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School and Student Variables of Reading Achievement: A Multilevel Mediation Model

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This study examines the associations between school-level organisational conditions, student-level motivational processes, and reading achievement in primary education using PIRLS 2021 data. Adopting a multilevel framework, it examines how instructional resource limitations, schools' emphasis on academic success, and students' engagement-related beliefs interact to explain fourth grade reading differences. Bayesian multilevel mediation modelling was employed to address the hierarchical structure of the data and multiple plausible values for reading achievement. At the student level, engagement in reading lessons is linked to confidence in reading, which functions as a proximal predictor of achievement. Gender and home socioeconomic status are included to control for background differences. At the school level, instructional resource shortages are negatively associated with schools' emphasis on academic success, which mediates the relationship between resources and between-school differences in reading achievement, while controlling for the presence of a school library. Results show distinct yet interconnected pathways at both levels. Student engagement predicts higher reading confidence, which mediates its effect on achievement. Schools' academic emphasis positively relates to achievement and mediates the impact of resource shortages. Overall, the findings highlight the importance of considering both organisational conditions and student-level motivational processes in understanding reading achievement and demonstrate the value of multilevel mediation models for analysing large-scale international assessment data.

Introduction

Reading literacy is a fundamental competence that supports students' academic development and long-term learning trajectories. Skills acquired during the early years of schooling facilitate learning across subject areas and enable children to participate more effectively in social and cultural contexts (OECD, 2019; Mullis et al., 2023). For this reason, identifying the individual and school-level factors associated with reading achievement remains a central concern in educational research.

The Progress in International Reading Literacy Study (PIRLS) provides a valuable framework for examining fourth-grade students' reading achievement alongside contextual variables related to students, teachers, and schools. Conducted at five-year intervals, PIRLS assesses students' comprehension of literary and informational texts and collects extensive contextual

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information that enables researchers to explore how school processes and student characteristics relate to reading outcomes (Mullis & Martin, 2019; Mullis et al., 2023).

Previous research indicates that schools differ in their capacity to support student learning, even when serving populations with similar socioeconomic characteristics (Scheerens & Bosker, 1997; Teddlie & Reynolds, 2000). One of the key constructs in this literature is school emphasis on academic success, which refers to the extent to which schools prioritise academic achievement, maintain high expectations, and create learning-oriented environments (Edmonds, 1979; Murphy et al., 1982). Empirical studies consistently demonstrate that stronger academic emphasis is associated with higher student achievement, including reading performance, after controlling for individual background characteristics (Goddard et al., 2000; Nilsen & Gustafsson, 2014).

At the same time, school climate research emphasises that academic orientation is shaped by broader organisational conditions, including the availability of instructional resources. Shortages of educational resources may weaken schools' ability to sustain academically focused environments, thereby limiting opportunities for student learning (Johnson et al., 2012; Kutsyuruba et al., 2015).

Alongside school-level conditions, student-level motivational processes also play an important role in reading development. Engagement in reading lessons has been linked to higher achievement because engaged students are more likely to invest effort and persist in challenging tasks (Guthrie & Wigfield, 2000). Engagement is also associated with students' self-beliefs, particularly confidence in reading. Students who perceive themselves as capable readers tend to demonstrate higher levels of academic performance (Schunk & Pajares, 2009). Analyses based on PIRLS data similarly show that engagement and reading confidence are important correlates of reading achievement across educational systems (Leino et al., 2022; Martin et al., 2013).

Despite this growing body of research, several gaps remain. Many studies have examined student-level motivational factors and school-level organisational conditions separately, limiting understanding of how these factors interact. Moreover, although large-scale assessment data are inherently hierarchical, relatively few studies have examined these relationships within a multilevel mediation framework that clarifies the mechanisms linking contextual and motivational variables to achievement (Nilsen & Gustafsson, 2014).

These limitations are particularly relevant in the Turkish context, where studies based on PIRLS data have generally focused on direct relationships between selected variables and reading achievement rather than examining mediating pathways (Ceylan & Sever, 2020). Consequently, less is known about how school-level organisational conditions and student-level motivational processes jointly contribute to reading outcomes.

The present study addresses these gaps by examining reading achievement in Türkiye using PIRLS 2021 data within a multilevel mediation framework. At the student level, the study investigates whether engagement in reading lessons is associated with reading achievement indirectly through reading confidence. At the school level, it examines whether instructional resource shortages influence reading achievement indirectly through schools' emphasis on academic success. By integrating these relationships within a single analytical model, the study aims to provide a more comprehensive explanation of reading achievement by linking organisational conditions and motivational processes across levels.

Theoretical Framework

This section outlines the theoretical and empirical foundations of the key variables examined in the study. The proposed mediation model is grounded in the distinction between more distal contextual or motivational conditions and more proximal processes that are more directly linked to achievement. At the student level, this logic is informed by motivation theory and self-efficacy theory. Engagement in reading lessons reflects students' active participation, effort, and involvement in reading-related classroom experiences, but engagement is not assumed to influence achievement only through immediate behavioural participation. Rather, repeated engagement provides students with mastery experiences, feedback, and opportunities to experience success, which are central sources of self-efficacy beliefs (Schunk & Pajares, 2009). In this sense, confidence in reading represents a more proximal motivational belief through which engagement is translated into achievement-related behaviour. Students who become more confident in their reading ability are more likely to persist with difficult texts, apply effective reading strategies, and sustain effort, thereby achieving at higher levels. Accordingly, the pathway from engagement to achievement is theorised to operate indirectly through reading confidence rather than as a simple unmediated association.

A parallel logic applies at the school level. Drawing on school effectiveness theory and organisational perspectives on schooling, instructional resource shortages are conceptualised as distal structural constraints rather than immediately achievement-producing conditions. Resource shortages may limit instructional coherence, reduce opportunities for systematic academic support, and weaken a school's capacity to maintain shared expectations for learning. In contrast, school emphasis on academic success reflects a more proximal organisational process, expressed through high expectations, academic press, instructional alignment, and a shared focus on achievement. From this perspective, resource shortages are expected to matter for achievement primarily insofar as they undermine the school's ability to sustain a strong academic orientation. Thus, academic emphasis is theorised as the mechanism through which broader organisational constraints are linked to between-school differences in reading achievement.

