
| RESEARCH ARTICLE

Examining Student and School Factors Predicting Reading Literacy in Saudi Arabia: Evidence from PISA 2022

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ABSTRACT

This study investigated student- and school-level factors associated with reading literacy among Saudi Arabian students using data from the Programme for International Student Assessment (PISA) 2022. The sample comprised 6,928 15-year-old students nested within 193 schools. Two-level hierarchical linear modeling was used to partition variation in reading literacy between students and schools and to estimate the independent associations of six student-level and five school-level predictors. At the student level, higher economic, social, and cultural status, higher expected occupational status, and greater availability of information and communication technology resources at home were positively associated with reading literacy, whereas male students scored lower than female students. Duration in early childhood education and sense of belonging were not statistically significant. At the school level, school type was the only statistically significant predictor: students in private independent schools had higher adjusted reading literacy scores than those in public schools. School location, school size, and perceived shortages of educational materials and staff were not statistically significant. Although the measured predictors substantially reduced between-school variation, a significant school-level effect remained. The findings highlight the importance of socioeconomic and cultural inequalities, gender differences, occupational expectations, access to ICT resources, and school-sector disparities in understanding reading literacy in Saudi Arabia, while underscoring that the observed relationships are predictive rather than causal.

| KEYWORDS

Reading literacy; socioeconomic status; expected occupational status; ICT resources; school type; PISA 2022; Saudi Arabia

| ARTICLE INFORMATION

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1. INTRODUCTION

Reading literacy extends beyond decoding written language. It concerns the capacity to understand, use, evaluate, reflect on, and engage with texts to pursue goals, develop knowledge and potential, and participate in society (OECD, 2019, 2023). This functional conception is particularly important in contemporary education, considering that students are exposed to information in both print and digital environments and need to judge, integrate and apply what they read. Therefore, reading literacy helps to learn in all subjects and is the basis for later participation in education, social and economic inclusion.

International large-scale assessments have enabled the study of reading literacy along with the conditions for its development. PISA has the advantage of testing 15-year-old students at the end of compulsory education and correlating achievement with extensive questionnaires on students and schools. The resulting data also show the nested organization of education, in which students develop in families and peer groups, attend schools, and experience institutional conditions that are shared in part with their schoolmates. Analyses that fail to incorporate this structure risk conflating individual differences with contextual differences.

Conversely, multilevel analysis differentiates between the variation among students within schools and the variation between schools (Raudenbush & Bryk, 2002).

Previous research has consistently demonstrated that reading achievement is linked to resources and dispositions at multiple levels. At the student level, it can affect access to books, language-rich interaction, ICT resources and educational guidance through socioeconomic and cultural advantages (Coleman et al., 1966; Gustafsson et al., 2018). International assessments also reveal gender differences in reading, but the size of these differences varies across educational systems (Reilly et al., 2019; Stoet & Geary, 2013). Students' expectations of occupational futures may reflect academic expectations and the value attached to continued learning, but early-childhood participation, access to Information and Communication Technology (ICT), and sense of belonging can also act as developmental, informational, and motivational supports. Location, size, governance sector and shortages of material or human resources at the school level can influence the opportunities for literacy learning (Agasisti et al., 2021; Zuze & Reddy, 2014).

The strength and, in some cases, the direction of these associations are context dependent. For example, a multilevel study in Morocco found that reading literacy was associated with a wide range of student and school conditions, such as expected occupational status, early-childhood education, location, school type, size, and resource constraints (Zhang et al., 2024). Evidence on ICT is especially mixed: access can widen opportunities to discover and use texts, but availability in itself does not guarantee educationally productive use, and relationships may depend on purpose and intensity (Gubbels et al., 2020; Hu et al., 2018; Martínez-Gautier et al., 2021). These findings are not directly generalisable to Saudi Arabia because national systems differ in school organization, advantage patterns, digital provision and distribution of educational resources.

Saudi Arabia is therefore an important setting for a country-specific multilevel investigation. Earlier work using Saudi PISA 2018 data identified student background, gender, and ICT-related factors as relevant and reported a location difference at the school level (Alshalawi & Alqurashi, 2022). The 2022 cycle provides an opportunity to reassess a theoretically related set of predictors after changes in both educational provision and the wider learning environment. Yet current evidence remains limited on whether commonly cited student predictors retain independent associations when considered simultaneously and on which observable school characteristics account for differences between Saudi schools. Addressing this gap can distinguish correlates located within students' immediate circumstances from those associated with the schools they attend. Accordingly, the present study uses PISA 2022 data and hierarchical linear modeling to estimate student- and school-level predictors of Saudi students' reading literacy. It addresses the following research questions:

1. To what extent do student-level factors, including economic, social, and cultural status, gender, expected occupational status, duration of participation in early childhood education, access to ICT resources, and sense of belonging, predict Saudi students' reading literacy?
2. To what extent do school-level factors, including school location, school size, school type, shortages of educational materials, and shortage of educational staff, predict differences in Saudi students' reading literacy across schools?

