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DIRECT AND INDIRECT ASSOCIATIONS BETWEEN PRINCIPAL LEADERSHIP, CLIMATE AND ACADEMIC RESULTS IN HIGH SCHOOL

ASSOCIAÇÕES DIRETAS E INDIRETAS ENTRE LIDERANÇA DO DIRETOR, CLIMA E RESULTADOS ACADÊMICOS NO ENSINO MÉDIO

ASOCIACIONES DIRECTAS E INDIRECTAS ENTRE LIDERAZGO PRINCIPAL, CLIMA Y RESULTADOS ACADÉMICOS EN LA ESCUELA SECUNDARIA

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ABSTRACT: This article investigates the associations between different sets of principal leadership practices, dimensions of school climate, and the academic results of 3rd-year high school students in two state education networks. Using a quantitative approach, primary data from a broader survey (which collected contextual information from more than 130 schools) was explored. Based on state external assessments, models with structural equations were estimated for proficiency in Portuguese and mathematics. The results indicate that the principal's leadership practices have strong and consistent associations with the academic and relational dimensions of the school climate. However, only the academic dimension is positively and consistently associated with educational results. Direct associations between principal leadership practices and academic outcomes were consistently positive and small. The indirect (or total) associations, mediated by other school factors, were constant and of greater magnitude.

KEYWORDS: Pedagogical management. Pedagogical intervention. Academic climate. Relational climate.

***RESUMO**: Este artigo investiga as associações entre diferentes conjuntos de práticas de liderança do diretor, dimensões do clima escolar e os resultados acadêmicos de estudantes do 3º ano do ensino médio em duas redes estaduais de ensino. Com uma abordagem quantitativa, exploraram-se os dados primários de uma pesquisa mais ampla (que coletou informações contextuais em mais de 130 escolas). Estimaram-se modelos com equações estruturais para a proficiência em língua portuguesa e matemática, a partir das avaliações externas estaduais. Os resultados indicam que as práticas de liderança do diretor apresentam associações fortes e consistentes com a dimensão acadêmica e relacional do clima escolar. Contudo, somente a dimensão acadêmica se associa positiva e consistentemente com os resultados acadêmicos. As associações diretas entre as práticas de liderança do diretor e os resultados acadêmicos foram consistentemente positivas e pequenas. As associações indiretas (ou totais), mediadas por outros fatores escolares, foram constantes e de maior magnitude.*

***PALAVRAS-CHAVE:** Gestão pedagógica. Intervenção pedagógica. Clima acadêmico. Clima relacional.*

***RESUMEN**: Este artículo investiga las asociaciones entre diferentes conjuntos de prácticas de liderazgo de directores, dimensiones del clima escolar y los resultados académicos de estudiantes de tercer año de secundaria en dos redes educativas estatales. Utilizando un enfoque cuantitativo, se exploraron datos primarios de una encuesta más amplia (que recopiló información contextual de más de 130 escuelas). Se estimaron modelos con ecuaciones estructurales para el dominio de portugués y matemáticas, con base en evaluaciones externas estatales. Los resultados indican que las prácticas de liderazgo del director tienen asociaciones fuertes y consistentes con las dimensiones académicas y relacionales del clima escolar. Sin embargo, sólo la dimensión académica se asocia positiva y consistentemente con los resultados académicos. Las asociaciones directas entre las prácticas de liderazgo de los principales y los resultados académicos fueron consistentemente positivas y pequeñas. Las asociaciones indirectas (o totales), mediadas por otros factores escolares, fueron constantes y de mayor magnitud.*

***PALABRAS CLAVE**: Gestión pedagógica. Intervención pedagógica. Clima acadêmico. Clima relacional.*

Introduction

This work is part of the discussion on the direct and indirect relationship between the leadership practices of school principals and the academic outcomes of students in basic education. Studies investigating effective schools, i.e., those schools that add value to their students' academic results regardless of their socioeconomic status, indicate that the leadership of the principal is an essential factor for school outcomes (Mortimore, 1991; Sammons, 2008). According to these studies, these schools' principals focus on the school's pedagogical aspects, such as curriculum, teaching strategies, classroom activities, and monitoring of learning (Rutter *et al*., 1979).

From this perspective, Day *et al.* (2008) and Day, Gu, and Sammons (2016) found in their research that principals of effective schools tend to use a common repertoire of school leadership practices, and these basic principles of leadership are executed in a manner sensitive to the context of each school. In this vein, Sammons (2008) argues that although the particular characteristics of individuals are important elements in understanding how school leadership is established, it is necessary to observe how the leadership of principals affects meaningful changes in the organizational context of the schools.

The concept of school leadership is quite recent in the Brazilian research field, however, there is a long trajectory of international empirical investigation regarding the effects of principals' leadership (Hallinger; Gümüs; Bellibas, 2020). For instance, the phenomenon known as school leadership occurs when the principal and/or management team and other school agents mobilize with the purpose of achieving shared goals and promoting the improvement of outcomes (Leithwood, 2009; Robinson; Hohepa; Lloyd, 2009). For instance, the phenomenon known as school leadership occurs when the principal and/or management team and other school agents mobilize with the purpose of achieving shared goals and promoting the improvement of outcomes (Elmore, 2006).

Studies on school effectiveness indicate that one of the indirect mechanisms of principals' leadership on academic outcomes occurs through the school climate (Rezende, 2016). This is a construct formed by different dimensions and has a synthetic and versatile nature (Moro; Vinha; Morais, 2019). However, systematic reviews indicate that the academic and relational dimensions of the school climate are the variables most associated with school outcomes (Pereira, 2021; Wang; Degol, 2016).

This work investigated the direct and indirect relationship between the leadership

practices of the principal (especially those of a pedagogical nature) and the academic results of high school students. Therefore, the constructs of interest in this study were termed "Pedagogical Intervention" and "Pedagogical Management." The first concept refers to a central role occupied by the principal, who is responsible for mobilizing and facilitating the work that occurs in the school with the objective of achieving established goals, particularly those affecting student learning (Leithwood; Aitken; Jantzi, 2006). The second concept refers to those practices of the principal related to the allocation of teachers with the desired interest and capability, supervision and evaluation of teaching, monitoring of student progress, and the effort to maintain the teachers' focus on work, avoiding potential distractions (Leithwood; Riehl, 2005).

