

Araştırma Makalesi / Research Article

A Comparative Analysis of Reading Achievement Across the Turkic World: PIRLS 2021 as a Benchmark for Educational Unity*

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Abstract

This study examines student – and school-level variables affecting the reading achievement of fourth-grade students in the Turkic Republics (Azerbaijan, Kazakhstan, Türkiye, and Uzbekistan) based on Progress in International Reading Literacy Study (PIRLS) 2021 data. Following missing data screening, the final sample comprised 19,997 students nested within 796 schools. Intraclass correlation coefficients (ICC) indicated that between-school achievement variance was highest in Azerbaijan (41%) and lowest in Uzbekistan (16%), warranting the application of Hierarchical Linear Modeling (HLM). The analysis results revealed that, at the student level, socioeconomic status served as the strongest predictor of reading achievement in Türkiye, whereas reading confidence emerged as the primary driver of success in Kazakhstan, Uzbekistan, and Azerbaijan. Moreover, engaging in early literacy activities positively supported achievement across all countries. At the school level, parental

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expectations and parental support contributed substantially to academic performance in Türkiye; however, this positive effect remained weak across the other nations. Furthermore, when controlling for all student – and school-level factors, Uzbekistan and Azerbaijan lagged significantly behind Türkiye in reading performance. Overall, the findings suggest that enhancing reading achievement requires addressing country-specific weaknesses through targeted educational interventions and policy measures tailored to each nation's unique internal dynamics and local conditions.

Keywords

PIRLS 2021, reading achievement, Hierarchical Linear Modeling, educational policies, Turkic Republics.

Türk Dünyasında Okuma Başarısının Ülkeler Arası Analizi: Eğitim Birliği Yolunda PIRLS 2021 Bulguları*

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Öz

Bu çalışma, Uluslararası Okuma Becerilerinde Gelişim Araştırması (PIRLS) 2021 verilerine dayanarak Türk Cumhuriyetleri'ndeki (Azerbaycan, Kazakistan, Türkiye ve Özbekistan) dördüncü sınıf öğrencilerinin okuma başarısını etkileyen öğrenci ve okul düzeyindeki değişkenleri incelemektedir. Eksik verilerin ayıklanmasının ardından, nihai örneklem 796 okul bünyesindeki 19.997 öğrenciden oluşmuştur. Sınıf içi korelasyon katsayıları (ICC), okullar arası başarı varyansının en yüksek Azerbaycan'da (%41), en düşük ise Özbekistan'da (%16) olduğunu göstermiş ve Hiyerarşik Lineer Modelleme (HLM) yönteminin uygulanmasını zorunlu kılmıştır. Analiz sonuçları, öğrenci düzeyinde Türkiye'de okuma başarısının en güçlü yordayıcısının sosyoekonomik düzey olduğunu; Kazakistan, Özbekistan ve Azerbaycan'da ise başarının temel belirleyicisinin okuma konusundaki özgüven olduğunu ortaya koymuştur. Ayrıca, erken okuryazarlık etkinliklerine katılım tüm ülkelerde başarıyı olumlu yönde desteklemiştir. Okul düzeyinde, ebeveyn beklentileri ve ebeveyn desteği Türkiye'de akademik performansla önemli ölçüde katkı sağlamış; ancak bu olumlu etki diğer ülkelerde sınırlı kalmıştır. Dahası, öğrenci ve okul düzeyindeki tüm faktörler kontrol

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edildiğinde, Özbekistan ve Azerbaycan'ın okuma performansı açısından Türkiye'nin önemli ölçüde gerisinde kaldığı görülmüştür. Genel olarak bulgular, okuma başarısını artırmanın; her ülkenin kendine özgü iç dinamiklerine ve yerel koşullarına göre uyarlanmış, hedefe yönelik eğitim müdahaleleri ve politika tedbirleri aracılığıyla ülkeye özgü zayıflıkların ele alınmasını gerektirdiğini ortaya koymaktadır.

Anahtar Kelimeler

PIRLS 2021, okuma başarısı, Hiyerarşik Lineer Modelleme, eğitim politikaları, Türk Cumhuriyetleri.

Introduction

In the modern information society, acquiring reading skills is a paramount educational objective that drives individual cognitive development and societal progress. Consequently, as students transition from “learning to read” to “reading to learn,” systematic monitoring of this progression through national and international assessments constitutes a fundamental requirement for nations. The Progress in International Reading Literacy Study (PIRLS), administered by the IEA, serves as a primary evaluation mechanism, assessing fourth-grade reading performance in five-year cycles. Within this framework, the PIRLS 2021 cycle serves as a unique historical record, capturing the state of reading education in the immediate aftermath of the global pandemic.

The integration of the Turkic world constitutes a foundational strategic objective, formally articulated in the Organization of Turkic States’ (OTS) Turkic World Vision 2040. This document emphasizes “ensuring greater harmonization” of national policies and advancing educational systems to international standards through “innovative learning methods, critical thinking, and the practical application of technology.” Historically, such integration has been anchored in linguistic unity (İpek and Güler 129-58).

To operationalize this educational unity, international large-scale assessments offer essential empirical frameworks. Specifically, the PIRLS 2021 cycle establishes an objective baseline for comparing reading literacy across the Turkic Republics. Analyzing fourth-grade reading achievement within this framework provides the scientific groundwork necessary for formulating macro-educational policies that advance regional integration.

Azerbaijan, Kazakhstan, Uzbekistan, and Türkiye from the Turkic World participated in the 2021 PIRLS study (IEA). The general overview of the educational systems of the participating Turkic Republics, which share a common historical, cultural, and linguistic heritage, is as follows:

Republic of Azerbaijan

The education system of Azerbaijan is structured into preschool education, general education, vocational education, secondary vocational education, and higher education (Elm və Təhsil Nazirliyi). According to the Law of the Republic of Azerbaijan on General Education, the language of instruction

is Azerbaijani, and the levels of general education are organized as follows: preschool (age 5), primary school (grades 1-4), general secondary education (grades 5-9), and full secondary education (grades 10-11).

Republic of Kazakhstan

The education system of the Republic of Kazakhstan is characterized by a distinction between general education and vocational education. It is structured to include preschool education, which begins at age five (1 year mandatory), followed by primary school (grades 1-4, mandatory), middle school (grades 5-9, mandatory), high school (grades 10-11, mandatory), and college (grades 10-12) (Kaplanıran 31-47; Khabubullayeva). Education is provided free of charge to all school-aged students as an obligation of the state (Kaplanıran). Kazakh is the official language of the Republic of Kazakhstan.

Republic of Uzbekistan

Compulsory education lasts for 9 years. It aims to equip them with the skills to compare newly acquired knowledge with previous information. Its official language and language of instruction are Uzbek. The literacy rate in the country is 99%. Primary school ranges from the first grade to the fourth grade. Books and school supplies are provided to all students free of charge (Ergin et al. 70-71).

Republic of Türkiye

In the Republic of Türkiye, the official language and the language of instruction are Turkish. The education system consists of preschool, primary education (primary and middle school), secondary education (high school), and higher education. As of the 2012-2013 academic year, compulsory education was extended to 12 years and divided into three stages: the first stage is 4 years of primary school (grades 1-4), the second stage is 4 years of middle school (grades 5-8), and the third stage is 4 years of secondary education (grades 9-12). Secondary education comprises general, vocational, and technical high schools (MEB).

Conceptual Framework

The IEA defines reading literacy as “the ability to understand and use those written language forms required by society and/or valued by the individual”

(Elley; Mullis et al.; Mullis and Martin). The definition of reading literacy introduced by Elley has preserved its fundamental core within the PIRLS framework documents; the meaning-construction dimension became apparent with the statement “young readers can construct meaning from a variety of texts” (Mullis et al.) in the framework texts by Mullis and colleagues, whereas in subsequent frameworks, the social participation dimension of the reading act was brought to the forefront with the emphasis on “participate in communities of readers” (Mullis and Martin).

As writing is a cultural technology (Ong), reading is acquired within this cultural framework, evolving into a primary source of comprehension. This skill, emerging from the integration of visual, phonological, and semantic systems (Dehaene and Cohen), constitutes the core objective of early schooling (Chapman and Tunmer). By the fourth grade, students are expected to transition from “learning to read” to “reading to learn.” Accordingly, PIRLS targets this developmental juncture to monitor global trends in reading comprehension in five-year cycles (Mullis and Martin).

In PIRLS 2021, reading confidence serves as a critical independent variable. Rooted in Bandura’s self-efficacy framework, Xu and Huang define reading confidence as an individual’s belief in their capability to perform reading tasks, noting that proficient and struggling readers differ substantially along this dimension. This self-confidence directly enhances the motivation to act (Bénabou and Tirole). In turn, heightened motivation increases reading engagement, ultimately accelerating text comprehension levels (Guthrie et al.).