2. LITERATURE REVIEW

2.1 Student-Level Factors Predicting Reading Literacy

Economic, social, and cultural status are among the most stable correlates of academic achievement. Differences in parental education and occupation and in learning-related possessions can influence the quantity and quality of literacy support available outside school. These resources may operate cumulatively through exposure to texts, vocabulary-rich interaction, academic guidance, and familiarity with institutional expectations (Coleman et al., 1966; Gustafsson et al., 2018; Karaman, 2022). Li et al. (2025) found that family socioeconomic status affects children's reading through home learning environments. In PISA-based research, socioeconomic advantage remains associated with achievement even when school context is considered, a pattern also reported for Turkish PISA 2018 reading literacy, where economic, social, and cultural status was among the most consistent background predictors of achievement (Karaman, 2022), which makes economic, social, and cultural status central to an analysis of educational equity.

Gender is also relevant because girls typically outperform boys in reading across many large-scale assessments, although the gap is not uniform across countries or cohorts. Explanations commonly refer to differences in reading engagement, self-concept, preferences, socialization, and the distribution of language-related behaviors, but observational PISA data cannot adjudicate among these mechanisms (Reilly et al., 2019; Stoet & Geary, 2013). In this study, gender is therefore modeled as a predictor rather than interpreted as an inherent difference in ability.

Expected occupational status provides a future-oriented complement to present family circumstances. Occupational expectations may summarize students' educational plans, perceived opportunities, and motivation to invest in academic work. Prior multilevel research has identified positive associations between expected occupational status and reading literacy, including in Morocco (Zhang et al., 2024). Similarly, in North Macedonia, results from the multiple regression analysis indicated students' occupational

and educational expectations significantly predict students' reading achievement (Lameva & Chonteva, 2025). Nevertheless, expectations and achievement may influence each other, so the present cross-sectional analysis treats the association as predictive rather than causal.

Participation in early childhood education can support language, emergent literacy, and familiarity with structured learning. Skill-formation research emphasizes that earlier capacities can facilitate later learning (Cunha & Heckman, 2008). Years of participation, however, are not a direct measure of program quality, language of instruction, curriculum, or continuity into primary schooling. Consequently, duration may show a weak independent relationship in adolescence after family background, and other experiences are controlled, even where high-quality early education is beneficial.

ICT resources can expand access to information and digital texts, but ownership is not equal to effective use for learning. Cross-national evidence links ICT and achievement in complex ways, with relationships varying by access, purpose, frequency, and educational context (Hu et al., 2018; Ma & Qin, 2021). Studies also suggest diminishing or non-linear returns when technology use becomes excessive or distracting (Gubbels et al., 2020; Martínez-Gautier et al., 2021; Goh et al., 2026). Using PISA 2018 data, Goh et al. (2026) reported an inverted-U relationship between home ICT resources and reading, mathematics, and science performance in Singapore, indicating that the benefit of ICT access can plateau or reverse beyond a moderate level. ICT resources in the present study measures availability at home; its coefficient should therefore be interpreted as the association of access, not digital competence or quality of use.

A sense of school belonging may foster engagement by making students feel accepted, connected, and supported. Tan et al. (2022) found that school belonging had a direct and positive effect on student reading literacy. Relationships with teachers and peers can influence participation and persistence, and teacher support has been linked to engagement and achievement (Klem & Connell, 2004). Yet belonging may relate more strongly to well-being or attendance than directly to test performance, and its independent association can diminish after socioeconomic and school differences are controlled. The model tests whether sense of belonging adds predictive information over and above the other characteristics of the student.

2.2 School-Level Factors Predicting Reading Literacy

Schools organise access to teachers, materials, peers and instructional routines. Location could be a proxy for differences in infrastructure, staffing, transport, community resources and student composition. The size of the school may impact the range of course offerings and the breadth of resources, but it can also affect personalisation and organisational complexity. School type may be associated with differences in governance, admissions, resources, peer composition, or instructional practices. These mechanisms are not directly seen here, and so any sector difference is seen as an adjusted association and not a causal private school effect (Sakellariou, 2017).

More immediate indicators of a school's ability to provide instruction are material and staff shortages. Limited texts, technology, facilities, qualified teachers or support personnel may reduce learning opportunities. International evidence links school resources to reading achievement and equity (Agasisti et al., 2021; Zuze & Reddy, 2014). Principal-reported shortage indices, in contrast, measure perceived constraints and may not reflect how resources are allocated or used. Where shortages are extensive, or where schools offset them through organisational practices, the effects can also be mitigated.

2.3 Reading Literacy in Saudi Arabia

To understand literacy in reading in the Kingdom of Saudi Arabia, a national system is required that aims at general educational improvement and serves students in different geographical and institutional settings. PISA provides a common assessment framework to evaluate whether 15-year-olds can apply reading knowledge in unfamiliar and applied contexts rather than merely reproducing curriculum content. This distinction is important for Saudi policy in that literacy underpins learning in disciplines and the capacity to navigate an increasingly digital knowledge environment.

Saudi evidence available shows inequalities at both student and school levels. Alshalawi and Alqurashi (2022), using PISA 2018, reported reading literacy to be associated with gender, economic, social and cultural status, and ICT resources, whereas school location differentiated school performance. The study contributed to establishing the relevance of multilevel analysis in the Saudi context, but was based on an earlier PISA cycle and a different specification. The current study looks at the extent to which a variety of student resources, expectations, early experiences and school-connection variables predict literacy in PISA 2022, as well as structural school characteristics and perceived shortages.

