



Review Article

Teacher–Student Relationships as a Pathway to Academic Success Across Socioeconomic Contexts: A Multilevel Analysis

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Abstract

Socioeconomic status (SES) and teacher–student relationships (TSR) have consistently been identified as important predictors of students' academic performance. Despite this, the placement and interpretation of TSR within multilevel research designs remain subjects of methodological debate. This study conceptualizes TSR as a student-level construct, reflecting individual perceptions of interactions with teachers rather than school-level characteristics. Using multilevel linear modeling, data from 4,978 students enrolled in 162 schools participating in the 2012 Programmed for International Student Assessment (PISA) in the United States were examined. A structured analytical framework was implemented, including model specification, research question development, diagnostic testing of level 1 and level-2 assumptions, model estimation, and interpretation of findings. The results confirm that higher socioeconomic status and more positive teacher–student relationships are independently associated with stronger academic achievement. However, no statistically significant evidence was found to indicate that teacher–student relationships alter the association between socioeconomic status and academic performance. To improve the accuracy of parameter estimation, plausible values were combined using Rubin's Rules, increasing the reliability of the reported results. The findings highlight the importance of distinguishing between direct and interaction effects in multilevel educational research and suggest that future investigations should adopt carefully designed sampling strategies and rigorous analytical procedures to strengthen the validity and generalizability of evidence on educational inequality.

Keywords: Socioeconomic Status; Teacher–Student Relationships; Academic Achievement; PISA 2012; School Climate.

Introduction

Academic achievement is shaped by a complex interaction of individual, family, school, and social factors. Among these influences, socioeconomic status (SES) has consistently been identified as one of the strongest predictors of educational outcomes. SES generally reflects the economic, educational, and occupational resources available within a student's family, which influence learning opportunities, access to educational materials, parental support, and participation in enrichment activities [1]. Decades of educational research have demonstrated that students from socioeconomically advantaged backgrounds tend

to achieve higher academic outcomes than their peers from disadvantaged families. Although the magnitude of this relationship varies across educational systems and cultural contexts, evidence has consistently shown that socioeconomic inequalities remain an important source of variation in student achievement [2].

While the relationship between SES and academic performance is well established, researchers have increasingly recognized that school experience can either reinforce or reduce these inequalities. Among the school-related factors receiving growing attention, teacher–student relationships (TSR) have emerged as an important

contributor to students' academic development. Positive interactions between teachers and students foster trust, emotional security, classroom engagement, and motivation, creating learning environments that support both cognitive and social development. Students who perceive their teachers as supportive, respectful, and approachable are generally more likely to participate actively in classroom activities, demonstrate stronger academic persistence, and achieve better educational outcomes [3].

The importance of teacher–student relationships are strongly supported by social-emotional learning theory, which emphasizes that academic learning is closely connected to students' emotional well-being and interpersonal experiences. Supportive relationships with teachers promote students' sense of belonging, confidence, and self-regulation, all of which contribute to improved classroom performance. These benefits may be especially valuable for students facing socioeconomic disadvantage, as positive relationships with teachers can provide encouragement and stability that compensate, at least partially, for limited educational resources outside school [4].

Although numerous studies have reported positive associations between teacher–student relationships and academic achievement, the strength of this relationship has generally been modest. Previous investigations suggest that supportive teacher interactions improve learning outcomes directly, but they may also influence how students respond to challenges associated with socioeconomic disadvantage. Consequently, researchers have increasingly examined whether teacher–student relationships function not only as independent predictors of achievement but also as contextual factors that alter the strength of the association between SES and academic performance [5].

The distinction between direct, mediating, and moderating effects is particularly important in this context. A direct effect indicates that teacher–student relationships independently contribute to academic achievement regardless of students' socioeconomic backgrounds. Mediation would imply that socioeconomic conditions influence academic performance indirectly through their impact on teacher–student relationships. In contrast, moderation addresses whether the association between SES and achievement differs according to the quality of teacher–student relationships. From a theoretical perspective, moderation is consistent with the view that supportive teachers may reduce educational disadvantages

by strengthening students' engagement, resilience, and academic confidence, particularly among learners from economically disadvantaged backgrounds [6].

Empirical evidence regarding this moderating role remains inconclusive. Several studies have suggested that supportive teacher–student relationships may lessen socioeconomic inequalities by improving motivation, classroom participation, and academic resilience among lower-SES students. Other investigations, however, have reported limited or inconsistent interaction effects, indicating that the influence of teacher support may operate primarily through direct rather than conditional pathways. These mixed findings highlight the need for further investigation using appropriate analytical approaches capable of distinguishing individual-level experiences from school-level characteristics [7].