Taken together, the model assumes that both levels of mediation reflect a progression from broader or more distal conditions to more proximal achievement-related processes. Student engagement is expected to foster reading confidence, which more directly supports achievement, whereas resource shortages are expected to shape achievement through their influence on school academic emphasis. Because the PIRLS 2021 data are cross-sectional, these pathways should be interpreted as theory-based explanatory mechanisms rather than definitive causal sequences. Nevertheless, specifying mediation is theoretically justified because the proposed mediators are conceptually closer to reading achievement than the antecedent variables and represent the processes through which broader motivational and organisational conditions are expected to operate. Drawing on school effectiveness theory, organisational perspectives on schooling, and motivational models of reading, the framework explains how school-level contextual conditions and student-level motivational processes interact to shape reading achievement. Each construct is addressed separately, and its hypothesised relationship within the proposed model is articulated.

School Emphasis on Academic Success

School emphasis on academic success refers to the extent to which schools prioritise learning outcomes, uphold high academic expectations, and foster a shared orientation toward academic achievement. Rooted in the effective school's tradition, this construct has long been viewed as a key organisational mechanism through which school practices are linked to student outcomes (Edmonds, 1979; Murphy et al., 1982).

Research on effective schooling consistently indicates that schools with a strong academic emphasis establish clear academic goals, systematically monitor student progress, and align instructional practices with these goals (Edmonds, 1979). Within such environments, academic success is valued and reinforced by school leaders, teachers, students, and parents, thereby fostering conditions that support students' motivation and sustained engagement in learning.

Evidence from multilevel empirical studies consistently indicates a positive relationship between schools' emphasis on academic success and student achievement. Goddard et al. (2000) demonstrated that academic emphasis significantly predicts students' reading and mathematics achievement even after accounting for socioeconomic background. Using two-level structural equation modelling, Nilsen and Gustafsson (2014) demonstrated that schools' emphasis on academic success constitutes a central factor in accounting for achievement differences across schools.

Findings from international large-scale assessments further corroborate the importance of this construct. Evidence from analyses of PIRLS data indicates that students enrolled in schools placing a stronger emphasis on academic success generally achieve higher levels of reading performance across a range of educational systems (Ceylan & Sever, 2020; Martin et al., 2013). Collectively, these findings point to academic emphasis as a contextual resource that broadens students' learning opportunities and fosters behaviours oriented toward achievement. Drawing on this body of research, it is hypothesised that there is a positive relationship between school emphasis on academic success and students' reading achievement (H1).

Instruction Affected by Resource Shortage

Instruction affected by resource shortages refers to the extent to which teaching and learning processes are constrained by limitations in instructional materials, physical infrastructure, available instructional time, or access to pedagogical resources (OECD, 2019; Mullis & Martin, 2019; UNESCO, 2016). From organisational and school effectiveness perspectives, the availability of instructional resources constitutes a fundamental condition for sustaining high-quality instruction and maintaining academically oriented school practices (Cohen et al., 2009; Kutsyuruba et al., 2015).

Research on school climate and organisational functioning suggests that resource shortages disrupt instructional coherence by compelling teachers and school leaders to focus on immediate problem-solving rather than long-term instructional planning (Johnson et al., 2012). In contexts where instructional materials are limited or physical conditions are inadequate, instructional practices are more likely to become fragmented, reducing opportunities for differentiated instruction and meaningful learning experiences. Such constraints may weaken schools' capacity to uphold consistent instructional standards and communicate clear academic expectations.

Importantly, theoretical perspectives suggest that instructional resource shortages are associated with student achievement primarily through indirect associations rather than direct relationships. Organisational models of schooling emphasise that contextual constraints shape outcomes by influencing schools' priorities, goal structures, and instructional organisation (Johnson et al., 2012). Within this framework, resource limitations are expected to weaken schools' emphasis on academic success by constraining instructional alignment and reducing institutional capacity to cultivate a strong academic culture.

Empirical evidence lends support to this assumption by indicating that schools facing more pronounced instructional constraints are likely to exhibit a weaker academic emphasis and less coherent instructional environments (Cohen et al., 2009; Kutsyuruba et al., 2015). Accordingly, it is hypothesised that there is a negative relationship between instruction affected by resource shortage and school emphasis on academic success (H2). Additionally, in line with organisational mediation perspectives, school emphasis on academic success is the mediator between instructional resource shortages and students' reading achievement (H3).

In this sense, instructional resource shortages are not conceptualised as affecting achievement only through direct material deprivation. Rather, their importance lies in their capacity to weaken the organisational conditions through which achievement is promoted, especially the school's emphasis on academic success. Academic emphasis is therefore treated as the more proximal school-level mechanism linking structural constraints to student outcomes.

Students' Engagement in Reading Lessons

Student engagement in reading lessons refers to the extent to which learners actively participate in classroom reading activities by sustaining effort and demonstrating behavioural, emotional, and cognitive involvement. Engagement occupies a central position in motivational theories of learning and reading development, as it represents a key process through which instructional experiences are transformed into learning outcomes (Guthrie & Wigfield, 2000).

Theoretical models of engagement suggest that active involvement in reading lessons increases the likelihood that students will expend effort, employ effective reading strategies, and persevere when faced with challenging tasks. Empirical research consistently demonstrates that engaged students achieve at higher levels across subject areas, including reading (Martin et al., 2013). In this sense, engagement functions as a proximal mechanism linking classroom experiences to academic performance.

At the same time, engagement is not merely an outcome of instructional quality but also a process through which students' motivational beliefs are shaped. Motivational theories emphasise that repeated engagement in learning activities provides mastery experiences that strengthen students' confidence in their own abilities (Schunk & Pajares, 2009). In reading contexts, active participation in lessons enables students to experience success, receive feedback, and develop a sense of competence.

Evidence from PIRLS-based studies supports this theoretical proposition. Martin et al. (2013) found that students who report higher engagement in reading lessons also tend to report stronger confidence in reading across countries. These findings suggest that engagement plays an important role in shaping motivational beliefs that support reading development. Accordingly, it is hypothesised that there is a positive relationship between students' engagement in reading lessons and students' confidence in reading (H5). From this

perspective, engagement is treated as a relatively more distal motivational process, whereas confidence in reading represents a more proximal self-belief directly related to performance. Therefore, the effect of engagement on reading achievement is expected to be transmitted, at least partly, through students' confidence in reading.

