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# Literacy Trends and Their Educational Drivers in the Middle East

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## ABSTRACT

The current research aims to examine the relationship between teacher availability, literacy gains, and complementary education indicators in nine middle eastern countries from 1990 to 2023, using harmonized data from the World Bank's World Development Indicators. The panel covers literacy rates, pupil-teacher ratios, primary completion rates, tertiary enrollment, education spending shares, and internet penetration, with missing values interpolated only within internal gaps. The results showed that the correlation analysis reveals large cross-country differences. In the United Arab Emirates, reduced pupil-teacher ratios correlate strongly with higher literacy ( $r = 0.926$ ,  $n = 19$ ), while in Egypt, the link is negligible ( $r = 0.040$ ,  $n = 14$ ). Stronger associations often coincide with parallel gains in tertiary enrollment and digital access. Fixed-effects regressions show positive relationships between literacy and both tertiary enrollment and internet use, alongside a negative relationship with pupil-teacher ratios. Standardized effects highlight digital access and higher education as key drivers. A high within- $R^2$  indicates that much of the variation is explained by persistent national characteristics and shared temporal trends, rather than short-term shifts in single inputs. The results suggest that sustained literacy improvements are most likely when manageable class sizes are combined with expanded post-secondary opportunities and digital infrastructure. Isolated reforms, such as class-size reduction alone, are unlikely to produce rapid gains without broader systemic changes.

## 1. Introduction

Improving literacy is central to global development and is embedded in SDG 4 (UNESCO, 2024). Despite widespread school enrollment, learning deficits persist globally, more than half of children and youth fail to reach minimum proficiency in reading and mathematics (UNESCO, 2017). In low- and middle-income contexts, nearly 70% of ten-year-olds cannot read a simple text (WB, 2022). In the Middle East and North Africa (MENA),

literacy has improved over time, yet gaps remain, particularly regarding the quality of learning (Akkari, 2004; Glewwe & Kremer, 2005). Progress in access has not always translated into outcomes, prompting calls for reforms that go beyond enrollment to focus on governance, pedagogy, and teacher effectiveness (WB, 2018, 2008).

Class size and teacher availability are widely studied determinants of educational outcomes. Robust evidence from randomized trials, such as

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the STAR experiment in Tennessee, shows that smaller class sizes can improve achievement, especially in early grades (Chingos, 2011; Rivkin et al., 2005), with follow-up analyses highlighting is associated with achievement gaps and graduation odds (Krueger & Whitmore, 2002; Finn et al., 2005). International findings echo this, though results are often context-dependent (Whitehurst & Chingos, 2011; Filges et al., 2018). In developing countries, high pupil–teacher ratios often coincide with lower learning outcomes, including literacy, a pattern observed across regions (Verner, 2004; Kremer & Holla, 2009). Qualitative studies further show how large classes hinder individualized instruction and increase discipline problems (Chand, 2023; Yelkperci et al., 2012). However, supply-side inputs like class size may yield limited improvements without complementary investments in teacher quality, instructional resources, and higher education access (Glewwe et al., 2011; Hanushek & Woessmann, 2015). For example, rising tertiary enrollment and internet access appear to correlate with literacy improvement in some Gulf countries, suggesting broader systemic factors at play (Ibourk & Jabrane, 2013; OWID, 2023). This study examines whether greater teacher availability, measured by lower pupil–teacher ratios, is associated with faster literacy gains in MENA countries, while also considering how tertiary access, primary completion, government education spending, and internet penetration contribute. We assemble a multi-indicator panel from 1990–2023 using the World Bank’s WDI API (WB, n.d.), with reproducible data processing and interpolation strategy (Little & Rubin, 2019). We then analyze trends, correlations, and fixed-effects regressions, situating findings within regional education reform debates (WB, 2023). Adult literacy is widely recognized as a slow-moving development indicator shaped by long-term structural, social, and institutional conditions. Although it does not fluctuate rapidly from year to year, it remains a critical measure of a country’s human capital foundation and educational progress. Using

adult literacy in a panel framework allows the study to capture broad, long-term associations between educational inputs and societal learning outcomes. In addition, tertiary enrollment and internet access are included because they reflect broader educational ecosystems: higher education expansion can strengthen intergenerational learning norms, while internet access facilitates informal learning, digital literacy, and exposure to educational resources.

