2 Unearthing Context: How Socioeconomic Status Shapes the Leadership-Science Achievement Nexus

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Introduction

The relationship between school leadership and student achievement has been a subject of extensive research, particularly in the context of large-scale educational assessments such as the Programme for International Student Assessment (PISA). Successful school leaders have a critical role in promoting school effectiveness and adapting their leadership practices to their school environment (Gurr et al., 2021; Leithwood et al., 2020).

In fact, when we are referring to school leadership and student academic outcomes, instructional leadership could act as an important leadership practice. Yet, this leadership perspective is presented through indirect pathways in which school leaders influence teaching and learning and supporting students, through curriculum management, teacher support, and fostering a learning-focused school culture (Hallinger, 2016; Robinson et al., 2008).

Additionally, the level of school autonomy is an important factor to take into consideration, influencing student academic outcomes. School autonomy refers to the extent to which school leaders have decision-making power over key aspects of school management, including curriculum design, resource allocation, and personnel decisions. In fact, granting more school autonomy could allow school leaders to adopt more context-specific leadership practices (Hanushek et al., 2013).

Therefore, the relationship between school leadership and student academic outcomes highlights the indirect influence that school leaders

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have on their students (Day et al., 2020). This indirect effect on student outcomes may be observed through school leaders' practices and styles that could include support for teachers' professional development, engagement with external stakeholders, supporting the overall teaching and learning process, fostering a participative leadership among the internal stakeholders, etc. (Brauckmann & Pashiardis, 2011).

Nevertheless, the impact of school leadership practices on student achievement can be influenced by a range of contextual factors, including the economic, social, and cultural status (ESCS) of students (Hallinger, 2016). Therefore, exploring how these particular factors interact with school leadership practices are important for developing policies that support students and school effectiveness in general.

Having said that, this chapter seeks to examine the role of ESCS in the relationships between instructional leadership, school autonomy, and students' science achievement in OECD's latest PISA cycle. Specifically, the research seeks to determine (1) whether ESCS moderates the effects of instructional leadership and school autonomy on student performance and (2) whether ESCS mediates these relationships. By highlighting the mediating and moderating roles of ESCS, this study offers valuable insights for policymakers and educators striving to enhance student learning outcomes through contextually informed leadership practices.

Theoretical Background

The Role of Contextual Factors and School Leadership

In general, it is highly important to recognize the complexities of the context in which school leaders operate, as these factors can significantly shape their perception and implementation of their leadership practice. Hallinger (2016) identified various contextual areas that affect school organizations and play a significant role in shaping and influencing school leaders' practices, including the institutional and community contexts. The institutional context, in particular, is defined by factors such as school size and the degree of centralization within the education system (Hallinger, 2016). For instance, centralization affects the vision and reforms that effective school leaders aim to implement, together with the school-level autonomy in school organizations. Also, the community context pertains to the actions of school leaders in the various communities where they lead their school organizations (Hallinger, 2016). Based on the above, school leaders' practices are affected on these

contextual factors. School leaders' leadership dimension and practices may depend on factors such as the socioeconomic status of students and the school's location.

In fact, the role of ESCS as both a mediator and moderator in these relationships adds further complexity. Specifically, these kind of factors could shape the relationship between instructional leadership and school autonomy and affect school leaders' practices. ESCS has long been recognized as a critical determinant of student achievement. ESCS, as measured in PISA, encompasses family wealth, parental education, and access to cultural resources, all of which contribute to students' educational opportunities (OECD, 2019). A study by Borgonovi and Pál (2016), suggested that ESCS mediates the effects of school leadership on student outcomes by influencing the availability of learning resources, parental support, and students' aspirations. Therefore, contextual elements play an important role when leading school organizations.

Additionally, ESCS may alternate the effectiveness of instructional leadership and school autonomy in school organizations. For instance, schools in high-ESCS contexts may benefit more from autonomy due to greater parental involvement and resource availability (Schleicher, 2018). Conversely, in low-ESCS settings, school autonomy may have limited positive effects if leaders lack the necessary capacity to navigate resource constraints effectively (Leithwood et al., 2020; Pashiardis et al., 2018).