Students' Confidence in Reading

Students' confidence in reading, commonly referred to as reading self-efficacy, reflects their beliefs about their ability to successfully carry out reading-related tasks. According to self-efficacy theory, such beliefs influence students' motivation, effort, persistence, and academic performance (Schunk & Pajares, 2009).

Students with higher confidence in reading are more likely to approach reading tasks with persistence, employ effective strategies, and remain engaged when encountering difficulties. Conversely, students with lower confidence may avoid challenging tasks and disengage more readily, thereby limiting their opportunities for learning. Reading confidence thus represents a critical motivational resource that supports achievement.

Empirical evidence from international large-scale assessments consistently demonstrates a strong positive association between reading confidence and reading achievement. Analyses of PIRLS data indicate that students who report higher confidence in reading tend to achieve higher reading scores across educational systems (Leino et al., 2022; Martin et al., 2013). Moreover, motivational models highlight confidence as a key mediating variable linking engagement and achievement, suggesting that engagement enhances achievement primarily by strengthening students' beliefs in their own competence (Schunk & Pajares, 2009). Based on this theoretical and empirical foundation, it is hypothesised that there is a positive relationship between students' confidence in reading and reading achievement (H4). Furthermore, students confidence is reading mediates the relationship between students' engagement in reading lessons and reading achievement (H6).

Within this model, reading confidence is conceptualised not simply as another correlate of achievement but as the motivational mechanism through which active engagement in reading lessons is transformed into higher achievement.

Method

This section describes the research model, sample characteristics, data collection instruments, and analytical procedures employed in the study.

Research Model

The study adopts a cross-sectional research design, a survey-based approach that is widely utilised in quantitative research. Figure 1 presents the proposed research model.

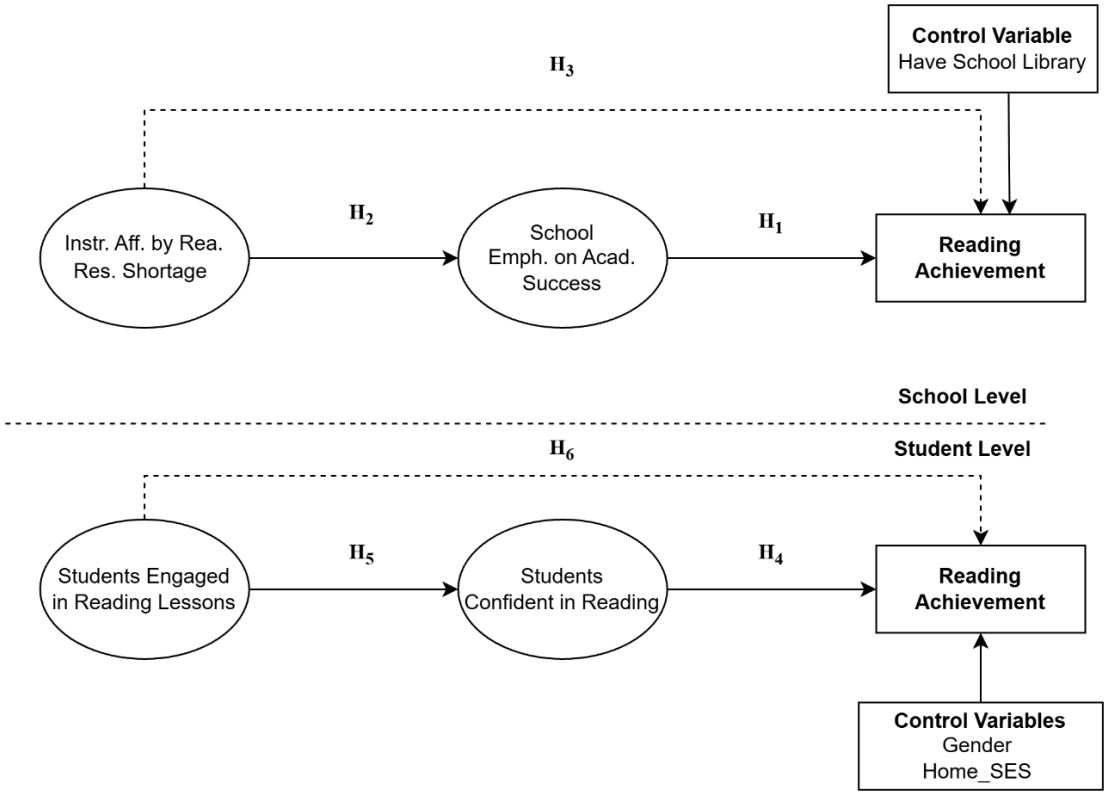

Figure 1 Research Model

Cross-sectional research designs involve collecting data at a single point in time in order to examine participants' current characteristics, perceptions, or responses with respect to the variables of interest (Creswell, 2017). This design is particularly suitable for studies using international large-scale assessment data, as it allows for the examination of relationships among variables measured concurrently across large and representative samples. The study draws on data from the Progress in International Reading Literacy Study (PIRLS) 2021, administered by the International Association for the Evaluation of Educational Achievement (IEA). The research model was constructed to examine the relationships between school-level contextual factors and student-level motivational processes in predicting students' reading achievement. At the school level, instruction affected by resource shortage and schools' emphasis on academic success were specified as the primary contextual variables in the analysis. At the student level, students' engagement in reading lessons and students' confidence in reading were incorporated as motivational variables. Reading achievement was specified as the outcome variable at the student level. The proposed research model adopts a multilevel approach, acknowledging the nested structure of students within schools and the relations between both school- and student-level factors and reading achievement. In this framework, school emphasis on academic success and students' confidence in reading were specified as mediating variables linking contextual and motivational factors to reading achievement. At the student level, gender and home socioeconomic status were included as control variables, whereas the presence of a school library was controlled for at the school level.