To analyze the indirect relationship between the principal's leadership practices and the academic outcomes of students, the study explored the potential of academic and relational aspects of school climate as mediating variables in the effect of principal leadership. The academic climate is composed of various characteristics related to the academic emphasis of the school, that is, focusing on the processes of teaching and learning. The relational environment, in turn, is made up of the relationships established among the various actors of the school community (Cohen *et al.,* 2009; Franco *et al*., 2007; Moro, 2018; Moro; Vinha; Morais, 2019; Pereira, 2021; Thapa *et al*., 2013; Wang; Degol, 2016).

In the Brazilian research field, the majority of empirical studies investigating the relationships between principal leadership and school outcomes use methods that only allow for the verification of direct relationships between these factors (Pena; Soares, 2014; Oliveira, 2018; Oliveira; Paes de Carvalho, 2018). Therefore, to conduct the empirical investigation proposed here, the use of Partial Least Squares Structural Equation Modeling (PLS-SEM) was chosen, as this modeling enables the simultaneous verification of direct and indirect relationships among different variables in a path model (Hair; Howard; Nitzl, 2020).

The paper is organized into six sections, including this introduction. In the second section, theoretical frameworks and empirical evidence regarding the direct and indirect effects of different school leadership models and specific practices of the principal are presented. In the third section, the empirical data of this study and the employed methodology are presented. Following this, the fourth section presents the main results obtained through the estimated models. The fifth section offers a brief discussion about the observed direct and indirect relationships. Finally, the study's conclusions and potential next steps are presented.

School Leadership: Debate on Direct and Indirect Effects

Various investigations on the subject have enabled the performance of meta-analyses and systematic reviews on the association between school leadership and academic outcomes. Witziers, Bosker, and Krüger (2003) conducted a meta-analysis that considered research carried out between 1986 and 1996, thus providing an international overview of the status of direct effects models. The researchers selected 37 multinational studies that, although different in terms of instrumentation, analyzed the direct relationship between school leadership and academic outcomes. Witziers, Bosker, and Krüger (2003) investigated only the direct relationships between these factors because, up to that point, there were few studies that used analytical models suitable for observing indirect effects.

The study by Witziers, Bosker, and Krüger (2003) indicated that the effect sizes were small overall, meaning the correlations between school leadership and student outcomes were less than 0.10 in standard deviations. The average effect found was 0.02 in standard deviations, an estimate commonly interpreted as a very weak or even non-existent relationship. The additional test of direct effects conducted by the authors proved inconclusive, leading them to emphasize the need for future studies to use more clearly defined theoretical constructs and consider the contextual differences of schools and the potential of intermediate factors and mediating variables.

In turn, Robinson, Lloyd, and Rowe (2008) conducted a meta-analysis to determine the impact of different models of school leadership. For this purpose, 27 studies published in the field of educational management that investigated the association between measures of school leadership and academic performance were selected. The work was composed of two complementary stages; in the first stage, the effects of two distinct theoretical models were compared: transformational leadership and instructional leadership. In the first model, the focus is on the development of human and organizational school structure, while in the second model, the focus is on teaching work, school curriculum, and learning quality.

In the second stage, the effects of five sets of school leadership practices were inductively examined (setting goals and expectations; strategically managing resources; planning, coordinating, and evaluating teaching and curriculum; promoting and participating in the professional development of teachers; ensuring an organized and supportive academic environment). Robinson, Lloyd, and Rowe (2008) found that the average effect of instructional leadership was three to four times greater than that of transformational leadership. The study also highlighted that the dimension "promotion and participation in teacher development" was

associated with student performance with a strong average effect, while the dimensions "setting goals and expectations" and "planning, coordinating, and evaluating teaching and curriculum" showed moderate effects.

While Witziers, Bosker, and Krüger (2003) sought to conduct an additional test of the overall impact of school leadership, the empirical strategy adopted in the study by Robinson, Lloyd, and Rowe (2008) consisted of identifying the effect of different types of leadership models, as well as school leadership practices. Robinson, Lloyd, and Rowe (2008) did not adopt a unitary theoretical abstraction, as the intent of the investigation was to understand how certain specific school leadership practices were associated with academic outcomes. The choice for transformational and instructional leadership was made because these models are theoretical constructs extensively explored in the research field (Hallinger; Murphy, 1985; Hallinger, 2005; Leithwood; Sun, 2012; Hallinger;Gümüs; Bellibas, 2020).

Regarding the indirect effects of school leadership, Robinson, Lloyd, and Rowe (2008) and Robinson, Hohepa, and Lloyd (2009) observed that transformational leadership has weak indirect effects on student outcomes. The researchers argue that transformational leadership moderately influences teachers' perceptions and attitudes about the organization and school climate; however, this effect does not directly reach the students. Conversely, instructional leadership showed a strong indirect relationship with school outcomes, with effect sizes being superior when compared to transformational leadership. The researchers note that the emphasis on the qualification of teachers and teaching, central characteristics of instructional leadership, are the school variables that best explain the intra-school residual variation in academic results.

In a study conducted by Leithwood and Sun (2018), the potential of a generalized latent construct, labeled as academic culture, to mediate the influence of principals' leadership was examined. The concept of academic culture is linked to studies investigating the conditions necessary for establishing a particular school ethos, that is, an organized environment focused on teaching and learning (Sammons, 2008). Therefore, academic culture pertains to the norms and beliefs shared by the school team, as well as the intentional work of school agents in achieving established goals, and the maximization of teaching time with students by teachers.

The findings by Leithwood and Sun (2018) supported their three study hypotheses: first, that academic culture would be a multivariable latent construct composed of three different

measures (academic press[4], disciplinary climate[5] and teachers' use of instructional time[6]), second, that academic culture would significantly explain the variation in students' academic results; and finally, that academic culture would be a significant mediating variable in the relationship between principals' leadership and academic outcomes. To conduct the study, the researchers used correlational analysis to observe the relationship between academic culture and student learning, and structural equation models to verify the indirect effect of school principals' leadership on learning.

Among the study's results, it was notable that the three components forming the academic culture variable correlated positively with student performance in language and mathematics. However, the correlations between student performance and academic press and disciplinary climate were higher compared to the correlation between student performance and the use of instructional time. Leithwood and Sun (2018) also found that socioeconomic level was statistically significantly correlated with student performance in language, but the correlation with student performance in mathematics was not significant.