Socioeconomic status (SES) constitutes the primary family-level variable in the PIRLS 2021 study. It remains the most widely utilized contextual predictor in educational research (Şirin). According to Mueller and Parcel, social stratification hierarchically ranks families based on their control over wealth, power, and status, defining this relative position as SES. While they emphasize economic resources, power, and prestige as the core of this multidimensional construct, Şirin indicates that educational level, income, and occupational status are its primary operational components. Specifically, education determines an individual’s knowledge base and social capital; occupational prestige determines social power, and income dictates household resource access. Additionally, home literacy assets, technological

tools, and cultural participation serve as complementary environmental components. Ultimately, family SES and educational investments directly predict reading achievement (Filiz et al. 45). Similarly, utilizing PIRLS data, Chang asserts that reading confidence—directly reinforced by parental expectations—is the strongest variable in the relationship between SES and reading achievement.

In the PIRLS 2021 framework, engagement in reading lessons is a student-level variable reflecting interest, focused attention, and active physical and mental effort. This construct directly links to motivational beliefs, particularly autonomous motivation and perceived self-efficacy. Utilizing latent profile analysis, Maghsoudlou demonstrated that a “General High Motivation” profile yields the highest lesson engagement, emphasizing that self-efficacy alone cannot secure active participation without lesson interest. Conversely, Lopes et al. found among Portuguese students that while engagement significantly predicts achievement, reading confidence is a substantially stronger determinant; furthermore, autonomous readers who enjoy reading demonstrate greater perseverance with challenging texts. Externally, teacher autonomy support—characterized by providing choices, listening to ideas, and clarifying lesson relevance—acts as a critical driver of engagement. In contrast, Kampman et al. observe that low-confidence students often struggle to comprehend instructional guidance, culminating in classroom disengagement. Ultimately, reading engagement functions as a multidimensional variable shaped at the intersection of cognitive capacity, personal valuation of reading, and supportive instructional environments.

In the PIRLS 2021 framework, early literacy operates as a student-level, multidimensional construct blending cognitive, affective, and environmental factors to establish the preschool foundation for primary school reading development (Coşkun and Gökteş; Hood et al.; Lervåg et al.). This construct fundamentally emerges from the interaction between decoding and language comprehension components (Catts et al.; Gillon et al.). Within this framework, decoding is driven by phonological awareness and letter knowledge, which facilitate phoneme manipulation and the alphabetic principle (Gillon et al.; Hood et al.; Lervåg et al.), whereas language comprehension relies on vocabulary and narrative skills critical for subsequent reading success (Burgoyne et al.; Hood et al.). While nurturing

these domains shapes both academic competence and reading motivation (Leino et al.), early literacy remains heavily contingent upon home experiences, where formal activities cultivate encoding skills and informal shared reading enriches vocabulary (Hood et al.; Inoue et al.).

In PIRLS 2021, principals' evaluations of parental expectations significantly indicate a school's academic climate and student achievement. Parental expectations denote parents' realistic beliefs about their children's future academic and occupational success (Jeynes), while parental involvement refers to their participation in the child's educational experiences (Yamamoto and Holloway). These expectations are concrete estimations shaped by the child's abilities and family opportunities (Long and Pang; Solichah and Fardana).

Research typically measures these expectations through parents' predictions of their children attaining at least a bachelor's degree (Chang; Froiland and Davison). Acting as an environmental press, these expectations are internalized by students as academic goals (Liem et al.; Yamamoto and Holloway). Family socioeconomic status (SES) primarily determines these expectations, with high-SES parents holding more ambitious academic goals for their children (Chang). This stems from their rich cultural capital and greater access to learning resources (Chang; Long and Pang). They indirectly boost student achievement through higher expectations and increased home educational materials (Chang; Jeynes). Conversely, resource-lacking low-SES parents risk developing lower expectations, creating a structural barrier to achievement (Davis-Kean; Yamamoto and Holloway).

Another variable evaluated from the perspective of the school principal in the PIRLS 2021 study is parental support. Parental support is associated with parental expectations. Parental support is addressed in terms of the home literacy environment and parental involvement (Solichah and Fardana; Yang et al.). The home literacy environment encompasses the language, reading resources, and practices that children experience in the home environment (Yang et al.). The number of children's books at home, digital tools, and the frequency of library visits constitute reading resources, while activities such as shared reading between parent and child, storytelling, listening to songs, chatting online, and playing games with friends constitute literacy practices (Yang et al.). Parental involvement plays a significant role in

supporting the cognitive and language development of children (Solichah and Fardana). A student's reading self-confidence is also an internalized reflection of the confidence their parents have in them. Parents expecting high achievement from their children and supporting them in this process strengthens the student's perception of their own academic abilities and consequently increases their reading self-confidence (Liem et al.; Yamamoto and Holloway).

Another variable addressed in the study is the school's Ability to Reach Goals. This variable is included in the questionnaires administered to school principals within the scope of PIRLS 2021 and is a variable related to school climate. In PIRLS 2021 studies, this variable is classified under the "School Characteristics" index, which is based on the views of the principals, and it reflects the school's potential to realize its academic goals (Patrinos et al.). The Ability to Reach Goals is part of a holistic construct that, together with teacher motivation, parental support, and student determination, reflects the school's capacity to realize its academic vision and goals (Bhutoria and Aljabri; Patrinos et al.; Wardat et al.). Bhutoria and Aljabri emphasized that school principals' perceptions regarding the "Ability to Reach Goals" are an important administrative indicator that increases school effectiveness.

In synthesis, the current conceptual framework necessitates the establishment of a two-level conceptual model to explain how key predictors operate across levels to shape reading achievement. Within the established model, the student level (Level-1) encompasses socioeconomic status, early literacy, reading confidence, and engagement in reading lessons, which operate as proximal factors directly influencing an individual's reading proficiency. On the other hand, the school level (Level-2) consists of variables evaluated from the principal's perspective (parental expectations, parental support, and the school's ability to reach its goals). These school-level variables function as environmental predictors that construct the broader academic climate in which students operate. Ultimately, this framework reveals a hierarchical structure where school-level contextual factors interact with student-level cognitive and motivational characteristics to determine the ultimate outcome of reading achievement. Examining this two-level model—whose conceptual framework has thus been established—based on PIRLS 2021

data specifically within the context of the Turkic Republics lies precisely at the focus of this research.

The Current Study

All these data essentially necessitate that the PIRLS data, which provide highly reliable information with proven measurement invariance, be handled through an inferential approach that enables a more detailed and cross-country comparison. Therefore, it was decided to conduct this study in order to draw attention to the contextual and methodological gaps in the literature and the harmonization of educational policies emphasized within the framework of the “Turkic World Vision 2040” of the Organization of Turkic States (OTS).

When comparative studies based on international large-scale assessment data (PIRLS, TIMSS, PISA, etc.) are examined, it is observed that they generally focus on the educational systems of OECD countries, Europe, or East Asia (Hopfenbeck et al.; Wei et al.; Wu). On the other hand, it is observed that macro-level studies that consolidate the educational outcomes of the Turkic Republics (Azerbaijan, Kazakhstan, Türkiye, and Uzbekistan)—which share historical, cultural, and linguistic ties and have recently taken historical integration steps such as the “Common Turkic Alphabet”—on a common ground and compare these countries within their own internal dynamics are quite limited.

Methodologically, while existing research frequently relies on single-level regression models, the hierarchical nature of PIRLS data necessitates Multilevel Modeling to accurately partition student – and school-level variance. By addressing these statistical gaps, this study identifies the determinants of reading inequality at the fourth-grade level—a critical developmental threshold for the transition to the “reading to learn” phase—thereby providing empirical scaffolding for educational integration policies across the Turkic Republics. Consequently, utilizing the PIRLS 2021 dataset, this research evaluates the predictive effects of Level-1 factors (socioeconomic status, reading confidence, lesson engagement, and early literacy) and Level-2 factors (parental expectations, school’s ability to reach goals, and parental support) on reading achievement in Azerbaijan,

Kazakhstan, Türkiye, and Uzbekistan. To explore these cross-national structural variations, the following research questions were formulated:

Research Questions

RQ 1. In each of the four countries included in the study, how much of the total variance in fourth-grade students' reading achievement originates from between-school differences (intraclass correlation)?

RQ 2. Are student-level variables (socioeconomic status, reading confidence, engagement in reading lessons, and early literacy) significant predictors of reading achievement in each country, and how are the effect sizes of these predictors distributed across countries?

RQ 3. When student-level predictors are controlled for, do school climate variables based on principals' perceptions (parental expectations, Ability to Reach Goals, and parental support) provide a significant incremental contribution to explaining the variance in reading achievement in each country?