## 2. Data Source and Construction

We compiled a balanced panel dataset for nine Middle Eastern countries including Saudi Arabia (SAU), United Arab Emirates (ARE), Kuwait (KWT), Egypt (EGY), Qatar (QAT), Oman (OMN), Jordan (JOR), Bahrain (BHR), and Lebanon (LBN) from the World Bank’s World Development Indicators (WDI) database (WB, n.d.). The selected indicators capture both core outcomes and system inputs: (i) literacy rate (adult and youth combined), (ii) pupil–teacher ratio at the primary level, (iii) primary completion rate, (iv) tertiary enrollment rate, (v) education spending as a percentage of total government expenditure, and (vi) internet users as a percentage of the population.

For each indicator, annual data were extracted for 1990–2023, subject to availability by country and series. All country–year observations were merged into a single panel with harmonized variable formats and Country–Year keys. Missing values within each country’s time series were imputed via linear interpolation strictly within observed gaps (limit\_area=inside), avoiding extrapolation beyond endpoints (Little & Rubin, 2019). This preserves empirical bounds while improving continuity for correlation and regression analysis.

Adult literacy rate is used as the dependent variable. Because literacy levels evolve gradually over time, this indicator captures long-term educational development rather than short-term fluctuations. Its slow-moving nature means the analysis focuses on structural associations rather than immediate year-to-year effects. This characteristic is acknowledged in the interpretation of the results.

### 2.1 Analytical Framework

The study proceeds in three stages:

1. Trend analysis: Time-series visualization of each indicator to assess long-term changes and heterogeneity across countries.
2. Correlation analysis: Estimation of both pooled and within-country (demeaned) correlation matrices to distinguish structural associations from country-specific mean effects (Verner, 2004).
3. Regression modelling: Fixed-effects ordinary least squares (OLS) with country and year dummies, using heteroscedasticity-robust (HC3) standard errors (Glewwe et al., 2011), to evaluate the relationship between literacy rates and other system inputs.

While the model includes key educational and socioeconomic predictors, several potentially relevant time-varying factors could not be incorporated due to data limitations. These include curriculum reforms, improvements in teacher quality, demographic shifts, conflict exposure, and other policy changes that may influence literacy outcomes. Their absence should be considered when interpreting the within-country variation captured by the fixed-effects model.

All data and code are available in a reproducible pipeline, ensuring that results can be updated when WDI releases new data or revises indicator definitions.

### 3. Temporal Trends in Key Education Indicators

We begin by examining the temporal evolution of core education outcomes and inputs across

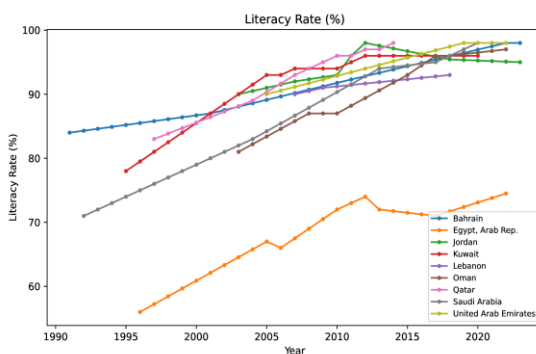
MENA countries. Figures 1–3 show indicator trajectories from 1990 to the latest available year, enabling cross-country comparison of both pace and consistency of change.

#### 3.1 Learning Outcomes and Inputs

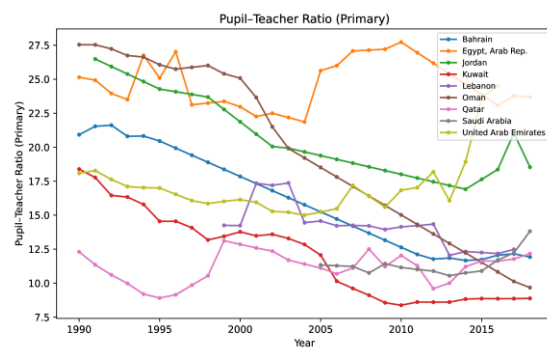
Figure 1 presents two fundamental indicators of education outcomes and inputs.

Panel (a) shows trends in adult literacy rates from 1990 to the most recent year available. Gulf Cooperation Council (GCC) countries such as Qatar, Bahrain, and the United Arab Emirates reached high literacy levels early in the period, with progress slowing as they approached near-universal literacy. Saudi Arabia also recorded steady gains, reaching above 95% by the mid-2010s. In contrast, Egypt and Lebanon exhibited more gradual improvements, reflecting differences in initial conditions and the scale of school expansion and adult literacy programs (WB, 2018).

