

Academic Achievement in Effective Schools

Marc Basque¹ and Yamina Bouchamma²

¹Université de Moncton, New Brunswick, Canada, ²Université Laval, Québec, Canada

Purpose: The purpose of this study is to identify predictors of achievement in mathematics in elementary schools in New Brunswick (Canada). **Data Collection:** Both teachers and school leaders (N = 111) completed a questionnaire on their practices and on school functioning. **Findings:** Multiple regression analyses revealed that the students' achievement in mathematics was determined by prior achievement, urban school attendance, and teaching quality. **Implications:** To counter the socioeconomic constraints on achievement in mathematics, taking a closer look at teaching quality represents a promising research area. The implications of this study on education policies and research are discussed.

L'objectif de cette étude était d'identifier les indicateurs de la réussite en mathématiques dans les écoles primaires du Nouveau-Brunswick (Canada). La cueillette de données s'est réalisée par un questionnaire administré aux enseignants et aux directions d'école (N=111) portant sur les pratiques d'enseignement et le fonctionnement de l'école. Des analyses de régression multiple ont révélé que le rendement des élèves en mathématiques était déterminé par les résultats antérieurs, la fréquentation d'écoles en milieu urbain et la qualité de l'enseignement. Comme stratégie pour contrebalancer les contraintes socioéconomiques qui agissent sur le rendement en mathématiques, la qualité de l'enseignement représente un domaine de recherche prometteur. Nous discutons des incidences de cette étude sur les politiques et la recherche en éducation.

Introduction

The commitment of political and school leaders toward improving school effectiveness translates to an increasing demand for additional resources (Moolenaar, Daly, & Slegers, 2010) as well as a greater emphasis on the question of public sector accountability (Ammar, Bifulco, Duncombe, & Wright, 2000). Examining the quality of education systems and identifying student performance indicators has thus become a growing concern (Sammons & Luyten, 2009), as supported by numerous national and international evaluations, including the Pan-Canadian Assessment Program (PCAP), the Programme for International Student Assessment (PISA), the Progress in International Reading Literacy Study (PIRLS), and the Trends in International Mathematics and Science Study (TEIMS).

In early 2000, students in New Brunswick, Canada were ranked last in reading, mathematics, and sciences on the PISA assessments (Nouveau-Brunswick, 2000), and later in 2007, the Department of Education confirmed that among the 11 Canadian jurisdictions, New Brunswick ranked 9th in reading and 8th in mathematics on PCAP assessments (Nouveau-Brunswick, 2007). This significantly low performance record prompted us to examine student achievement factors to gain insights into improving school effectiveness.

We focused on identifying predictors of student performance in mathematics in New Brunswick's French-language primary schools. Mathematics was selected because schools have the ability to influence student achievement and that this influence may vary from one subject to another (Von Secker & Lissitz, 1997). This influence can range from having a significant impact on certain subjects, such as mathematics and sciences, to a lesser effect on others, such as languages (Sammons & Luyten, 2009).

Conceptual Framework

This study was guided by the premise that school practices have an impact on student performance. To determine school effectiveness in this regard, three key concepts were defined: (1) the main predictors related to school effectiveness; (2) the concept of school effectiveness; and (3) the effects of achievement predictors.

Predictors Related to School Effectiveness

Political and educational stakeholders first became interested in school effectiveness when the "Equality in Education Opportunity", also known as The Coleman Report, was published (Coleman et al., 1966). The Coleman Report revealed the predominance of social background on student performance-related factors. In reaction to this study, research into the topic of school effectiveness emerged (e.g., Levine & Lezotte, 1990; Marzano, 2003; Sammons, Hillman, & Mortimore, 1995; Scheerens & Bosker, 1997).

Despite differences in the operationalization of certain determinants, Scheerens (2000) identified five main themes in the literature as being fundamental conditions for achievement: (1) *achievement-oriented strategy*; (2) *cooperation*; (3) *strong educational leadership*; (4) *frequent monitoring*; and (5) *time, learning opportunities, and structure*.

Achievement-oriented strategy. Achievement or output-oriented strategy refers to the importance a school gives to improving the performance level of its students (Scheerens & Bosker, 1997). Although the prime directive of school is learning, not every school is the same and major variations exist with regard to achieving the end results (Sammons et al., 1995). Schools concentrate their efforts on the achievement of the greatest number of students possible (Marzano, 2003; Scheerens, 2000). To reach its goal of student learning, a school will plan common objectives centered on improving student outcomes (Sammons et al., 1995). Additionally, the school will inform its teachers of the mission and its foundations, reinforcing cohesion among the teaching staff.

Scheerens and Bosker (1997) identified three components of the achievement-oriented strategy: "...a clear focus on the mastery of basic subjects, fostering high expectations on pupils' achievement, [and] the use of records of pupils' progress" (p. 101). Several studies have demonstrated the importance of focusing on the acquisition of basic skills as a strategy to improve student outcomes (e.g., Goddard, Sweetland, & Hoy, 2000; Levine & Lezotte, 1990). Basic skills are essential to applying and learning new knowledge or skills and, as a result, researchers have focused on high expectations with regard to student achievement (e.g., Levine & Lezotte, 1990). These expectations must be realistic and communicated to the students. Additionally, attention has been paid to the instruments and processes that systematically monitor students' academic progress (DuFour & Marzano, 2011).