Furthermore, Schwarz and Brauckmann (2015) emphasize the importance of context, noting that school leaders' practices are strongly influenced by their perceptions of their environment. Specifically, they referred to the concept of the 'area close to the school' (ACTS) and how it influences school leaders' leadership and performance (Schwarz & Brauckmann, 2015). Similarly, Hallinger (2016) highlights the significance of the community context in shaping school leaders' practices. According to studies conducted in Europe, factors such as the school's geographical location, parental engagement, financial constraints, and student behaviour affect school leaders' instructional practices (Brauckmann & Pashiardis, 2011; Pashiardis, 2014). Therefore, it is important to acknowledge that contextual factors, including ESCS, directly impact school leadership effectiveness, making it impossible to separate leadership success from its surrounding environment (Brauckmann-Sajkiewicz & Pashiardis, 2022).

Instructional Leadership and Student Achievement

Instructional leadership is considered one of the most prominent leadership models in education and has been widely examined due to its potential to impact student learning outcomes, as part of the indirect role of school leaders in influencing student learning outcomes. Hallinger (2016) emphasized that instructional leadership impacts student achievement primarily through the development of teacher capacity, curriculum management, and the establishment of a school culture that prioritizes learning. However, the strength of this effect has been debated, with some studies indicating that while instructional leadership contributes to student achievement, the effect size remains modest (Leithwood & Jantzi, 2008).

Empirical evidence suggests that instructional leadership is more effective when mediated through factors such as teacher collaboration, professional development, and a structured learning environment (Robinson et al., 2008). Despite this, some studies have reported contradictory findings, suggesting that the direct impact of instructional leadership on student achievement is limited and may depend on contextual factors such as students' socioeconomic background (Hallinger & Heck, 1996).

For instance, Hallinger et al. (1996) found that instructional leadership had no direct effect on student achievement but influenced school effectiveness through shaping the instructional climate. Similarly, Heaven and Bourne (2016) found a weak correlation between instructional leadership and student performance in Jamaican schools, suggesting that other factors, such as teacher involvement and school environment, play a role in academic achievement.

Also, in another study, Hou et al. (2019) observed that instructional leadership had a significant moderating influence on the relationship between students' high school entrance scores and college entrance scores. Therefore, while instructional leadership is recognized as a key factor in shaping student achievement, its impact is largely indirect and influenced by mediating variables such as teacher collaboration, instructional strategies, and school climate. In addition to this, students' economic, social, and cultural Status (ESCS) adds further complexity.

School Autonomy and Student Academic Outcomes

Additionally, school autonomy has emerged as a key factor in shaping school leaders' practices and its impact on student achievement. Yet, we need to consider that contextual factors, as mentioned above, could in

fact affect school effectiveness and student academic outcomes. Specifically, a literature review provides some information on school leaders' level of autonomy and its effect on student academic outcomes. Some research suggests that granting schools greater autonomy can lead to improved student outcomes, as it allows for more context-specific decision-making and resource allocation (Hanushek et al., 2013).

Jackson (2023) examined a policy in Chicago that increased school-level control and found that school leaders' indirect support improved maths and English passing rates. Kemethofer et al. (2023) used PISA 2015 data to examine the associations between school leadership, autonomy, and student achievement. Their findings indicated no direct link between school autonomy and leadership behaviour, but accountability and leadership were correlated. Additionally, their study found that parental involvement played a significant role in linking leadership to student outcomes.

However, Cheng et al. (2016) support previous studies that show research on school autonomy often overlooks cultural and structural dimensions, leading to inconsistent findings. Therefore, they suggest that school autonomy should be analysed in terms of functional, structural, and cultural components to better understand its impact on student learning.

Additionally, the literature suggests that the benefits of school autonomy depend on the capacity of school leaders to make effective decisions and on the level of accountability mechanisms in place (OECD, 2019). In fact, an important debate in the literature concerns whether school autonomy leads to better academic performance across different socioeconomic contexts. Some studies indicate that autonomy is beneficial in high-performing education systems where school leaders have the skills and resources to support their independence effectively (Dronkers & Robert, 2007). However, in less resourced contexts, increased autonomy without adequate support may exacerbate existing inequalities and lead to divergent outcomes (Woessmann, 2016). Yet, we need to take into consideration that school autonomy allows school organizations to be innovative in teaching and learning and to respond more directly to the needs of the communities they serve (Kemethofer et al., 2023).

Concluding Remarks and the Logic of This Study

In general, the literature suggests that instructional leadership and school autonomy can influence student achievement, with the role of

school leaders being particularly important. However, contextual factors such as the level of autonomy in school organizations, whether centralized or decentralized, along with the economic, social, and cultural status of students, can shape the role of school leaders. Instructional leadership enhances student learning primarily through teacher development and curriculum management rather than directly affecting student performance. Similarly, the impact of school autonomy on student achievement varies depending on school leadership capacity, accountability structures, and socioeconomic conditions. The economic, social, and cultural status of students plays a crucial role in moderating and mediating these relationships, underscoring the need for context-sensitive leadership approaches.