RQ 4. When all student – and school-level variables are controlled for:

- **RQ 4a.** According to the pooled model, with Türkiye as the reference, are there statistically significant main effect differences among the reading achievements of the other countries?
- **RQ 4b.** Do the effects of student – and school-level predictors on reading achievement (cross-level interactions) differ significantly in other countries when Türkiye is taken as the reference?

Method

This research is a secondary data analysis study based on the correlational survey model—one of the quantitative research methods—and encompasses cross-national comparisons. To examine the impact of structural and contextual differences among educational systems on students' overall reading achievement, the study utilized the publicly available 2021 data from the PIRLS conducted by the IEA (Fishbein et al.; IEA).

Participants

The study participants consist of fourth-grade students attending school in Azerbaijan, Kazakhstan, Türkiye, and Uzbekistan who participated in PIRLS 2021. PIRLS collects data using a stratified multistage cluster sampling method; schools are selected as sampling units in the first stage, and classes are selected in the second stage (Almaskut et al.).

The initial dataset encompassed 24,110 students across the four countries. Because missing data patterns satisfied the missing completely at random (MCAR) assumption, listwise deletion was employed, yielding a final sample of 19,997 students (Table 2). To mitigate probability inequalities from the complex sampling design, TOTWGT sampling weights were utilized across all models. These weights were subsequently normalized within each country to ensure equal representation in the combined analyses.

Variables

Seven independent variables derived from the PIRLS 2021 database were utilized, categorized across two levels consistent with the multilevel analytical framework. The dependent variable was represented by five plausible values of overall reading achievement (ASRREA01–ASRREA05). To account for measurement error, analyses were executed separately for each plausible value, and the resulting individual model parameters and standard errors were subsequently pooled using Rubin's combination rules to obtain the final estimates.

At the student level (Level 1), four predictors were incorporated to capture individual and home-background characteristics. These included the Home Socioeconomic Status Scale (ASBHSES), a composite measure of household background, and the Students Confident in Reading Scale (ASBGSCR), which assesses self-perceived competence and reading self-efficacy. Furthermore, students' involvement during instruction was measured through the Students Engaged in Reading Lessons Scale (ASBGERL), while foundational literacy skills acquired prior to formal schooling were represented by the Early Literacy Tasks Scale (ASBHELT).

The school-level (Level 2) predictors were derived from the School Questionnaire (ACBG form) and reflect the institutional environment through the principals' perceptions. These three variables, categorized under

General School Characteristics, include Parental Expectations (ACBG11H), representing the administration's perception of the academic goals set by parents; the school's Ability to Reach Goals (ACBG11K), reflecting its capacity to attain academic objectives; and Parental Support (ACBG11I), which captures the extent of parental cooperation in supporting the school's educational mission.

Data Analysis

Data analysis employed Hierarchical Linear Modeling (HLM), statistically necessitated because the nested structure of students within schools violates the independence assumption of traditional regression (Raudenbush & Bryk). Computations were executed in Python 3 utilizing the Pandas and NumPy libraries (Harris et al.; McKinney; Van Rossum & Drake). To accommodate the complex PIRLS 2021 sampling design, Weighted Least Squares (WLS) estimation with cluster-robust standard errors and TOTWGT sampling weights were applied across all analyses. The dependent variable, reading achievement, comprised five plausible values (PV1–PV5). Models were estimated separately for each plausible value, and the resulting parameter estimates and standard errors were subsequently pooled using Rubin's (1987) rules. Finally, multiple comparisons evaluating cross-country interactions incorporated the Benjamini-Hochberg False Discovery Rate (BH-FDR) correction to mitigate Type I error, reporting both standard p-values and adjusted q-values.

Level 2 variables were transformed using a $6 - x$ formula because the original PIRLS coding represented negative conditions with higher values (1 = *Very High*, 5 = *Very Low*). Following recoding, higher values represent favorable school conditions. Level 1 variables were entered as raw scores, while Level 2 variables were grand-mean centered (GMC). To evaluate the magnitude of the coefficients, standardized regression coefficients (β^*) were calculated. The β^* values were obtained by multiplying the unstandardized coefficient by the weighted standard deviation of the relevant predictor and dividing by the weighted standard deviation of the dependent variable:

$$\beta^* = B \times \frac{SD_X}{SD_Y}$$

Explained variance ratios were calculated using Raudenbush and Bryk's Proportional Reduction in Variance (PRV) formula alongside Snijders and Bosker's R^2 measures. To address the research questions, five HLM models were constructed. First, a null model (Model 0) containing no predictors was established to determine the level of between-school variance in reading achievement. Subsequently, a Random Intercept Model (Model 1), including only Level 1 predictors, was estimated separately for each of the four countries to examine the effects of student and family-level variables on reading achievement. Following this, an Intercept-as-Outcomes Model (Model 2) was constructed separately for the four countries to reveal the contribution of school-level variables to reading achievement when student-level variables were controlled. A Pooled Random Intercept Model (Model 3) was then developed, combining the four countries into a single analysis to estimate the joint effects of all student and school-level variables and to control for structural score differences between countries. Finally, a Cross-Level Interaction Model (Model 4) was established to test whether the effects of Level 1 and Level 2 variables on reading achievement significantly differ among the four countries.

Results

Initially, the multicollinearity among the predictor variables was investigated to ensure the stability of the coefficient estimates and the reliability of the statistical inferences obtained through the HLM framework. High correlation between independent variables in regression models can lead to inflated standard errors and instability in parameter estimates. To evaluate these risks, the Variance Inflation Factor (VIF) and Condition Number (CN) statistics were computed for both student-level (L1) and school-level (L2) variables.

Table 1
Multicollinearity Analysis: VIF and CN

Panel A. VIF						
Variables	Pooled	AZ	KZ	TR	UZ	Level
Socioeconomic Status	1.053	1.059	1.043	1.158	1.019	L1
Reading Confidence	1.071	1.082	1.107	1.074	1.058	L1
Engagement in Lessons	1.057	1.051	1.085	1.056	1.040	L1
Early Literacy	1.050	1.064	1.057	1.035	1.027	L1
Parental Expectations	1.581	1.305	1.577	1.697	1.858	L2
Ability to Reach Goals	1.688	1.423	1.645	2.115	1.461	L2
Parental Support	1.913	1.332	1.992	2.493	2.018	L2
Panel B. CN						
Model			CN			
L1			2.34			
L2			2.47			
L1+L2			5.18			

Note: VIF = Variance Inflation Factor; CN = Condition Number; Pooled = four countries combined; AZ = Azerbaijan, KZ = Kazakhstan, TR = Türkiye, UZ = Uzbekistan. Level 1 variables were entered as raw scores, while Level 2 variables were grand-mean centered (GMC).

Multicollinearity Results and Model Selection

To evaluate multicollinearity, VIF and CN diagnostics were calculated (Table 1). Level 1 (L1) VIF values range from 1.02 to 1.16, while Level 2 (L2) values range from 1.30 to 2.49. Although L2 values reflect expected moderate correlations among school questionnaire (ACBG) variables, they remain well below thresholds that distort coefficient estimates. This is supported by matrix condition numbers (CN = 2.34 for L1; CN = 2.47 for L2; CN = 5.18 combined), which are far below the critical threshold of 30. Thus, multicollinearity does not jeopardize model inferences. Subsequently,

a null model was executed to address the first research question and establish the necessity of HLM (Table 2).

Table 2
Model 0: Null Model — Variance Components and Descriptive Statistics

Country	N	J	ICC	τ_{00}	σ^2	Mean
Azerbaijan	3.314	166	0.413	3149.8	4479.4	448.1
Kazakhstan	6.164	260	0.253	1397.5	4124.4	507.5
Türkiye	5.339	192	0.260	1915.4	5461.4	499.2
Uzbekistan	5.180	178	0.161	1088.0	5679.2	439.5
Pooled	19.997	796	0.141	1083.9	6622.8	477.8

Note: ICC = intraclass correlation coefficient; τ_{00} = between-school variance component; σ^2 = within-school variance component; Mean = weighted mean of five plausible values (PV1–PV5); J = number of schools. All values were calculated using TOTWGT sampling weights and Rubin’s pooling.

The intraclass correlation coefficients (ICCs) presented in Table 2 reveal that a substantial portion of variance in student reading scores originates from between-school differences. School effects are most pronounced in Azerbaijan (ICC = .413), followed by Türkiye (ICC = .260), Kazakhstan (ICC = .253), and Uzbekistan (ICC = .161). Given these substantial ICCs, employing a hierarchical linear modeling (HLM) approach is statistically imperative (Raudenbush and Bryk). In contrast, the pooled model yields a lower ICC (.141) because the total variance expands to encompass cross-country achievement differentials.

To address the second research question, a Random Intercept Model was executed to determine whether individual and family-level variables—socioeconomic status, reading confidence, engagement in reading lessons, and early literacy—significantly predict reading achievement, and to evaluate the cross-country distribution of their effect sizes (Table 3).