Cooperation. Cooperation among the teaching staff is represented by the level of

collegiality and collaboration (Marzano, 2003) through interactions and discussions with peers in a spirit of mutual respect and support (Villani, 2004). These authentic interactions go hand in hand with professional behavior (Fullan & Hargreaves, 1996). Cooperation has been shown to have many positive effects on teachers, including a strong sense of professional effectiveness (Thoonen, Slegers, Oort, Peetsma, & Geijsel, 2011), decreased feelings of isolation (Lieberman, 2000), improved teacher retention rates (Grossman, Wineburg, & Woolworth, 2001), as well as a sense of satisfaction with their profession (Wynn, Carboni, & Patall, 2007). These numerous positive effects are the reason for the sudden strong interest in professional learning communities whose collaborative activities strive to explore successful practices to help teachers improve student performance in their schools (DuFour & Eaker, 2004; Wiley, 2001).

Strong school leadership. The concept of strong school leadership refers to both the principal's leadership and to instructional leadership (Townsend, Acker-Hocevar, Ballenger, & Place, 2013). The practices of the school head consist of a network of relationships (Heck, Larsen, & Marcoulides, 1990) that are combined to influence instructional actions that favor learning and achievement. Yet, despite these affirmations, the relationship between the principal's leadership practices and student outcomes remains complex and not easily measurable (Hallinger & Heck, 1996; Leithwood & Jantzi, 2000; Marzano, McNulty, & Waters, 2005). In their meta-analysis, Witziers, Bosker, and Krüger (2003) found that school leaders had an indirect effect on learning and a direct effect on teachers' practices, which, as a result, had a positive influence on student achievement (DuFour & Marzano, 2011). In addition to the difficulty measuring and determining the effects of instructional leadership, it has been shown that this variable is highly sensitive to context (e.g., Hofman & Hofman, 2011), particularly in regards to school organization (Hallinger & Leithwood, 1994).

Frequent monitoring. The concept of frequent monitoring refers to the supervision of teaching and learning activities (DuFour & Marzano, 2011) in the guise of frequent formative evaluations that enable a systematic control of the students' progress as a means to provide them with appropriate feedback. In a review of over 800 meta-analyses, Hattie (2009) concluded that the strongest predictor of academic achievement was the feedback given to students. This feedback must be offered at the appropriate time and be specific to the content presented to students (Marzano, 2003). In addition to effective feedback, systematic evaluations enabled teachers to identify at-risk students and to plan interventions to respond to their students' instructional needs, similar to the principle of adapted education (Darling-Hammond, 2002). These assessments also provided crucial information to the teachers and school administrators on what had been learned and on the effectiveness of the procedures and methods employed in the classroom.

Learning time, learning opportunities, and structure. The elements of learning time, learning opportunity, and structure refer to the teachers' pedagogical practices in the classroom. Learning time is the amount of time students spend on learning activities (Harn, Linan-Thompson, & Roberts, 2008), meaning the time devoted to instruction and not to administrative activities. The literature has often shown that learning time has an impact on student outcomes (e.g., Bellei, 2009; Harn et al., 2008). Learning time may signify a school day, the length of a school year, or merely a task. (Hattie, 2009). The students' commitment to what they are learning, which is crucial to their success, will depend on the challenges and academic demands they are given by their teachers (Yair, 2000).

Learning opportunities. Learning opportunities pertain to the content presented in the education programs covered by the instruction (Wang, 1998). The greater the amount of content

received, the stronger student outcomes will be (Tornroos, 2005). In addition to the content presented to students, this variable addresses the quality of this content (Scheerens & Bosker, 1997). In order to learn, students must have access to the appropriate educational content. While teachers are asked to teach identical content to their students, significant variations have been observed among schools (Bennett & Turner-Bisset, 1993). In countries such as the United States, where there is no national curriculum, the differences are even more flagrant. These variations are also determined by the length of both the school day and school year (Muijs & Reynolds, 2003).

Structure. Finally, structure refers to classroom organization and management at the instructional level (Scheerens & Bosker, 1997). Student achievement is maximized when the presented content is well-structured, meaning that a level of importance is given to the fundamental elements of the lesson and that these elements are reviewed at the end of each session (Brophy & Good, 1986). In a review of the literature, Sammons et al. (1995) demonstrated that structure is an important part of quality teaching, which they defined “efficient organisation, clarity of purpose, structured lessons and adaptive practice” (p. 15-17). Similarly, Scheerens & Bosker (1997) defined quality teaching as the “preparation of lessons, structure of lessons, direct instruction, and monitoring” (p. 128-130).

Despite the multitude of studies on school effectiveness, some authors, such as Reynolds and Cuttance (1992) and Willms (1992), revealed that school effectiveness was not a combination of simple factors. Instead, school effectiveness is most likely a complex combination of the factors outlined above (Sammons et al., 1995).

Concept of School Effectiveness

School effectiveness can be explained as the ability of a school to reach its goals, compared to other schools of equivalent socioeconomic status (Scheerens, 2000; Scheerens, Bosker, & Creemers, 2000). These goals may be cognitive (e.g., acquiring knowledge) or non-cognitive (e.g., school climate). Non-cognitive objectives refer to the concept of “school quality” rather than school effectiveness (Thomas & Smees, 1998). Student performance is generally measured by scores on standard assessments (Scheerens, 2006).

Because the primary objective of a school is learning, most studies on the subject have employed cognitive factors to assess school effectiveness. In other words, as stated by Papanastasiou (2008) “a more effective school is one where the school achievement score is higher than the score that would be predicted from the student characteristics” (p. 26). Many studies on effective schools have been conducted in underprivileged areas and have focused on the school characteristics capable of countering the negative effects of the milieu on student achievement. It is in this perspective that school effectiveness is defined as economically challenged schools in which student outcomes equal or surpass outcomes from more advantaged contexts (Bissonnette, Richard, & Gauthier, 2006).

The Effects of Achievement Predictors

Among the variables that explain student achievement are factors related to the student (*student effect*), the environment or context of the school (*context effect*), the school (*school effect*), and the classroom (*teacher effect*).