Therefore, based on the literature review, in Figure 2.1 we present the conceptual model of this study. The model illustrates the direct and indirect effects of instructional leadership and school autonomy on students' science achievement, with ESCS serving as both a mediator and a moderator. The mediation pathway suggests that ESCS may partially explain the relationship between instructional leadership, school autonomy and student outcomes, while the moderation pathway posits that the strength of these relationships depends on varying levels of ESCS.

The following hypotheses are formulated on the basis of this model:

H1 *Instructional leadership and school autonomy are significantly associated with students' science achievement.*

H2 *Instructional leadership and school autonomy are significantly associated with ESCS.*

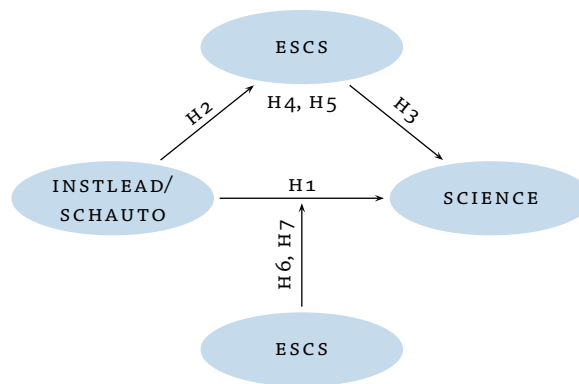

Figure 2.1
A Conceptual Model of the Study

H3 *ESCS is positively associated with students' science achievement.*

H4 *ESCS mediates the relationship between instructional leadership and science achievement.*

H5 *ESCS mediates the relationship between school autonomy and science achievement.*

H6 *ESCS moderates the relationship between instructional leadership and science achievement.*

H7 *ESCS moderates the relationship between school autonomy and science achievement.*

The following section of the article describes the methodology used to test these relationships.

Methodology

Data Source and Variables

This study examines the relationship between ESCS, school leaders' instructional leadership, school autonomy, and students' science achievement. The study uses secondary data analysis of the latest OECD PISA 2022 results. Based on available data, a total of 60 countries and regions were included in the final analysis. These are countries that are members of the Organisation for Economic Co-Operation and Development (OECD) or OECD partner countries.

Independent Variables

In this study, we chose as independent variables two scales from the OECD PISA 2022 cycle: Instructional Leadership (INSTLEAD), and School Autonomy (SCHAUTO). Both scales are from the school leaders survey. For instructional leadership (INSTLEAD), school leaders were asked to rate (5-point scale) how often they or other members of their school management team engaged in activities or behaviours related to teaching or instructional leadership during the last 12 months (Organisation for Economic Co-Operation and Development, 2024).

Higher scale score values indicate higher frequencies of engagement by the school leader and school management team in instructional leadership activities, and vice versa. Meanwhile, the school autonomy (SCHAUTO) scale comprises 12 items (e.g. 'Appointing or hiring teachers,' 'Determining teachers' salary increases') and principals are asked about who had the main responsibility for various decisions or activities

at their school (Organisation for Economic Co-Operation and Development, 2024). Higher scale score values indicate that the school leader, teachers or members of the school management team, and the school governing board had a greater level of autonomy in decision-making activities at their school. Lower scale score values indicate that these groups had less autonomy.

Dependent Variable

As a dependent variable in this study, students science scores in the latest OECD PISA results were selected. Scientific performance, for PISA, measures the scientific literacy of a 15-year-old in the use of scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues (Organisation for Economic Co-Operation and Development, 2023a). In the 2022 Programme for International Student Assessment (PISA), the average science score among OECD countries was 485 points (Organisation for Economic Co-Operation and Development, 2023b).

Mediator/Moderator

Economic, social, and cultural status (ESCS) was chosen as mediator and moderator between school autonomy, principal instructional leadership and science achievement. ESCS is the OECD PISA 2022 index of economic, social and cultural status. ESCS is a composite score derived, as in previous assessments, from three indicators related to family background: parents' highest education, in years (PAREDINT), parents' highest occupational status (HISEI) and home possessions (HOMEPOS) (Organisation for Economic Co-Operation and Development, 2023a). It must be mentioned that this index is constructed from students' survey results. The higher the value of ESCS, the higher the socioeconomic status. The ESCS scale has a mean of 0 and a standard deviation of 1 across OECD countries (Organisation for Economic Co-Operation and Development, 2023b).