Panel (b) tracks the pupil–teacher ratio (primary level), a key measure of teacher availability. The United Arab Emirates and Qatar show consistent declines over the full period, indicating significant investments in teacher recruitment and retention. Bahrain and Oman also reduced ratios substantially, although progress slowed after the early 2010s. Egypt and Jordan maintain comparatively higher ratios, suggesting ongoing challenges in achieving smaller class sizes and more individualized instruction (Whitehurst & Chingos, 2011; Chand, 2023).



(a) Literacy rate trends.



(b) Pupil–teacher ratio trends.

Figure 1: Core learning outcome and input across countries (1990 to latest available year).

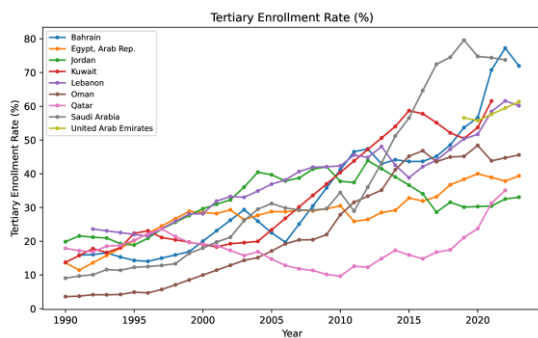
### 3.2 Participation and Attainment

Figure 2 illustrates how participation in higher education and the completion of primary schooling have evolved over the past three decades.

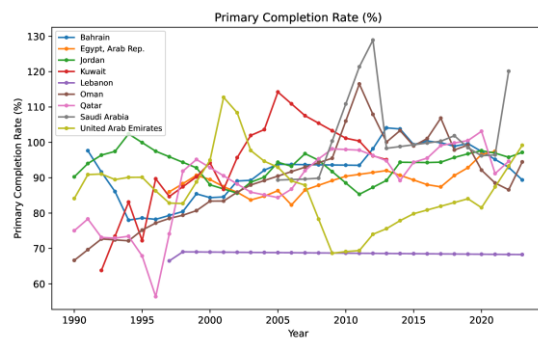
Panel (a) of Figure 2 presents tertiary enrollment rates from 1990 to 2023. Gulf states such as Saudi Arabia, the United Arab Emirates, Qatar, and Bahrain show rapid and sustained increases, reflecting significant investments in expanding higher education capacity (Ibourk & Jabrane, 2013). Other countries, including Egypt, Lebanon, and Jordan, have also recorded gains but at a slower or more irregular pace. In some cases, such as Lebanon, volatility in the trend may be linked to economic instability or political disruptions that affected university access. Overall, the widening gap between fast-

expanding systems in the Gulf and more gradual progress elsewhere points to differing policy priorities and fiscal capacities.

Panel (b) depicts primary completion rates. Most countries, particularly Oman, Kuwait, and Bahrain, exhibit steady gains, with rates approaching or exceeding 100%, indicating that nearly all children are completing primary school on time. Egypt and Lebanon also show improvements, though their trajectories level off in recent years, suggesting persistent dropout or repetition challenges. In contrast, Jordan's rates plateau earlier in the period, possibly due to capacity limits in the upper primary grades. These patterns highlight that while access to primary education is generally strong across the region, ensuring full and consistent completion remains a challenge in several systems.



(a) Tertiary enrollment trends.



(b) Primary completion trends.

**Figure 2: Participation and attainment at higher and primary levels.**

### 3.3 Enabling Conditions for Education Systems

Figure 3 illustrates two important enabling conditions for educational progress.

Panel (a) shows internet penetration over time. Access increased modestly in the 1990s but accelerated sharply after 2000. By the late 2010s, Gulf states such as the United Arab Emirates, Qatar, and Bahrain had achieved near-universal internet use, while Saudi Arabia and Oman also posted rapid gains. In contrast, Egypt and Lebanon recorded slower, though still substantial, increases. Expanding connectivity is significant for education policy because it

underpins digital learning opportunities and access to online resources (OWID, 2023).

Panel (b) presents education spending as a share of total government expenditure. The trajectories vary considerably. Oman and Bahrain consistently allocated a high proportion of their budgets to education, whereas Kuwait and Qatar showed more fluctuation. Egypt and Jordan maintained moderate but steady shares, while Lebanon's spending proportion remained relatively flat. These differences may reflect variations in fiscal capacity, resource dependency, and the prioritization of education relative to other policy areas (WB, 2008).