Sample and Data Collection

To test the research hypotheses, the study draws on responses provided by primary school teachers who participated in PIRLS 2021, administered by the IEA. PIRLS 2021 was managed by the IEA's TIMSS & PIRLS International Study Centre at Boston College in

close collaboration with the IEA Amsterdam and IEA Hamburg offices in 57 participating countries (Mullis et al., 2023). A two-stage stratified sampling method was employed in the study. In the first stage, 192 schools from 12 regions in Türkiye were identified. In the second stage, classes were determined within these schools. In determining the classes, two were taken from schools with more than 179 students (Almaskut et al., 2023, p.138). Consequently, 6032 students from 192 schools in Türkiye participated in the study. Analyses were conducted with the data of 6032 students. Table 1 presents the demographic information of the participating students.

Table 1. The sampling of the study

Variables	Characteristics	Frequency	Percentage (%)
Gender	Male	3043	50.4
	Female	2989	49.6
Have School Library	Yes	3673	60.9
	No	2359	39.1
Home Socioeconomic Status	Low	1910	31.7
	Medium	2765	45.8
	High	949	15.7
	Missing	408	6.8

Table 1 summarises the descriptive characteristics of the study sample. The sample consisted of 6,032 students, of whom 3,043 (50.4%) were male and 2,989 (49.6%) were female, indicating a nearly balanced gender distribution. Regarding school resources, 3,673 students (60.9%) attended schools with a library, while 2,359 students (39.1%) were enrolled in schools without a library. Students' home socioeconomic status (SES) was categorized into three groups: low (n=1,910), medium (n=2,765), and high (n=949).

Variables and Measures

All contextual scales used in this study, engagement in reading lessons, confidence in reading, instructional resource shortages, and academic emphasis, were based on the official PIRLS 2021 scale scores constructed using IRT scaling by the IEA.

Students Confident in Reading

Students' confidence in reading was assessed using the *Students Confident in Reading* scale included in the PIRLS 2021 student questionnaire (items ASBR08A-ASBR08F). The scale captures students' self-perceptions regarding their reading ability and the perceived ease or difficulty of reading-related tasks. Students responded to six statements using a four-point Likert-type format ranging from *agree a lot* to *disagree a lot*. Three items were positively worded (e.g., "I usually do well in reading", "Reading is easy for me"), while three items were negatively worded and subsequently reverse coded (e.g., "I have trouble reading stories with difficult words", "Reading is harder for me than for many of my classmates", "I am just not good at reading"). Following reverse coding, higher scale scores reflected higher levels of confidence in reading.

Students' raw responses were converted into standardised scale scores using the PIRLS 2021 scaling procedures. An equivalence table was applied to ensure comparability across

participants and assessment cycles. Based on the transformed scores, students were classified into three predefined categories: *Very Confident in Reading*, *Somewhat Confident in Reading*, and *Not Confident in Reading*. Students with scores at or above 10.2 were categorised as *Very Confident*, whereas those with scores at or below 8.2 were classified as *Not Confident*. Students whose scores fell between these cut points were categorised as *Somewhat Confident*.

For the Turkish sample, the internal consistency of the scale was acceptable, with a Cronbach's alpha coefficient of .68. Principal Components Analysis indicated that the scale accounted for 40% of the total variance, supporting a unidimensional structure. Item-level factor loadings ranged from .51 to .86, indicating that all items contributed meaningfully to the measurement of reading confidence (Yin & Reynolds, 2023, pp. 40-45). The internal consistency and construct validity of the scale were evaluated using multiple indicators to ensure measurement precision. While the Cronbach's alpha was .68, more robust indicators provided a superior assessment of reliability. Specifically, McDonald's Omega was calculated as .792, and the Composite Reliability (CR) was .851, both of which significantly exceed the conventional .70 threshold for research (Muthén & Asparouhov, 2012). Furthermore, the Average Variance Extracted (AVE) was .494, indicating that the latent construct explains nearly 50% of the variance in its indicators. Given these strong reliability and validity indices, the scale was deemed highly suitable for the two-level structural equation model employed in this study.

Students Engaged in Reading Lessons

Students' engagement in reading lessons was measured using the *Students Engaged in Reading Lessons* scale from the PIRLS 2021 student questionnaire (items ASBR01A-ASBR01I). The scale consists of nine items intended to assess students' affective and instructional engagement in classroom reading activities. Students reported their level of agreement with each item on a four-point response scale ranging from "agree a lot" to "disagree a lot." The items reflect multiple dimensions of engagement, including interest in reading materials, clarity of instructional expectations, teacher support, encouragement to express ideas, feedback on mistakes, and exposure to varied instructional practices (e.g., "I like what I read about in school", "My teacher encourages me to say what I think about what I have read", "My teacher tells me how to do better when I make a mistake").

Responses to the nine items were aggregated to form an overall engagement score, with higher values indicating higher levels of engagement in reading lessons. Raw scores were transformed into standardised scale scores following the PIRLS 2021 scaling procedures to ensure comparability across students and assessment cycles. Based on predefined cut scores, students were classified into three categories: *Very Engaged in Reading Lessons*, *Somewhat Engaged in Reading Lessons*, and *Less than Engaged in Reading Lessons*. Students classified as Very Engaged exhibited response patterns characterised by "agree a lot" on five items and "agree a little" on the remaining four. In contrast, students classified as Less than Engaged showed average responses corresponding to "disagree a little" on five items and "agree a little" on the other four. All other students were classified as Somewhat Engaged.

For Türkiye, the scale demonstrated acceptable internal consistency, as indicated by a Cronbach's alpha coefficient of .72, McDonald's Omega was calculated as .865, CR was .896, and AVE was .486. The scale explained 32% of the total variance, supporting the adequacy of its unidimensional structure within the Turkish sample. Transformed scale scores ranged from 7.1 to 9.5. Students scoring at or below 7.1 were classified as *Less than Engaged*,

while those scoring at or above 9.5 were classified as *Very Engaged*. Students with intermediate scores were categorised as *Somewhat Engaged* (Yin & Reynolds, 2023, pp. 46-51).

Home Socioeconomic Status

Students' home socioeconomic status (SES) was measured using a composite scale derived from the PIRLS 2021 home questionnaire (variables ASBH12-ASBH13 and ASDHEDUP–ASDHOCCP). This derived measure reflects key educational and socioeconomic resources available in students' home environments, based on parental reports. The scale comprises four indicators: (a) the number of books in the home, (b) the number of children's books in the home, (c) the highest level of education attained by either parent, and (d) the highest occupational status of either parent.