Factors related to the student (student effect) regard the influence of the students’

background on their performance level (Mortimore, 1991). Here, performance is determined primarily by student characteristics, such as intelligence, skills, aptitudes, and motivation, which are closely related to social origin (Van den Broeck, Opdenakker, & Van Damme, 2005).

Attributing academic achievement to only one group of variables is difficult. As a result, some studies allude to the context effect to demonstrate that factors correlated with high performing schools vary depending on geographical context (Reynolds, 2006). Particular attention is therefore given to the differences between students and the practices of schools from different communities (Hannaway & Talbert, 1993). Academic achievement is influenced by student background, which in turn is directly related to the conditions or context present within the community (Heck, 2000). Various types of effects related to context can be found. For example, the students' socioeconomic status, type of community (rural vs. urban), and type of school (elementary or secondary) (Teddlie, Reynolds, & Sammons, 2000).

Family, familial structure, and resources are also key factors affecting academic achievement (Downey, 1995; Roscigno & Crowley, 2001). For example, student achievement in the United States was reported to be lower in rural area schools than in urban schools (Roscigno & Crowley, 2001). This was also confirmed in Australia, where research showed that the location of the school had a significant effect on student outcomes (Young, 1998). This disadvantage with regard to rural area schools can be explained by the poverty level of their students and by insufficient education resources (Roscigno & Crowley, 2001).

Despite these convincing arguments, more recent works have failed to show the primacy of student achievement in urban over that in rural schools (Reeves & Bylund, 2005). A lack of consensus has also been found with regard to results, even when similar databases are used (e.g., Fan & Chen, 1999; Roscigno & Crowley, 2001), which is why school context must be considered when analyzing school effectiveness (Thrupp & Lupton, 2006). To obtain a just comparison between schools, studies must therefore take into account the impact of socioeconomic and cultural factors as well as the students' prior achievement (Heck, 2000; Willms & Kerckhoff, 1995).

School effect pertains to the influence that a school may have on students' intellectual and social development, regardless of background (Austin & Reynolds, 1990) or cognitive abilities (Luyten, 2003). School effect is studied to identify the characteristics of effective schools to ultimately alter the practices used in ineffective schools. On the basis that reduced inequalities will improve student outcomes, the goal is to alleviate inequalities between students and to ensure the academic achievement of the greatest number of students. Several studies note the added value some schools may provide to their students and their performance (e.g., Doran, 2003; Timmermans, Snijders, & Bosker, 2012). The question is determining whether students in certain schools fare better or worse than those in similar schools.

The variables related to teacher effect refers to the impact of teacher behaviors and practices on student achievement (Marzano, 2003). Significant variations in teaching practices result in variations in student performance. Research on school effectiveness has clearly shown that academic achievement depends greatly on the quality of what is taught (Marzano, 2003; Scheerens & Bosker, 1997) and some studies have also demonstrated the cumulative effect teachers have on how well their students perform (Rowan, Correnti & Miller, 2002). It is important to make a distinction between school effect and teacher effect, two different yet intrinsically related concepts, as the methods and practices used in the classroom are influenced by the school's organization and policies (Murphy & Louis, 1999). Thus the practices of the principal have an impact on both teaching and learning (Hallinger & Heck, 1996).

We therefore hypothesized that student achievement in mathematics could be explained by variables related to:

- student effect (student background and prior achievement)
- context effect (school size, location, etc.)
- school effect (results-oriented strategy, cooperation, leadership, frequent monitoring)
- teacher effect (learning time, learning opportunities, structure)

Using this perspective, based on Scheerens (2000), we asked the following question: “Why does school A do better than school B, if the differences are not due to differences in the student population of the two schools?” (p. 19).

Methodology

Sample

We analyzed the mathematics outcomes of 2436 Grade 8 students (end of elementary school) in 60 francophone schools. Principals and teachers from 50 of those schools answered a questionnaire (N = 111).

Variables

Dependent variable: Academic achievement measured by results in mathematics of eighth grade students. School effectiveness is generally determined by the students’ level of achievement on standard basic subject assessments. In our study, we examined eighth grade mathematics outcomes from the New Brunswick Department of Education mandatory exam for the 2009-2010 school year. This assessment consisted of 32 items (reliability .88) evaluating the following concepts: numbers and operations, patterns and relations, shape and space, and lastly, statistics and probability. In the present study, the students’ “true score” was used. The Department of Education applies an equating process to compare scores from one year to the next. To do so, the assessment items are determined according to a reference year, which balances the administered tests. The mean of the test was 70.21%.

Student-related variable: Prior achievement based on fifth grade outcomes. Prior achievements are excellent predictors of academic achievement (Hemmings, Grootenboer, & Kay, 2010). In addition to evaluating the students’ early skills, they also allow for socioeconomic status to be included as a factor (Fitz-Gibbon, 1996). The fifth grade scores on the 2006-2007 provincial assessments therefore constituted this variable for our study. As with the eighth grade outcomes, the true score was used. The 29 items of this assessment evaluated the same concepts as those in the eighth grade, with a reliability of .87. The mean of the test was 66.60%.

School-related variables. As mentioned in our conceptual framework, we devised a questionnaire based on the literature on effective schools to measure these school-related factors. Items covering the aspects related to the school (expectations toward the students, principal’s leadership, etc.), the teachers’ practices (learning time, progress monitoring, etc.), and the context of schools in New Brunswick were added to take into account the specificity of francophone elementary schools in New Brunswick (literacy program, laptop program, etc.). Likert-type questions were used, ranging from 1 (totally disagree) to 6 (totally agree).