A comparative analysis with other national contexts can be illuminating but has to be done with caution. The Moroccan PISA 2018 study found that differences between schools played a much larger role and identified several school factors as significant (Zhang et al., 2024). Similarly, Turkish research shows student and school predictors may function differently when modelled simultaneously (Ertem, 2021; Karaman, 2022). Evidence from Singapore, a high-performing PISA system, also suggests that the link between student ICT engagement and achievement is not always linear, even with high levels of engagement (Goh et al., 2026). This implies that predictor relationships found in other contexts cannot be assumed to hold in Saudi Arabia. This variation

highlights the need to predict relationships in Saudi Arabia rather than assume that predictors have universal effects. The present study contributes to this by providing a focused two-level account of which measured factors independently differentiate Saudi students and schools in the 2022 data.

2.4 Conceptual Framework

The study is guided by an ecological and multilevel perspective on literacy development. Rather than seeing achievement as a product of individual personal characteristics in isolation, ecological systems theory places individual development in nested social environments (Bronfenbrenner, 1979). In the case of reading literacy, the student is the immediate unit of learning, but opportunities and constraints are distributed across home resources, aspirations, experiences, relationships, and the organisational setting of the school. This view is consistent with the hierarchical structure of the PISA data and supports the distinction between within-school and between-school processes.

Ecological systems theory was adopted over frameworks that focus narrowly on the individual learner because reading literacy in Saudi Arabia is situated in a unique multilevel context, including a highly centralised national education system, ongoing curricular and institutional reform under Vision 2030, and a marked structural distinction between public and private-independent school sectors. Under these conditions, student outcomes cannot be adequately explained by individual cognitive or motivational characteristics alone, but must be placed in nested layers of family resources, school organization and system-level policy that jointly shape learning opportunities. The same logic has guided previous multilevel research on reading literacy in other national contexts (Zhang, et al., 2024). The conceptual framework is depicted in Figure 1.

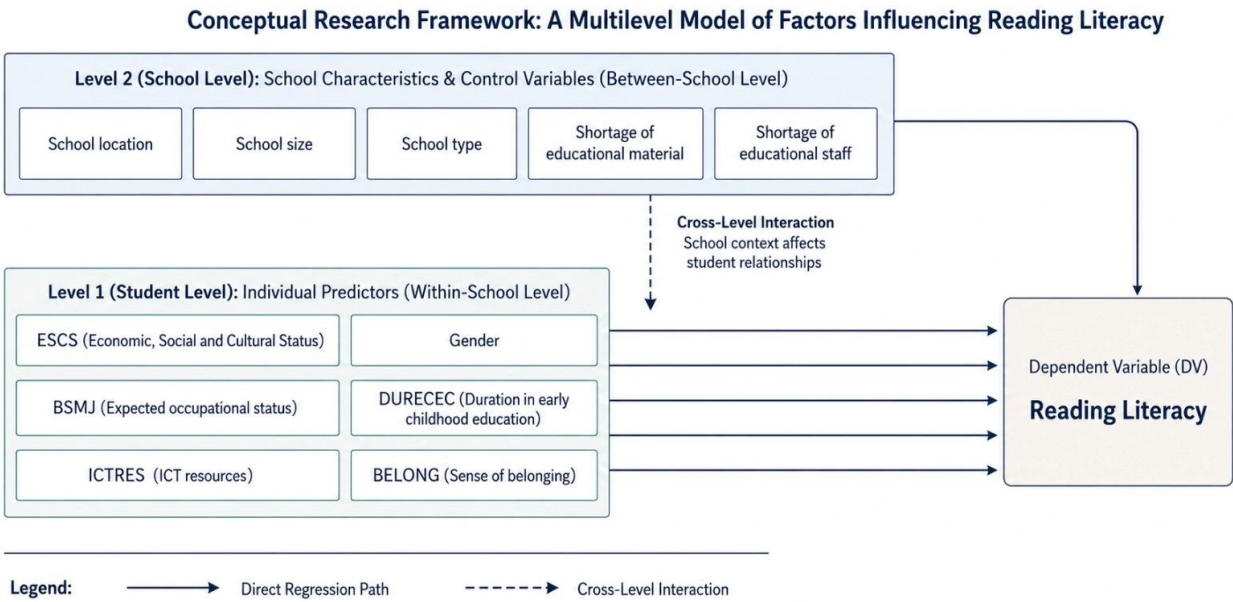


Figure1. Conceptual framework (Source: Developed by the author)

Level 1 (student level): Economic, social and cultural status refers to access to economic, social and cultural resources that can support literacy learning. Gender accounts for systematic differences in reading engagement and achievement across education systems. Future-oriented educational aspiration is proxied by expected occupational status: students expecting higher-status occupations might assign greater instrumental value to academic learning. Duration in early childhood education is an indicator of the cumulative exposure to organised learning prior to primary school. The index of ICT resources measures availability of electronic devices that may support access to information and engagement with text. Sense of belonging measures students’ social connection to school, a condition that may support participation and engagement.

