well-founded reasons. First, the student is the subject of a set of scholastic attitudes and expectations, the result of the dynamic and conflictive process of the conversion of *cultural capital* (provided by his/her family social origin) into *scholastic capital* (Bourdieu, 1988; Bourdieu and Passeron, 1981) through scholastic action. Motivation and a positive attitude toward the school and academic knowledge are part of this set, and are related with scholastic achievement. According to Carroll (1963), the degree of learning is based on the time the student actually spends on a particular learning task, and the time the task requires. If the time assigned by the instructor to the teaching of a specific task, the aptitude of the student, and the quality of the teaching are maintained constant, then learning will depend on the student's perseverance or effort (the time the student is actively involved), which in turn depends not only on the student's motivation—a mixture of the *cultural capital* inherited from his/her family, and of previous school experiences—but also on incentive, "the product of specific strategies for increasing motivation" (Slavin, 1996, p. 8) which the teacher adopts in the teaching/learning process.

Second, the review of studies has established that the behavior of a given factor may vary according to the source of information. Stringfield (1994) has observed that the measurements of school climate based on the perceptions of the principal, the teachers and the students are not necessarily parallel. Generally, the perceptions of the first two are more closely associated with socioeconomic status than with student achievement, while measurements based on the students' perceptions are more independent of the socioeconomic level. Therefore, the author suggests that "future large-scale studies on scholastic effects" should no longer ask teachers or principals, but should" ask students directly about their school climate" (Stringfield, 1994, p.68.) In sum, both the attitudes and behaviors of students (*ethos*) and their perception of the school climate, seem theoretically and methodologically inescapable when one wishes to evaluate any factor of school effectiveness.

There are different approaches to the relationship between the concepts of *culture* and *climate*. In Tagiuri's proposal (1968), culture is part of the *institutional climate*,

a broad concept that includes aspects such as physical environment, actors' demographic characteristics (socio-economic composition), organizational structure and operational procedures (system social). Moos (1979), however, in another focus prefers to limit the expression of *social climate* to social behavior (sociodynamic aspect of the classroom environment), which together with the characteristics of the physical environment (ecological) and the group of students (social origin, educational background, gender, etc.) make up the *ecological environment* of the classroom.

In any case, there is assumed a close overlapping and causal relationship between the regulatory structure and behavior of individuals. Behaviors indicate the existence of rules and therefore "a scrutiny of practices allows us to reveal the hidden cultural assumptions that guide those practices" (Angelides and Ainscow, 2000). So for example, Yasumoto, Uekawa and Bidwell (2001) see density of interrelationships and consistency in teaching practice (observed) as indicating the existence of a normative culture pertaining to good teaching practice. Or, the best school climate is based on a consensus and a morality shared by its members (Bryk, 1988; Coleman, Hoffer and Kilgore, 1982a 1982b). Indeed, measurements of culture tend to include both dimensions. For example, the School Culture Scale applied to students (Power, Higgins and Kohlberg, 1989) leads to four factors or subscales: normative expectations concerning students' behavior (e.g. discipline); the quality of student-teacher and student-school relationships; and student perception regarding the educational opportunities provided by the school.

Finally, whatever the concept adopted, there seems to be an unquestionable need to include indicators on the subject of the *physical environment*. In the educational setting, this dimension should consider not only the operative aspect (infrastructure, maintenance, etc.) and furnishings, but also the availability of resources and teaching aids. The debate on the importance of these requirements has a long history beginning with the Coleman Report, in developed countries. The greater homogeneity of material provisions in these countries explains, in great part, why the effect estimated on performance for this type of variable is often non-significant. It is therefore quite common in those countries for investigations on effectiveness to lack measurements of the level and quality of material resources. For Third-World countries, however, the pronounced institutional heterogeneity in the offer of school supplies urges that such measurements be included.