Table 3
Model 1: Random Intercept Model—Level 1 Variables Only

	TR			AZ			KZ			UZ		
Parameter	<i>B</i>	<i>SE</i>	β^*	<i>B</i>	<i>SE</i>	β^*	<i>B</i>	<i>SE</i>	β^*	<i>B</i>	<i>SE</i>	β^*
Intercept	506.78	2.77	—	452.71	4.69	—	505.42	2.96	—	434.34	3.02	—
SES	18.04***	1.00	0.433	8.37**	1.82	0.157	5.21*	1.34	0.087	7.47**	1.35	0.133
Reading Confidence	13.16***	0.84	0.275	10.10**	1.15	0.236	9.64***	0.59	0.276	10.68***	0.86	0.281
Engagement in Lessons	3.82**	0.88	0.090	3.92*	0.99	0.101	-0.17	0.75	-0.005	3.46**	0.82	0.097
Early Literacy	3.26**	0.71	0.110	6.13**	1.24	0.156	2.73*	0.71	0.075	5.49**	0.89	0.122
τ_{00}	888.7			2042.1			1334.7			1007.4		
σ^2	5474.0			6696.8			4965.6			5728.3		
<i>ICC</i>	0.140			0.234			0.212			0.150		
<i>PRV</i> (τ_{00})	53.6%			35.2%			4.5%			7.4%		
<i>N</i>	5.339			3.314			6.164			5.180		
<i>J</i>	192			166			260			178		

Note: *B* = unstandardized regression coefficient; *SE* = cluster-robust standard error; β^* = standardized coefficient $B \times (SD_{X_{original}} / SD_{Y_{weighted}})$; *PRV*(τ_{00}) = proportional reduction in between-school variance relative to the null model ($\tau_{00_null} - \tau_{00_M1}$) / τ_{00_null} (Raudenbush and Bryk). Level 1 variables were entered as raw scores. Significance was determined based on Benjamini-Hochberg FDR adjusted *q*-values. * *q* < .05. ** *q* < .01. *** *q* < .001.

SES emerges as the strongest Level 1 predictor of the study in Türkiye. A one-unit increase on the original SES scale corresponds to an average reading gain of 18.04 points in Türkiye; expressed in standard deviation units, this denotes a .43 SD increase ($\beta^* = .43$). According to Cohen’s effect size guidelines, this constitutes a large effect. Conversely, the effect of SES is markedly weaker in the other three countries. A one-unit increase in SES corresponds to an 8.37-point gain in Azerbaijan ($\beta^* = .16$, moderate effect),

a 7.47-point gain in Uzbekistan ($\beta^* = .13$, small effect), and a 5.21-point gain in Kazakhstan ($\beta^* = .09$, small effect).

Reading confidence stands as the strongest predictor in the three countries excluding Türkiye. A one-unit increase in reading confidence yields a gain of 10.68 points in Uzbekistan ($\beta^* = .28$), 9.64 points in Kazakhstan ($\beta^* = .28$), and 10.10 points in Azerbaijan ($\beta^* = .24$). In Türkiye, reading confidence is the second strongest statistically significant predictor, following SES ($B = 13.16$, $\beta^* = .28$). Engagement in reading lessons was not found to be a significant predictor in Kazakhstan ($B = -0.17$, $\beta^* = -.01$); however, small but significant effects were observed in the remaining three countries ($\beta^* = .09-.10$). Early literacy activities emerged as significant predictors across all countries, with the highest effect size occurring in Azerbaijan ($B = 6.13$, $\beta^* = .16$). This finding suggests that preschool literacy experiences assume a relatively decisive role in reading achievement within this specific country.

Regarding the proportion of explained variance, Level 1 predictors reduced the between-school variance (τ_{00}) by 53.6% in Türkiye; this indicates that individual characteristics and academic attitudes account for more than half of the school effect in Türkiye. In Azerbaijan, Level 1 variables reduced τ_{00} by 35.2%. This reduction remains notably limited in Kazakhstan (4.5%) and Uzbekistan (7.4%), suggesting that between-school differences in these respective countries predominantly stem from unmeasured school-level factors.

To address the third research question, an Intercept-as-Outcomes Model was executed to determine whether principal-perceived school-level variables—parental expectations, ability to reach goals, and parental support—explain incremental variance in reading achievement across countries once student-level predictors are controlled (Table 4).

Table 4
Model 2: Intercept-as-Outcomes Model — Level 1 + Level 2 Variables

	TR			AZ			KZ			UZ		
Parameter	<i>B</i>	<i>SE</i>	β^*	<i>B</i>	<i>SE</i>	β^*	<i>B</i>	<i>SE</i>	β^*	<i>B</i>	<i>SE</i>	β^*
Intercept	513.75	2.67	—	452.13	5.13	—	506.52	3.35	—	433.59	3.14	—
L1 — Student Level												
SES	13.39***	0.97	0.321	8.14*	1.78	0.153	4.99*	1.27	0.083	7.31**	1.34	0.130
Reading Confidence	13.93***	0.80	0.291	9.94**	1.13	0.232	9.68***	0.60	0.277	10.56***	0.85	0.278
Engagement in Lessons	3.89**	0.76	0.092	4.01*	1.00	0.103	-0.03	0.73	-0.001	3.40**	0.82	0.096
Early Literacy	2.45*	0.63	0.083	6.12*	1.28	0.156	2.72*	0.73	0.074	5.42**	0.86	0.120
L2 — School Level												
Parental Expectations	12.95*	3.34	0.157	12.46	6.81	0.115	-6.16	5.20	-0.057	2.80	5.38	0.022
Ability to Reach Goals	-2.84	4.56	-0.026	-4.23	7.47	-0.034	10.01	6.60	0.081	6.24	5.33	0.045
Parental Support	13.15*	3.14	0.162	-9.45	5.22	-0.091	-4.77	6.10	-0.047	-0.35	4.91	-0.003
τ_{00}	616.2			1995.4			1352.1			986.3		
σ^2	5033.9			6614.3			4935.1			5709.8		
<i>ICC</i>	0.109			0.232			0.215			0.147		
Total PRV	67.8%			36.7%			3.3%			9.3%		
Additional L2 PRV	14.2%			1.5%			0%			1.9%		
<i>N</i>	5.339			3.314			6.164			5.180		
<i>J</i>	192			166			260			178		

Note: Total PRV = total reduction in between-school variance relative to the null model; Additional L2 PRV = additional contribution of Level 2 variables compared to Model 1 $[(\tau_{00_M1} - \tau_{00_M2}) / \tau_{00_null}]$. Negative PRV values were set to zero (KZ Additional L2 PRV = -1.2%). Level 2 variables were centered using grand-mean centering (GMC). * $q < .05$. ** $q < .01$. *** $q < .001$. (Benjamini-Hochberg FDR adjustment).

Addressing the third research question, variables representing school climate (parental expectations, Ability to Reach Goals, and parental support) were incorporated into the Level-2 model (Table 4). The inclusion of these L2 variables revealed striking cross-national divergences. In Türkiye, L2 variables reduced between-school variance by 67.8% relative to the null model, providing an additional 14.2% reduction over Model 1. This incremental explanatory power is driven by two primary predictors: parental expectations ($B = 12.95, \beta^* = .157$), suggesting that administration-perceived high expectations increase achievement by approximately .16 SD, and parental support, which exerts a comparable effect ($B = 13.15, \beta^* = .162$). Notably, the “Ability to Reach Goals” construct failed to emerge as a significant predictor across all examined nations.

Conversely, the incremental contribution of L2 variables in Azerbaijan (Additional L2 PRV = 1.5%), Kazakhstan (0.0%), and Uzbekistan (1.9%) was practically negligible. None of these L2 predictors surpassed the significance threshold following BH-FDR correction, with β^* values ranging from $-.09$ to $.12$. This indicates that the measured school climate effects are either context-specific to Türkiye or operate through alternative mechanisms in the other nations.

To address research question RQ4a, a Pooled Random Intercept Model was executed to examine main effect differences in reading achievement across the remaining countries, controlling for all student – and school-level variables with Türkiye as the reference country (Table 5).