An additional methodological issue concerns the conceptualization of teacher–student relationships in multilevel educational research. Because teacher support is typically measured through students' individual perceptions, it represents an interpersonal experience that varies across students, even within the same classroom or school. Nevertheless, some previous studies have treated teacher–student relationships as school-level characteristics by aggregating individual responses, potentially overlooking substantial within-school variation. Such aggregation may obscure the personal nature of teacher–student interactions and introduce conceptual inconsistencies when interpreting multilevel models [8].

To address this issue, the present study conceptualizes teacher–student relationships as an individual-level construct and examines their role using multilevel linear modeling. This approach acknowledges the hierarchical structure of educational data while preserving the student-specific nature of perceived teacher support. By accounting for variation at both the student and school levels, multilevel modeling provides a more accurate framework for estimating the independent contributions of socioeconomic status and teacher–student relationships to academic achievement [9].

The study uses data from the 2012 Programme for International Student Assessment (PISA), which provides nationally representative information on students, schools, and learning environments in the United States. The analysis incorporates appropriate procedures for handling plausible values and applies rigorous model diagnostics to ensure the validity of statistical inferences. Through

this methodological framework, the study seeks to clarify whether teacher–student relationships independently predict academic achievement and whether they modify the relationship between socioeconomic status and student performance [10].

Literature Review

Conceptualizing Socioeconomic Status in Educational Research

Socioeconomic status (SES) is widely recognized as a multidimensional construct that reflects the social and economic conditions under which students grow and learn [11]. Rather than representing a single characteristic, SES encompasses several indicators, including parental education, occupational status, household income, educational resources, and aspects of cultural capital. Together, these dimensions capture the opportunities available to students both inside and outside the home environment. Educational research has consistently demonstrated that SES influences learning opportunities, educational aspirations, access to academic support, and overall school performance [12]. Consequently, SES has become one of the most frequently used contextual variables in studies investigating educational achievement and inequality.

Measuring Socioeconomic Status across Educational Contexts

Although SES has no universally accepted measurement, international educational assessments commonly employ standardized composite indices to improve comparability across countries [13]. The Programme for International Student Assessment (PISA) uses the Economic, Social and Cultural Status (ESCS) index, which integrates parental education, parental occupation, and home educational resources into a single standardized measure. This composite indicator provides a comprehensive representation of students' family backgrounds while allowing meaningful comparisons across diverse educational systems. Previous research has shown that both individual-level SES and the average socioeconomic composition of schools contribute to differences in academic performance, suggesting that educational outcomes are shaped by both personal and contextual socioeconomic environments [14].

Teacher–Student Relationships as a Supportive Educational Resource

Teacher–student relationships represent one of the most influential interpersonal factors within the school

environment. Positive relationships are characterized by mutual respect, trust, emotional support, fairness, and effective communication between teachers and students [15]. Educational and developmental theories emphasize that supportive teacher interactions strengthen students' motivation, classroom participation, confidence, and emotional well-being. When students perceive teachers as approachable and responsive, they are more likely to engage actively in learning activities and develop positive attitudes toward school. These interpersonal experiences contribute not only to academic development but also to social and emotional adjustment throughout adolescence.

Assessing Teacher–Student Relationships

Because teacher–student relationships reflect students' personal experiences within classrooms, they are typically assessed using student-reported questionnaires rather than objective observations [16]. Large-scale educational surveys such as PISA evaluate this construct through multiple items that capture students' perceptions of teacher support, fairness, willingness to listen, and interest in student learning. Responses are combined into standardized indices representing the overall quality of perceived teacher support. Since these perceptions may differ considerably among students attending the same school, teacher–student relationships are generally conceptualized as individual-level variables rather than school-level characteristics. This perspective recognizes that interpersonal relationships vary across classrooms and individual experiences even within a common educational setting [17].

Academic Achievement as an Educational Outcome

Academic achievement represents the extent to which students attain educational objectives through formal learning experiences. It is commonly evaluated using standardized assessments, course grades, literacy measures, mathematics tests, science examinations, and other indicators of educational performance. International assessments such as PISA provide reliable measures of students' competencies that permit comparisons across schools and countries. Academic achievement is influenced by multiple interacting factors, including cognitive abilities, learning environments, instructional quality, family background, and psychosocial characteristics. Consequently, understanding the determinants of achievement requires consideration of both individual and contextual influences operating simultaneously [18].