1.3. The analysis technique

The technique of *multilevel analysis* (or *hierarchical linear models*) was developed recently to address the serious technical problems that arose when the traditional method of ordinary least squares (OLS) was applied to the analysis of data with a "hierarchical clustering structure" (Aitkin and Longford, 1986; Bryk and Raudenbush, 1992; Goldstein, 1987), as is the case of data in the education sector (students are part of a classroom, which in turn is part of a school situated in a district within a state, etc.) So for example, the new correlational technique is more

appropriate for analyzing variations in the mathematics achievement of students who are members of a school, which in turn is part of a state, allowing the decomposition of one variable (*performance*) in components within the group (*intra-school; inter-state*) and within a group (*inter-school, inter-state*) and for analyzing the association between variables in these different levels of aggregation (characteristics of the student, classroom or school). Given these advantages, the new methodology has been widely accepted, and its use has experienced a sustained expansion. Some studies (Ridell, 1993, 1997) have shown that the application of the traditional technique (OLS) and the multilevel to the same data usually produces different results. If this is true, the findings and results of a large part of *school effectiveness* studies should be placed in parentheses.

In summary, review of the current debate surrounding the research proposed to identify *factors of effectiveness* demonstrates the importance of addressing certain methodological criteria. It is important to include various and different measurements of the student's individual records, but it is also necessary to transform these variables into measurements of *context* or student-body composition, and to include them in the analysis along with other contextual measurements from different sources; for example, variables relating to the physical environment and availability of school resources in the establishment. For the study of institutional, classroom and teaching practice it is advisable to include measurements based on students' own perceptions of the dynamics of these aspects of school reality, as well as their attitudes, expectations and school behaviors (student *ethos*). Finally, the analysis technique recommended for this type of data is that of *multilevel* models (or *hierarchical linear* models); especially when it has to do with educational systems with strong inter-institutional variations, such as in the case of Argentina. This work is guided by these criteria.

II. Objectives and Methodology

2.1. Objectives

This study investigates the relationships between (a) the composition of the school's student body; (b) certain features of the schooling process, according to students' perceptions, and (c) the mathematics achievement of students in the final year of Argentina's high schools, using the technique of *multilevel statistical analysis* with three levels (student, school and state), and data available from the 1998 National Census of High School Completion, carried out by the nation's Ministry of Culture and Education. It has to do establishing whether the school culture and social climate (school process), according to the students of the school have a specific effect on mathematics achievement after controlling the effect of variables related to socioeconomic and cultural origin, gender, and students' academic background, considering both the level of the student and that of the school (school student-body composition). The end result of this exercise will be used as a reference model in future studies aimed at evaluating institutional factors measured on the basis of the questionnaire answered by the school principal.

2.2. Data

We have analyzed data provided by the (1) mathematics test, (2) the student questionnaire, and (3) the questionnaire applied to the principals during the 1998 National Census of High School Completion.[1] The evaluation was made at the end of the school year. Both questionnaires were self-applied. In the analysis were included only the students who took the mathematics test and answered the corresponding questionnaire, and whose principal also answered his/her questionnaire. Two of the three modalities of Argentina's high school education were included: high school and business school.[2] Furthermore, schools with less than 10 students were not considered. With these conditions, the file is made up of 134,939 students in 2,708 schools from 25 states.[3]

2.3. Variables

The dependent variable or *criterion* is the score (gross) obtained by the student on a standardized mathematics test. The independent variables are the characteristics of the student and of the school, and may be organized in three blocks:

a) Student's individual variables refer to family financial capital, family cultural capital, gender, academic background and daily work hours. They are operationally defined as follows:

- Property: availability of 17 durable goods and services in the home.
- Education: educational level of father and mother.
- Books: availability of books in the home.
- Teaching: availability of books, cards and school notes.
- Female: *dummy* variable with code *zero* for men and *one* for women, including why most of the research reported that men show better achievement in mathematics (for Argentina, see: Cervini, 2002, 2003).
- Repeater: *dummy* variable with code *zero* for students who did not repeat any year in high school and *one* for those who repeated at least once. This is the only indicator (*proxy*) available from the record of student academic achievement.
- Work hours: per day number of hours that student spent working. The measurement not only provides greater precision concerning the student's social origin, but also allows detection of variations in the "opportunity to learn" (Carroll, 1963) outside school, one of the major conditioners of performance level.

b) The student-body composition variables are scholastic averag*es of each student's individual variable except gender and repetition (*dummies), defined as scholastic percentages. They are named using the same acronym as the individual variables, except for adding the ending _e. For example, *libro_e* is the average number of *books* in the school. Within the concept student-body composition are also included two variables on school resources and the physical

environment of the school (Tagiuri, 1968; Moos, 1979); both come from the school principal's questionnaire:

- Infra_e: status of the establishment's infrastructure.
- Recursos_e: teaching resources available in the establishment.

c) The school process variables are the results of gathering—scholastic level—information provided by the student questionnaire. The questions have to do with attitudes regarding mathematics and the school, behavior in school, and the student's perception of the school and the classroom. A majority of the questions have a four-point (Likert-type) scale as a response option. To reduce the numbers of variables, questions relating to attitudes towards mathematics and the classroom were subjected to a principal component analysis with varimax rotation, yielding three factors. The same analysis was applied to the questions regarding (the attitude toward) evaluating the school, and obtained a single factor. In all cases, the variable is the sum of the scores of each question of the factor, after reversing the direction where relevant. Other measures consist of unusual or unique questions.