Theoretical Model, Main Hypotheses, and Methodological Strategy

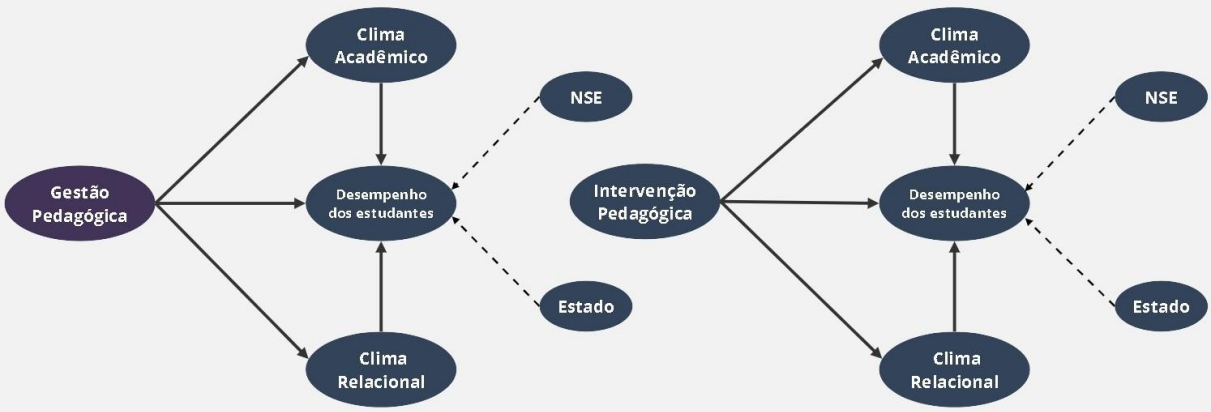
For this study, it was assumed that the principal's leadership practices of a pedagogical nature, i.e., practices aimed at improving the quality of teaching and expanding learning opportunities for all students, positively impact the academic outcomes of the school (Leithwood; Aitken; Jantzi, 2006). However, studies on management and school leadership demonstrate that the principal's leadership practices reach students indirectly and that factors at the classroom level and specific dimensions of the school climate would have a more significant direct impact on academic outcomes (Day *et al.,* 2008; Wang; Degol, 2016; Franklin, 2023).

Considering the aforementioned assumptions involving the principal's leadership, dimensions of school climate, and academic outcomes, four initial hypotheses are proposed.

[4] The theoretical construct known as "academic press" is defined in the literature as a synthesis involving the following school elements: high goals for teacher performance, positive student response to the established goals, and the presence of a principal who provides resources and collaborates with other school agents to achieve these goals (Leithwood; Sun, 2018).
[5] The term "disciplinary climate" refers to rules and school compliance, such as students' disciplinary experiences, behavior rules, teacher-student relationships, among other characteristics (Ma, 2003).
[6] Leithwood and Sun (2018) argue that "teachers' use of instructional time" corresponds to efforts to maximize the time dedicated to teaching and learning, creating classroom conditions that allow for an appropriate pace of instruction, as well as providing assistance to students so that they can be autonomous in their learning.

The first hypothesis is that there is a direct relationship between Intervention, Pedagogical Management, and academic outcomes. The second hypothesis is that there is also a direct relationship between Intervention, Pedagogical Management, Academic Climate, and Relational Climate. The third hypothesis proposes that there is a direct relationship between Academic Climate, Relational Climate, and academic outcomes. The fourth hypothesis suggests that there is an indirect relationship between Intervention, Pedagogical Management, and academic outcomes, occurring through Academic Climate and Relational Climate. Figure 1 presents the hypothetical relationships mentioned above.

Figure 1 – Initial Research Model



Source: Developed by the authors (2024).

"Pedagogical Management" and "Pedagogical Intervention" are the exogenous latent variables of the model, meaning they are the constructs that only emit effects. "Academic Climate" and "Relational Climate" are the endogenous latent variables of the model; that is, they are the constructs that receive effects from other variables and, in this case, are responsible for mediating effects in the path model. Meanwhile, the aggregated socioeconomic level (NSE) and the status of the schools in the sample (Piauí and Espírito Santo) are the control variables of the model, while student performance is the response variable.

Latent variables are concepts that cannot be measured directly; thus, manifest variables are used as proxies to measure the phenomenon under observation. From this perspective, each construct was measured considering the perceptions of the teachers in the sample, that is, through the teachers' responses to the items on the contextual questionnaire. The cross-sectional measures of performance in Portuguese and mathematics are derived from external state assessments conducted in 2022. The variable related to socioeconomic level (NSE) comes from

the microdata of the Basic Education Evaluation System (SAEB) of 2021, and the variable related to the state of the schools followed this coding: Piauí = 0; Espírito Santo = 1.

The database for this exploratory study was composed of contextual information collected in 2022 through a broader survey (PGLEQE - Practices of Management, Educational Leadership, and Quality of Education in Brazilian High Schools) in two Brazilian states, Piauí and Espírito Santo, involving principals, pedagogical coordinators, and teachers[7]. In addition to the contextual data, the study also included cross-sectional measures of student performance in Portuguese and mathematics from the external assessments of the states that participated in the study[8].

For the conduct of this exploratory study and taking into account the empirical data from the aforementioned research, 137 schools were observed, comprising 67 schools in Piauí (601 responding teachers) and 70 schools in Espírito Santo (682 responding teachers). Table 1 presents the latent variables, i.e., the theoretical constructs that make up the analytical model. Also presented are the scales used in the teachers' questionnaire and how they were operationalized.

Table 1 - Description of the variables in the analytical model

Constructs	Data Source	Scales and Operationalization
Pedagogical Intervention	Teacher Questionnaire	The scale "frequently, occasionally, rarely, never" was parameterized from 4 to 1, respectively. The observation for each school corresponds to the arithmetic mean.
Pedagogical Management	Teacher Questionnaire	The scales "strongly agree, agree, disagree, strongly disagree" and "frequently, occasionally, rarely, never" were parameterized from 4 to 1, respectively. The observation for each school corresponds to the arithmetic mean.
Academic Climate	Teacher Questionnaire	The scale "strongly agree, agree, disagree, strongly disagree" was parameterized from 4 to 1, respectively. The observation for each school corresponds to the arithmetic mean.
Relational Climate	Teacher Questionnaire	The scale "very good, good, average, poor, very poor" was parameterized from 5 to 1, respectively. The observation for each school corresponds to the arithmetic mean.
Student Performance in High School	SAEPI (PI) and PAEBES (ES)	Annual proficiency measures in Portuguese and mathematics for 12th-grade students aggregated by school.