At Level 2 (school level), school location, size and type refer to the structural context in which teaching takes place. Shortage of educational materials and shortage of educational staff indicate principals’ perception on constraints of material provision and staffing. These variables may differentiate the instructional opportunities shared by students in the same school. The framework does not assume that every theoretically relevant factor must have a detectable independent effect. Rather, it tests whether each

factor predicts reading literacy after the other variables at its level and across levels are taken into account. The outcome is reading literacy, and the models estimate direct fixed associations while allowing school's mean achievement to vary randomly. No cross-level interaction is tested in the present analysis.

3. MATERIAL AND METHODS

3.1 Data Source

The data of this study were obtained from the Programme for International Student Assessment (PISA) 2022 database for Saudi Arabia, which was made publicly available by the Organization for Economic Co-operation and Development (OECD). The dataset included information collected through both the student background questionnaire and the school questionnaire completed by school principals. PISA employs a two-stage stratified sampling design in which schools are selected at the first stage, followed by the random selection of 15-year-old students within participating schools at the second stage (OECD, 2024). The Saudi Arabian sample comprised 6,928 students nested within 193 schools (see Table 1). The PISA 2022 database provided information on students' background characteristics, school characteristics, and reading literacy achievement. Reading literacy was measured using the plausible values provided by PISA, which represent multiple imputed estimates of students' achievement based on their responses to the assessment items and were analyzed in accordance with OECD procedures (OECD, 2024). Given the hierarchical structure of the data, with students nested within schools, hierarchical linear modeling (HLM) was employed as the appropriate analytical approach to account for this nested structure (Raudenbush & Bryk, 2002).

3.2 Variables

3.2.1 Students Level Variables (Level 1)

The study included a set of individual and background characteristics that may be associated with students' reading literacy. These variables were selected based on their theoretical relevance and their availability in the PISA 2022 database and were included in the multilevel model as student-level predictors (see Table 2).

Gender was included as a student-level variable and coded as a dummy variable, with female students coded as 0 and male students coded as 1.

Economic, social, and cultural status (ESCS) is a composite index developed by PISA to capture students' socioeconomic and cultural background. It is based on parents' educational attainment, parents' occupational status, and home possessions. Higher ESCS values indicate a more advantaged socioeconomic and cultural background (OECD, 2023).

Expected occupational status measures students expected occupational status based on the occupation they expect to have at approximately 30 years of age. Students' reported occupations are coded according to the ISCO-08 classification and then converted to the International Socio-Economic Index of Occupational Status (ISEI). Higher BSMJ values indicate higher expected occupational status (OECD, 2024).

Duration in early childhood education represents the estimated duration, in years, of students' participation in early childhood education and care before entry into primary education. Higher values indicate a longer duration of participation in early childhood education and care (OECD, 2024).

ICT Resources are an index measuring the availability of information and communication technology resources to students at home. The index is based on students' reported access to a range of ICT resources, with higher values indicating greater availability of such resources (OECD, 2024).

Sense of belonging measures students' sense of belonging at school based on their perceptions and experiences within the school environment. Higher values indicate a stronger sense of belonging to school (OECD, 2024).

Table 1. Descriptive Statistics of the Study Sample Categorical Variables.

Variable	PISA Code	Category	Frequency (N)	Percentage (%)
Gender	-	Female	3555	51.3
		Male	3373	48.7
School type	SCHLTYPE	Public	152	78.8
		Private independent	41	21.2
School location*		A village, hamlet or rural area	11	5.8
		A small town	10	5.2

SC001Q01TA	A town	16	8.4
	A city	64	33.5
	A large city	90	47.1

*Note. School location was unavailable for 2 of the 193 schools (n = 191); percentages for school location are therefore calculated on valid responses only and do not sum to the full school sample.

3.2.2 School Level Variables (Level 2)

The study included a set of contextual and structural school characteristics that may be associated with students' reading literacy. These variables were selected based on their relevance to the school context and their availability in the PISA 2022 database and were included in the multilevel model as school-level predictors (see Table 2).

School Location was included as a school-level variable to capture differences in schools' geographical settings. In PISA 2022, school location was classified into five categories: a village, hamlet, or rural area (SHL_V); a small town (SHL_ST); a town (SHL_T); a city (SHL_C); and a large city (SHL_LC) (OECD, 2024). The city (SHL_C) category was used as the reference group in the analysis.

School Size refers to the total number of students enrolled in the school. It was included as a school-level variable to examine whether differences in school size were associated with students' reading literacy (OECD, 2024).

School type was included as a school-level variable to distinguish between public and private independent schools. The variable was dummy-coded, with public schools coded as 0 and private independent schools coded as 1.

Shortage of educational material measures the extent to which shortages or inadequacies in educational materials and physical infrastructure hinder a school's capacity to provide instruction. Higher values indicate that principals perceive shortages of educational materials and related resources as a greater obstacle to instruction (OECD, 2024).

Shortage of educational staff measures the extent to which shortages or inadequacies in teaching and assisting staff hinder a school's capacity to provide instruction. Higher values indicate that principals perceive shortages of educational staff as a greater obstacle to instruction (OECD, 2024).