Data Analyses

To examine the relationships between instructional leadership, school autonomy, Economic, Social, and Cultural Status (ESCS), and students' science achievement, the analysis of mediation and moderation was

used. For this purpose, the Hayes' PROCESS Procedure for SPSS Version 4.0 (Hayes, 2022) was chosen. This approach provides a robust framework for testing indirect and interaction effects through bootstrapped confidence intervals, improving upon traditional stepwise regression methods (Baron & Kenny, 1986). Descriptive statistics and Pearson correlation were computed before the main analysis to assess variable relationships and potential multicollinearity. Statistical significance was set at $p < 0.05$.

Mediation analysis was conducted using PROCESS Model 4 to determine whether ESCS mediates the relationships between instructional leadership, school autonomy, and students' science achievement. This model estimates:

- Path a: The direct effect of instructional leadership and school autonomy on ESCS.
- Path b: The direct effect of ESCS on science achievement, controlling for instructional leadership and school autonomy.
- Path c': The direct effect of instructional leadership and school autonomy on science achievement after controlling for ESCS.
- Path c: The total effect of instructional leadership and school autonomy on science achievement. The total effect is the sum of the direct and the indirect effect ($c = c' + a \times b$).
- Indirect Effect ($a \times b$): Bootstrapping with 5,000 resamples was used to estimate bias-corrected confidence intervals (95% CI) for the indirect effect. Mediation was considered statistically significant if the BootLLCI and BootULCI did not include zero (Preacher & Hayes, 2008).

The mediation model follows the equations:

$$M = \beta_0 + \beta_1 X + \varepsilon,$$
$$Y = \beta_0 + \beta_2 X + \beta_3 M + \varepsilon,$$

where M represents ESCS, X represents instructional leadership or school autonomy, and Y represents students' science achievement. The indirect effect (IE) was calculated as $\beta_1 \times \beta 3$. The overall mediation model of this study is presented in Figure 2.2.

To assess whether ESCS moderates the relationships between instructional leadership, school autonomy, and science achievement, we employed PROCESS Model 1. This model tests:

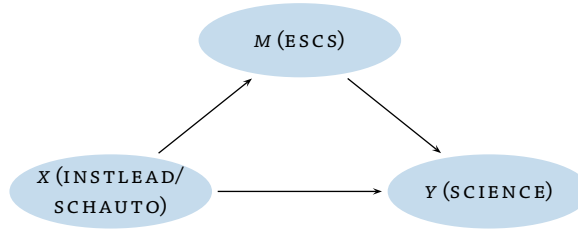

Figure 2.2
Conceptual Model of Mediation

- The main effects of instructional leadership and school autonomy on science achievement.
- The moderating role of ESCS, assessed using an interaction term ($X \times W$).
- Simple slopes analysis, examining the conditional effects of instructional leadership and school autonomy on science achievement at different levels of ESCS.

The moderation model follows the equation:

$$Y = \beta_0 + \beta_1 X + \beta_2 W + \beta_3 (X \times W) + \varepsilon,$$

where W represents the moderator (ESCS), and $X \times W$ represents the interaction term. Moderation was considered statistically significant if the coefficient β_3 was significant ($p < 0.05$). The conceptual model of moderation is presented in Figure 2.3.

In the results section, we present the results of the analysis that examines the role of economic, social, and cultural status (ESCS) as a mediator and moderator in the relationships between school autonomy (SCHAUTO), instructional leadership (INSTLEAD), and students' science scores in PISA 2022.

Results

Prior to conducting the mediation and moderation analyses, Pearson correlation coefficients were computed to examine the relation-

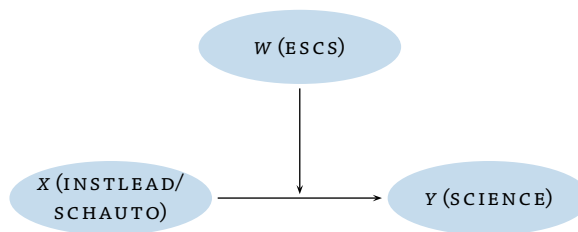

Figure 2.3
Conceptual Model of Moderation

Table 2.1 Descriptive Statistics and Correlations of Study Variables

Variable	Mean	SD	INSTLEAD	SCHAUTO	ESCS
INSTLEAD	0.28	0.44			
SCHAUTO	−0.34	0.78	−0.154		
ESCS	−0.44	0.61	−0.300*	0.322*	
SCIENCE	440.00	55.00	−0.443**	0.416**	0.703**

NOTES $N = 60$. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

ships between instructional leadership (INSTLEAD), school autonomy (SCHAUTO), economic, social, and cultural status (ESCS), and science achievement (see Table 2.1).