Context-related variables. Some items in the questionnaire pertained to certain characteristics of the school and its environment, such as number of students in the school, geographical location (urban vs. rural), community school status, and laptop program participation. The item “number of students in the school” was a continuous variable, whereas three items were dichotomous: “school location” was coded 0 (rural area) or 1 (urban area); “community school status” was coded 0 (has no status) or 1 (has community school status); and “laptop program participation” was coded 0 (does not participate in the program) or 1 (participates in the program).

Demographic variables. Demographic questions were also included in the questionnaire to determine whether the teachers’ personal characteristics had any effect on student achievement. The items concerning this aspect were teaching experience, experience teaching in this grade, and school experience.

Analyses

We first had to determine whether the variables in the questionnaire measured separate or combined constructs. We therefore conducted an exploratory factorial analysis in order to reduce the amount of information on a given subject down to an easier to interpret number of elements (Stafford & Bodson, 2006). The variables were then subjected to a varimax rotation analysis based on the following three categories: school operation, principal’s practices, and teachers’ practices. To determine whether these factors met the necessary criteria to proceed with a factorial analysis, two tests were conducted, namely, the Barlett’s test of sphericity and the KMO (Kaiser-Meyer-Olkin) test. Thereafter, the scale was validated for internal coherence (Cronbach’s alpha).

Following verification of the descriptive statistics of each variable, we examined the inter-variable correlations. This enabled us to identify any multicollinearity problems, such as a relation between independent variables, that would hinder regression analyses and to retain only those variables correlated with the dependent variable in the subsequent analyses.

In order to develop a model to explain achievement in eighth grade mathematics by considering the factors related to the student, the classroom, the school, and the school’s context, we performed a series of multiple regression analyses. We also verified the assumptions relative to these analyses (Pallant, 2010), namely, the presence of significantly more statistical units than independent variables (sample size), that outlier had no undue effect on the model, an absence of multicollinearity, and finally, residual normality, linearity, and homoscedasticity.

To demonstrate the influence of effective schools on student achievement, we identified these schools by comparing predicted results (based on fifth grade scores) with those in eighth grade. To support these analyses, we also examined the evolution of these outcomes (improvement, regression, or stability of the results obtained) which were coded as exempted, unsatisfactory, acceptable, expected, or superior.

Results

Factorial Analysis

The factorial analysis revealed that the Bartlett’s test of sphericity was significant for the three categories under study. In addition, these analyses showed that the three categories met the

requirements for the KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) which is .6 (Pallant, 2010):

- school operation process: .818
- principal's practices: .815
- teachers' practices: .675.

All of the variables demonstrated satisfactory internal consistency, with a Cronbach's alpha higher than .7 (Table 1).

Table 1

Factorial Analysis Results

Variables	Cronbach's alpha
Principal's support	.87
Participative management	.83
Technology integration	.76
Prioritized basic subjects	.93
Evaluation process	.81
Teaching quality	.83
Monitoring of students' progress	.79
Instructional supervision	.87

Table 2

Descriptive Statistics of the Demographic and Explanatory Variables and the Dependent Variable

	M	SD	Minimum	Maximum
Student outcomes				
Results math–8th	70.22	18.09	30.29	100.00
Results math–5th	66.60	18.00	27.02	100.00
Demographic variables				
Number of students	261.88	146.27	54.00	656.00
Teaching experience	12.92	6.62	1.00	28.00
Grade experience	8.36	3.64	1.00	20.00
School experience	7.15	4.18	1.00	24.00
School variables				
Principal's support	5.13	0.69	3.40	6.00
Participative management	4.80	0.70	3.00	6.00
Technology integration	4.69	0.55	3.67	6.00
Prioritized basic subjects	5.23	0.46	3.63	5.97
Evaluation process	4.85	0.76	1.00	6.00
Teaching quality	4.88	0.53	2.50	5.67
Monitoring of progress	4.92	0.49	4.00	5.88
Instructional supervision	4.95	0.66	3.43	6.00

Descriptive Statistics

Students performed better in eighth grade ($M = 70.22$) than they did in fifth grade ($M = 66.60$). The size of the schools ranged from 54 to 656 students ($M = 261.88$). The teachers had an average of 13 years of teaching experience (Table 2).

Correlations

Table 3 presents significant correlations between the dependent variable (eighth grade results in mathematics) and the following independent variables: fifth grade results, teaching experience, grade experience, school experience, and number of students. We also found strong correlations between teaching experience and grade experience ($r = .83^{**}$), teaching experience and school experience ($r = .67^{**}$), and finally grade experience and school experience ($r = .64^{**}$). Due to its strong correlation, only teaching experience was retained for subsequent analysis. This problem of multicollinearity was also observed between the variables school location and number of students. As a result, we only retained the former for subsequent analysis.

In Table 4, the correlation matrix between the eighth grade outcomes and the variables of the questionnaire revealed a significant correlation between the eighth grade results in mathematics and the variables principal's support, participative management, technology integration, teaching quality, and instructional supervision.

Among these variables, three were directly correlated, demonstrating obvious multicollinearity: principal's support and instructional supervision ($r = .83^{**}$), principal's support and participative management ($r = .75^{**}$), and instructional supervision and participative management ($r = .72^{**}$). Elevated correlations between these variables were common because they all pertained to the principal's duties.

Other analyses were performed to verify the correlations between the demographic variables and those of the school. Results indicated that the variables teaching experience and teaching quality correlated significantly ($r = .38^{**}$). Preliminary multiple regression analyses enabled us to identify any instances of multicollinearity between these two variables. This was also evident between the variables teaching quality and technology integration ($r = .46^{**}$).

As we wished to retain only those variables correlating with the dependent variable and those presenting no multicollinearity, the following variables were retained for multiple regression analyses: prior achievement, teaching quality, participative management, and school location.