Parents reported the number of books and children's books using ordered response categories ranging from 0-10 to more than 200 books for general books and from 0–10 to more than 100 books for children's books. Parental education was reported on a five-level scale ranging from no formal schooling or incomplete primary education to completed university education or higher. Parental occupation was classified across categories ranging from never having worked outside the home or general labour to professional occupations. Responses across these four indicators were combined to generate an overall SES scale score.

Based on predefined cut points, students were categorised into three SES groups: *Higher*, *Middle*, and *Lower Socioeconomic Status*. Students with scale scores at or above 11.1 were classified as *Higher SES*, whereas those with scores at or below 8.5 were classified as *Lower SES*. Students with intermediate scores were categorised as *Middle SES*. On average, students in the Higher SES group were characterised by households containing more than 25 books and children's books, at least one parent with a university degree, and at least one parent employed in a professional occupation. In contrast, students in the Lower SES group typically came from households with 25 or fewer books and children's books, no parent educated beyond upper secondary level, and no parent employed in clerical, small business, or professional occupations.

For the Turkish sample, the Home Socioeconomic Status scale showed good internal consistency, with a Cronbach's alpha of .78, and explained 61% of the total variance, reflecting a strong and coherent representation of socioeconomic resources (Yin & Reynolds, 2023, pp. 97-102).

School Emphasis on Academic Success

School emphasis on academic success was assessed using the School Emphasis on Academic Success scale, derived from teachers' responses to the PIRLS 2021 teacher questionnaire (items ATBG10A-ATBG10L). The scale reflects teachers' perceptions of the degree to which academic success is prioritised within the school context. Teachers evaluated twelve aspects of their school using ordered response categories ranging from *very high* to *very low*. The scale encompasses dimensions related to curricular clarity, expectations for student achievement, instructional effectiveness, leadership-teacher collaboration, parental involvement and expectations, student motivation, and students' respect for academic success.

For scaling purposes, response categories with very low frequencies were combined, with the

low and *very low* categories collapsed prior to analysis. Students' scale scores were derived from their teachers' responses and transformed into standardised scale scores using the PIRLS 2021 scaling procedures to ensure comparability across schools and assessment cycles. Using predefined cut scores, students were grouped into three categories: Very High, High, and Medium Emphasis on Academic Success. Students enrolled in schools classified as having Very High Emphasis obtained scale scores of 12.9 or higher, which on average corresponded to teachers rating six aspects as very high and the remaining six as high. Students attending schools with *Medium Emphasis* had scale scores at or below 9.2. All remaining students were classified as attending schools with High Emphasis on Academic Success.

For Türkiye, the scale exhibited excellent internal consistency, as reflected by a Cronbach's alpha of .90, McDonald's Omega was calculated as .895, CR was .904, and AVE was .658.

Instruction Affected by Reading Resource Shortages

Instruction affected by reading resource shortages was assessed using the Instruction Affected by Reading Resource Shortages scale, derived from principals' responses to the PIRLS 2021 school questionnaire (items ACBG10AA-ACBG10BD). This scale assesses principals' perceptions of the extent to which shortages in school and classroom resources constrain the provision of effective reading instruction. Principals reported the extent to which instruction was affected by shortages across thirteen resources using a four-point response scale ranging from "not at all" to "a lot."

The items represent two broad categories: general school resources and resources specific to reading instruction. General resources include instructional materials and supplies, physical infrastructure, instructional space, technological resources, and staff capacity. Reading-specific resources include teachers specialised in reading, instructional software, library resources, and reading materials such as textbooks and reading series. Students' scale scores were derived from principals' responses and transformed into standardised scale scores using the PIRLS 2021 scaling procedures.

Based on predefined cut scores, students were classified into three categories: *Not Affected*, *Somewhat Affected*, and *Affected A Lot by Reading Resource Shortages*. Students attending schools classified as *Not Affected* had scale scores at or above 11.0, whereas those attending schools classified as *Affected A Lot* had scores at or below 7.0. All remaining students were classified as attending schools where instruction was *Somewhat Affected*. For Türkiye, the scale exhibited excellent internal consistency (Cronbach's alpha = .94, McDonald's Omega= 0.955, CR= .918, and AVE=.617.) and explained 60% of the total variance, reflecting a strong and coherent measurement of instructional constraints related to reading resources (Yin & Reynolds, 2023, pp. 141-145).

Control Variables

Consistent with earlier PIRLS studies, the model controlled for multiple variables at both the student and school levels, including gender and home socioeconomic status at the student level due to their established relationships with reading achievement (Mullis & Martin, 2019; Mullis et al., 2023). Socioeconomic background is associated with access to reading materials and literacy-related experiences outside school, while gender differences in reading achievement have been observed across educational systems.

At the school level, the presence of a school library was included as a control variable, given

evidence that access to books and reading materials supports students' reading engagement and achievement, particularly in primary education (Mullis et al., 2023). Controlling for these variables enables a more accurate estimation of the relationships among the focal constructs in the proposed multilevel model.

Analytical Strategy

To investigate the individual and school-level mechanisms associated with reading achievement, the study adopted a Bayesian multilevel structural equation modelling (MSEM) mediation approach. This modelling strategy was selected for three main reasons. First, PIRLS 2021 data have a hierarchical structure, with students nested within schools, requiring multilevel modelling to avoid biased standard errors and incorrect inferences (Preacher et al., 2010). Second, PIRLS reports student achievement using plausible values, which represent multiple imputations of latent proficiency rather than single observed scores. Bayesian estimation provides a flexible framework for combining parameter estimates across plausible values and appropriately reflecting uncertainty in achievement estimates (IEA, 2023). Third, Bayesian estimation is particularly suitable for complex multilevel mediation models, as it produces stable parameter estimates and more accurate interval estimates in models involving indirect effects and hierarchical structures (Muthén & Asparouhov, 2012).