The results revealed that school principals instructional leadership was significantly negatively correlated with ESCS ($r = -0.300$, $p < 0.05$) and science achievement ($r = -0.443$, $p < 0.01$), suggesting that higher instructional leadership was associated with lower ESCS levels and lower student performance in science. Meanwhile, school autonomy was positively correlated with ESCS ($r = 0.322$, $p < 0.05$) and science achievement ($r = 0.416$, $p < 0.01$), indicating that greater school autonomy was associated with higher ESCS and better science performance. In this regard, both Hypothesis 1 and Hypothesis 2 are confirmed.

As expected, ESCS showed the strongest correlation with science achievement ($r = 0.703$, $p < 0.01$), confirming that students from higher socioeconomic backgrounds tend to perform better in science. So, Hypothesis 3 is confirmed. These findings establish the foundational relationships among key variables, providing justification for conducting mediation and moderation analyses to further explore the role of ESCS in explaining and moderating these effects.

Testing for the Moderation Effects

The first moderation analysis aimed to examine whether ESCS moderates the relationship between school principals' instructional leadership and science achievement. As can be seen in Table 2.2, the model explained 56% of the variance in science achievement ($R^2 = 0.56$), which indicates a strong explanatory power. The overall model was statistically significant, $F(3,56) = 23.34$, $p < 0.001$, suggesting that the included predictors (INSTLEAD, ESCS, and their interaction) contribute significantly to explaining science scores.

Table 2.2 Moderating Effect of ESCS on the Relation between Instructional Leadership and Students' Science Scores in PISA 2022

Predictors	β (SE)	t	(1)	(2)
INSTLEAD	−33.26 (12.08)	−2.75**	[−57.46, −9.06]	[−58.72, −15.10]
ESCS	56.32 (8.43)	6.68**	[39.44, 73.21]	[38.96, 69.84]
Interaction	9.96 (19.46)	0.50	[−29.30, 48.68]	[−18.24, 52.83]

NOTES 95% confidence interval: (1) low limit, upper limit, (2) boot low limit, boot upper limit. R^2 = 0.56, F = 23.34**, N = 60. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Instructional leadership had a significant negative effect on science scores (β = −33.26, p = 0.01). Meanwhile, ESCS had a significant positive effect on science scores (β = 56.32, p < 0.001), suggesting that students from higher socioeconomic backgrounds perform better in science. The interaction effect between instructional leadership and ESCS was not statistically significant (β = 9.96, p = 0.62), indicating that ESCS does not moderate the relationship between instructional leadership and science scores (see Figure 2.4).

The Bootstrap confidence intervals for instructional leadership ([−58.72, −15.10]) confirm that its negative impact on science achievement is robust, as the CI does not include zero. The interaction effect's confidence interval ([−18.24, 52.83]) contains zero, reinforcing the conclusion that moderation is not significant. Therefore, Hypothesis 6 – ESCS moderates the relationship between instructional leadership and science achievement – is not supported.

The moderating role of ESCS in the relationship between School Autonomy (SCHAUTO) and science achievement was also examined (see Table 2.3).

The model explains 56% of the variance in science achievement (R^2 = 0.56), indicating strong explanatory power. The overall model is statistically significant F (3,56) = 23.67, p < 0.001), meaning the predictors (SCHAUTO, ESCS, and their interaction) contribute significantly to ex-

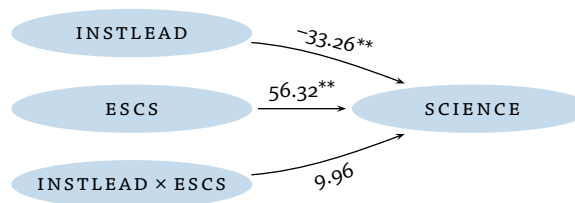

Figure 2.4 Moderating Effect of ESCS between Instructional Leadership and Science Scores

Table 2.3 Moderating Effect of ESCS on the Relation between School Autonomy and Students' Science Scores in PISA 2022