- Motivation: Motivation in mathematics (first component with six items, for example. "Mathematics is the subject that interests me.")
- Evaluation: the importance given to knowledge in mathematics (third component with 3 items; for example. "I can use the issues I learned in math in my daily life.")
- Teacher: student's perceptions on teaching practices and teacher/student interpersonal relations in the classroom (second component with three items; for example. "How many of your teachers are willing to listen to your concerns?" and "What percentage of class time did the teachers devote to teaching the content of their subjects?")
- Success: expectation of future success because of the school (one component of six items; for example. "According to what you learned at school, what degree of success do you think you will have in college?"
- Effort: single question with four points: "Do you always turn in your work on time?" Scale is *almost never* to *always*.
- Indiscipline: single question with five points: "Are there discipline problems in your school?" Scale of *none* to *very serious*.
- Violence: single question with five points: "Are there problems of violence in your school?" Scale of *no* to *very serious*.
- Dropout: single question with five points: "In your school are there problems of students who drop out?" Scale of *no* to *very serious*.

This set of variables covers the two dimensions of the school or the classroom identified by the literature on school climate (Fraser, 1989; Moos, 1980): the physical and sociodynamic contexts. The first (student-body composition) refers to the characteristics of the group of students (social origin, gender, academic ability) configured by the type of student attending or attracted by the school (extracurricular determination) and school resources available in the school. The

second (process) are measurements of the sociodynamic aspects, close to the idea of social climate (Moos, 1979) and *school culture* (Tagiuri, 1968). The measurements refer to certain characteristics that school effectiveness research has repeatedly confirmed, such as an "orderly atmosphere" at school (Scheerens and Bosker, 1997), "positive academic climate" (Stringfield, 1994) or "normative expectations regarding student behavior" (Power, Higgins and Kohlberg, 1989) —*indiscipline*, *violence*, *dropout*— "effective learning time (Scheerens and Bosker, 1997), "cordiality and availability shown by the teacher to the student" (Moos, 1987), and "remedial education" (Creemers, 1994) —*teacher*. There are included as well, measurements of the student *ethos*, a set of attitudes toward mathematical knowledge—*motivation*, *valuation*—of evaluation of the school experience or "perception of the learning opportunities offered by the school" (Power, Higgins and Kohlberg, 1989) —*success*—and of behavior in school—*effort*. *Ethos* is assumed to be the result of the joint determinations of family origin and the school's action.

2.4. Technical analysis and strategy

For the analysis of the relationship between performance and the different variables, we used the technique called *multi-level* statistical analysis or *hierarchical linear models* (Aitkin and Longford, 1986; Bryk and Raudenbush, 1992; Goldstein, 1987). First, we analyzed the correlations between the characteristics of school process (*Sp*) among themselves; and those of the student-body composition (*Sbc)*. Second, we estimated the *null* model (with no predictor) and the effect of each *Sp* indicator, which would indicate the initial relevance of each of these measurements. The third step was to estimate two models: one with all the variables of the *Sp* and another with all the variables of the *Sbc*. The objective was to compare the magnitude of the effect of both sets of variables on mathematics achievement. The fourth step incorporated the student's individual variables into the two previous models. The objective was to evaluate the behavior of the variables of *Sbc* and *Sp* when controlled by individual student inputs. Then we analyzed a model with all the independent variables available. Thus, there was offered an idea of the relative importance of both sets of variables under study, i.e. the context and school process variables. Finally, there was developed an analysis of interaction between some of the student's characteristics and the *Sp*. To analyze the data we used the computer program MLWIN (Goldstein, 1987). To estimate the probability of the effect of variables we used the test of the ratio of maximum probability.[4]