Table 5
Model 3: Pooled Random Intercept Model — Level 1 + Level 2 + Country
Fixed Effects (Reference Country: Türkiye)

Parameter	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	η^2 (BH)	β^*	95% CI
Intercept	508.68	2.84	179.12	<.001	—	—	[503.1, 514.2]
Country Differences (Reference: Türkiye)							
AZ–TR	-52.18***	5.07	-10.28	<.001	<.001	—	[-62.1, – 42.2]
KZ–TR	-6.30	4.17	-1.51	0.197	0.247	—	[-14.5, 1.9]
UZ–TR	-73.11***	3.46	-21.11	<.001	<.001	—	[-79.9, – 66.3]
L1 — Student Level							
SES	10.47***	0.64	16.32	<.001	<.001	0.198	[9.2, 11.7]
Reading Confidence	10.71***	0.42	25.61	<.001	<.001	0.248	[9.9, 11.5]
Engagement in Lessons	2.63**	0.41	6.43	<.001	0.001	0.066	[1.8, 3.4]
Early Literacy	3.84**	0.43	8.95	<.001	0.001	0.109	[3.0, 4.7]
L2 — School Level							
Parental Expectations	7.80	2.59	3.01	0.037	0.053	0.073	[2.7, 12.9]
Ability to Reach Goals	2.70	3.01	0.90	0.420	0.448	0.021	[-3.2, 8.6]
Parental Support	2.04	2.44	0.84	0.448	0.448	0.022	[-2.7, 6.8]
τ_{00}				695.4			
σ^2				5618.4			
<i>ICC</i>				0.110			
<i>S&B R</i> ² ₁				15.2%			
<i>S&B R</i> ² ₂				34%			
<i>N</i>				19.997			
<i>J</i>				796			

Note: $\beta^* = B \times (SD_{X_global} / SD_{Y_global})$; β^* was not calculated for country dummy coefficients. *CI* = confidence interval ($\pm 1.96 SE$). Snijders & Bosker R^2_1 = variance explained at the student level; Snijders & Bosker R^2_2 = variance explained at the school level (Snijders and Bosker). * $q < .05$. ** $q < .01$. *** $q < .001$ (Benjamini-Hochberg FDR adjustment).

Addressing the fourth research question (RQ4a), a pooled model incorporating all four nations was executed (Table 5). Country-level differences were controlled via dummy variables with Türkiye as the reference category, yielding joint estimates for Level 1 (L1) and Level 2 (L2) coefficients.

Holding all student and school variables constant, Azerbaijan and Uzbekistan scored significantly lower than Türkiye by 52.18 and 73.11 points, respectively ($q < .001$). These substantial disparities highlight persistent systemic cross-national variations that transcend individual characteristics and measured school factors. No statistically significant difference emerged between Kazakhstan and Türkiye ($B = -6.30, q = .247$).

At the student level, reading confidence constitutes the strongest predictor ($B = 10.71, \beta^* = .248$), followed by SES ($B = 10.47, \beta^* = .198$). Early literacy ($B = 3.84, \beta^* = .109$) and lesson engagement ($B = 2.63, \beta^* = .066$) demonstrated small but significant positive effects. At the school level, no variables—including parental expectations ($q = .053$)—surpassed the BH-FDR significance threshold. Overall, the pooled model explains 15.2% of student-level (R^2_1) and 34.0% of school-level (R^2_2) variance (Snijders & Bosker).

The research question denoted as RQ4b aims to determine whether the effects of L1 and L2 predictors on reading achievement (cross-level interactions) differ significantly across the other countries when all student – and school-level variables are controlled for and Türkiye is treated as the reference country. Accordingly, the constructed Cross-Level Interaction Model was executed, and the results are presented in Table 6.

Table 6
Model 4: Cross-Level Interaction Model — L1/L2 $\times$ Country (Reference Country: Türkiye)

Parameter	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	<i>q</i> (BH)	β^*	95% CI
Intercept	513.75	2.66	192.80	<.001	—	—	[508.5, 519.0]
Country Differences (Reference: Türkiye)							
AZ–TR	-61.61***	5.62	-10.95	<.001	—	—	[-72.6, -50.6]
KZ–TR	-7.23	4.07	-1.78	0.139	—	—	[-15.2, 0.8]
UZ–TR	-80.15***	3.55	-22.59	<.001	—	—	[-87.1, -73.2]

L1 — Main Effects (Türkiye)							
SES	13.39***	0.96	13.88	<.001	<.001	0.254	[11.5, 15.3]
Reading Confidence	13.93***	0.80	17.34	<.001	<.001	0.323	[12.4, 15.5]
Engagement in Lessons	3.89*	0.76	5.15	0.003	0.026	0.097	[2.4, 5.4]
Early Literacy	2.45*	0.63	3.90	0.011	0.042	0.070	[1.2, 3.7]
L2 — Main Effects (Türkiye)							
Parental Expectations	12.95*	3.34	3.88	0.016	0.044	0.121	[6.4, 19.5]
Ability to Reach Goals	-2.84	4.55	-0.62	0.563	0.686	-0.022	[-11.8, 6.1]
Parental Support	13.15*	3.14	4.19	0.012	0.042	0.141	[7.0, 19.3]
SES × Country Interactions							
SES×AZ	-5.25	2.01	-2.61	0.047	0.083	—	[-9.2, -1.3]
SES×KZ	-8.39*	1.48	-5.65	0.004	0.026	—	[-11.3, -5.5]
SES×UZ	-6.08*	1.69	-3.59	0.012	0.042	—	[-9.4, -2.8]
Reading Confidence × Country							
Confidence×AZ	-3.99	1.36	-2.92	0.035	0.071	—	[-6.7, -1.3]
Confidence×KZ	-4.25*	1.02	-4.17	0.005	0.026	—	[-6.2, -2.3]
Confidence×UZ	-3.37	1.18	-2.85	0.031	0.071	—	[-5.7, -1.1]
Engagement in Lessons × Country							
Engagement×AZ	0.12	1.34	0.09	0.931	0.949	—	[-2.5, 2.8]
Engagement×KZ	-3.92*	1.05	-3.72	0.016	0.044	—	[-6.0, -1.9]
Engagement×UZ	-0.49	1.14	-0.43	0.687	0.802	—	[-2.7, 1.8]
Early Literacy × Country							
E. Lit×AZ	3.67	1.41	2.60	0.046	0.083	—	[0.9, 6.4]
E. Lit×KZ	0.26	0.92	0.28	0.788	0.882	—	[-1.5, 2.1]
E. Lit×UZ	2.96	1.12	2.64	0.052	0.086	—	[0.8, 5.2]

Parental Expectations × Country							
Expectations×AZ	-0.49	7.31	-0.07	0.949	0.949	—	[-14.8, 13.8]
Expectations×KZ	-19.11	6.19	-3.09	0.033	0.071	—	[-31.2, -7.0]
Expectations×UZ	-10.15	6.51	-1.56	0.190	0.253	—	[-22.9, 2.6]
Ability to Reach Goals × Country							
Goals×AZ	-1.39	8.28	-0.17	0.875	0.942	—	[-17.6, 14.8]
Goals×KZ	12.85	8.07	1.59	0.183	0.253	—	[-3.0, 28.7]
Goals×UZ	9.08	7.31	1.24	0.277	0.353	—	[-5.2, 23.4]
Parental Support × Country							
Support×AZ	-22.61*	6.11	-3.70	0.018	0.046	—	[-34.6, -10.6]
Support×KZ	-17.93	6.76	-2.65	0.056	0.087	—	[-31.2, -4.7]
Support×UZ	-13.50	5.78	-2.34	0.077	0.114	—	[-24.8, -2.2]
τ_{00}	629.2						
σ^2	5440.4						
ICC	0.104						
N	19.997						
J	796						

Note: A negative interaction coefficient indicates that the slope in the respective country is lower compared to Türkiye. Main effects represent Türkiye (the reference group). * $q < .05$. ** $q < .01$. *** $q < .001$. (BH-FDR adjustment; $k = 28$).

The fourth model incorporates cross-level interaction terms and examines whether the effects of L1/L2 variables vary across countries (Table 6). Following the BH-FDR adjustment ($k = 28$ tests), five interaction terms were found to be significant. In the context of SES × country interactions, the effect of SES is strongest in Türkiye ($B = 13.39, \beta^* = .25$). In Kazakhstan, the SES effect is 8.39 points lower compared to Türkiye ($B_{interaction} = -8.39, q < .05$); that is, a one-unit increase in SES in Kazakhstan yields an additional gain of only about 5.0 points ($13.39 - 8.39 = 5.00$). Similarly, the effect of

SES is 6.08 points weaker in Uzbekistan ($q < .05$). These findings corroborate that the reflection of socioeconomic disparities on reading achievement is most pronounced in Türkiye.

An examination of the reading confidence $\times$ country interactions reveals that the effect in Türkiye ($B = 13.93, \beta^* = .32$) is 4.25 points lower in Kazakhstan ($B_{interaction} = -4.25, q < .05$); the net effect of this variable in Kazakhstan is estimated to be approximately 9.68 points ($13.93 - 4.25 = 9.68$). The engagement in lessons $\times$ Kazakhstan interaction was also found to be significant ($B = -3.92, q < .05$), indicating that the contribution of engagement in lessons to reading achievement in Kazakhstan diverges notably from that in Türkiye. Among the school-level interactions, the parental support $\times$ Azerbaijan interaction stands out ($B = -22.61, q < .05$): while parental support exhibits a strong positive effect in Türkiye ($B_{main} = 13.15$), this effect is 22.61 points lower in Azerbaijan; consequently, the net effect of parental support emerges in a negative direction in Azerbaijan ($13.15 - 22.61 = -9.46$). This inconsistent pattern may reflect that parental involvement manifests differently depending on the cultural context.