Predictors	β (SE)	t	(1)	(2)
SCHAUTO	14.88 (6.60)	2.26*	[1.67, 28.09]	[0.37, 28.19]
ESCS	59.36 (8.53)	6.96**	[42.26, 76.45]	[46.60, 74.83]
Interaction	23.87 (13.55)	1.76	[−3.28, 51.01]	[−3.01, 48.92]
Conditional Effects of School Autonomy at Different ESCS Levels				
Low (−0.61)	0.34 (10.56)	0.03	[−20.81, 21.49]	
Average (0.00)	14.88 (6.60)	2.26*	[1.67, 28.09]	
High (0.610)	29.43 (10.58)	2.78**	[8.23, 50.62]	

NOTES 95% confidence interval: (1) low limit, upper limit, (2) boot low limit, boot upper limit. R^2 = 0.56**, F = 23.67, N = 60. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

plaining science scores. Results show that school autonomy had a significant positive main effect on science scores (β = 14.88, p = 0.03). Similarly, ESCS had a significant positive effect on science scores (β = 59.36, p < 0.001), while the interaction effect between school autonomy and ESCS was not statistically significant (β = 23.87, p = 0.08). This result indicates that ESCS does not significantly moderate the relationship between school autonomy and science achievement (see Figure 2.5). Therefore, Hypothesis 7 is not supported.

However, the conditional effects analysis suggests that the impact of school autonomy varies across different ESCS levels:

- At low ESCS (−0.61), the effect of school autonomy on science scores was negligible and not significant (p = 0.97).
- At average ESCS (0.000), school autonomy had a significant positive effect on science scores (p = 0.03).
- At high ESCS (0.610), the effect of school autonomy on science scores was stronger and statistically significant (p = 0.01).

The Bootstrap confidence intervals for school autonomy ([0.37, 28.19]) confirm that the positive effect is robust. The interaction effect's confi-

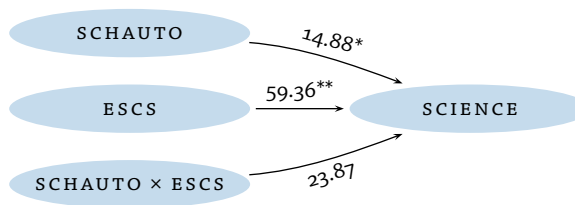

Figure 2.5 Moderating Effect of ESCS between School Autonomy and Science Scores

dence interval ([–3.01, 48.92]) includes zero, reinforcing that the moderation effect is not significant.

Testing for the Mediation Effects

The mediating role of ESCS in the relationship between instructional leadership and science scores was investigated. The overall model explains 55% of the variance in science achievement (R^2 = 0.55), with a significant overall model fit (F (2,57) = 35.36, p < 0.001). As can be seen in Table 2.4, the total effect of instructional leadership on science scores was negative and significant (β = –54.78, p < 0.001).

The first regression equation examined the effect of instructional leadership on ESCS. The results indicated a significant negative relationship (β = –0.41, p = 0.02). The second regression equation examined the effect of ESCS on science achievement while controlling for instructional leadership. The results indicated a significant positive relationship (β = 56.51, p < 0.001), meaning students with higher ESCS scores performed better in science. When controlling for ESCS, instructional leadership remained a significant predictor of science achievement, though its effect was reduced (β = –31.49, p < 0.001). The aforementioned statistics are visually presented in Figure 2.6.

A bootstrapped confidence interval (CI) was used to test the significance of the indirect effect. The indirect effect of instructional leadership on science scores through ESCS was significant and negative (β = –23.28, BootSE = 8.97, 95% CI [–40.08,–3.56]). This result indicates that ESCS mediated the relationship between instructional leadership and science achievement. The mediation is partial, meaning instructional

Table 2.4 Mediating Effect of ESCS on the Relation between Instructional Leadership and Students' Science Scores in PISA 2022

Predictors	β (SE)	t	(1)	(2)
INSTLEAD–ESCS	–0.41 (0.17)	–2.40*	[–0.75, –0.07]	
ESCS–Science	56.51 (8.36)	6.76**	[39.76, 73.26]	
INSTLEAD–Science	–31.49 (11.47)	–2.75**	[–54.47, –8.52]	
Total effect	–54.78 (14.56)	–3.76**	[–83.92, –25.64]	
Ind. effect INSTLEAD–ESCS–Science	–23.28 (8.97)			[–40.08, –3.56]

NOTES 95% confidence interval: (1) low limit, upper limit, (2) boot low limit, boot upper limit. R^2 = 0.55**, F = 35.36, N = 60. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