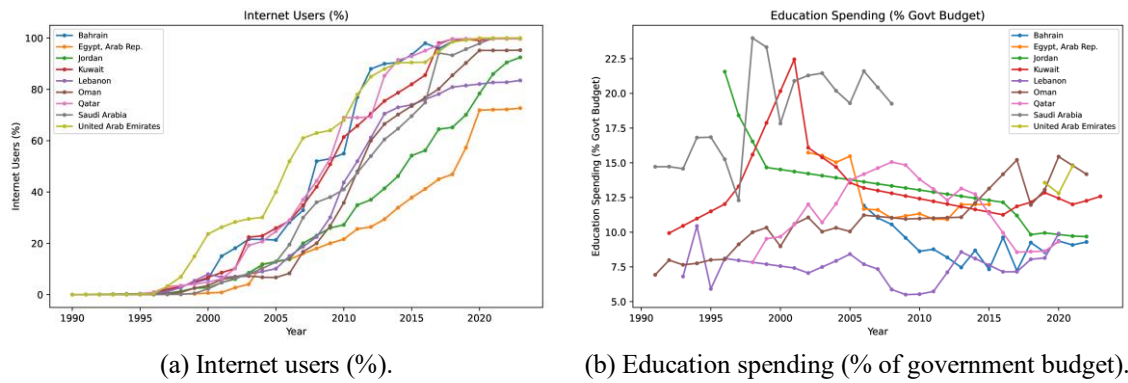


Figure 3: Enabling factors related to technology and public finance.

#### 4 Correlation Structure of Education Indicators

To explore how education system inputs and outcomes are related, we compute bivariate Pearson correlation coefficients for all indicators. Two complementary approaches are applied:

1. Pooled correlations use the complete country–year dataset without demeaning, capturing both differences across countries and changes within them over time.
2. Within-country correlations use demeaned series, where each country’s values are centered on its mean. This removes persistent country-specific levels and highlights short-term co-movements (Verner, 2004).

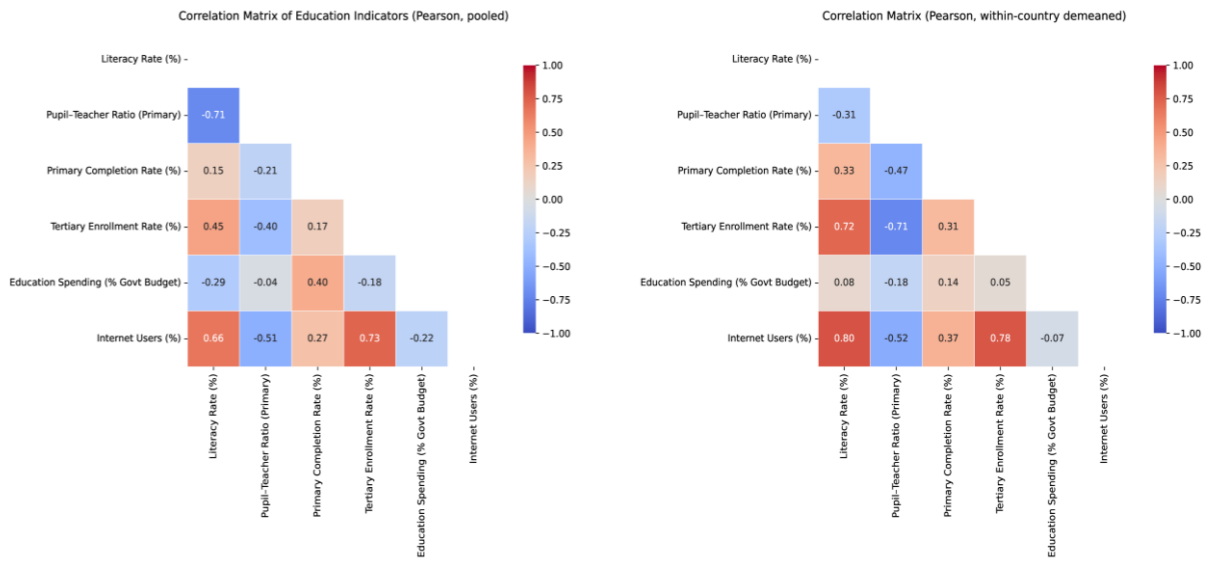
The pooled correlation matrix (Figure 4a) shows that literacy rates, tertiary enrollment, and internet usage are strongly and positively linked. Countries that score higher in one of these measures tend to score higher in the others. Education spending as a share of government budgets also correlates positively with literacy, though the association is weaker, implying that fiscal commitment supports, but does not guarantee, improvements in literacy. The pupil–teacher ratio is negatively correlated with literacy, completion rates, and tertiary enrollment, supporting the view that smaller classes are associated with better learning outcomes.