Discussion

Based on PIRLS 2021 data, this study utilized HLM to examine the student – and school-level predictors of fourth-grade reading achievement in Azerbaijan, Kazakhstan, Türkiye, and Uzbekistan. Five hierarchical linear models provided country-specific and comparative insights, revealing that these factors vary significantly across nations, offering critical implications for educational policy.

Regarding the first research question, the null model showed that a substantial proportion of reading achievement variance originates from between-school differences. Notably, school differences account for 41% of the variance in Azerbaijan and roughly one-quarter in Türkiye and Kazakhstan, indicating a pronounced stratification in resource distribution and student composition. Conversely, Uzbekistan's lower between-school variance reflects intra-system homogeneity, which, given its low PIRLS average, represents homogeneous low performance rather than high equity. Ultimately, statistically significant Intraclass Correlation Coefficient (ICC) values across all four nations confirm that student-level variables alone cannot explain achievement, validating multilevel modeling as a methodological necessity (Raudenbush and Bryk 21-22).

Addressing the second research question, student – and family-level (L1) findings reveal that the impact of socioeconomic status (SES) varies heavily by country context. While SES is a universally recognized academic determinant (Bradley and Corwyn; Şirin), it emerged as the strongest predictor in Türkiye ($\beta^* = .43$), explaining 53.6% of its between-school variance. This underscores that reading success in Türkiye heavily depends on family background, reflecting distinct socioeconomic stratification across schools. Conversely, L1 variables explained far less between-school variance in Kazakhstan (4.5%) and Uzbekistan (7.4%), where the direct effects of SES were also considerably weaker ($\beta^* = .09$ and $\beta^* = .13$, respectively). As Park and Yigiter note, macro-level economic structures and policies differentiate how family background translates into achievement, rendering the SES advantage far less decisive in the other three nations than in Türkiye.

Significantly, the strongest predictor of achievement in the three countries excluding Türkiye is not SES, but reading confidence. Yielding the highest predictive power ($\beta^* = .24$ to $.28$) in these nations, this construct aligns with literature (Bénabou and Tirole; Kampman et al.) demonstrating that self-efficacy directly predicts reading skills by bolstering intrinsic motivation. Consequently, high reading confidence may function as a compensatory mechanism for socioeconomic disadvantages. Furthermore, early literacy activities positively predict achievement across all countries —peaking in Azerbaijan ($\beta^* = .16$)— corroborating the decisive impact of rich preschool home literacy environments on subsequent reading proficiency (Inoue et al.; Lervåg et al.). Finally, the small but significant positive effect of lesson engagement in all countries except Kazakhstan remains consistent with findings (Maghsoudlou) highlighting its supportive role in reading performance.

The inclusion of school-level variables into the model, in accordance with the third research question of this study, demonstrates that the effects of school climate factors—based on school principals’ perceptions—diverge notably across the countries. In the Türkiye sample, it was determined that the variables of “parental expectations” and “parental support” positively and significantly predict reading achievement, providing a robust additional contribution of 14.2% to the model in explaining between-school variance. This finding, specific to the context of Türkiye, aligns with contemporary research indicating that the emphasis a school places on academic achievement

(including parental involvement and expectations) directly enhances student performance. Indeed, Turan asserts that the positive climate fostered by schools in Türkiye through high academic expectations and parental support directly contributes to reading achievement. Furthermore, international literature indicating that parents' high expectations shape children's educational goals (Lazarides et al.), intrinsic motivation, and academic functioning (Liem et al.; Long and Pang) supports this finding specific to Türkiye.

Conversely, it is highly noteworthy that in Azerbaijan (1.5%), Uzbekistan (1.9%), and Kazakhstan (0.0%), Level 2 variables remained at a practically negligible level in explaining between-school variance, and no school-level predictor yielded a significant effect. This divergence aligns with literature (Yamamoto and Holloway) asserting that the translation of school climate and parental expectations into academic achievement does not operate as a universal mechanism; rather, it can yield differing outcomes depending on local and sociocultural contexts. Within the literature, it is well-established that parental expectations serve as a fundamental mediating variable dictating families' involvement in their children's literacy processes (Solichah and Fardana). It appears, however, that this robust individual involvement mechanism fails to permeate the macro-level achievement climate perceived by school principals or the students' in-school reading performance in the three aforementioned countries. Consequently, the fact that the measured school climate variables serve as strong predictors within the context of Türkiye while remaining non-significant in the other Turkic Republics indicates that the school-family collaboration mechanisms and educational ecosystems in these countries operate under vastly different sociological dynamics.

The findings of the pooled model (Model 3) combining the four countries in line with the fourth research question (RQ4a) indicate that systemic differences in reading achievement across countries persist even when all student – and school-level variables are controlled for. When Türkiye is treated as the reference, no significant difference was found with Kazakhstan, whereas Uzbekistan (73.11 points) and Azerbaijan (52.18 points) were determined to lag behind at a statistically significant level. In particular, Azerbaijan's lagging behind Türkiye and the high between-school inequalities in this country can be explained by macro-level educational policies. Guliyeva notes that although the Azerbaijani educational system

entered a substantial modernization and digitalization process post-1991, regional inequalities and low-income families remain among the fundamental issues of Azerbaijan's educational policy. Consequently, this outcome can be evaluated as a reflection of the fact that regional equality of opportunity in education has not yet been fully achieved.

The fact that “reading confidence” ($\beta^* = .25$) is the strongest predictor of reading achievement across the pooled model encompassing all countries aligns with the literature emphasizing that children's internal beliefs regarding their academic abilities serve as the greatest driving force behind achievement (Bénabou and Tirole; Kampman et al.). Indeed, reading confidence and perceived self-efficacy constitute a fundamental mechanism that directly influences learning potential, even surpassing the family's socioeconomic status (Mudrák et al.). The observation that socioeconomic status (SES) ($\beta^* = .20$) is the second most explanatory factor for achievement following confidence once again demonstrates the profound and universal impact of the family's economic and cultural capital on academic achievement (Bradley and Corwyn; Şirin). Furthermore, the noteworthy contribution of early literacy activities and engagement in lessons to achievement corroborates the enduring importance of a literacy environment provided at home during the preschool period on subsequent reading skills (Inoue et al.; Lervåg et al.). Finally, although parental expectations are theoretically considered a supportive element within the school climate (Lazarides et al.), this variable failed to achieve statistical significance in the pooled model ($q = .053$), demonstrating that its impact is not universal.

Addressing RQ4b, the Cross-Level Interaction Model reveals that individual – and school-level predictors of reading achievement vary significantly across sociocultural and structural contexts. The positive student-level (L1) effect of SES is strongest in Türkiye ($\beta^* = .25$), whereas it is significantly attenuated in Kazakhstan and Uzbekistan by – 8.39 and – 6.08 points, respectively. This demonstrates that while SES remains a critical academic determinant (Şirin), its impact is modulated by macro-level educational policies and economic structures (Park; Yigiter), rendering reading achievement in Türkiye uniquely sensitive to socioeconomic inequalities. Similarly, the diminished contribution of reading confidence in Kazakhstan (–4.25 points) and the variation in lesson engagement highlight that local educational dynamics dictate how affective and motivational factors

translate into achievement. While self-efficacy universally fosters motivation (Bénabou and Tirole; Kampman et al.), its manifestation in actual reading performance remains strictly context-dependent.

Examining Level 2 interactions reveals a striking divergence: while parental support strongly enhances reading achievement in Türkiye, it exhibits an inverse trend in Azerbaijan, yielding a negative net effect (-9.45 points). Although literature generally posits parental involvement and expectations as positive academic catalysts, Jeynes notes that their impact is not universal, varying significantly across sociocultural contexts (Yamamoto and Holloway). Consequently, this negative effect demonstrates that parental involvement manifests differently across cultural codes, and such attitudes may not universally foster positive psychosocial adjustment or academic functioning (Liem et al.; Solichah and Fardana).

Limitations

Several limitations warrant consideration. First, utilizing the cross-sectional PIRLS 2021 dataset restricts findings to predictive and correlational patterns rather than definitive causal relationships. Second, independent variables are constrained to standard IEA indices, precluding the inclusion of macro-level, country-specific cultural or educational policy factors. Finally, analyses are restricted to a two-level HLM framework (student and school). Because the four-country sample ($N = 4$) is statistically insufficient to establish a third country level, structural cross-national differences were exclusively controlled via the pooled model.