Source: Developed by the authors (2024).

The contextual items related to the latent variable "Pedagogical Intervention" had missing responses, and for this reason, the technique of data imputation by the general sample

[7] For more detailed information about the Research, see Oliveira *et al*. (2024) in the opening article of this dossier, "*Dossiê: Práticas de Gestão, Liderança Educativa e Qualidade da Educação em Escolas de Ensino Médio no Brasil*" published in this issue.

[8] The Piauí Educational Assessment System (SAEPI) and the Espírito Santo Basic Education Assessment Program.

mean for each item was used. The responses to the items related to this latent variable were predominantly in the option "frequently". Meanwhile, responses to the items related to the variable "Pedagogical Management," which consists of two distinct Likert-type scales, are primarily in the options "strongly agree" and "frequently". Responses to the items related to the latent variable "Academic Climate" were predominantly in the options "strongly agree" and "agree", and the responses to the items related to the variable "Relational Climate" were predominantly in the option "good".

Table 2 presents the variation of aggregated values by school of the variables that compose the theoretical-exploratory model, the lowest and highest values found, and their average, as well as their standard deviation.

Table 2 - Descriptive Statistics

	Minimum	Maximum	Average	Standard Deviation
Pedagogical Intervention	-3,51	1,38	-0,014	1,000
Pedagogical Management	-3,84	1,77	-0,004	1,007
Academic Climate	-3,36	1,92	-0,005	1,006
Relational Climate	-2,40	2,15	-0,015	0,999
Portuguese Language	204,47	312,11	262,64	24,25
Mathematics	221,95	340,00	263,82	26,14
NSE	3,13	5,53	4,60	0,48

Source: Developed by the authors (2024).

The analytical model for this study was estimated using RStudio software, with the PLS Path Modeling (PLS-PM) package, which facilitated data modeling with structural equations (SEM). The use of this modeling is recommended in the following situations: (i) when testing and validating exploratory models; (ii) when research is in the initial stages of theoretical formulation; and (iii) when conducting studies with a predictive nature (Shmueli *et al*., 2019; Hair; Howard; Nitzl, 2020).

The PLS-SEM model (Partial Least Squares Structural Equation Modeling) essentially consists of two groups of linear equations identified as the inner model and the outer model. The inner model refers to the relationships between latent variables, while the outer model pertains to the relationships between a latent variable and its manifest variables. Therefore, a two-step process is necessary: validation of the outer model and validation of the inner model (Sanchez, 2013). The outer models in this study are reflective, meaning the latent variables were measured using the technique of common factor analysis. Thus, the contextual items answered by teachers reflect the theoretical constructs.

Results of the Analytical Models

Factor loadings specify the correlation between items of the contextual questionnaire and the theoretical constructs. The absolute values of the factor loadings indicate the importance of manifest variables for the interpretation of factor analysis (Oliveira; Waldhelm, 2016). Most of the manifest variables achieved satisfactory factor loadings; only two variables showed factor loadings below 0.50 in models estimating both Portuguese language and mathematics. The manifest variables in question are: "Records teachers' absences and delays, communicating to higher authorities when necessary," corresponding to the latent variable Pedagogical Intervention, and "Discipline/behavior of students," corresponding to the latent variable Relational Climate. It was decided to retain both variables in the models as they each bring an individual contribution to the measurement and interpretation of the constructs (Moro, Vinha, Morais, 2019).

Tables 3, 4, 5, and 6 present the contextual items (manifest variables) of each theoretical construct (latent variable) of the exploratory model and their respective factor loadings.

Table 3 – Factor Loadings for Manifest Variables Related to Pedagogical Management

Pedagogical Management	Factor Loading	
Manifest Variables	**L. P.**	**MAT**
Works with teachers to define concrete goals to implement the educational policy project	0.849	0.848
When you showed improvement in your work, the principal recognized your efforts	0.766	0.766
Discusses educational topics with you	0.831	0.832
Uses data from classroom observations to propose continuing education activities	0.783	0.784
Uses data from classroom observations to conduct continuing education activities themselves	0.742	0.744
Uses data from classroom observations to support your pedagogical practice	0.817	0.819
Promotes the use of Information and Communication Technologies (ICT) to improve learning	0.836	0.836
Uses results from external assessments as input for discussions with faculty about pedagogical work at school	0.834	0.834
Highlights the importance of reflecting on the unique characteristics of youth and accommodating these characteristics at school	0.839	0.838
Discusses classroom management strategies (indiscipline, conflicts, pedagogical management) with teachers	0.862	0.861
Signals to teachers in meetings and individual guidance on the importance of studying and adhering to the curriculum of the educational network	0.870	0.870
Implements specific actions to improve the unit's performance in external evaluations	0.878	0.877
Develops specific actions to disseminate the results of external evaluations to the community and families	0.806	0.805
Ensures that each teacher in this establishment works to achieve specific objectives in relation to student learning	0.866	0.866
Coordinates the work among teachers from different areas and/or educational levels	0.865	0.865

Prevents proposals and initiatives external to the school from disrupting the routine, diverting schoolwork from its educational priorities	0.605	0.607

Source: Developed by the authors (2024).

Table 4 – Factor Loadings for Manifest Variables Related to Pedagogical Intervention

Pedagogical Intervention	Factor Loading	
Manifest Variables	**L. P.**	**MAT**
Addresses a teacher who approaches to discuss problems related to their class	0.736	0.733
Resolves the reported problem with teacher participation	0.790	0.787
Clearly communicates to teachers what is expected of their work	0.776	0.774
Cares about the well-being of teachers	0.749	0.750
Encourages teachers to improve their classroom performance	0.867	0.866
Records teachers' absences and delays, reporting to higher authorities when necessary	0.304	0.305
Ensures equal treatment for all teachers in matters related to faculty duties and commitments	0.603	0.607
Maintains a calm learning environment, reinforcing and ensuring that students adhere to school norms	0.769	0.771
Supports disciplinary measures adopted by teachers	0.661	0.663
Intervenes in student behavior, addressing misconduct and applying the appropriate corrective measures	0.676	0.678
Encourages teachers to consider new ideas in their lessons	0.813	0.811

Source: Developed by the authors (2024).