The analytical procedure was implemented in three consecutive stages. In the first stage, weighted descriptive statistics and correlation coefficients were calculated for variables at both the student and school levels. All estimates accounted for the complex sampling design of PIRLS, including stratification and clustering, and were obtained using the IEA IDB Analyzer in combination with Mplus. These preliminary analyses served two purposes: (a) to describe the distributions of the key variables and (b) to examine whether statistically meaningful associations existed among the study variables at both levels. Evidence of significant associations across variables provided empirical support for the use of multilevel modelling techniques and for testing the hypothesised mediation relationships (Preacher et al., 2010).

In the second stage, a theory-driven two-level mediation model was specified. At the student level, engagement in reading lessons was modelled as an exogenous variable, confidence in reading as a mediator, and reading achievement as the outcome variable. Student gender and home socioeconomic status were included as control variables to account for well-established background differences in reading achievement. At the school level, instruction in schools reporting resource shortages was included in the model as a school-level characteristic associated with school emphasis on academic success, which was expected to be related to school-level reading achievement. The presence of a school library was included as an additional school-level control variable. The multilevel mediation framework enabled the simultaneous estimation of indirect relationships at both the within-school (student) and between-school (school) levels, consistent with contemporary multilevel structural equation modelling approaches (Preacher et al., 2010).

In the third stage, the multilevel mediation model was estimated using Bayesian Markov Chain Monte Carlo (MCMC) procedures in Mplus. Model estimation was conducted separately for each of the five plausible values of reading achievement (PV1–PV5). Following established guidelines for international large-scale assessment data, separate models were fitted for each plausible value and the resulting parameter estimates were combined using Rubin's (1987) combination rules, producing pooled posterior medians,

posterior standard deviations, and 95% Bayesian credibility intervals.

For the Bayesian estimation, non-informative (diffuse) priors were used for all model parameters, consistent with common practice in large-scale educational modelling when strong prior information is not available (Muthén & Asparouhov, 2012). Regression coefficients were assigned normal priors centred at zero with large variances, while variance parameters were assigned inverse-gamma priors with diffuse hyperparameters, allowing the data to primarily determine the posterior estimates.

The multilevel mediation model was estimated using Bayesian Markov Chain Monte Carlo (MCMC) procedures implemented in Mplus. By default, the estimation employed two parallel chains. A total of 5,000 MCMC iterations were specified, with the initial iterations automatically treated as burn-in by the Mplus Bayesian estimation algorithm to allow the chains to reach a stationary distribution before posterior summaries were calculated. Posterior estimates were therefore based on the remaining iterations after the burn-in phase. Convergence of the Markov chains was evaluated using the Potential Scale Reduction (PSR) statistic reported in the TECH8 output. PSR values close to 1 indicate convergence across chains. Across all estimated models, PSR values ranged between 1.000 and 1.013, indicating satisfactory convergence. In addition, trace plots were visually inspected to confirm stable mixing and convergence of the Markov chains.

Model fit was evaluated using the Posterior Predictive P-value (PPP) and the associated 95% credibility interval for the difference between observed and replicated chi-square values. Although the PPP value was low (PPP = .000), such outcomes are frequently observed in large-scale international assessment datasets due to their large sample sizes and complex structures. Importantly, the parameter estimates were stable and their credibility intervals were theoretically coherent, suggesting that the model adequately captured the key relationships among the variables (Muthén & Asparouhov, 2012).

Finally, model explanatory power was assessed using R^2 values calculated separately for each endogenous variable at both the within-school and between-school levels. These statistics allowed an evaluation of the proportion of variance in reading achievement associated with student-level motivational and socioeconomic factors as well as school-level organisational characteristics.

Results

Primarily Analysis

Table 2 displays the descriptive statistics, including means and standard deviations, as well as the inter-correlations among the study variables at both the student and school levels. All analyses were conducted using weighted data and the IEA IDB Analyzer to account for the complex sampling design and the nested structure of the data.

Table 2 Descriptive Statistics and Correlations Among Study Variables

Variables	M	SD	1	2	3	4	5
Student Level							
1. GENDER	—	—	—				
2. ASBHSES	9.07	2.02	.00	—			
3. ASBGSCR	10.00	1.76	−.10***	.19***	—		
4. ASBGERL	10.65	1.99	−.06*	.10***	.21***	—	
5. ASRREAD	499.11	87.41	−.09***	.49***	.38***	.19***	—
School Level							
1. ACBG07A	1.47	0.50	—				
2. ACBGEAS	10.18	2.48	−.15	—			
3. ACBGRRS	7.84	2.20	−.07	.10	—		
4. ASRREAD	491.45	51.82	−.12	.52	.14	—	

Note. ACBGEAS = *School Emphasis on Academic Success*; ACBGRRS = *Instruction Affected by Resource Shortage*; ACBG07A = *School Has a Library*; ACBG07B = *Number of Books in the School Library*; ASBGERL = *Students Engaged in Reading Lessons*; ASBGSCR = *Students Confident in Reading*; GENDER=*Student Gender*; ASBHSES = *Home Socioeconomic Status*; ASRREAD = Reading Achievement, All statistics are weighted and obtained using the IEA IDB Analyzer. $p < .05$*, $p < .01$*, **$p < .001$.

Student-Level Results At the student level, the descriptive statistics indicated that the average reading achievement score was 499.11 (*SD* = 87.41). Correlational analyses revealed that all student-level predictors were significantly associated with reading achievement in the expected directions. Specifically, Home Socioeconomic Status exhibited the strongest positive correlation with reading achievement (r = .49, p < .001). This was followed by students' confidence in reading (r = .38, p < .001) and their engagement in reading lessons (r = .19, p < .001). Student gender showed a small but statistically significant negative correlation with achievement (r = -.09, p < .001), suggesting a slight performance gap. Additionally, a notable positive relationship was observed between students' reading confidence and their early engagement in reading lessons (r = .21, p < .001).

School-Level Results At the school level, the mean reading achievement across the sampled schools was 491.45 (*SD* = 51.82). The correlational analysis revealed a strong positive relationship between school emphasis on academic success and reading achievement at the school level (r = .52). Although school-level correlations often involve smaller sample sizes (k = 192 schools), this coefficient suggests that schools with a robust academic focus tend to yield higher achievement scores. Conversely, the presence of a school library and instruction affected by resource shortage showed relatively weak and non-significant correlations with aggregate reading achievement (r = -.12 and r = .14, respectively). Interestingly, a negative trend was observed between instructional hours/library presence and academic emphasis (r = -.15), indicating that school-level factors may interact in complex ways within the institutional climate.