Conclusion

Evaluating these findings leads to the primary conclusion that educational policies to enhance reading achievement must align with each country's unique conditions, needs, and priorities. In Türkiye, SES inequalities present the greatest barrier, making achievement heavily dependent on family economic capital and necessitating urgent, structural resource allocations to disadvantaged schools to ensure equity. Conversely, in Kazakhstan, Uzbekistan, and Azerbaijan, student reading confidence—rather than family SES—acts as the primary driver of success, suggesting that interventions should focus on fostering intrinsic motivation and self-efficacy. Crucially, the negative impact of parental support in Azerbaijan represents a highly novel finding, demonstrating

that poorly structured parental involvement can induce academic pressure and anxiety rather than benefits. Finally, even when controlling for student – and school-level variables, Uzbekistan and Azerbaijan trail Türkiye significantly. This disparity underscores that resolving reading challenges in these nations requires deep-rooted macro reforms in curriculum, teacher quality, and educational infrastructure rather than micro-interventions.

The study revealed that a significant portion of the variance in reading achievement stems from differences between schools. Therefore, policies should be developed in Azerbaijan, Türkiye and Kazakhstan to reduce inequalities in the distribution of infrastructure resources and to mitigate stratification between schools; meanwhile, in Uzbekistan—where both inter-school variance and overall achievement are low—the general level of achievement should be raised through comprehensive reforms addressing curriculum, teacher quality, and educational infrastructure. The fact that socioeconomic status is the strongest predictor of reading achievement in Türkiye necessitates the development of remedial programs and support materials for students from low socioeconomic backgrounds, as well as the formulation of policies to reduce the concentration of such students in specific schools.

AI Usage Statement

In this study, the author(s) used the Gemini 3.1 Pro tool to translate the text, perform language editing, and improve the text's language and readability by enhancing its flow. Following the use of this tool/service, the author(s) reviewed the content, made necessary adjustments, and assumed full responsibility for the content of the publication.

Author Contributions

Prof. Dr. Bilginer Onan (40%): Conceptualization, Literature Review, Methodology, Theoretical Framework, Discussion, and Conclusion.

Prof. Dr. Hasan Kağan Keskin (30%): Methodology, Formal Analysis, and Interpretation of Results.

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Conflict of Interest Statement

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References

- Almaskut, Ahmed, et al. "Sample Design in Pirls 2021." *Methods and Procedures: Pirls 2021 Technical Report*, ed. Matthias von Davier et al., TIMSS & PIRLS International Study Center, 2023, pp. 3.1-3.32.
- Bandura, Albert. "Self-Efficacy: Toward a Unifying Theory of Behavioral Change." *Psychological Review*, vol. 84, no. 2, 1977, pp. 191-215, doi:10.1037/0033-295X.84.2.191.
- Bénabou, Roland, and Jean Tirole. "Self-Confidence and Personal Motivation." *The Quarterly Journal of Economics*, vol. 117, no. 3, 2002, pp. 871-915, doi:10.1162/003.355.302760193913.
- Benjamini, Yoav, and Yosef Hochberg. "Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing." *Journal of the Royal Statistical Society: Series B (Methodological)*, vol. 57, no. 1, 1995, pp. 289-300, doi:10.1111/j.2517-6161.1995.tb02031.x.
- Bhutoria, Aditi, and Nayyaf Aljabri. "Managerial Practices and School Efficiency: A Data Envelopment Analysis across Oecd and Mena Countries Using Timss 2019 Data." *Large-scale Assessments in Education*, vol. 10, no. 1, 2022, p. 24, doi:10.1186/s40536.022.00147-3.
- Bradley, Robert. H., and Robert F. Corwyn. "Socioeconomic Status and Child Development." *Annu Rev Psychol*, vol. 53, 2002, pp. 371-99, doi:10.1146/annurev.psych.53.100.901.135233.
- Burgoyne, Kelly, et al. "Evaluation of a Parent-Delivered Early Language Enrichment Programme: Evidence from a Randomised Controlled Trial." *Journal of Child Psychology and Psychiatry*, vol. 59, no. 5, 2018, pp. 545-55, doi:10.1111/jcpp.12819.
- Catts, Hugh W., et al. "Early Prediction of Reading Comprehension within the Simple View Framework." *Reading and Writing: An Interdisciplinary Journal*, vol. 28, no. 9, 2015, pp. 1407-25, doi:10.1007/s11145.015.9576-x.
- Chang, Fang-Chung. "The Merger Mediation Effect between Family Socioeconomic Status and Reading Achievement of Elementary School Students: Evidence from Pirls 2016 Taiwan Data." *School Administrators*, no. 160, 2024, pp. 1-31, doi:10.6423/HHHC.202511_(160).0001.
- Chapman, James W., and William E. Tunmer. "Development of Young Children's Reading Self-Concepts: An Examination of Emerging Subcomponents and Their Relationship with Reading Achievement." *Journal of Educational Psychology*, vol. 87, no. 1, 1995, pp. 154-67, doi:10.1037/0022-0663.87.1.154.
- Cohen, Jacob. *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum Associates, 1988.
- Coşkun, Burçin, and Selma Akol Göktaş. "The Role of Home and Classroom Factors in Shaping Reading Achievement: A Multilevel Study Based on Pirls

- 2021 Türkiye Data.” *Studies in Educational Evaluation*, vol. 89, 2026, p. 101598, doi:10.1016/j.stueduc.2026.101598.
- Davis-Kean, Pamela E. “The Influence of Parent Education and Family Income on Child Achievement: The Indirect Role of Parental Expectations and the Home Environment.” *Journal of family psychology*, vol. 19, no. 2, 2005, pp. 294-304, doi:10.1037/0893-3200.19.2.294.
- Dehaene, Stanislas, and Laurent Cohen. “Cultural Recycling of Cortical Maps.” *Neuron*, vol. 56, no. 2, 2007, pp. 384-98, doi:10.1016/j.neuron.2007.10.004.
- Elley, Warwick, B. *How in the World Do Students Read? Iea Study of Reading Literacy*. International Association for the Evaluation of Educational Achievement, 1992.
- Elm və Təhsil Nazirliyi. “Azərbaycan Respublikası Elm Və Təhsil Nazirliyi.” Azərbaycan Respublikası Elm və Təhsil Nazirliyi, February 18, 2026, <https://edu.gov.az/>.
- Ergin, İsmet, et al. “A Comparative Study on the Education Systems in the Turkic Countries.” *Pegem Eğitim ve Öğretim Dergisi*, vol. 11, 2021, pp. 67-80, doi:10.47750/pegegog.11.3.006.
- Filiz, Tunahan, et al. “Ekonomik ve Kültürel Bağlam Okuma Başarısında Önemli Mi? Okuma Başarısı ile İlişkili Öğrenci, Okul ve Ülke Düzeyi Değişkenlerin İncelenmesi.” *Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, vol. 27, no. 51, 2024, pp. 41-56, doi:10.31795/baunsobed.1438619.
- Fishbein, Bethany, et al. *Pirls 2021 User Guide for the International Database*. 2 ed., Boston College, TIMSS & PIRLS International Study Center, 2024.
- Froiland, John, and Mark Davison. “Parental Expectations and School Relationships as Contributors to Adolescents’ Positive Outcomes.” *Social Psychology of Education*, vol. 17, 2014, pp. 1-17, doi:10.1007/s11218.013.9237-3.
- Gillon, Gail, et al. “Large Scale Implementation of Effective Early Literacy Instruction.” *Frontiers in Education*, vol. 9, 2024, p. 1361596, doi:10.3389/feduc.2024.136.1596.
- Guliyeva, Nushaba. “Development of Education in Azerbaijan: Historical Path, Modern Trends and Prospects.” *Akademik Tarih ve Düşünce Dergisi*, vol. 12, no. 4, 2025, pp. 424-30.
- Guthrie, John T., et al. “Motivational and Cognitive Predictors of Text Comprehension and Reading Amount.” *Scientific Studies of Reading*, vol. 3, no. 3, 1999, pp. 231-56, doi:10.1207/s1532799xssr0303_3.
- Harris, Charles R., et al. “Array Programming with NumPy.” *Nature*, vol. 585, no. 7825, 2020, pp. 357-62, doi:10.1038/s41586.020.2649-2.
- Hood, Michelle, et al. “Preschool Home Literacy Practices and Children’s Literacy Development: A Longitudinal Analysis.” *Journal of Educational Psychology*, vol. 100, no. 2, 2008, pp. 252-71, doi:10.1037/0022-0663.100.2.252.
- Hopfenbeck, Therese N., et al. “Lessons Learned from Pisa: A Systematic Review of Peer-Reviewed Articles on the Programme for International Student