Table 5 – Factor Loadings for Manifest Variables Related to Academic Climate

Academic Climate	Factor Loading	
Manifest Variables	**L. P.**	**MAT**
This school conducts activities to reinforce and recover learning	0.731	0.729
This school maintains minimum infrastructure and equipment conditions for teachers to perform well	0.575	0.565
This school provides sufficient learning resources (e.g., books, stationery materials, copies, games) for students and teachers	0.711	0.705
This school provides adequate support to teachers when there are students with disabilities, global developmental disorders, high abilities/giftedness, or other specific educational needs in their classes	0.698	0.693
The learning environment is organized and disciplined	0.557	0.554
The teaching and learning processes adopted by teachers are based on similar approaches	0.802	0.802
There is a team spirit among teachers	0.612	0.619
Problems or conflicts are resolved quickly	0.617	0.617
Teachers in this school make efforts to involve parents in the learning processes of students	0.726	0.728
Teachers share the same values and objectives of this school	0.677	0.683
Teachers often discuss among themselves how to improve teaching	0.761	0.767
Teachers, as a whole, feel responsible for contributing to the improvement of this school	0.608	0.613
Teachers have access to technical-pedagogical support from their peers when needed	0.722	0.726
Teachers frequently plan and evaluate their work collaboratively	0.851	0.854

Source: Developed by the authors (2024).

Table 6 – Factor Loadings for Manifest Variables Related to Relational Climate

Relational Climate	Factor Loading	
Manifest Variables	**L. P.**	**MAT**
Interpersonal relationships among individuals	0.742	0.746
Discipline/behavior of students	0.486	0.487
Relationship between teachers and students	0.597	0.599
General relationship among teachers	0.690	0.695
Relationship between teachers and pedagogical coordinators	0.695	0.699
Relationship between teachers and the principal	0.868	0.869
Relationship between students and staff/administrative personnel	0.731	0.730
Relationship between teachers and staff/administrative personnel	0.793	0.795
Relationship between the principal and staff/administrative personnel	0.905	0.904
Relationship between the principal and students	0.857	0.855
Relationship between the principal and parents of students	0.792	0.788

Source: Developed by the authors (2024).

After assessing the potential of the items, the validation of the reflective measurement models proceeded by checking the following parameters: (i) unidimensionality, (ii) convergent validity, and (iii) discriminant validity. The first parameter indicates the extent to which the manifest variables of a construct are related and shares the same dimensional space, the second parameter indicates the degree of common variance shared among the manifest variables of the construct, and the last parameter shows how much a latent variable is distinct from the others (Hair *et al.*, 2016; Gobbi *et al.,* 2020).

Table 1 presents the results obtained from the estimated models, taking into consideration the criteria for unidimensionality, convergent validity, and discriminant validity.

Table 1 – Internal Consistency of Latent Variables in the Measurement Model

Latent Variables	Unidimensionality				Convergent Validity	Discriminant Validity
	Cronbach's Alpha	Rho of D. G.	1st Eigenvalue	2nd Eigenvalue	Variance Extracted	Fornell-Larcker Criterion
Pedagogical Intervention	0.900	0.919	5.69	1.21	0.516	0.718
Pedagogical Management	0.967	0.970	10.73	1.14	0.670	0.818
Relational Climate	0.928	0.939	6.47	1.47	0.563	0.750
Academic Climate	0.917	0.930	6.85	1.73	0.482	0.694

Source: Developed by the authors (2024).

In Partial Least Squares Structural Equation Modeling (PLS-SEM), two measures of reliability are estimated, Cronbach's Alpha and Dillon-Goldstein's Rho. Cronbach's Alpha coefficient indicates the degree of internal consistency among multiple indicators of a construct,

while Dillon-Goldstein's Rho is an indicator of composite reliability. However, regarding the first measure, there is a tendency in PLS-SEM models to underestimate the internal consistency of latent variables, and regarding the second measure, there is a tendency to overestimate it.

Considering the threats mentioned above, it is advisable to take Cronbach's Alpha and Dillon-Goldstein's Rho, respectively, as a lower limit (0.70) and an upper limit (0.95) for internal reliability (Hair *et al.*, 2016). It is observable that the latent variables of the models estimated in this study, for both Portuguese and mathematics, achieved quite satisfactory Cronbach's Alpha coefficients, i.e., above 0.90. Dillon-Goldstein's Rho coefficients did not exceed the upper limit (0.95) except for the latent variable Pedagogical Management (0.97).

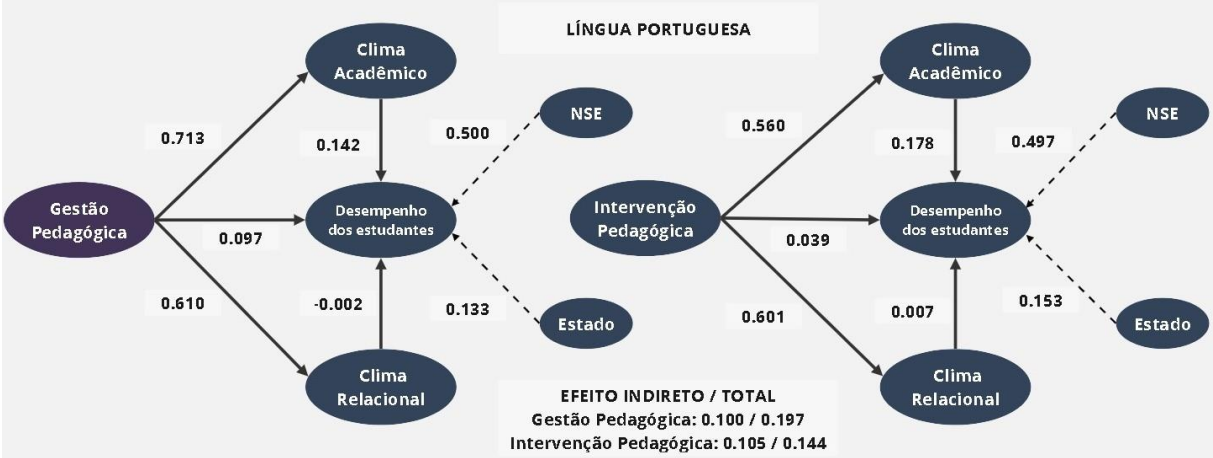
The analyzed latent variables displayed first eigenvalue coefficients greater than 1 and second eigenvalue coefficients significantly lower than the first, as recommended by Sanchez (2013). Moreover, the results indicated satisfactory coefficients for both convergent validity and discriminant validity. To analyze convergent validity, the Average Variance Extracted (AVE) was observed, which indicates how much, on average, the latent variable can explain more than half of its indicators. For discriminant validity, the Fornell-Larcker criterion was observed, which stipulates that the square root of the AVE must be greater than its correlation with other constructs (Fornell; Larcker, 1981).