Regression Analysis

Table 5 presents the final model which included the three variables that were predictors of student achievement. Our findings indicated that this achievement, as measured by the eighth grade outcomes in mathematics, could be explained by prior achievement (in this case, fifth grade outcomes), urban school attendance, and teaching quality. The variable "participative management" was not a significant predictor of mathematics achievement.

The regression analysis results revealed that these three variables explained 48% (adjusted $R^2 = .480$) of the total variance of student achievement in eighth grade mathematics.

Table 3

Correlation Matrix of the Demographic Variables and Math Outcomes (Grades 5 and 8)

Variables	8th grade math	5th grade math	Teaching experience	Grade experience	School experience	Number of students
8th grade math	1.0					
5th grade math	.65**	1.0				
Teaching experience	.17**	.05	1.0			
Grade experience	.15**	.05	.83**	1.0		
School experience	.06*	.01	.67**	.64**	1.0	
Number of students	.21**	.04	.39**	.32**	.06*	1.0

Table 4

Correlation Matrix of the Explanatory Variables and the 8th Grade Math Outcomes

Variables	Math.	Principal's support	Participative management	Technology integration	Basic subjects	Evaluation process	Teaching quality	Monitoring of progress	Supervision
Math.	1.0								
Principal's support	-.06*	1.0							
Participative management	-.09**	.75**	1.0						
Technology integration	-.07**	.02	.01	1.0					
Basic subjects	.00	.52**	.43**	.03	1.0				
Evaluation process	-.04	.11**	.16**	.26**	.34**	1.0			
Teaching quality	.19**	-.01	-.05	.46**	.17**	.21**	1.0		
Monitoring of progress	.01	.49**	.54**	.27**	.66**	.35**	.46**	1.0	
Supervision	-.08**	.83**	.72**	.11**	.60**	.49**	.02	.54**	1.0

Table 5

Multiple Linear Regression Coefficients

Model	B	bêta	t	Sig.
Constant	-13.413		-2.891	.004
5th grade math score	.675	.637	26.682	.000
School location (rural/urban)	2.755	.074	2.803	.005
Teaching quality	7.784	.227	8.625	.000

R = .694; R² = .481; adj. R² = .480; F=283.778; P < .001

The standardized or *beta* coefficient indicated the degree of importance of the three variables to explain achievement in eighth grade mathematics, as follows:

1. prior achievement
2. teaching quality
3. school location (urban vs. rural)

The variable prior achievement had the most significant impact on achievement in eighth grade mathematics. Additionally, we observed that when the variable teaching quality was augmented by one point on the scale, the students' performance in mathematics increased by almost eight points.

The initial verification of the assumptions relative to the regression analyses showed that the sample used in this study was sufficiently large according to the equation put forth by Tabachnick and Fidell (2007), namely, " $N > 50 + 8m$ " (p. 123), which translated in our study to $111 > 50 + 8(3)$.

Our verification of the Cook's distance (no value beyond 1) for the outliers revealed no undue influence on the model (Field, 2009).

The variance inflation factor analysis indicated no multicollinearity for these three independent variables, as each one displayed a value of less than 10 (Field, 2009): prior achievement, 1.009; school location, 1.224; and teaching quality, 1.232.

A residual scatterplot (Tabachnick & Fidell, 2007) showed that the conditions were respected for normality, linearity, and homoscedasticity between the predicted results of the dependent variable and the errors of prediction.

Discussion and Conclusion

We sought to identify the predictors of academic achievement in effective schools by focusing on student outcomes in eighth grade mathematics. Our findings show that the fifth grade outcomes in mathematics (prior achievement) predicted achievement in this subject in Grade 8. Our findings are supported by previous studies that demonstrated that this variable (prior achievement) is an excellent predictor of academic achievement (Hemmings et al., 2010). Addressing the students' cognitive abilities as well as socioeconomic status, this variable had the greatest influence on achievement in eighth grade mathematics.

Among the school-related variables, school location was shown to be significant in predicting performance in math, even after other variables were controlled. These results are in agreement with those of Roscigno and Crowley (2001) and Young (1998) who found that students in urban schools performed better than their counterparts in rural schools, which is a typical observation because of the poverty aspect in the rural areas. This fact is even more evident in New Brunswick, where many workers in this province hold seasonal jobs and the local economy continues to struggle under budget restrictions.

For the variables related to the school and the classroom, teaching quality was the only one capable of predicting achievement in eighth grade math. When the variables prior achievement and school location were controlled, teaching quality remained significant in predicting performance. Despite being less prominent than students' past results in explaining achievement, a difference of only one echelon on the Likert-type scale for this variable raised the eighth grade math scores by eight points. This variable thus represents enormous potential for improving student achievement, specifically achievement in mathematics. This research finding

is in agreement with the results of DuFour and Marzano (2011) citing other studies (e.g., Hattie, 2009; Marzano, 2003) that also singled out teaching quality as the most important predictor of academic achievement.

The properties of the variable teaching quality, as it is defined here, concur with those presented in a review of literature by Stronge (2007): “maximizing instructional time, expecting students to achieve, using assessments to meet their needs, [and] use of instructional strategies” (p. 55-92). Effective teachers thus expect every student to learn regardless of their skills level (Covino & Iwanicki, 1996). In addition, they use evaluation data in their decision-making processes and in monitoring students (Cawelti, 2004) by employing a variety of proven strategies that take into account their students’ abilities.

Of interest is that certain variables that do not predict achievement in mathematics may nevertheless be factors that contribute to teaching quality. For example, Huang and Moon (2009) found that the number of years of teaching experience in a grade was associated with a better performance in reading. In our study, this is demonstrated by the significant correlation between the variables teaching experience and teaching quality. The more experience a teacher gains, the better their teaching will be and the better their students will perform. More experienced teachers master a greater number of strategies to plan their in-class activities (Stronge, 2007) and are more competent in applying these strategies (Covino & Iwanicki, 1996).