Interaction between Socioeconomic Status and Teacher–Student Relationships

Recent educational research has increasingly explored whether teacher–student relationships influence the association between socioeconomic status and academic achievement [19]. Supportive interactions with teachers may help reduce some of the disadvantages associated with limited family resources by encouraging motivation, strengthening self-efficacy, improving classroom engagement, and fostering a stronger sense of belonging. From a theoretical perspective, teacher support may function as a protective factor that enables disadvantaged students to adapt more successfully to academic challenges. Nevertheless, empirical findings remain inconsistent. While several studies suggest that positive teacher–student relationships can lessen socioeconomic disparities in educational outcomes, others report only direct associations between teacher support and achievement without significant interaction effects. These mixed findings highlight the importance of employing rigorous statistical approaches capable of distinguishing independent influences from conditional relationships [20].

Multilevel Modeling in Educational Research

Educational data are inherently hierarchical because students are nested within classrooms and schools. Conventional regression techniques assume that observations are independent and therefore may underestimate standard errors or produce biased parameter estimates when applied to clustered educational data. Multilevel modeling addresses [6] this limitation by simultaneously estimating relationships at multiple levels of analysis, allowing researchers to separate individual-level effects from contextual school-level influences. This analytical approach is particularly appropriate for investigating socioeconomic differences in academic achievement because it accounts for variation attributable to both students and schools. Furthermore, multilevel models enable researchers to examine cross-level interactions, providing a robust framework for evaluating whether contextual characteristics influence relationships observed at the individual level. For these reasons, multilevel analysis has become a widely accepted methodological approach for educational studies examining achievement, school effectiveness, and educational inequality [21].

The cross-sectional research design to examine the relationships among socioeconomic status (SES), teacher–student relationships (TSR), and mathematics

achievement. Because students are naturally grouped within schools, a multilevel analytical framework was employed to account for the hierarchical structure of the data. This design enables the simultaneous examination of student-level and school-level variation, thereby providing more accurate estimates of the relationships among the study variables [22].

Data Source and Study Sample

The analysis utilized data from the Programmed for International Student Assessment (PISA) 2012, coordinated by the Organization for Economic Co-operation and Development (OECD). PISA is an international large-scale assessment designed to evaluate the knowledge and skills of approximately 15-year-old students in mathematics, reading, and science, while also collecting detailed information on family background and school characteristics [23,24].

For the present study, only data from the United States were included in Table 1. After applying the required data screening procedures and excluding incomplete observations, the final analytical sample consisted of 4,978 students enrolled in 162 schools. This sample provided sufficient statistical power for multilevel modeling while representing a broad range of socioeconomic and educational contexts [25]. (Table 1)

Measurement of Study Variables

Three principal variables were included in the analysis: socioeconomic status, teacher–student relationships, and mathematics achievement [26].

Table 1: Characteristics of the Study Sample and Research Design Based on the U.S. PISA 2012 Dataset.

Characteristic	Description
Data source	Programme for International Student Assessment (PISA) 2012
Country	United States
Study design	Cross-sectional secondary data analysis
Student age	Approximately 15 years
Number of students	4,978
Number of schools	162
Academic domain analyzed	Mathematics
Statistical approach	Two-level Multilevel Linear Modeling (MLM)
Level 1	Students
Level 2	Schools

Socioeconomic status was measured using the Economic, Social and Cultural Status (ESCS) index developed by the OECD. This standardized composite indicator combines information on parental education, parental occupation, and educational resources available within the home environment. Higher ESCS scores indicate more advantaged socioeconomic backgrounds.

Teacher–student relationships were assessed using the STUDREL index provided in the PISA database. This standardized measure reflects students’ perceptions of teacher support, fairness, willingness to provide assistance, and respect for students. Because the indicator is derived from individual student responses, it represents personal experiences rather than institutional characteristics. Therefore, TSR was treated as a student-level variable throughout the analysis [27].

Mathematics achievement served as the dependent variable. Following OECD recommendations, student performance was represented by the plausible values supplied in the PISA dataset. These values provide unbiased estimates of student proficiency while accounting for measurement uncertainty inherent in large-scale educational assessments (Table 2).