III. Results

3.1. Relations between the variables of student-body composition (*Sbc*) and school process (*Sp*)

First, we explored the relationships between school composition variables (*Sbc*) and school process (*Sp*) through the coefficient of correlation (Table I). Some variables of the *Sp* maintain a high correlation with almost all the measurements of

the *Sbc*. This is the case of *success* and *dropout*. Overall, then, schools in the higher socioeconomic level, with a lower proportion of repeaters and more institutional resources available, usually have a higher expectation of future success due to the school and lower (perceived) dropout levels. Although less intensely, *effort* behaves in the same way. The effect of gender composition is unique: it is not related with *success* and *dropout*, but it is related with *effort*; that is, the greater the percentage of women in school, the higher the average of task completion. Attitudes towards mathematics (academic knowledge) are those least associated with the *Sbc* variables. This behavior is consistent with the hypothesis that these attitudinal variables express in large measure, the effect of school action. It is also interesting to observe that there is no significant covariation between the perception of the indiscipline level, and of *Sbc* variables. The perception of the threshold of violence shows a greater adjustment to the *Sbc*, but much smaller than that displayed by *dropout*. If there is adopted the hypothesis, common enough, that the objective level of indiscipline increases with the decreasing economic level of the student, then the behavior of indiscipline suggests that the student's sense of discipline changes according to the social composition. Therefore we see the weak association between the level of *indiscipline* and the *Sbc* also registered by international literature (Stringfield, 1994). Nor is the students' perception of the effectiveness of teaching practice and their relationship with teachers significantly associated with the *Sbc*. We might ask whether the reversal hypothesis is also applicable to this variable.

Table I. Coefficients of correlation between the variables of process and student-body composition

Variables de composition	**Variables of process**							
	Indiscipline	Violence	Dropout	Motivation	Evaluation	Success	Effort	Teacher
property_e	-.026	-.138	-.718	.058	.062	.560	.245	.104
educa_e	-.048	-.133	-.722	.046	.061	.497	.189	.047
books_e	-.002	-.132	-.695	.097	.058	.581	.307	.087
didactic_e	-.254	-.243	-.345	-.059	.133	.506	.468	.279
hm_work_e	.035	.197	.637	-.050	.001	-.449	-.237	-.062
%feminine	-.188	-.132	-.034	.137	.001	.018	.330	-.065
%repeaters	.173	.345	.607	-.060	-.155	-.518	-.365	-.132
infra_e	-.094	-.168	- .503	.020	.019	.382	.203	.114
resources_e	-.016	-.110	-.431	.034	.046	.379	.198	.035

3.2. Null model and school process variables (*Sp*)

In the multilevel analysis, the first step is the initial partition of the performance variance in all three levels of aggregation (state, school and student).[5] The set of these estimates is called the *null* model because it has no predictors at all. The results are presented in Table II. About 47% of the variation in performance is due to differences between regions and schools, although 34% belongs mostly to the latter. However, the results indicate the importance of including the state level of aggregation, since failure to do this would cause 13% of the total variation of

performance to be incorrectly judged as *inter-school* variation. Based on a review of more than 40 Third-World investigations and using multilevel analysis, Ridell (1997) concluded that *inter-school* differences are smaller than the gap between students, that is, "the influence of the home is greater than that of the school" (p. 185). According to data presented by Ridell regarding the performance in high school mathematics, the average *inter-student* difference is slightly below 55%, an estimate similar to that reached in this work (56.5%).

There is introduced in this *null* model, each of the variables of the *Sp*. It can be observed that the estimates for all the measurements are significant when considered individually (Table II). According to students' perceptions, the more intense the indiscipline, violence and dropout in the school, the lower the mathematics achievement. On the other hand, the more intense the motivation, valuation of mathematics, expectation of success (in what is learned at school), and the completion of homework, the greater the achievement. Finally, the more positive the student's image of the quality of interaction with teachers of their effectiveness, the greater the achievement. In principle, then, the measurements behave according to the expectation, and in a manner consistent with international literature.