When persistent cross-country differences are removed in the within-country matrix (Figure 4b), many of these associations weaken. The directions of the relationships generally remain the same, but the magnitudes are smaller and in some cases only marginally significant. This indicates that much of the stronger pooled correlation reflects long-standing structural differences between countries rather than year-to-year changes within them.

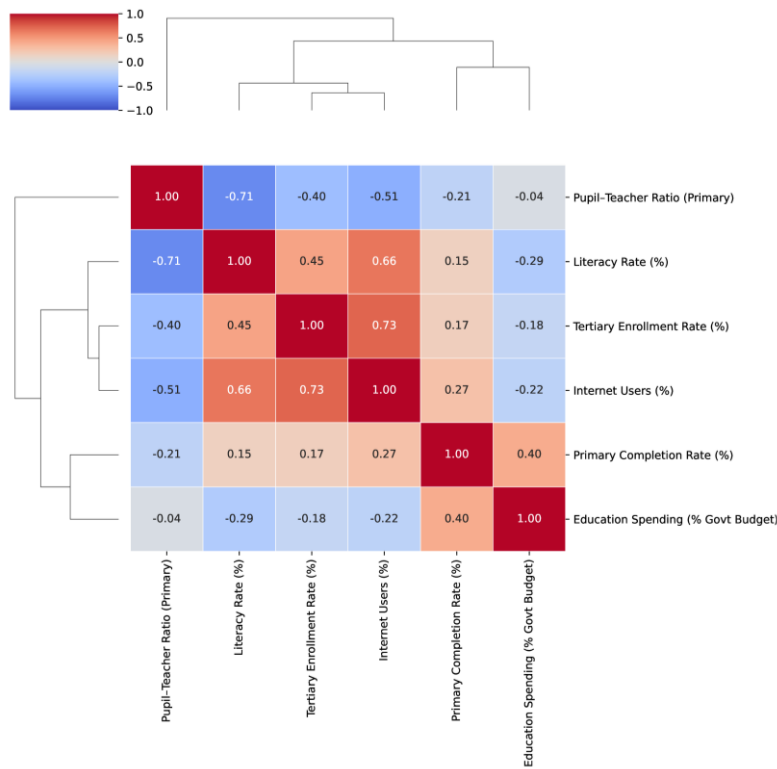
The clustered pooled correlation matrix (Figure 5) groups indicators into two main clusters. The first contains core outcomes and advanced participation measures, literacy, tertiary enrollment, and internet use, showing how progress in one often accompanies gains in the others. The second cluster contains more input-oriented variables such as pupil–teacher ratio, spending share, and primary completion. This separation reinforces the idea that while improvements in outcomes and participation often move together, changes in resource allocation follow their own patterns and may respond differently to policy or economic shifts.

#### 5. Regression Analysis: Drivers of Literacy Rate

To assess the potential drivers of literacy rate improvements, we estimate a fixed-effects ordinary least squares (OLS) model including country and year dummies, following standard panel data approaches for education outcomes (Verner, 2004; Glewwe et al., 2011; Hanushek & Woessmann, 2015). Heteroscedasticity-robust (HC3) standard errors are used to mitigate the effects of unequal error variances (Little & Rubin, 2019). The dependent variable is the adult literacy rate, while the explanatory variables include the pupil–teacher ratio at the primary level, tertiary enrollment rate, primary completion rate, and internet usage rate, capturing both resource-based and access-oriented determinants (Kremer & Holla, 2009; Uwezo, 2016).



(a) Pooled correlation matrix. (b) Within-country (demeaned) correlation matrix.  
**Figure 4: Cross-indicator correlation structure**



**Figure 5: Clustered correlation matrix (pooled).**

The pooled fixed-effects results (Figure 5a) show that higher tertiary enrollment and greater internet usage are positively associated with literacy rates, whereas higher pupil-teacher ratios are negatively associated, consistent with the established literature linking smaller class

sizes to improved learning outcomes (Chingos, 2011; Whitehurst & Chingos, 2011; Filges et al., 2018). In the unstandardized model, the coefficient for tertiary enrollment is 0.046, for internet usage 0.207, and for the primary completion rate

0.032, while the pupil–teacher ratio shows a small negative value of  $-0.007$ . However, when controlling for country-specific unobserved heterogeneity and common temporal shocks, none of these coefficients reach conventional significance thresholds, suggesting that much of the cross-sectional association is driven by long-standing differences between countries rather than short-run changes.