Table 2. Descriptive Statistics at Student Level and School Level Continuous Variables

Level	PISA code	Variable	Data type	Mean	Standard deviation
Student	ESCS	Economic, social and cultural status	Numerical	-0.278	1.05
	BSMJ	Expected occupation status	Numerical	73.948	14.92
	DURECEC	Duration in early childhood education	Numerical	1.691	1.13
	ICTRES	ICT Resources	Numerical	-0.276	1.29
	BELONG	Sense of belonging	Numerical	0.005	1.02
School	SCHSIZE	School Size	Numerical	414.591	671.19
	EDUSHORT	Shortage of educational material	Numerical	0.233	1.54
	STAFFSHORT	Shortage of educational staff	Numerical	0.739	1.60

3.3 Data Analysis Procedure

A two-level hierarchical linear modeling (HLM) approach was employed to examine the factors associated with reading literacy among Saudi students in PISA 2022. Given the nested structure of the data, with students nested within schools, the analysis was conducted in several sequential stages. In the first stage, correlations among the student-level variables were examined to assess the bivariate relationships among the predictors included at the student level. The second stage involved estimating the null model (Model 1), which contained no predictor variables and was used to partition the variance in reading literacy into within-school and

between-school components and to calculate the intraclass correlation coefficient (ICC), thereby determining the extent to which differences between schools accounted for variation in students' reading literacy (Raudenbush & Bryk, 2002). In the third stage (Model 2), the student-level variables, including economic, social, and cultural status, gender, expected occupational status, duration in early childhood education, ICT resources, and sense of belonging, were introduced to examine their associations with reading literacy. Finally, in the fourth stage (Model 3), the school-level variables, including school location, school size, school type, shortage of educational materials, and shortage of educational staff, were added to assess whether school-level contextual characteristics contributed to explaining differences in students' reading literacy beyond the student-level predictors.

4. RESULTS

4.1 Correlation Among Student-Level Variables

The correlation matrix indicated that reading literacy was positively and significantly associated with economic, social, and cultural status ($r = .268, p < .001$), expected occupational status ($r = .198, p < .001$), ICT resources ($r = .238, p < .001$), and sense of belonging ($r = .076, p < .001$). In contrast, the relationship between reading literacy and duration in early childhood education was positive but weak and non-significant ($r = .017, p > .05$). Among the student-level predictors, economic, social, and cultural status showed a strong positive association with ICT resources ($r = .601, p < .001$), whereas its relationships with expected occupational status ($r = .125, p < .001$), duration in early childhood education ($r = .056, p < .001$), and sense of belonging ($r = .064, p < .001$) were positive but weak. Expected occupational status was positively related to sense of belonging ($r = .031, p < .05$) and ICT resources ($r = .120, p < .001$), whereas its association with duration in early childhood education was weak and non-significant ($r = .018, p > .05$). Duration in early childhood education was negatively associated with sense of belonging ($r = -.036, p < .05$), whereas ICT resources were positively associated with sense of belonging ($r = .113, p < .001$). Overall, the correlations among the student-level variables were generally weak to moderate, with the strongest association observed between economic, social, and cultural status, and ICT resources ($r = .601, p < .001$), whereas the weakest association observed between duration in early childhood education and ICT resources ($r = .002, p > .05$).

4.2 Null Model (Model 1)

The null model (Model 1) was estimated to partition the variance in reading literacy into two components: variance among students within schools (Level 1) and variance between schools (Level 2). The intraclass correlation coefficient (ICC) was calculated to determine the proportion of variance in reading literacy attributable to differences between schools. As shown in Table 3, overall, the mean score for reading literacy (y_{00}) was 385 with 2.55 standard error. The school-level variance component was 1,121, whereas the student-level residual variance was 4,204. The ICC was .210, indicating that approximately 21.0% of the variance in students' reading literacy was attributable to differences between schools, whereas the remaining 79.0% was attributable to differences among students within schools. The school-level variance was statistically significant ($X^2 = 1,105, df = 1, p < .001$), indicating significant variation in reading literacy across schools. The ICC exceeded the 10% threshold, further supporting the appropriateness of using hierarchical linear modeling to examine the factors associated with students' reading literacy (Lee, 2000).

4.3 Student-Level Model (Model 2)

In Model 2, the student-level variables were introduced to examine their associations with reading literacy while accounting for the hierarchical structure of the data. As shown in Table 3, economic, social, and cultural status was positively and significantly associated with reading literacy ($\beta = 16.92, p < .001$), indicating that students with higher socioeconomic and cultural status tended to have higher reading literacy scores. Gender was also statistically significant ($\beta = -22.60, p < .001$), with the negative coefficient indicating male students scored lower on reading literacy than female students, the reference group. Expected occupational status showed a positive and statistically significant association with reading literacy ($\beta = 0.53, p < .001$), suggesting that students with higher expected occupational status tended to have higher reading literacy scores. In contrast, duration in early childhood education was not significantly associated with reading literacy ($\beta = -0.06, p = .959$). ICT resources showed a positive but marginal, non-significant association with reading literacy ($\beta = 2.46, p = .054$). Sense of belonging was also positively related to reading literacy, but the association was not statistically significant ($\beta = 1.24, p = .326$).