Following the validation of the measurement models, the models estimating student performance were analyzed. It was found, through the models for the Portuguese language variable, that both Pedagogical Management and Pedagogical Intervention are directly and positively associated with academic outcomes, but with a minimal and statistically non-significant magnitude. Pedagogical Management and Pedagogical Intervention have a direct, strong, positive, and statistically significant relationship with both Academic Climate and Relational Climate. Academic Climate shows a direct, positive, and non-significant relationship with student performance, while Relational Climate is associated with student performance with a path coefficient very close to zero and not statistically significant.

The indirect associations between the exogenous variables of the structural models, namely Pedagogical Management and Pedagogical Intervention, and student performance were identified through positive path coefficients. It was also observed that the socioeconomic level (NSE) of the school is directly and positively associated with student performance, this association being statistically significant. In contrast, the variable related to the state participating in the study (PI or ES) shows a positive association with student performance, but this association is not statistically significant.

Figure 2 presents the models that estimated the Portuguese language variable, with the path coefficients of direct relationships and the coefficients of the indirect and total effect of Pedagogical Management and Pedagogical Intervention.

Figure 2 – Results from the Models Estimating the "Portuguese Language" Variable



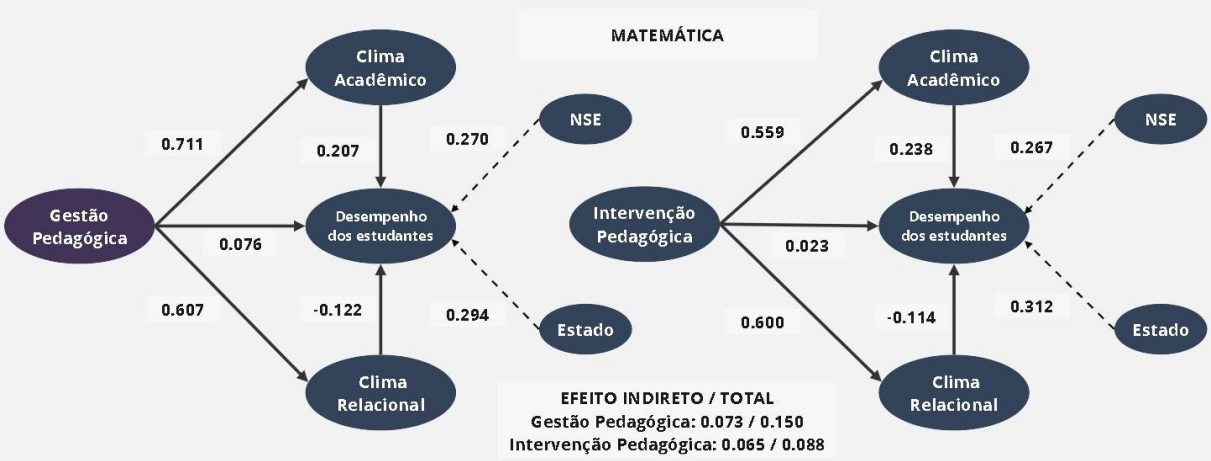
Source: Developed by the authors (2024).

The models that estimated the mathematics variable showed the same trend as the previous models regarding the direct and indirect relationships between "Pedagogical Management" and "Pedagogical Intervention" and the average performance of schools. This trend also persisted in the direct relationships between Pedagogical Management, Pedagogical Intervention, Academic Climate, and Relational Climate. Finally, unlike the previous models, Academic Climate is associated with student performance in a direct, positive, and statistically significant manner, while Relational Climate is associated with student performance with a negative path coefficient and is not statistically significant.

It was found that the socioeconomic level (NSE) of the school is directly associated with student performance in mathematics in a positive and statistically significant manner, through a path coefficient smaller than that observed in the models estimated for the Portuguese language variable. In turn, the variable related to the state (PI or ES) of the schools is positively and statistically significantly associated with student performance, indicating that schools in the state education network of Espírito Santo perform better on average than those in Piauí.

Figure 3 presents the structural models estimating the mathematics variable, as well as the path coefficients of the direct relationships in the model and the coefficients of the indirect and total effect of Pedagogical Management and Pedagogical Intervention.

Figure 3 – Results from the Models Estimating the "Mathematics" Variable



Source: Developed by the authors (2024).

Discussion and Conclusions

The results achieved align with the international literature specialized in the field, which indicates a weaker direct association and a stronger indirect association between the principal's leadership and academic outcomes (Robinson; Lloyd; Rowe, 2008; Leithwood; Sun, 2018). The exploratory models reinforced the initial hypotheses of the study, namely the verification of the following relationships: a) the direct association between Intervention, Pedagogical Management, and academic outcomes; b) the direct association between Intervention, Pedagogical Management, and both Academic Climate and Relational Climate; c) the direct association between Academic Climate, Relational Climate, and academic outcomes; and d) the indirect association between Intervention, Pedagogical Management, and academic outcomes, occurring through the mediation of Academic Climate and Relational Climate.

It was observed through the models estimated for Portuguese language and mathematics that the two exogenous latent variables, namely Pedagogical Management and Pedagogical Intervention, showed a significant association with Relational Climate and Academic Climate. This empirical evidence indicates that, regardless of the concepts explored in relation to school leadership, the principal's leadership practices, whether instructional or pedagogical in nature, focusing on the teaching and learning processes of the school, have a strong relationship with different dimensions of the school climate. These results converge with those pointed out by Robinson, Lloyd, and Rowe (2008), who found that the average effect, direct or indirect, of the instructional leadership model was superior to that of the transformational leadership model.

On the other hand, the direct association between Pedagogical Management and performance in Portuguese language and mathematics showed a higher path coefficient compared to the relationship between Pedagogical Intervention and student performance. The same trend was observed in relation to indirect or total effects. Therefore, when considering the work routine of principals, it is reasonable to consider that certain school leadership practices have greater relevance for academic outcomes. Again, such evidence aligns with that found by Robinson, Lloyd, and Rowe (2008), which indicates that the more principals center their relationships and their work on the qualification of teaching and learning, the greater their influence on the academic results of students.