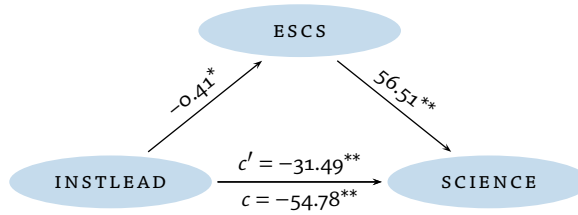

Figure 2.6
Mediating Effect of ESCS between Instructional Leadership and Science Scores

Table 2.5 Mediating Effect of ESCS on the Relation between School Autonomy and Students' Science Scores in PISA 2022

Predictors	β (SE)	t	(1)	(2)
SCHAUTO–ESCS	0.25 (0.10)	2.59**	[0.06, 0.45]	
ESCS–Science	57.27 (8.60)	6.66**	[40.04, 74.50]	
SCHAUTO–Science	14.86 (6.72)	6.72*	[1.41, 28.30]	
Total effect	29.26 (8.40)	3.48**	[12.44, 46.08]	
Ind. effect SCHAUTO–ESCS–Science	14.40 (5.90)			[5.01, 28.08]

NOTES 95% confidence interval: (1) low limit, upper limit, (2) boot low limit, boot upper limit. R^2 = 0.55**, F = 35.36, N = 60. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

leadership affects science both directly and indirectly through ESCS. Therefore, Hypothesis 4 is partially confirmed.

The mediating role of ESCS in the relationship between school autonomy and science scores was also assessed (see Table 2.5). The overall model explained 53% of the variance in science achievement (R^2 = 0.53), with a significant overall model fit (F (2,57) = 32.74, p < 0.001). The total effect of school autonomy on science achievement was significant (β = 29.26, p < 0.001) suggesting that higher levels of school autonomy were associated with improved science scores.

The first regression equation examined the effect of school autonomy on ESCS. The results indicated a significant positive relationship (β = 0.25, p = 0.01). The second regression equation examined the effect of ESCS on science achievement while controlling for school autonomy. The results indicated a significant positive relationship (β = 57.27, p < 0.001), meaning that students with higher ESCS performed better in science. When controlling for ESCS, school autonomy remained a significant predictor of science achievement, though its effect was reduced (β = 14.86, p = 0.03).

The indirect effect of school autonomy on science scores through

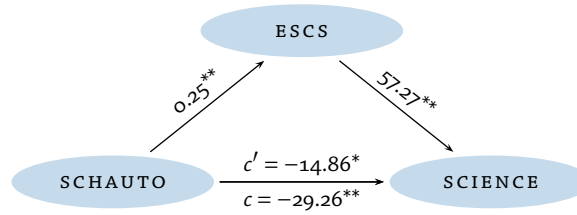

Figure 2.7
Mediating Effect of ESCS between School Autonomy and Science Scores

ESCS was significant and positive (β = 14.40, BootSE = 5.90, 95% CI [5.01, 28.08]). These findings indicate that ESCS partially mediated the relationship between school autonomy and science achievement. The mediation is partial, meaning school autonomy affects science both directly and indirectly through ESCS. Therefore, Hypothesis 5 is partially supported. Overall, our study shows that ESCS has a mediating, instead of moderating, effect between school leaders' instructional leadership, school autonomy and students' science achievement.

Discussion and Implications

This study aimed to analyse the complex relationships between instructional leadership, school autonomy, economic, social and cultural status (ESCS) and student science achievements. While there is considerable scientific evidence on the links between ESCS and student achievement, there is little research on *how* ESCS works and *for which groups*. Our study shows that ESCS plays a mediating rather than a moderating role in the relationship between instructional leadership, school autonomy and student science achievement. Our findings suggest that ESCS partially mediates the effects of both instructional leadership and school autonomy on student achievement. The confirmation of partial mediation suggests that while instructional leadership and school autonomy have a direct effect on science achievement, a significant part of their effect is channelled through the mediating mechanism of socioeconomic status. This means that the effectiveness of instructional leadership and the benefits of school autonomy depend on the socioeconomic context in which they are implemented (Chen et al., 2018). The impact of socioeconomic status on academic achievement has been the subject of extensive debate (Carlisle & Murray, 2015; Chen et al., 2018). Socioeconomic status, which reflects the socioeconomic status of family members, is often considered a key factor influencing children's academic and cognitive development (Chen et al., 2018). Instructional lead-

ership and school autonomy can be enhanced or diminished depending on the socioeconomic status of students and schools (Carlisle & Murray, 2015).