Following the inclusion of the student-level predictors, the student-level residual variance was 3,931, whereas the school-level variance was 464. The ICC decreased from .210 in the null model to .106 in Model 2, indicating that approximately 10.6% of the remaining variance in reading literacy was attributable to differences between schools. Compared with the null model, the student-level predictors reduced the within-school variance from 4,204 to 3,931, representing an approximate reduction of 6.5%. The school-level random effect remained statistically significant ($X^2 = 99.0, p < .001$), indicating that significant differences in reading literacy remained between schools after accounting for the student-level predictors.

4.4 School-Level Model (Model 3)

In Model 3, the school-level variables were added to the student-level predictors to examine whether school-contextual characteristics contributed to explaining differences in students' reading literacy. As shown in Table 3, the effects of the main

student-level predictors remained largely consistent with those observed in Model 2. Economic, social, and cultural status remained a positive and statistically significant predictor of reading literacy ($\beta = 16.22$, $p < .001$), whereas gender remained statistically significant ($\beta = -24.00$, $p < .001$), indicating that male students had lower reading literacy scores than female students. Expected occupational status also remained positively and significantly associated with reading literacy ($\beta = 0.54$, $p < .001$). In contrast, duration in early childhood education ($\beta = -0.42$, $p = .737$) and sense of belonging ($\beta = 1.31$, $p = .319$) were not statistically significant. ICT resources showed a positive and statistically significant association with reading literacy in Model 3 ($\beta = 2.64$, $p = .049$).

Among the school-level variables, school location was not statistically significant relative to the city reference category. Specifically, none of the school-location categories - large city ($\beta = 0.18$, $p = .970$), town ($\beta = -7.76$, $p = .357$), small town ($\beta = 0.34$, $p = .972$), or village, hamlet, or rural area ($\beta = -18.23$, $p = .108$) - showed a statistically significant association with reading literacy. School size was also not statistically significant ($\beta = 0.01$, $p = .087$). In contrast, school type was positively and significantly associated with reading literacy ($\beta = 15.63$, $p = .008$), indicating that students in private independent schools had, on average, higher reading literacy scores than students in the reference category after controlling for the student- and school-level variables. Neither the shortage of educational materials ($\beta = -1.22$, $p = .538$) nor the shortage of educational staff ($\beta = 2.69$, $p = .175$) was statistically significant.

The residual variance within school was 3936 and the remaining variance between school was 432, giving an ICC of .099 as shown in Table 3. Model 2 had a between-school variance of 464, which was reduced to 432, a reduction of approximately 6.9%. The ICC also dropped from .106 to .099, indicating that about 9.9% of the residual variance in reading literacy was attributable to between-school differences. The school-level random effect remained statistically significant ($X^2 = 81.3$, $p < .001$), indicating that significant variation in reading literacy remained across schools after accounting for both student- and school-level predictors.

Table 3. HLM Analysis of Factors Influencing Students' Reading Literacy

	Null Model Coefficiente (β) (SE)	Model 2 Coefficient (SE)	Model 3 Coefficient (SE)
Intercept γ_{00}	385 (2.55) ***	389.2257 (2.0757) ***	390.7688 (2.19046) ***
Variance (School average)	1121	464	432
Variance (Level-1 Effect)	4204	3931	3936
ICC	0.210	0.106	0.0990
X^2	1105	99.0	81.3
Student-level predictors			
Economic, social, and cultural status		16.9222 (1.6993) ***	
Gender		-22.6025 (4.1999) ***	
Expected occupational status		0.5256 (0.0946) ***	
Duration in early childhood education		-0.0620 (1.2016)	
ICT resources		2.4605 (1.2786)	
Sense of belonging		1.2367 (1.2592)	
School-level predictors			
Economic, social, and cultural status			16.2152 (1.79424) ***
Gender			-23.9991 (4.45510) ***
Expected occupational status			0.5370 (0.09854) ***
Duration in early childhood education			-0.4245 (1.26208)
ICT resources			2.6385 (1.33680) *
Sense of belonging			1.3106 (1.31451)
School location: A large city			0.1825 (4.89981)
School location: A town			-7.7594 (8.39655)
School location: A small town			0.3422 (9.91059)
School location: A village, hamlet, or rural area			-18.2303 (11.30022)
School size			0.0149 (0.00861)
School type			15.6296 (5.80176) **
Shortage of educational materials			-1.2192 (1.97573)
Shortage of educational staff			2.6898 (1.97457)

Note. Gender was coded 0 = female and 1 = male. School Location was coded 0 = city and 1 = other locations. School Type was coded 0 = public and 1 = private independent. * $p < .05$, ** $p < .01$, *** $p < .001$

5. DISCUSSION

This study investigated the student- and school-level factors associated with reading literacy among Saudi Arabian students in PISA 2022. The findings provide a differentiated answer to the two research questions. At the student level, economic, social, and cultural status, gender, and expected occupational status significantly predicted reading literacy, whereas duration in early childhood education, ICT resources and sense of belonging were not significantly predicted reading literacy. ICT resources became statistically significant after the school-level predictors were added in Model 3. At the school level, school type was the only measured characteristic that significantly predicted reading literacy; school location, school size, and perceived shortages of educational materials and staff were not significant. The results therefore indicate that reading literacy in Saudi Arabia is shaped primarily by student-level characteristics within the present model, while also reflecting school-context differences that are not fully captured by the included structural indicators.