Pedagogical Management was the variable that was most associated both directly and indirectly with academic outcomes. Thus, by exercising this specific repertoire of leadership practices, the principal becomes more actively involved with the school's pedagogy and influences school outcomes. Mobilizing the teaching staff to achieve concrete goals that realize the school's educational policy project, participating in the planning and management strategies of classroom management, and ensuring conditions for each teacher to achieve specific objectives in relation to student learning are examples of mechanisms through which the principal can shape the academic characteristics of the school (Leithwood; Harris; Hopkins, 2019).

The relationship between proficiency in the Portuguese language and Relational Climate showed path coefficients very close to zero and always inconsistent, sometimes positive and sometimes negative. Meanwhile, the relationship between proficiency in mathematics and Relational Climate showed consistently negative and statistically non-significant path coefficients. On the other hand, the associations between Academic Climate and student proficiency are consistently positive; the relationship with Portuguese language proficiency is not significant, and the relationship with mathematics proficiency is significant. The results indicate that Academic Climate has a stronger association with student performance in mathematics than in the Portuguese language, as that subject area has a pronounced academic character, meaning that proficiency in mathematics depends more strongly on the quality of the school experience (Franco *et al.*, 2007).

A recent study on the direct and indirect effects of the principal's pedagogical leadership practices in the context of early childhood education in the municipal network of Rio de Janeiro found that the relational dimension of the school climate had a greater relationship with the learning of preschool children (Franklin, 2023). Thus, the evidence indicates a reversal of logic

when the observed context is secondary education. While the relational dimension of the school climate is a strong predictor of educational outcomes at the beginning of children's educational trajectory, the academic dimension of the school climate becomes a more relevant factor for student performance.

The potential of academic dimensions of the school climate to mediate the principal's leadership was also empirically observed by Leithwood and Sun (2018). The researchers found that academic culture is a significant mediating factor, as well as a relevant and significant predictor of variation in academic outcomes. The results of the current study involving the Academic Climate follow the trend observed in other research, namely, that school environments focused on teaching and learning processes favor student performance (Sammons, 2008).

Final considerations

This empirical study used cross-sectional measures of student performance (collected at a single sample point) from external evaluation systems of two Brazilian states. The analyses had to contend with the relatively small sample size, as well as data loss caused by the absence of responses to certain items in the contextual questionnaire, and consequently, the imputation of these data. Despite these limitations, the study verified the influence of the principal's leadership practices on academic outcomes and the school climate, from the teachers' perceptions, as well as the influence of specific dimensions of the school climate on academic results.

Although the collection of contextual data and the analyses performed bring important and novel contributions, we emphasize the need to replicate the research in other Brazilian states to better understand the trends and relationships established between school factors in different contexts. We also advocate for the necessity of future research to be conducted longitudinally, i.e., with proficiency measures collected over time, thereby enabling more substantive analyses regarding the influence of school factors on student learning gains.

Similarly, there is a need for studies on management, leadership, and school climate that measure their explanatory variables from the perspective shared by all segments of the school community, so that plausible hypotheses about the complex relationships between processes and school outcomes can be explored. Future research, using both quantitative and qualitative approaches, could bring significant contributions both to the research field and to policymakers

in educational public policy and, consequently, support training programs for principals or management teams in Brazilian schools.

REFERENCES

COHEN, J.; MCCABE, L.; MICHELLI, N. M.; PICKERAL, T. School climate: Research, policy, practice, and teacher education. **Teachers College Record**, [*S. l.*], v. 111, n. 1, p. 180-213, 2009.

DAY, C.; GU, Q.; SAMMONS, P. The Impact of Leadership on Student Outcomes. **Educational Administration Quarterly**, Thousand Oaks: Sage, [*S. l.*], v. 52, n. 2, p. 221-258, fev. 2016.

DAY, C. *et al*., A. **The impact of school leadership on pupil outcomes**: Interim report. Department for Children, Schools and Families Research, London, 2008.

ELMORE, R. Leadership as the practice of improvement. **Mitstifier address at the University Council for Educational Administration Annual Conference**, 11 nov. 2006.

FORNELL, C.; LARCKER, D. Structural equationmodelswithunobservable variables and measurementerror: algebra and statistics. **Journal of Marketing Research**, [*S. l.*], v. 18, n. 3, p. 328-388, 1981.

FRANCO, C.; ORTIGÃO, I.; ALBERNAZ, A.; BONAMINO, A; AGUIAR, G.; ALVES, F.; SÁTYRO, N. Qualidade e equidade em educação: reconsiderando o significado de "fatores intra-escolares". **Ensaio: Avaliação e Políticas Públicas em Educação**, [*S. l.*], v. 15, n. 55, p. 277-298, abr./jun., 2007.

FRANKLIN, H. C. **O perfil da gestão na pré-escola**: a relação direta e indireta entre as práticas de liderança pedagógica do(a) diretor(a) e o desenvolvimento cognitivo das crianças. 2023. 131 f. Dissertação (Mestrado em Educação) - Centro de Filosofia e Ciências Humanas. Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2023.

GOBBI, B. C.; LACRUZ, A. J.; AMERICO, B. L.; FILHO, H. Z. Uma boa gestão melhora o desempenho da escola, mas o que sabemos acerca do efeito da complexidade da gestão nessa relação. **Ensaio: Avaliação e Políticas Públicas em Educação**, Rio de Janeiro, v. 28, n. 106, p. 198-220, jan./mar. 2020.

HAIR, J. F. *et al.* **A Primer Partial Least Squares Structural Equation Modeling (PLS-SEM)**. Los Angeles: Sage, 2016.

HAIR, J. F.; HOWARD, M. C.; NITZL, C. Assessing measurement model quality in PLS-SEM using confirmatory composite analysis, **Journal of Business Research**, [*S. l.*], v. 109, p. 101-110, 2020.

HALLINGER, P. Instructional leadership and the school principal: A passing fancy that refuses to fade away. **Leadership and Policy in Schools**, [*S. l.*], v. 4, n. 3, p. 221-239, 2005.

HALLINGER, P.; GÜMÜS, S.; BELLIBAS, M. S. 'Are principals instructional leaders yet?' A science map of the knowledge base on instructional leadership, 1940–2018. **Scientometrics**, [*S. l.*], v. 122, n. 3, p. 1629-1650, jan. 2020.