However, the research findings are mixed when it comes to ESCS as a moderator. The rejection of the hypotheses that socioeconomic status is a moderator of the relationships between instructional leadership/school autonomy and science achievement suggests that the strength or direction of these relationships does not change significantly with different socioeconomic statuses. However, this does not mean that social-economic status (SES) has no effect – on the contrary, its effect is indirect, i.e. it acts as a mediator rather than as a condition that modifies the strength (Munir et al., 2023). At the same time, this implies that the effects of instructional leadership and school autonomy on science achievement remain fairly constant across socioeconomic backgrounds. This finding reinforces a recurring idea in the literature that leadership has a greater effect across schools but does not necessarily reduce SES differences within schools (Tan et al., 2020; Perry & Mcconney., 2010). Furthermore, it is important to recognize that the relationship between socioeconomic status and academic success is multidimensional and depends on a variety of factors, with exceptions and differences within and between countries (Munir et al., 2023). The absence of moderating effects does not negate the importance of socioeconomic status but rather suggests that its influence operates primarily through mediating pathways. This nuanced understanding highlights the need to consider socioeconomic status as an integral part of the educational ecosystem, shaping the indirect effects of leadership and autonomy rather than directly modifying their effects.

Another important finding of our study – the negative relationship between instructional leadership and science achievement – also deserves separate attention in this discussion. This finding contradicts the classical notion that instructional leadership is related with increased students' achievement (Karadag, 2020). This seemingly illogical finding may be related to the specific measures used to assess instructional leadership in this study, or it may reflect a complex interplay of factors that are not fully reflected in this model. As suggested by Eryilmaz and Sandoval-Hernandez (2021), it is the limitations of the indicators used in international studies that may lead to such seemingly illogical results. Simply put, this may mean that the meaning and application of in-

structional leadership varies across contexts. In systems where instructional leadership is implemented through formal or top-down mechanisms (e.g. frequent lesson observations, performance monitoring), it may create unintended pressures or fail to address the true learning needs of students. For example, research has shown that in countries with strong bureaucratic traditions, principals' instructional leadership may still reflect administrative control rather than pedagogical support (Nedzinskaitė-Mačiūnienė & Jurgilė, 2023).

In contrast, school autonomy was positively related to achievement and had both direct and indirect effects through ESCS. This is consistent with previous research (Hanushek et al., 2013) that greater autonomy allows schools to adapt to the needs of their communities, especially where resources and parental involvement are high. However, this advantage may be less available in contexts with low ESCS, where schools lack the capacity to fully exercise decision-making freedom. Moreover, in the absence of compensatory policies, it may even widen the gap between schools with different levels of social capital (Schleicher, 2018).

The findings of this study contribute to a deeper understanding of school leadership and educational equity in the context of international student achievement assessments, such as PISA and TIMSS (Trends in International Mathematics and Science Study). These assessments aim not only to measure student achievement internationally, but also to identify key contextual factors – such as leadership practices, school autonomy and socioeconomic status – that determine educational outcomes (Organisation for Economic Co-Operation and Development, 2020; Mullis et al., 2020). The partial mediation effects of ESCS identified in this study are consistent with PISA data, which consistently show that socioeconomically advantaged students tend to perform better, regardless of the policies of the school itself (Organisation for Economic Co-Operation and Development, 2023a). Meanwhile, the fact that the moderation effect was not statistically significant suggests that the impact of leadership practices on achievement remains stable across SES strata. This adds new nuances to the debate on educational equity and highlights the need to analyse the indirect pathways through which social context influences learning (Schleicher, 2018). Furthermore, the negative association between instructional leadership and science achievement calls into question the universality of international indices of leadership. Such indices used in the TALIS

(Teaching and Learning International Survey) and PISA surveys may not account for cultural and systemic differences in the implementation of leadership across countries (Eryilmaz & Sandoval-Hernandez, 2021).

Therefore, these findings reinforce calls for a more context-sensitive interpretation of international assessments and a more cautious approach to generalized global educational recommendations. Particularly, some implications for policy and practice could be associated with context-sensitive school leadership development. Educational policy should consider tailored training that informs school leaders about the presence of diverse school environments and socioeconomic contexts in school organizations. Also, given the mediating role of ESCS, educational reforms should incorporate broader socioeconomic interventions, such as parental engagement programmes, resource allocation adjustments, and community-based support initiatives, to mitigate the disparities in student achievement. Finally, future research should examine variations in leadership practices across different governance structures and cultural settings to refine school leadership models across the multiple contexts.

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