5.1 Student-Level Factors Predicting Reading Literacy

Economic, social, and cultural status was the strongest and most stable student-level predictor across the conditional models. Its association with reading literacy remained significant after school characteristics were introduced, indicating that the observed relationship was not explained by differences in school location, size, type, or reported resource shortages. This finding is in line with the ecological framework of the study in which literacy development occurs within the framework of unequal access to economic, social and cultural resources. These resources may support reading through access to texts, language rich interaction, educational guidance and knowledge of institutional expectations. This finding is consistent with long-standing evidence on socioeconomic inequalities in achievement (Coleman et al., 1966; Gustafsson et al., 2018), findings from Turkish PISA 2018 data (Karaman, 2022), and evidence that the home learning environment helps explain the association between family socioeconomic status and children's reading development (Li et al., 2025). The persistence of this association in the Saudi context suggests that schooling does not remove inequalities related to the resources available to students at home.

Also, gender was consistently related to reading literacy scores, where boys had lower adjusted reading literacy scores than girls. This pattern is consistent with international evidence that girls generally do better than boys in reading, although the size of the difference varies across education systems (Reilly et al., 2019; Stoet & Geary, 2013), and with the earlier Saudi PISA 2018 analysis (Alshalawi & Alqurashi, 2022). This association is not to be taken to mean that there is an inherent difference in reading ability. The current data do not directly test potential mechanisms, such as reading engagement, self-concept, preferences, or socialisation. They only suggest that the gender difference remained significant after controlling for the student and school-level variables included in the analysis.

Expected occupational status was positively related to reading literacy and remained significant when school-level variables were entered. This finding supports the interpretation that students' expected occupational futures may reflect educational expectations, perceived opportunities, and the value placed on continued academic learning. This is in line with results from Morocco (Zhang et al., 2024) and North Macedonia (Lameva & Chonteva, 2025) where occupational expectations were also found to be related to reading achievement. However, the cross-sectional design does not prove directionality. Stronger readers may have higher occupational expectations, those expectations may lead to more academic investment, or both may be the product of other unmeasured experiences. Thus, the result is best interpreted as a stable predictive association, rather than as a causal effect.

After the inclusion of the school-level variables, ICT resources at home was a positive, statistically significant predictor in Model 3, while the association was marginally non-significant in Model 2 including student-level predictors. This pattern is model-dependent and needs to be interpreted with caution. Thus, household ICT access provided little independent predictive information beyond its overlap with socioeconomic and cultural status, once school-context variables were accounted for. This finding is consistent with previous Saudi PISA 2018 evidence that ICT-related factors were relevant to reading achievement (Alshalawi & Alqurashi, 2022) and also in line with research that shows relationships between ICT and achievement are different depending on access, purpose, frequency and context (Hu et al., 2018; Ma & Qin, 2021; Martínez-Gautier et al., 2021). Also, evidence of non-linear associations in other settings should remind us that greater access does not mean better outcomes (Gubbels et al., 2020; Goh et al., 2026). Because the PISA index measures availability at home, the present finding concerns access rather than digital competence or educationally productive use.

Duration in early childhood education did not significantly predict reading literacy in either conditional model. This finding does not challenge the broader importance of high-quality early learning (Cunha & Heckman, 2008); rather, it reflects the limits of the measure used here. The PISA indicator captures estimated duration of participation, not program quality, curriculum, language of instruction, or continuity into primary schooling. By age 15, an independent association with duration alone may also be difficult to detect after current family resources, expectations, and other student characteristics are taken into account. Accordingly, the result indicates that duration, as operationalized in PISA 2022, did not add predictive information in this model.

Sense of belonging was positively related to reading literacy at the bivariate level but was not significant in either multilevel model. The loss of significance after adjustment indicates that belonging did not explain unique variation beyond the other included

predictors. This differs from Tan et al. (2022), who reported a direct positive relationship between school belonging and reading literacy, and it provides no direct support here for the broader link between supportive relationships, engagement, and achievement described by Klem and Connell (2004). Belonging may be more closely related to participation, attendance, or well-being than directly to assessment of performance. The result should therefore not be taken to imply that belonging is unimportant to students' school experience; it means only that the index was not an independent predictor of reading literacy in the specified model.

5.2 School-Level Factors Predicting Reading Literacy

Among the school-level predictors measured, only school type remained statistically significant. Once the student and school characteristics in the analysis were taken into account, adjusted reading literacy was higher among students in private independent schools than among students in public schools. This is a sector difference after adjustment, not evidence private schooling causes higher achievement. Differences in school type may indicate differences in governance, admissions, resources, peer composition or instructional practice, none of which was isolated in the analysis. The finding should thus be cautiously interpreted in accordance with comparative research on public and private schools (Sakellariou, 2017), and while acknowledging school sector as a meaningful marker of unequal outcomes in the measured Saudi context.