Table II. Results of multilevel analysis. Performance in mathematics with variables of process and student-body composition added

Variables	**Effect of each process indicator**		**Model 1 process**		**Model 2 composition**		**Variables**
	Estimate	e.s.	Estimate	e.s.	Estimate	e.s	
indiscipline	-.063**	.010	-.018	.011	-.026	.021	(property_e)
violence	-.142**	.010	-.023*	.011	.029	.024	(educa_e)
dropout	-.345**	.009	-.221**	.011	.209**	.022	(books_e)
motivation	.087**	.010	.064**	.009	.038**	.010	(didactic_e)
evaluation	.118**	.010	.012	.010	-.083**	.011	(hm_work_e)
success	.339**	.010	.218**	.012	-.020*	.008	(%feminine)
effort	.162**	.011	.037**	.009	-.145**	.010	(%repeaters)
teacher	.060**	.010	.097**	.010	.029**	.010	(infra_e)
					.024**	.010	(resources_e)
Levels	Model 0 (*null*)						
State	.131	.044	.061	.021	.048	.017	State
School	.341	.010	.178	.005	.178	.005	School
Student	.565	.002	.565	.002	.565	.002	Student
Probability test	314624.7		313019.8		313001.3		Probability test

* p ≤ 0.05; ** *p* ≤ 0.001

3.3. The effect of student-body composition and school process

In this step are analyzed two multilevel models: one with all the variables of the *Sp* (Model 1), and the other with the variables of the student-body composition (Model

2). The object is to evaluate the effect of the set of indicators on the variations of Levels 2 and 3, and not the behavior of each individual indicator. Let us note, however, that the two indicators of *organized climate* (*indiscipline* and *violence*) and *valuation* lose the high significance they had. This is probably due to the "colinearity" between the first two variables, and between the last and *motivation*.[6] Nor are the variables *property_e* and *educa_e* significant; this has already been proved and analyzed in previous works (Cervini, 2002; 2003).

The effect of the set of *Sp* variables on performance in the three levels (Model 1) is very similar to that shown by the *Sbc* (Model 2). Each set of indicators, separately, explains half of the *inter-school* variation. The same behavior is observed concerning the geographic variation, although here the *Sbc* is slightly more effective than the *Sp*. The total unexplained variation has fallen about 20% in both models, indicating a high level of statistic significance.[7]

3.4. Contextual variables and individual student backgrounds

This step monitors the effect of *Sp* and *Sbc* by the measurements referring to the student's personal background.[8] The variable *property* is not included because a previous study (Cervini, 2002) demonstrated that it is dispensable when acting together with other variables. Extracted as well are *educa_e* and *property_e*, also dispensable (Model 2). The % female was redundant too, and therefore removed from the subsequent analysis. Estimates of the variables of the *Sp* (Table II, Model 3), *dropout* and *success* show a sharp decline, while the rest decline slightly. Furthermore, we observed that the decrease in *inter-school* and *inter-state* variations are of the same magnitude as that experienced by the *intra-school* (or *inter-student*) variation. They indicate the high socioeconomic and aptitudinal selectivity of students, especially at the school level. Regarding the *Sbc* variables (Model 4), there is shown a drop in the estimates, due to the selectivity of the system, but now the rest of the *inter-school inter-state* and variations are not altered. This result was to be expected, and indicates that the effect of the individual variables of the state and school is completely mixed up with that of the *Sbc* variables.

3.5. Final model, complete

At this stage the three groups of variables were analyzed together. None of the estimates of individual student variables was altered; that is, all retain their significance. In general, both the estimates of the *Sbc* and the *Sp* decreased, although the former did it in a more pronounced fashion (Table III, the complete final model). Measurement of family and institutional teaching resources and school physical environment lost significance.[9] The effect of the composition of repeaters also fell sharply.

On the side of the *Sp*, the perception of *school dropout* and the *Sp* variables, the perception of ESL and expectation of future success (evaluation of the school) show the greatest changes, while motivation toward mathematics and finishing

homework were almost unaffected. The two measurements of *perception of order* could not be clearly evaluated because of the existence of "colinearity", but the comparison with the estimates presented in Model 1 indicates that they are very little affected. Finally, *effort* and *teacher* maintain the same level of significance. The pronounced decline in *dropout* and *success* were expected because of the high correlation both have with all the *Sbc* measurements (Table I), with a probable overlap of their effects on performance. By contrast, attitudes towards mathematics, having low correlations with the variables of the *Sbc*, maintain their own effect.