The fact that our results showed no significant correlation between academic achievement and several variables coincides with the relative lack of consensus observed from one country to the next in terms of the different predictors of achievement (Scheerens, 2000; Teddlie et al., 2000). The very strong similarity observed in the current practices in New Brunswick schools may partly explain why some variables, such as principal’s leadership and instructional supervision, were not significant here. The negative correlation of instruction supervision with eighth grade mathematics scores may be explained as school principals only become involved in the education process when outcomes are mediocre, compared to giving leeway when outcomes are good (Van der Werf, 1997).

Implications of this Study

Identifying predictors of student achievement will enable education leaders to critically examine the school system and to intervene with schools that do not meet expectations. The practical implications of this study are thus significant, as we studied the school system as a whole and systematic action on alterable factors will foster improved achievement for a larger number of students.

Our results showed that students’ prior achievement (fifth grade mathematics) predicted performance in the eighth grade and lead to the possibility of identifying at-risk students three years before their final exams. From this observation, it is imperative that each school develop a strategic recovery plan for students who have not attained the expected results with their earlier outcomes.

This study also showed that students in urban schools fare better than students in rural areas, which may be explained by the lack of human as well as material resources. The long distances to the workplace, the inherent difficulties of this environment, among other factors, result in teachers preferring positions in urban schools. Adequate measures must therefore be taken to attract and retain competent teachers in rural schools. School leaders must develop education policies that will enable rural schools to thrive through the provision of resources (for

instance, teachers, school libraries during the summer months) and support for student motivation and commitment (for instance, school programs centered on helping students connect their education to the job market, the use of technological infrastructures within their learning activities, and greater involvement of parents in school activities).

Also demonstrated in this study was the importance of teaching quality and its impact on student achievement. To ensure that teachers provide high-quality learning activities for their students, school principals must establish adequate instructional supervision, particularly for new teachers. Frequent in-class observations and discussions on effective education practices could encourage teachers to change how they teach to support student achievement. School leaders must also establish professional development programs to counter any flaws identified during this supervision, and ideally, to focus on established and effective practices.

Muijs, Harris, Chapman, Stoll, and Russ (2004) detailed four factors that play an important role in school improvement programs:

- When teachers view methods as being effective
- When school heads manage and support change
- When a culture of continuous professional development is present
- When active recruitment of high-quality staff is a priority (p. 167).

These strategies could be used in New Brunswick elementary schools to improve student achievement. Because elementary schools have a long-term effect on level of achievement (Goldstein & Sammons, 1995), it is important that attention be focused on helping low-performing students from impoverished areas to improve their chances of completing their secondary education.

Future Research

Several research projects will follow this study, including a panCanadian study which will take into account both official language sectors (English and French) and include a mixed methods approach to triangulate the collected data (interviews, questionnaires, in-class observations). Future research may also address how schools evolve (longitudinal study) and may consider, in addition to student achievement, the competencies related to the students' personal and affective development.

References

- Ammar, S., Bifulco, R., Duncombe, W., & Wright, R. (2000). Identifying low-performance public schools. *Studies in Educational Evaluation, 26*(3), 259-287.
- Austin, G., & Reynolds, D. (1990). Managing for improved school effectiveness: An international survey. *School Organization, 10*(2), 167-178.
- Bellei, C. (2009). Does lengthening the school day increase students' academic achievement? Results from a natural experiment in Chile. *Economics of Education Review, 28*(5), 629-640.
- Bennett, N., & Turner-Bisset, R. (1993). Knowledge bases and teaching performance. In N. Bennett & C. Carré (Eds.), *Learning to teach* (pp. 5149-5164). New York, NY: Routledge.
- Bissonnette, S., Richard, M., & Gauthier, C. (2006). *Comment enseigne-t-on dans les écoles efficaces? Efficacité des écoles et des réformes*. Saint-Nicolas, Québec: Les Presses de l'Université Laval.