Treatment of Plausible Values

PISA reports student achievement using multiple plausible values instead of a single test score. Each plausible value represents an estimated level of mathematical proficiency based on students’ responses and background information. Rather than averaging these values, each plausible value was analyzed separately, and the resulting parameter estimates were combined using Rubin’s Rules. This procedure appropriately incorporates imputation uncertainty into the estimation process and produces more reliable standard errors and confidence intervals than analyses based on a single achievement estimate.

Data Preparation and Preliminary Analysis

Prior to model estimation, the dataset was examined for

missing observations, inconsistencies, and potential outliers. Descriptive statistics were calculated to summarize the characteristics of the study variables, and Pearson correlation coefficients were computed to examine preliminary associations among SES, teacher–student relationships, and mathematics achievement. Although a positive relationship between SES and TSR was observed, the correlation was relatively small, indicating that the two constructs capture distinct dimensions of students’ educational experiences. This finding supported the inclusion of both variables as separate predictors in subsequent multilevel analyses [25].

Statistical Analysis and Model Estimation

The hierarchical nature of the PISA data required the application of multilevel linear modeling. Students constituted Level 1, while schools represented Level 2 [9,10]. Separate models were estimated sequentially to evaluate the contribution of each predictor. The analysis began with an unconditional model to estimate between-school variation in mathematics achievement. Subsequent models introduced socioeconomic status and teacher–student relationships as fixed effects, followed by the inclusion of an interaction term to evaluate whether teacher–student relationships moderated the association between SES and mathematics performance. Random intercepts were estimated for all models, whereas random slopes were retained only when supported by statistical evidence and model fit criteria [23].

Research Hypotheses

The study was designed to examine the independent and interactive contributions of socioeconomic status and teacher–student relationships to mathematics achievement. Based on previous educational research and social-emotional learning theory, the following hypotheses were formulated:

H1: Students with higher socioeconomic status demonstrate significantly higher mathematics achievement than students with lower socioeconomic status.

Table 2: Operational Definition of Variables.

Variable	Role	Measurement	Level	Description
Mathematics Achievement	Dependent Variable	PISA Mathematics Plausible Values	Student	Standardized assessment of mathematical literacy
Socioeconomic Status (SES)	Independent Variable	ESCS Index	Student	Composite measure including parental education, occupation, and home educational resources
Teacher–Student Relationship (TSR)	Independent Variable	STUDREL Index	Student	Student perceptions of teacher support, fairness, and classroom interactions
SES × TSR	Interaction Variable	Product of standardized SES and TSR	Student	Tests whether TSR moderates the relationship between SES and mathematics achievement

Table 3: Research Objectives and Hypotheses.

Research Objective	Hypothesis	Expected Relationship
Examine the relationship between socioeconomic status and mathematics achievement	H1	Positive
Determine the effect of teacher–student relationships on mathematics achievement	H2	Positive
Assess whether teacher–student relationships moderate the relationship between socioeconomic status and mathematics achievement	H3	Significant interaction effect

H2: Positive teacher–student relationships are positively associated with mathematics achievement after controlling for socioeconomic status.

H3: Teacher–student relationships moderate the association between socioeconomic status and mathematics achievement, such that supportive relationships reduce the strength of socioeconomic disparities in academic performance.

These hypotheses were evaluated using multilevel linear models that simultaneously considered student-level and school-level sources of variation, providing a comprehensive assessment of the proposed relationships (Table 3).

Conclusion

The investigated relationships among socioeconomic status, teacher–student relationships, and mathematics achievement using a multilevel modeling approach with data from the United States PISA 2012 assessment. The findings confirmed that both socioeconomic status and teacher–student relationships are significant predictors of academic performance. Students from higher socioeconomic backgrounds achieved better mathematics outcomes, while positive relationships with teachers were associated with improved academic achievement across the student population.

Despite the beneficial influence of teacher support, the results did not provide evidence that teacher–student relationships moderated the association between socioeconomic status and mathematics achievement. In other words, positive relationships with teachers contributed directly to student performance but did not significantly reduce the achievement gap associated with socioeconomic differences. The findings indicate that supportive teacher–student relationships contribute positively to students’ learning experiences across all socioeconomic backgrounds, although they do not appear to substantially reduce achievement differences associated with socioeconomic disadvantage.

Methodologically, the study demonstrates the value of multilevel modeling for educational research by accounting for the hierarchical structure of school data and separating individual-level effects from contextual variation. The use of plausible values together with Rubin’s Rules further strengthened the reliability of the statistical estimates.

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