These results indicate that, overall, an important part of the effects of student-body composition and school process overlap. In spite of this, the majority of the estimates of *Sp* variables remained significant even after considering the variables of student-body composition; that is, they maintain their own effect on student performance. Thus, for example, the highest performance a hypothetical student would get by switching to a school with a lower percentage of repeaters and with the same characteristics of student-body composition would decrease if in his/her new school, process characteristics were less *positive* than those in the average schools. On the other hand, the effects of some *Sp* indicators are more *independent* of the *Sbc* variables. This is the case of attitudes toward mathematics.

Beyond the statistical significance of each of the estimates, the most important question concerns how much the *Sp* variables add to the prediction of performance once the *Sbc* variables are taken into account. The set of *Sp* measurements manages to reduce the rest of the state level (.049), and school (.179) (Model 4), to .047 and .157, respectively, i.e. approximately 2.5% of the total regional variation (state) and institutional (school).

3.6. Final model, reduced

In this model the redundant or dispensable variables have been removed. Its value is merely instrumental, since it will serve as a reference model for subsequent analysis and for future research, as stated in the objectives.

Table III. Results of multilevel analysis. Performance in mathematics with individual student variables and with process and student-body composition variables added

Variables and levels	Model 3 (M1+individual)		Model 4 (M2+individual)		Model 5 Final, complete		Model 6 Final, reduced	
	Estimate	e.s.	Estimate	e.s.	Estimate	e.s.	Estimate	e.s.
Student								
education	.058	.003	.057	.003	.057**	.003	.057**	.003
books	.080	.003	.079	.003	.079**	.003	.079**	.003
didactic	.021	.002	.022	.002	.022**	.002	.022**	.002
hm_work	-.033	.002	-.032	.002	-.032**	.002	-.032**	.002
feminine	-.058	.005	-.059	.005	-.059**	.005	-.059**	.005
repeaters	-.233	.005	-.231	.005	-.231**	.005	-.231**	.005
Sb Composition								
books_e			.147	.013	.102**	.014	.100**	.014
didactic_e			.030	.009	.015	.010		
hm_work_e			-.065	.011	-.049**	.010	.050**	.010
%repeaters			-.100	.010	-.025**	.011	-.029**	.011
infra_e			.028	.011	.015	.010		
resources_e			.022	.010	.006	.009		
Process								
indiscipline	.001	.010			-.020*	.010	-.025*	.009
violence	-.017	.011			-.011	.011		
dropout	-.153	.011			-.060**	.013	-.067**	.013
motivation	.061	.009			.063**	.009	.063**	.009
evaluation	.015	.009			.020*	.009	.020*	.009
success	.180	.012			.133**	.013	.133**	.013
effort	.034	.009			.031**	.009	.028**	.009
teacher	.086	.010			.069**	.010	.071**	.010
Levels								
State	.056	.019	.049	.017	.047	.016	.046	.016
School	.165	.005	.179	.005	.157	.005	.158	.005
Student	.544	.002	.544	.002	.544	.002	.544	.002
Probability test	307665,0		307845,5		307540,7		307547,3	

* $p \leq 0.05$; ** $p \leq 0.001$.

3.7. Analysis of interaction

Finally, interactions were explored between the effects of *Sp* variables and that of two indicators of individual student records, namely the student's academic background—*repeater*—and the educational level of the family—*education*. The final model, reduced, was used as reference.[10] First, there were included all the terms interactive with repeaters. The results are presented in Table IV, Model 7. Only two terms are highly significant. The positive sign of the interaction *dropout x repeater* indicates that in the institutional context where *dropout* (perceived) is higher, and the average performance notably lower, there was verified a shortening

of the distance between the performances of repeater and non-repeater students. This drawing closer is due to the fact that the decline in average performance of the non-repeaters is more pronounced than that of the repeaters. Moreover, the interactive term *effort x repeater* indicates that in the contexts where the level of doing homework is low, the distance between the performance of the repeaters and the non-repeaters diminishes, because of the average performance of the non-repeaters. The effect of the parents' education, one of the student's indicators of social origin, interacts significantly with an indicator of the school culture of the student body—*success*— (Table IV, Model 8). According to the results, as the positive attitude toward the *benefits of future schooling increases*, the effect of the student's social origin on performance decreases. This behavior suggest the *redistributive* ability of some aspects of the student *ethos* regarding achievement in mathematics. Model 9 shows the estimates of the significant interactive terms in Models 7 and 8, but now acting together on performance. No important alteration in the estimates was observed, and therefore, the previous conclusions were maintained. Finally, it is important to observe that the inclusion of the interactive terms has produced no reduction in those remaining (unexplained variation). Thus, they help in understanding the relationships between the effects, but do not increase our predictive power on performance.