- Brophy, J. E., & Good, T. L. (1986). Teacher behaviour and student achievement. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 328-375). New York, NY: Macmillan.
- Cawelti, G. (Ed.) (2004). *Handbook of research on improving student achievement* (3rd ed.). Arlington, VA: Educational Research Service.
- Coleman, J., Campbell, E., Hobson, C., McPartland, J., Mood, A., Weinfeld, F., & York, R. (1966). *Equality of educational opportunity*. Washington, DC: Department of Health, Education and Welfare.
- Covino, E. A., & Iwanicki, E. F. (1996). Experienced teachers: Their constructs of effective teaching. *Journal of Personnel Evaluation in Education*, 10(4), 325-363.
- Darling-Hammond, L. (2002). *Redesigning schools: What matters and what works*. Stanford, CA: Stanford University, School Redesign Network.
- Doran, H. C. (2003, April). *Value-added analysis: A review of related issues*. Paper presented at the American Educational Research Association, Chicago, IL.
- Downey, D. (1995). When bigger is not better: Family size, parental resources, and children's educational performance. *American Sociological Review*, 60(5) 746-761.
- DuFour, R., & Eaker, R. (2004). *Professionnal learning communities at work: Best practices for enhancing student achievement*. Alexandria, VA: Association for Supervision and Curriculum Development.
- DuFour, R., & Marzano, R. J. (2011). *Leaders of learning: How district, school, and classroom leaders improve student achievement*. Bloomington, IN: Solution Tree Press.
- Fan, X., & Chen, M. J. (1999). Academic achievement of rural school students: A multi-year comparison with their peers in suburban and urban schools. *Journal of Research in Rural Education*, 15(1), 31-46.
- Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Thousand Oaks, CA: SAGE Publications, Inc.
- Fitz-Gibbon, C. T. (1996). *Monitoring education: Indicators, quality and effectiveness*. London, UK: Cassell.
- Fullan, M., & Hargreaves, A. (1996). *What's worth fighting for in your school?* New York, NY: Teachers College Press.
- Goddard, R. D., Sweetland, S. R., & Hoy, W. K. (2000). Academic emphasis of urban elementary schools and student achievement in reading and mathematics: A multilevel analysis. *Educational Administration Quarterly*, 36(5), 683-702.
- Goldstein, H., & Sammons, P. (1995). *The influence of secondary and junior on sixteen year examination performance: A cross-classified multilevel analysis*. London, UK: Institute of Education.
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teaching community. *Teachers College Record*, 103(6), 942-1012.
- Hallinger, P., & Heck, R. (1996). Reassessing the principal's role in school effectiveness: A review of empirical research, 1980-1995. *Educational Administration Quarterly*, 32(1), 5-44.
- Hallinger, P., & Leithwood, K. (1994). Introduction: Exploring the impact of principal leadership. *School Effectiveness and School Improvement*, 5(3), 206-218.
- Hannaway, J., & Talbert, J. E. (1993). Bringing context into effective schools research: Urban-suburban differences. *Educational Administration Quarterly*, 29(2), 164-186.
- Harn, B. A., Linan-Thompson, S., & Roberts, G. (2008). Intensifying instruction: Does additional instructional time make a difference for the most at-risk first graders? *Journal of Learning Disabilities*, 41(2), 115-125.
- Hattie, J. (2009). *Visible learning. A synthesis of over 800 meta-analyses relating to achievement*. New York, NY: Routledge.
- Heck, R. (2000). Examining the impact of school quality on school outcomes and improvement: A value-added approach. *Educational Administration Quarterly*, 36(4), 513-552.
- Heck, R., Larson, T., & Marcoulides, G. (1990). Principal instructional leadership and school achievement: Validation of a causal model. *Educational Administration Quarterly*, 26, 94-125.

- Hemmings, B., Grootenboer, P., & Kay, R. (2010). Predicting mathematics achievement: The influence of prior achievement and attitudes. *International Journal of Science and Mathematics Education, 4*, 691-705.
- Hofman, W. H., & Hofman, R. H. (2011). Smart management in effective schools: Effective management configurations in general and vocational education in the Netherlands. *Educational Administration Quarterly, 47*(4), 620-645.
- Huang, F. L., & Moon, T. R. (2009). Is experience the best teacher? A multilevel analysis of teacher experience characteristics and student achievement in low performing schools. *Education Assessment Evaluation and Accountability, 21*(3), 209-234.
- Leithwood, K., & Jantzi, D. (2000). Principal and teacher leadership effects. A replication. *School Leadership & Management, 20*(4), 415-434.
- Levine, D. U., & Lezotte, L. W. (1990). *Unusually effective schools. A review and analysis of research and practice*. Madison, WI: National Center for Effective Schools Research and Development.
- Lieberman, A. (2000). Networks as learning communities, shaping the future of teacher development. *Journal of Teacher Education, 51*(3), 221-227.
- Luyten, H. (2003). The size of school effects compared to teacher effects: An overview of the research literature. *School Effectiveness and School Improvement, 14*(1), 31-51.
- Marzano, R. J. (2003). *What works in schools. Translating research into action*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Marzano, R. J., McNulty, B. A., & Waters, T. (2005). *School leadership that works: From research to results*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Moolenaar, N. M., Daly, A. J., & Slegers, J. C. (2010). Occupying the principal position: Examining relationships between transformational leadership, social network position, and schools' innovative climate. *Educational Administration Quarterly, 46*(5), 623-670.
- Mortimore, P. (1991). School effectiveness research: Which way at the crossroads? *School Effectiveness and School Improvement, 2*(3), 213-229.
- Muijs, D., Harris, A., Chapman, C., Stoll, L., & Russ, J. (2004). Improving schools in socioeconomically disadvantaged areas: A review of research evidence. *School Effectiveness and School Improvement, 15*(2), 149-175.
- Muijs, D., & Reynolds, D. (2003). Student background and teacher effects on achievement and attainment in mathematics: A longitudinal study. *Educational Research and Evaluation, 9*(3), 289-314.
- Murphy, J., & Louis, K. S. (1999). Handbook editor's introduction: Notes from the handbook. *Educational Administration Quarterly, 35*(4), 472-476.
- Nouveau-Brunswick. Ministère de l'Éducation. (2000). *PISA 2000: Résultats de la performance des élèves du Nouveau-Brunswick*. Fredericton: Ministère de l'Éducation, Direction de la mesure et de l'évaluation. Retrieved from <http://www.gnb.ca/0000/publications/evalf/pisa2000.pdf>
- Nouveau-Brunswick. Ministère de l'Éducation. (2007). *PPCE-13 de 2007: Points saillants*. Fredericton: Ministère de l'Éducation, Direction de la mesure et de l'évaluation.
- Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS* (4th ed.). Maidenhead, UK: Open University Press McGraw-Hill.
- Papanastasiou, C. (2008). A residual analysis of effective schools and effective teaching in mathematics. *Studies in Educational Evaluation, 34*(1), 24-30.
- Reeves, E. B., & Bylund, R. A. (2005). Are rural schools inferior to urban schools? A multilevel analysis of school accountability trends in Kentucky. *Rural Sociology, 70*(3), 360-386.
- Reynolds, D. (2006). World class schools: Some methodological and substantive findings and implications of the International School Effectiveness Research Projects (ISERP). *Educational Research and Evaluation, 12*(6), 535-560.
- Reynolds, D., & Cuttance, P. (Eds.). (1992). *School effectiveness research, policy and practice*. London, UK: Cassell.