These preliminary correlational findings suggest the multidimensional nature of reading achievement, which is associated with both individual psychological and socioeconomic factors as well as broader institutional orientations. The significant inter-correlations among predictors at the student level justify the further use of MSEM to test the hypothesized mediation effects while controlling for the nested structure of the data. The Bayesian two-level mediation model was estimated using five plausible values of reading achievement (PV1–PV5). Separate models were fitted for each plausible value, and parameter estimates

were combined following Rubin's (1987) rules. For each model, two Markov Chain Monte Carlo (MCMC) chains were specified. Convergence diagnostics based on the Potential Scale Reduction (PSR) statistic obtained from the TECH8 output indicated satisfactory convergence across all models (PSR range = 1.000–1.013).

Little's MCAR test suggested that the missing data mechanism violated the assumption of missing completely at random, $\chi^2(65) = 171.016$, $p < .001$. Accordingly, Bayesian estimation was conducted under the Missing at Random (MAR) assumption, and model fit was assessed using the Posterior Predictive P-value (PPP). Although the PPP value was low (PPP = .000), this outcome is commonly observed in large-scale educational datasets and does not necessarily indicate model misspecification. Importantly, parameter estimates were stable, and their credibility intervals were theoretically coherent, supporting the adequacy of the proposed model.

Model Analysis

Table 3 and Figure 2 summarize the outcomes of the Bayesian multilevel mediation model, which was estimated using the five plausible values and subsequently pooled following Rubin's (1987) guidelines.

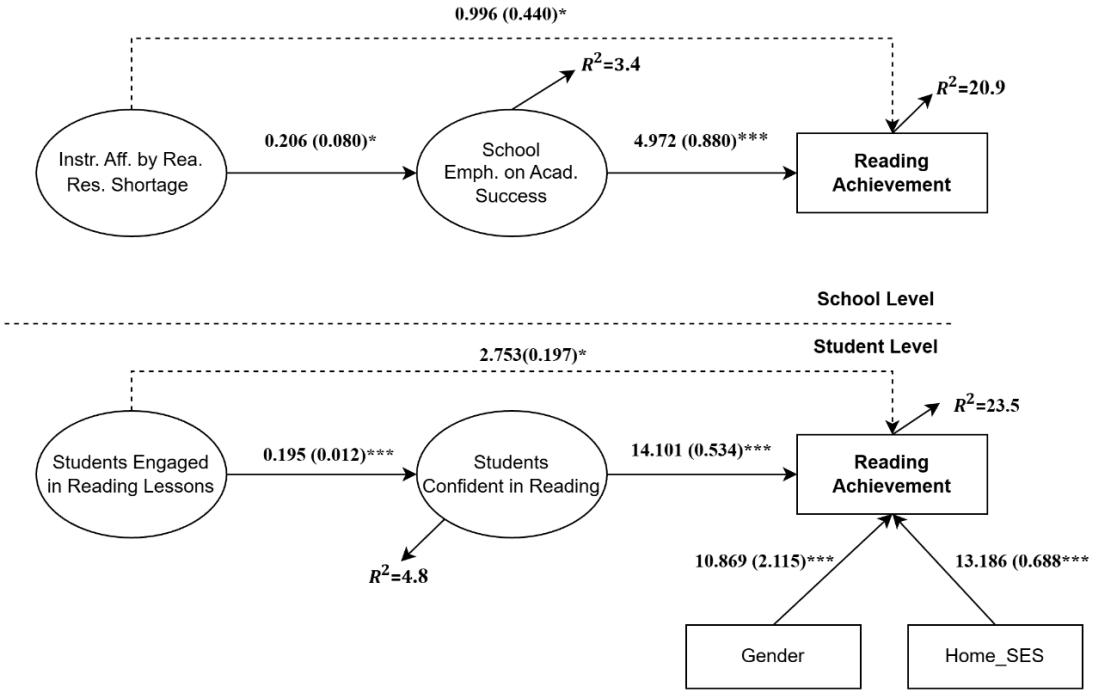

Figure 2. Model results.

Table 3. Bayesian Multilevel Mediation Results

Level and Parameter Path	Standardized Coefficients (B)	Standard Deviation (SD)	95% Credibility Interval
Student Level			
Students Engaged → Reading Confidence	0.195***	0.012	[0.171, 0.219]
Reading Confidence → Reading Achievement	14.101***	0.534	[13.051, 15.150]
Gender → Reading Achievement	10.869***	2.115	[6.602, 15.137]
Home SES → Reading Achievement	13.186***	0.688	[11.806, 14.566]
School Level			
Reading Resource Shortage → Academic Emphasis	0.206*	0.080	[0.049, 0.363]
Academic Emphasis → Reading Achievement	4.972***	0.880	[3.247, 6.696]
School Library → Reading Achievement	3.119	4.394	[-5.501, 11.740]
Indirect Effects			
Student-Level Indirect Effect	2.753*	0.197	[2.367, 3.138]
School-Level Indirect Effect	0.996*	0.440	[0.133, 1.859]
R^2 Reading Achievement (Within)	23.5	10	
R^2 Students Confident (Within)	4.8	6	
R^2 Reading Achievement (Between)	20.9	62	
R^2 Academic Emphasis (Between)	3.4	25	

Notes. Standardized coefficients (B) are reported with standard deviations (SD). Values in brackets indicate 95% Bayesian credibility intervals. * p < .05, ** p < .01, *** p < .001.

As shown in Table 3 and Figure 2, the model accounted for a considerable proportion of variance at both levels of analysis. At the student level (Level 1), 23.5% of the variance in reading achievement (R^2 = .235, SD = .010) and 4.8% of the variance in reading confidence (R^2 = .048, SD = .006) were accounted for. At the school level (Level 2), the model explained 20.9% of the between-school variance in reading achievement (R^2 = .209, SD = .062) and 3.4% of the variance in academic emphasis (R^2 = .034, SD = .025), indicating meaningful explanatory power across levels.