Table IV. Results of analysis of interaction between the scholastic process variables and some personal characteristics of the student (repetition and family education)

Variables of the scholastic process	**Model 7**		**Model 8**		**Model 9**			
	X Repeater		**X Education**		**X Repeater**		**X Education**	
	Estimate	e.s.	Estimate	e.s.	Estimate	e.s.	Estimate	e.s.
indiscipline	.005	.006	.003*	.001			-.003*	.001
dropout	. .035**	.007	.001	.001	.037**	.006		
motivation	-.004	.006	.000	.001				
evaluation	.016*	.006	-.002	.001	.015*	.005		
success	.004	.008	.004**	.001			.004**	.001
effort	-.024**	.006	.002	.001	-.026**	.006		
teacher	-.022*	.007	.002	.001	-.019*	.006		
State	.046	.016	.045	.015	.045	(.016)		
School	.157	.005	.157	.005	.157	(.005)		
Student	.543	.002	.544	.002	.543	(.002)		
Probability test	307469,7		307513,0		307447,1			

* p ≤ 0.05; ** *p* ≤ 0.001

IV. Conclusions

The particularity of this study has been to explore the association between indicators referring to different aspects of the schooling process (*Sp*), as perceived by students, and math performance of students in the final year of Argentina's high

schools. Apparently, the results of the initial analysis of these relationships validated the thesis of the *school effectiveness* approach. All measurements available on the institutional life of the school showed a significant correlation with performance. Thus, when the institutional environment is more "orderly", the scholastic ethos of the students is stronger or teacher-student relations are of better quality; then the level of performance will be higher. This set of variables, without any "adjustment", seems to explain 50% of the differences in total average performance between schools, an extremely high estimate.

However, this conclusion did not hold when the analysis went deeper, that is, when other relevant factors were considered. First, it included a heterogeneous set of variables related to the student, such as family economic and cultural capital, gender, length of work hours, and academic history. Thereafter, all these measurements were added to the school level, and indicators of student-body composition (*Sbc*) were obtained, supplemented with measurements referring to the physical environment and the availability of resources and scholastic aids in the school (principals' questionnaire). All the individual and group variables were integrated into the analysis with the objective of evaluating their relationships with performance and *Sp* variables.

The analysis confirmed previous findings (Cervini, 2002). First, the student's personal variables principally affect the *inter-school* variation and not the *intra-school* variation, which can be interpreted as the operational expression of a high level of social selectivity or segmentation of the educational system's institutional network. In other words, schools tend to be very homogeneous, socially. Second, the family and contextual *cultural capital* is what shapes the profile of the distribution of school achievement, and not the family's financial capital. The action of this last comes first, and determines the possibility of accessing and reaching the final year of high school education. Third, the effect of student-body membership on performance is greater than that attributable to the set of indicators for the student's personal and family background.

To this previous knowledge, this analysis contributed new inferences about the behavior of mathematics achievement in high school education. It was confirmed that, although slightly, the effect of the *Sbc* on performance is greater than that exercised by the *Sp* measurements. It was also verified that there are important relationships of some *Sp* variables with those of the *Sbc*. The valuation of what is learned in school in general—one aspect of the existing *student culture*, and the (perceived) level of school dropout—an indicator of the *positive learning environment*—are highly correlated with all the *Sbc* indicators studied, except for gender. The attitude toward typically scholastic mathematical knowledge does not behave in the same way. The low association with the *Sbc* could be reflecting the effect of the school over time. On the other hand, the perception of the level of indiscipline is shown to be much more independent of the *Sbc* variables than the perception of the violence level. These confirmations suggest that the relationships between student-body composition and process can experience

important variations, according to the specific aspects considered, and how they are measured.

When the variables of *Sbc* and *Sp* were included together in the analysis, most estimates of the variables in both groups dropped significantly. Other studies have confirmed empirically that "a substantial portion of the variance at school level is *caused* by a combined effect of characteristics of the school process and student-body composition" (Opdenakker and Van Damme, 2001, p. 422). From this behavior there is inferred the inescapable requirement to include student-body composition measurements in studies of *school effectiveness*, as recently acknowledged both by proponents and by opponents of this type of studies. In addition, the empirical behavior and the high correlations between some variables of the *Sp* and the *Sbc* make reasonable the hypothesis of a complex structure in the determination of scholastic learning, where part of the total effect of some features of the *Sbc* on performance could be direct, while the other could be through certain characteristics of the school process, or indirectly.