- Roscigno, V. J., & Crowley, M. L. (2001). Rurality, institutional disadvantage, and achievement/attainment. *Rural Sociology*, 66(2), 268-292.
- Rowan, B., Correnti, R., & Miller, R. J. (2002). What large scale, survey research tells us about teacher effects on student achievement: Insights from the prospects study of elementary schools. *Teachers College Record*, 104(3), 1525-1567.
- Sammons, P., Hillman, J., & Mortimore, P. (1995). *Key characteristics of effective schools. A review of school effectiveness research*. London, UK: Institute of Education.
- Sammons, P., & Luyten, H. (2009). Editorial article for special issue on alternative methods for assessing school effects and schooling effects. *School Effectiveness and School Improvement*, 20(2), 133-143.
- Scheerens, J. (2000). *Improving school effectiveness*. Paris: UNESCO, International Institute for Educational Planning.
- Scheerens, J. (2006). Concepts and theories of school effectiveness. In A. J. Visscher (Ed.), *Managing schools towards high performance. Linking school management theory to the school effectiveness knowledge base* (pp. 37-70). New York, NY: Taylor & Francis.
- Scheerens, J., & Bosker, R. (1997). *The foundations of educational effectiveness*. Oxford, UK: Pergamon.
- Scheerens, J., Bosker, R., & Creemers, B. P. (2000). Time for self-criticism: On the viability of school effectiveness research. *School Effectiveness and School Improvement*, 12(1), 131-157.
- Stafford, J., & Bodson, P. (2006). *L'analyse multivariée avec SPSS*. Sainte-Foy, Québec: Presses de l'Université du Québec.
- Stronge, J. H. (2007). *Qualities of effective teachers* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). New York, NY: Pearson Education, Inc.
- Teddlie, C., Reynolds, D. & Sammons, P. (2000). The methodology and scientific properties of school effectiveness research. In C. Teddlie & D. Reynolds (Eds.), *The international handbook of school effectiveness research* (pp. 55-133). New York, NY: Falmer Press.
- Thomas, S., & Smees, R. (1998, April). *Dimensions of secondary school effectiveness: Comparing the findings from four academic studies*. Paper presented at the American Educational Research Association, San Diego, CA.
- Thoonen, E. E., Slegers, P. J., Oort, F. J., Peetsma, T. T., & Geijsel, F. P. (2011). How to improve teaching practices: The role of teacher motivation, organizational factors, and leadership practices. *Educational Administration Quarterly*, 47(3) 496-536.
- Thrupp, M., & Lupton, R. (2006). Taking school contexts more seriously: The social justice challenge. *British Journal of Educational Studies*, 54(3), 308-328.
- Timmermans, A. C., Snijders, T. A., & Bosker, R. J. (2012). In search of value added in the case of complex school effects. *Educational and Psychological Measurement*, 73(2), 210-228.
- Tornroos, J. (2005). Mathematics textbooks, opportunity to learn and student achievement. *Studies in Educational Evaluation*, 31(4) 315-327.
- Townsend, T., Acker-Hocevar, M., Ballenger, J., & Place, W. A. (2013). Voices from the field: What have we learned about instructional leadership? *Leadership and Policy in Schools*, 12(1), 12-40.
- Villani, C. J. (2004). The story of an urban learning community. *School Community Journal*, 4(1) 81-89.
- Van den Broeck, A., Opdenakker, M.-C., & Van Damme, J. (2005). The effects of student characteristics on mathematics achievement in Flemish TIMSS 1999 data. *Educational Research and Evaluation*, 11(2), 107-121.
- Van der Werf, G. (1997). Differences in school and instruction characteristics between high-, average-, and low-effective schools. *School Effectiveness and School Improvement*, 8(4), 430-448.
- Von Secker, C. E., & Lissitz, R. W. (1997, March). *Estimating school value-added effectiveness: Consequences of respecification of hierarchical linear models*. Paper presented at the American Educational Research Association, Chicago, IL.

- Wang, J. (1998). Opportunity to learn: The impacts and policy implications. *Educational Evaluation and Policy Analysis*, 20(3) 137-156.
- Wiley, S. (2001). Contextual effects of student achievement: School leadership and professional community. *Journal of Educational Change*, 2(1), 1-33.
- Willms, D. J. (1992). *Monitoring school performance: A guide for educators*. Washington, DC: Falmer.
- Willms, D. J., & Kerckhoff, A. C. (1995). The challenge of developing new educational indicators. *Educational Evaluation and Policy Analysis*, 17(1), 113-131.
- Witziers, B., Bosker, R. J., & Krüger, M. L. (2003). Educational leadership and student achievement: The elusive search for an association. *Educational Administration Quarterly*, 39(3), 398-425.
- Wynn, S. R., Carboni, L. W., & Patall, E. A. (2007). Beginning teachers' perceptions of mentoring, climate, and leadership: Promoting retention through a learning community's perspective. *Leadership and Policy in Schools*, 6(3), 209-229.
- Yair, G. (2000). Educational battlefields in America: The tug-of-war over students' engagement with instruction. *Sociology of Education*, 73(4), 247-269.
- Young, D. Y. (1998). Rural and urban in student achievement in science and mathematics: A multilevel analysis. *School Effectiveness and School Improvement*, 9(4), 386-418.

Marc Basque is Assistant Professor in the Department of Education and Letters at the University of Moncton, Edmundston Campus. He is a former primary school principal. His research interests include school effectiveness, poverty in school, teaching quality, and motivation.

Yamina Bouchamma is Full Professor in the Department of Foundations and Practices in Education at Laval University. She is also head of the Leadership Program for a New School and the School Management Diploma. Her research interests include student achievement, instructional leadership and supervision, professional learning communities and communities of practices, school effectiveness, and the inclusion of minorities (ethnic, linguistic, etc.).