At the student level, engagement in reading lessons was positively associated with reading confidence (B = 0.195, SD = 0.012, 95% CI [0.171, 0.219], p < .001; see Table 3). Reading confidence, in turn, was found to be a strong predictor of reading achievement (B = 14.101, SD = 0.534, 95% CI [13.051, 15.150], p < .001). These two paths jointly produced a statistically significant indirect effect of student engagement on reading achievement via reading confidence (B = 2.753, SD = 0.197, 95% CI [2.367, 3.138], p < .05). This finding indicates that the positive relationship between engagement on achievement and students' enhanced confidence in reading, underscoring the central mediating role of affective–motivational factors at the individual level. Among the student-level control variables, both gender (B = 10.869, SD = 2.115, 95% CI [6.602, 15.137], p < .001) and home socioeconomic status (B = 13.186, SD = 0.688, 95% CI [11.806, 14.566], p < .001) were significant predictors of reading achievement.

At the school level, perceived shortages in reading-related instructional resources were positively associated with academic emphasis (B = 0.206, SD = 0.080, 95% CI [0.049, 0.363], p < .05). Academic emphasis, in turn, was a significant predictor of school-level reading achievement (B = 4.972, SD = 0.880, 95% CI [3.247, 6.696], p < .001). Together, these paths yielded a statistically significant indirect effect of instructional resource shortage on reading achievement through academic emphasis (B = 0.996, SD = 0.440, 95% CI [0.133, 1.859], p <

.05). This result suggests that school-level structural conditions are related to student outcomes through their associations with collective academic priorities and instructional focus. With respect to school-level control variables, the presence of a school library was not a statistically significant predictor of reading achievement (B = 3.119, SD = 4.394, 95% CI [–5.501, 11.740], p > .05).

Discussion and conclusion

The present study examined the relationships between school-level organisational conditions, student-level motivational processes, and reading achievement using PIRLS 2021 data within a multilevel mediation framework. The findings contribute to the literature by integrating contextual and motivational factors and by examining both direct and indirect pathways to reading achievement.

Several limitations should be considered when interpreting the findings. First, the analysis relied on self-reported data obtained from PIRLS student, teacher, and school questionnaires. Such measures may be subject to response bias and subjective interpretations (Podsakoff et al., 2003). Second, although the model included key variables identified in previous research, reading achievement is influenced by a wider range of factors such as instructional quality, teacher expertise, and home literacy environments. Finally, the cross-sectional nature of PIRLS data limits causal interpretations. The relationships identified in the study therefore represent theoretically informed explanatory mechanisms rather than definitive causal processes. In addition, the findings are based on data from a single national context, which may limit their generalisability to other educational systems.

Despite these limitations, the findings provide important insights into the mechanisms linking school environments and student motivation to reading achievement. At the school level, instructional resource shortages were negatively associated with schools' emphasis on academic success. This finding is consistent with previous research suggesting that limited instructional resources may weaken schools' ability to maintain academically oriented environments and sustain high expectations (Cohen et al., 2009; Johnson et al., 2012; Kutsyuruba et al., 2015). In this sense, resource shortages appear to influence student outcomes indirectly by shaping organisational priorities and instructional practices.

Consistent with the effective schools literature, school emphasis on academic success demonstrated a significant positive relationship with reading achievement. Schools that maintain strong academic expectations and clear instructional goals tend to create environments that support student learning and engagement (Edmonds, 1979; Goddard et al., 2000). Evidence from PIRLS-based studies similarly indicates that stronger academic emphasis is associated with higher reading performance across educational systems (Martin et al., 2013; Nilsen & Gustafsson, 2014). The present findings confirm the relevance of this relationship within the Turkish educational context.

The analysis also showed that the presence of a school library was not significantly associated with reading achievement. Although previous studies often report positive relationships between school library resources and reading outcomes, this result suggests that the mere presence of a library may not be sufficient to influence achievement. The effectiveness of library resources may depend on factors such as the quality of the collection, the frequency of student use, and the extent to which library materials are integrated into instructional activities.

The mediation analysis further demonstrated that school emphasis on academic success functions as an intermediary mechanism linking instructional resource shortages to reading achievement. Rather than exerting a direct influence on performance, resource shortages appear to affect achievement by weakening schools' academic orientation. This finding is consistent with organisational theories of schooling, which suggest that contextual constraints influence student outcomes primarily through school processes and priorities.

At the student level, engagement in reading lessons was positively associated with students' confidence in reading. This finding aligns with motivational theories suggesting that active participation in learning activities contributes to the development of self-efficacy beliefs (Guthrie & Wigfield, 2000; Schunk & Pajares, 2009). Students who are actively involved in reading lessons gain opportunities to experience success and receive feedback, which can strengthen their beliefs about their reading abilities.

Reading confidence was also found to be a strong predictor of reading achievement. Students who believe in their reading abilities are more likely to persist when encountering challenging texts and employ effective reading strategies. This result is consistent with previous PIRLS studies highlighting the importance of motivational beliefs in reading development (Leino et al., 2022; Martin et al., 2013).

Importantly, the mediation analysis indicated that confidence in reading mediates the relationship between engagement in reading lessons and reading achievement. This finding suggests that engagement contributes to achievement primarily through the development of positive self-beliefs. In other words, engagement alone may not directly translate into improved performance unless it strengthens students' confidence in their reading abilities.

Taken together, the findings highlight the interconnected roles of school-level organisational conditions and student-level motivational processes in shaping reading achievement. School emphasis on academic success appears to be an important organisational mechanism supporting achievement, while engagement and confidence in reading function as key motivational processes at the student level.

From a policy perspective, the results suggest that improving reading achievement requires more than simply increasing material resources. Efforts to enhance student outcomes should also focus on strengthening schools' academic orientation and fostering classroom practices that support student engagement and confidence in reading. By integrating organisational and motivational dimensions, the study provides a more comprehensive understanding of how reading achievement develops in primary education.

Declarations

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Informed Consent: Informed consent was obtained from all participants within the scope of the PIRLS 2021 study, and participation was entirely voluntary. The data were accessed and used strictly for research purposes in compliance with IEA data use policies.
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