Either way, the data support the conclusion that certain characteristics of the school process have a specific effect all their own, in other words, not everything is attributable to the direct and indirect effect of the *Sbc*. However, the magnitude of this effect is less than the optimistic expectations of some speeches on school effectiveness. In this conclusion, the present study converges with the findings of recent research at the international level (Scheerens and Bosker, 1997; Opdenakker and Van Damme, 2001).

We identified two significant interactions, one referring to the students' academic record (repetition); the other to their social background (parents' education). Regarding the first, it was confirmed that performance differences between non-repeater students, and repeaters (more/less academic aptitude) decrease in schools with evidence of *negative academic climate* (high dropout and low effort or performance of the students), and that this decrease is mainly due to the decline of the average performance of non-repeater students. Or put another way, schools with *positive academic climate* get better results by extending the distance between the two categories of students, benefiting non-repeaters. The second interaction, highly significant, showed that in schools where the average positive valuation of student learning (expectation of future success) is high, the effect of student social background (parental education) on performance is reduced. Of two schools having the same *Sbc*, in the one where the future benefits of schooling is more highly esteemed (on the average), there are registered higher achievements. Then, while the first interaction speaks of greater inequality (referring to aptitude), the second identifies results of equity (referring to social origin), demonstrating the complexity of the determinations in the educational system.

The study has demonstrated the effectiveness of the measurements constructed based on the student questionnaire, both referred to as the *Sp* and the *Sbc*. The results obtained indicate that any future study designed to identify factors of institutional effectiveness through information from other sources (e.g.

questionnaire applied to the principal), should include measurements largely unexplored in this work. Moreover, over 45% of the differences in average performance between schools—15% of the total variation of performance—has been unexplained. To attribute this variation a *priori* to the *Sbc* or *Sp* is methodologically unacceptable. The failures of measuring both concepts may be similar. Only through additional analysis, incorporating new measurements, will it be possible to increase the understanding of the unexplained remainder.

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Translator: Lessie Evona York-Weatherman

UABC Mexicali

[1] The principals' questionnaire was applied in 1997 and in 1998. However, in 1998, many of the questionnaires were answered after the evaluation workday, and were mailed afterward. This circumstance throws doubt on the quality of the data collected, as well as an imporantant decrease in the effective coverage. Because of this, we decided to use the 1997 questionnaires applied according to the standard established procedure. If the principal did not answer the 1997 questionnaire, but did answer that for 1998, the 1998 questionnaire was used (323 schools).

[2] The technical schools are not included because of the important curricular differences which impede their direct comparison with other modalities.

[3] For the analysis, the state of Buenos Aires is divided into Greater Buenos Aires (Urban) and the rest of the state.

[4] Probability is estimated based on the difference between the values of the ratio of maximum probability of the model analyzed and the background model, a difference that can be referred to the chi-square distribution, and whose degrees of freedom are defined by the number of new parameters that have been adjusted in the model analyzed.

[5] The sum of the proportions of each level is slightly higher than the unit due to fluctuations in the sample.

[6] This interepretation is based on the high correlations between these variables: 456 for *motivation* and *valoration* and .634 for *indiscipline* and *violence*.

[7] The difference in the maximum probability test of Model 1 (313019,8) regarding the "null" model (314624.7) is 1604.9 which, with 8 df. (number of new parameters set), has a probability of occurrence of less than 1 per thousand. Model 2 produces an even greater distance (=1623.4), and therefore, the same conclusion applies.

[8] Processing not presented indicated that the joint action of all the student's individual variables decreases the *inter-state* variation to .103, the *inter-school* to .260, and the *inter-student* to .544. Therefore, their major effect is located in the variations of levels 2 and 3, but is notably less than than of the variables of *Sbc* and *Sp* (Cervini, 2002; 2003).

[9] Three models were processed to analyze the effect of each of the three variables when excluding the other two. None were significant. In this way, the doubt as to whether the collinearity between them could explain the non-significant estimates was cleared up.

[10] The presentation of the estimates of the fixed part of the models is obvious because there is produced no change that could alter the conclusions drawn above.