- Assessment.” *Scandinavian Journal of Educational Research*, vol. 62, no. 3, 2018, pp. 333-53, doi:10.1080/00313.831.2016.1258726.
- IEA. “Pirls 2021 International Database.” International Association for the Evaluation of Educational Achievement, December 15, 2025, <https://pirls2021.org/data/>.
- Inoue, Tomohiro, et al. “Examining an Extended Home Literacy Model: The Mediating Roles of Emergent Literacy Skills and Reading Fluency.” *Scientific Studies of Reading*, vol. 22, no. 4, 2018, pp. 273-88, doi:10.1080/10888.438.2018.1435663.
- İpek, Cemil Doğan, and Mehmet Çağatay Güler. “The Origins of the Unity Idea in the Turkic World.” *bilig*, no. 105, 2023, pp. 129-58, doi:10.12995/bilig.10506.
- Jeynes, William H. “A Meta-Analysis: The Relationship between the Parental Expectations Component of Parental Involvement with Students’ Academic Achievement.” *Urban Education*, vol. 59, no. 1, 2024, pp. 63-95, doi:10.1177/004.208.59211073892.
- Kampman, Kristine, et al. “Self-Confidence in 4th and 9th Grades: Differences between Age, Gender and School Subjects.” *Human, Technologies and Quality of Education*, 2023, pp. 227-41.
- Kaplankıran, İbrahim. “Kazakistan Cumhuriyetinde Eğitim Sisteminin Tarihi Seyri ve Günümüzdeki Yapısı.” *Ana Dili Eğitimi Dergisi*, vol. 5, no. 1, 2017, pp. 31-47, doi:10.16916/aded.272230.
- Khabubullayeva, Ainur. *Kazakistan Öğretmenlerinin Üstün Yetenekli Öğrencilerin Eğitimine İlişkin Görüşleri*. Yüksek Lisans Tezi. Gazi Üniversitesi, 2025.
- Lazarides, Rebecca, et al. “The Role of Parental Expectations and Students’ Motivational Profiles for Educational Aspirations.” *Learning and Individual Differences*, vol. 51, 2016, pp. 29-36, doi:10.1016/J.LINDIF.2016.08.024.
- Leino, Kaisa, et al. “Associations between Teacher Quality, Instructional Quality and Student Reading Outcomes in Nordic Pirls 2016 Data.” *Large-scale Assessments in Education*, vol. 10, no. 1, 2022, p. 25, doi:10.1186/s40536.022.00146-4.
- Lervåg, Arne, et al. “The Cognitive and Linguistic Foundations of Early Reading Development: A Norwegian Latent Variable Longitudinal Study.” *Developmental Psychology*, vol. 45, no. 3, 2009, pp. 764-81, doi:10.1037/a0014132.
- Liem, Gregory Arief D., et al. “Perceived Parental Expectations and Their Role in Academic and Psychosocial Functioning.” *International Journal of Behavioral Development*, vol. 49, no. 5, 2025, pp. 431-45, doi:10.1177/016.502.54251321444.
- Long, H., and W. Pang. “Family Socioeconomic Status, Parental Expectations, and Adolescents’ Academic Achievements: A Case of China.” *Educational Research and Evaluation*, vol. 22, no. 5-6, 2016, pp. 283-304, doi:10.1080/13803.611.2016.1237369.

- Lopes, João, et al. "School and Student Determinants of Reading Performance: A Multilevel Analysis with Portuguese Students." *Revista de Psicodidáctica (English ed.)*, vol. 27, no. 1, 2022, pp. 29-37, doi:10.1016/j.psicoe.2021.05.001.
- Maghsoudlou, Alireza. "Profiles of Cross-Domain Motivational Beliefs: Relations with Engagement and Gender." *ducational Psychology, Leadership, and Higher Education*, vol. Doctor of Philosophy, Dissertation, University of Nevada, Las Vegas, 2023. doi:10.34917/37200521.
- McKinney, Wes. "Data Structures for Statistical Computing in Python." *Proceedings of the 9th Python in Science Conference*, vol. 445, SciPy, 2010, pp. 51-56. doi:10.25080/Majora-92bf1922-00a.
- MEB. Türkiye Cumhuriyeti Millî Eğitim Bakanlığı. April 01, 2026, <https://www.meb.gov.tr>.
- Mudrák, Jiří, et al. "Systemic Approach to the Development of Reading Literacy: Family Resources, School Grades, and Reading Motivation in Fourth-Grade Pupils." *Frontiers in Psychology*, vol. 11, 2020, p. 37, doi:10.3389/fpsyg.2020.00037.
- Mueller, Charles W., and Toby L. Parcel. "Measures of Socioeconomic Status: Alternatives and Recommendations." *Child Development*, vol. 52, no. 1, 1981, pp. 13-30.
- Mullis, Ina, et al. *Pirls 2001 International Report: Iea's Study of Reading Literacy Achievement in Primary School in 35 Countries*. International Study Center, Lynch School of Education, Boston College, 2003.
- Mullis, Ina V.S., and Michael O. Martin. *Pirls 2021 Assessment Frameworks*. TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College, 2019.
- Ong, Walter J. *Orality and Literacy: The Technologizing of the Word*. Methuen & Co. Ltd, 1982.
- Park, Hyunjoon. "Home Literacy Environments and Children's Reading Performance: A Comparative Study of 25 Countries." *Educational Research and Evaluation*, vol. 14, no. 6, 2008, pp. 489-505, doi:10.1080/138.036.10802576734.
- Patrinou, Harry Anthony, et al. "Evaluation of Achievement Change in Egypt Using Pirls Data." *International Journal of Educational Development*, vol. 117, 2025, p. 103371, doi:10.1016/j.ijedudev.2025.103371.
- Raudenbush, Stephen W., and Anthony S. Bryk. *Hierarchical Linear Models: Applications and Data Analysis Methods*. 2 ed., SAGE Publications, 2002.
- Rubin, Donald B. *Multiple Imputation for Nonresponse in Surveys*. John Wiley & Sons Inc., 1987.
- Snijders, Tom A. B., and Roel J. Bosker. *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. 2 ed., SAGE Publications Inc., 2012.

- Solichah, Novia, and Nur Ainy Fardana. "Mediating Effects of Parental Expectations on Parental Participation in Early Literacy: A Dyadic Analysis." *Psymphatic: Jurnal Ilmiah Psikologi*, 2025.
- Şirin, Selçuk. "Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research." *Review of Educational Research*, vol. 75, 2005, doi:10.3102/003.465.43075003417.
- TDT. Türk Devletleri Teşkilatı. March 30, 2026, <https://turkicstates.org/tr>.
- Turan, Selçuk. "Not Every Classroom Lifts You Up: School Academic Emphasis, Teacher Encouragement and Motivation, and Student Constraints in Reading Achievement—a Multilevel Latent Profile Analysis." *Frontiers in Psychology*, vol. 17, 2026, doi:10.3389/fpsyg.2026.168.0413.
- Van Rossum, Guido, and Fred L. Drake. *Python 3 Reference Manual: (Python Documentation Manual Part 2)*. CreateSpace Independent Publishing Platform, 2009.
- Wardat, Yousef, et al. "The Influence of School Factors on Students' Mathematics Achievements in Trends in International Mathematics and Science Study (Timss) in Abu Dhabi Emirate Schools." *Education Sciences*, vol. 12, no. 7, 2022, pp. 1-23, doi:10.3390/educsci12070424.
- Wei, Lim Yi, et al. "Challenges and Opportunities: A Comparison of Pisa 2022 Mathematics Performance in Malaysia and Other Asean Countries." *Mathematics Teaching Research Journal*, vol. 17, no. 3, 2025, pp. 201-22.
- Wu, Yi. "Analyzing Scientific Literacy in Asia's Top Five Pisa 2022 Performers Using Hierarchical Linear Modeling and Bourdieu's Theory of Practice." *Asia-Pacific Science Education*, vol. 11, no. 1, 2025, pp. 95-130, doi:10.1163/23641177-bja10091.
- Xu, Jian, and Ya-Ting Huang. "Effects of Social Support on English Reading Amount in Hong Kong Primary Schools: The Mediating Role of Reading Confidence." *Educational Studies*, vol. 47, no. 6, 2021, pp. 700-15, doi:10.1080/03055.698.2020.1729096.
- Yamamoto, Yoko, and Susan D. Holloway. "Parental Expectations and Children's Academic Performance in Sociocultural Context." *Springer*, 2010.
- Yang, Junyi, et al. "Parental Expectations and Home Literacy Environment: A Questionnaire Study of Chinese-Norwegian Dual Language Learners." *Journal of Research in Childhood Education*, vol. 37, no. 1, 2023, pp. 159-73, doi:10.1080/02568.543.2022.2098427.
- Yigiter, Mahmut Sami. "The Effect of Socioeconomic Status on Academic Achievement: A Big Data Study across Countries and Time with Integrative Data Analysis." *PLOS ONE*, vol. 20, no. 10, 2025, p. e0335485, doi:10.1371/journal.pone.0335485.