HALLINGER, P.; MURPHY, J. F. Avaliação do comportamento de gestão instrucional dos diretores. **O Diário do Ensino Fundamental**, [*S. l.*], v. 86, n. 2, p. 217-247, 1985.

LEITHWOOD, K. **¿Como liderar nuestras escuelas? Aportes desde La investigación**. Santiago: Saleasianos, 2009.

LEITHWOOD, K.; AITKEN, R.; JANTZI, D. **Making Schools Smarter**: Leading with Evidence. Califórnia: Corwin Publishers, 2006.

LEITHWOOD, K.; HARRIS, A.; HOPKINS, D. Seven strong claims about successful school leadership revisited. **School Leadership & Management**, [*S. l.*], v. 40, n. 1, p. 5-22, 19 abr. 2019.

LEITHWOOD, K.; RIEHL, C. O que sabemos sobre a liderança escolar de sucesso. *In*: FIRESTONE, W. ; RIEHL, C. (org.). **Uma nova agenda**: Direções para a pesquisa sobre a liderança educacional. Nova York: Teachers College Press, 2005.

LEITHWOOD, K.; SUN, J. Academic Culture: A Promising Mediator of School Leaders' Influence on Student Learning. **Journal of Educational Administration**, [*S. l.*], v. 56, n. 3, p. 350-363, 2018. Disponível em: https://www.emerald.com/insight/content/doi/10.1108/JEA-01-2017-0009/full/html. Acesso em: 21 nov. 2023.

LEITHWOOD, K.; SUN, J. The Nature and Effects of Transformational School Leadership: A Meta-Analytic Review of Unpublished Research, **Educational Administration Quarterly**, Thousand Oaks, v. 48, n. 3, p. 387-423, 2012. DOI:10.1177/0013161X11436268.

MA, X. Effects of early acceleration of students in mathematics on attitude and anxiety toward mathematics: Teachers college record. **Journal for Research in Mathematics Education**, [*S. l.*], v. 30, n. 5, p. 438-464, 2003.

MORO, A. **A construção e as evidências de validade de instrumentos de medida para avaliar o clima escolar**. 2018. Tese (Doutorado em Educação) – Faculdade de Educação, Universidade Estadual de Campinas, Campinas, SP, 2018.

MORO, A.; VINHA, T. P.; MORAIS, A. Avaliação do clima escolar: construção e validação de instrumentos de medida. **Cadernos de Pesquisa**, São Paulo, v. 49, n. 172, p. 312-334, jun. 2019.

MORTIMORE, P. The nature and findings of school effectiveness research in primary sector. *In*: RIDDELL, S.; PECK, E. (org.). **School effectiveness research**: **its message for school improvement.** Londres: HMSO, 1991.

OLIVEIRA, A. C. P. **Gestão, liderança e clima escolar**. Curitiba: Appris Editora, 2018.

OLIVEIRA, A. C. P.; PAES DE CARVALHO, C. Gestão escolar, liderança do diretor e resultados educacionais no Brasil. *In*: REUNIÃO NACIONAL DA ANPED, 37., Florianópolis, 2018. **Anais** [...]. Florianópolis, SC: [*s. n.*], 2018.

OLIVEIRA, A. C. P.; WALDHELM, A. P. S. Liderança do diretor, clima escolar e desempenho dos alunos: qual a relação? **Revista Ensaio: Avaliação e Políticas Públicas em Educação**, Rio de Janeiro, v. 24, n. 93, out/dez., 2016.

PENA, A. C.; Soares, T. M. Fatores de liderança escolar e sua relação com o desempenho: Um estudo com diretores de escolas da rede pública de Minas Gerais/Brasil. **Revista Electrónica Iberoamericana Sobre Calidad, Eficacia y Cambio em Educación**, v. 12, p. 43-59, 2014.

PEREIRA, A. F. P. **Efeitos do clima escolar na educação infantil**: uma revisão sistemática. 2021. 117 f. Dissertação (Mestrado em Educação) - Centro de Filosofia e Ciências Humanas, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2021.

REZENDE, W. S. A influência do contexto normativo do clima escolar no desempenho estudantil no Seape 2012. **Cadernos Cenpec: pesquisa e ação educacional**, [*S. l.*], v. 6, n. 1, 2016.

ROBINSON, V. M. J.; LLOYD, C. A.; ROWE, K. J. The Impact of Leadership on Student Outcomes: an analysis of the differential effects of leadership types. **Educational Administration Quarterly**, [*S. l.*], v. 44, n. 5, p. 635-674, dez. 2008.

ROBINSON, V.; HOHEPA, M.; LLOYD, C. **School leadership and student outcomes**: Identifying what works and why. Best evidence synthesis iteration [BES]. Winmalee: Australian Council for Educational Leaders, 2009.

RUTTER, M. *et al.* **Fifteen thousand hours**: secondary schools and their effects on children. London: Open Books, 1979.

SAMMONS, P. As características-chave das escolas eficazes. *In*: BROOKE, N.; SOARES, J. F. (org.). **Pesquisa em eficácia escolar:** origem e trajetórias. Belo Horizonte: UFMG, 2008.

SANCHEZ, G. **PLS Path Modeling with R Trowchez Editions**. Berkeley: Trowchez Editions, 2013.

SHMUELI, G.; SARSTEDT, M.; HAIR, J.F.; CHEAH, J.; TING, H.; VAITHILINGAM, S.; RINGLE, C. M. Predictive model assessment in PLS-SEM: guidelines for using PLS predict, **European Journal of Marketing**, [*S. l.*], v. 53, p. 2322-2347, 2019.

THAPA, A.; COHEN, J.; GUFFEY, S; HIGGINS-D'ALESSANDRO, A. A Review of School Climate Research. **Review of Educational Research**, [*S. l.*], v. 83, n. 3, p. 357–385, 2013.

WANG, M., DEGOL, J. School Climate: A Review of the Construct, Measurement, and Impact on Student Outcomes. **Educational Psychology Review**, [*S. l.*], v. 28, p. 315–352,

2016. Disponível em: https://link.springer.com/article/10.1007/s10648-015-9319-1. Acesso em: 3 dez. 2023.

WITZIERS, B.; BOSKER, R. J.; KRÜGER, M. L. Educational leadership and student achievement: The elusive search for an association. **Educational Administration Quarterly**, Thousand Oaks, v. 39, n. 3, p. 398-425, 2003.

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