Reading literacy did not differ significantly by school location compared to the city reference category. This finding is contrary to the findings of the previous Saudi PISA 2018 study (Alshalawi & Alqurashi, 2022) and the Moroccan analysis (Zhang et al., 2024) which found that location was relevant. The contrast may reflect differences across national contexts, PISA cycles, measures or model specifications. Interpretation should also consider the limited representation of rural schools in the present sample. The present evidence, therefore, is unable to support an independent location effect after controlling for student composition and the other school characteristics measured; it does not preclude the possibility that geographical category is absent.

School size was also not a significant predictor. Total enrolment can be indicative of competing organisational processes, as larger schools may provide a broader array of resources and courses, while smaller schools may provide more personalisation. The null result suggests that size alone did not tap into a consistent net association with reading literacy in this sample. Conversely, the significant relationship reported in Morocco (Zhang et al., 2024) shows that broad structural indicators can behave differently across education systems.

Perceived shortages of educational materials and staff were not significantly related to reading literacy. The findings are at odds with studies that connect school resources to achievement and equity (Agasisti et al., 2021; Zuze & Reddy, 2014), but the measures used in PISA assess principals' perceptions, not direct inventories of the quality, allocation, or classroom use of resources. Associations may also be attenuated when constraints are pervasive or when schools compensate with standardised practices. The null coefficients do not mean that resources do not matter; they mean that these two perceived-shortage indices did not independently predict reading literacy in the specified model.

5.3 Theoretical and Practical Implications

The findings point to an ecological and multilevel account of reading literacy, demonstrating that achievement is patterned across nested student and school contexts. The most important predictors were at the student level, but the initial between-school variation, the adjusted school-type difference, and the substantial residual school effect show that school context also matters. At the same time, several theoretically plausible variables failed to have independent associations when we modelled correlated predictors and levels together. The findings thus challenge explanations based on any one student characteristic or school feature and instead support a framework in which the importance of factors depends on their contribution relative to other features of students and schools.

Practically, the persistent linkage of reading literacy with economic, social, and cultural status bolsters efforts to expand literacy-rich opportunities for students with fewer home-based resources. The gender gap suggests the significance of ongoing attention to boys' reading engagement and outcomes, not as a fixed or essential difference. The link to occupational expectations suggests potential value in helping students to link current learning to valid educational and occupational pathways. The ICT finding supports attention to equitable digital access but its modest, model-dependent nature, and the difference between availability and effective use, suggest that provision should be accompanied by purposeful pedagogical integration and support for digital proficiency.

At the school level, the public-private-independent distinction requires an examination of the organisational, compositional, and instructional features that distinguish the sectors. It should guide diagnostic inquiry rather than be regarded as evidence of a causal sector advantage. Similarly, the non-significant effects of location, size and perceived shortages warn against the use of broad structural categories as sufficient explanations of school performance. The residual variation between schools points to the importance of investigating unmeasured variation in student composition, instructional practice, governance, and resource use, although we note that these mechanisms were not tested in the current study.

5.4 Limitations and Future Research

There are some limitations on the scope of interpretation. The cross-sectional observational design permits adjusted associations but not causal conclusions, especially for occupational expectations, ICT resources and type of school. The analysis was also limited by the constructs available in the PISA questionnaires. ICT resources measure availability of household, not competence or quality of use; duration in early childhood education does not measure program quality or content; and shortage indices measure principals' perceptions, not direct resource provision. School type cannot identify the mechanisms of the observed sector difference. In addition, school-location categories were not equally represented and the analysis estimated direct fixed associations but did not test cross-level interactions. Finally, the large residual school-level variation indicates that the measured predictors did not account for all relevant differences among schools.

Future research should employ longitudinal or other stronger designs to elucidate temporal and causal ordering while preserving the multilevel structure of the data. More fine-grained measures may help disentangle ICT access from educational use, early childhood education duration from program quality, and perceived shortages from actual allocation and classroom deployment. The private-independent school association should be examined through measures of admissions, student composition, governance, instructional practice, and resource use. Further work could also investigate the school conditions represented by the residual between-school variation; test theoretically justified cross-level interactions and compare PISA cycles to determine whether differences from the Saudi 2018 findings reflect changing relationships or differences in measurement and model specification.

6. CONCLUSION

Using PISA 2022 data from 6,928 students nested within 193 schools, this study examined student- and school-level factors associated with reading literacy in Saudi Arabia. The null model showed that a meaningful proportion of the variation in reading literacy occurred between schools, supporting the use of a multilevel approach. At the student level, economic, social, and cultural status, gender, and expected occupational status were statistically significant predictors, whereas duration in early childhood education and sense of belonging were not statistically significant. ICT resources were not significant when the student-level predictors were initially examined but became statistically significant after the school-level predictors were added. At the school level, school type was the only statistically significant predictor, with students in private independent schools achieving higher adjusted reading literacy scores than students in public schools. School location, school size, and perceived shortages of educational materials and staff were not statistically significant. Significant between-school variation nevertheless remained after the measured predictors were included. Overall, the findings identify socioeconomic and cultural status, gender, occupational expectations, access to ICT resources at home, and school type as relevant correlates of reading literacy in Saudi Arabia. They further show that the school characteristics we observe do not fully explain school differences and that the relationships we identify are best viewed as predictive associations rather than causal effects.

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