To aid interpretability, Figure 5b presents standardized coefficients, showing the estimated effect of a one-standard-deviation change in each predictor on literacy. Here, internet usage stands out with the largest positive standardized coefficient (1.033), followed by tertiary enrollment (0.490) and primary completion rate (0.395). The pupil–teacher ratio retains a negative sign ( $-0.194$ ) in standardized terms, though its magnitude is modest compared to the other variables. These results suggest that improvements in digital access and post-secondary participation have relatively stronger associations with literacy gains than marginal changes in class size, at least in the short to medium term (UNESCO, 2017; WB, 2018).

The association between primary completion and adult literacy should be interpreted with caution, as these variables may be jointly determined by underlying educational investments and historical schooling conditions. This potential endogeneity limits the extent to which the coefficient can be considered independent of broader structural factors. The strong associations observed for tertiary enrollment and internet access align with theoretical expectations: expansion of higher education can enhance societal learning norms and intergenerational knowledge transfer, while internet access broadens opportunities for informal learning and digital engagement.

The model yields a high within- $R^2$ , indicating that the fixed-effects specification explains a large share of the year-to-year variation in literacy within countries. This reflects the influence of persistent country-specific factors, such as institutional quality, long-standing education policies, and economic structure, alongside global temporal influences like

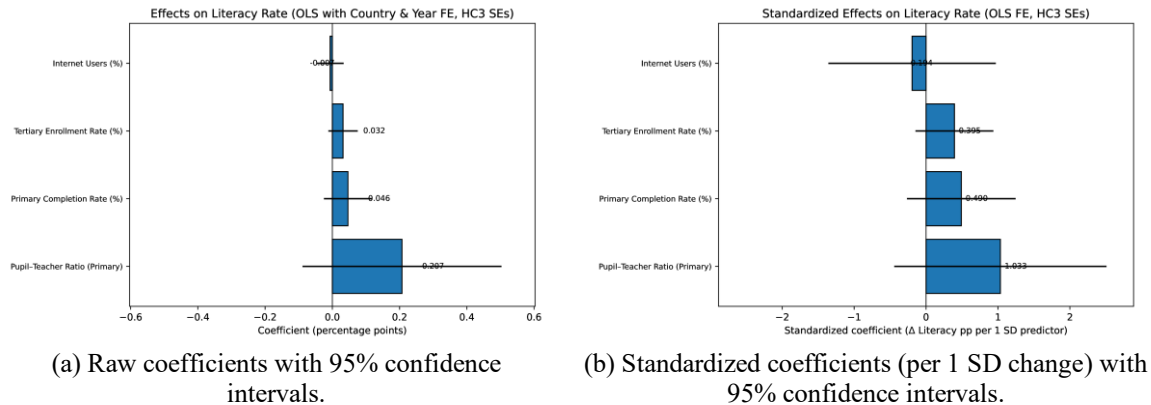
regional economic trends and technological adoption waves. While a high within- $R^2$  strengthens statistical explanatory power, it also highlights a limitation: much of the variation explained is structural and slow-moving, rather than attributable to short-term policy shifts. Consequently, improvements in literacy are closely tied to enduring national characteristics and long-run development trajectories, and short-run fluctuations in any single indicator are unlikely to yield large immediate effects unless accompanied by systemic reforms.

## 6 Diagnostic Tests

To assess the suitability of the panel data estimates, several diagnostic tests were conducted. Serial correlation was examined with the Wooldridge test, and cross-sectional dependence was evaluated with the Pesaran CD test. In addition, unit root properties of the main variables were assessed with the Levin–Lin–Chu test. These diagnostics help ensure that the panel structure and the statistical assumptions underlying the fixed-effects model are adequately addressed.

The diagnostic tests indicate that the panel data exhibit characteristics relevant to interpretation. The Wooldridge test indicates the presence or absence of serial correlation, as reported, while the Pesaran CD test provides evidence of cross-sectional dependence among countries. The Levin–Lin–Chu test results confirm the stationarity of the key variables. These findings support the robustness of the estimation strategy while also highlighting the model's limitations.

In summary, the regression findings indicate that expanding tertiary education opportunities and improving internet access could have substantial long-term benefits for literacy. These gains, however, are likely to be maximized when combined with sustained enhancements in teaching resources and broader quality improvements across the education system. The high within- $R^2$  underscores the need for policy evaluation frameworks that account for structural persistence and long adjustment lags, rather than expecting rapid outcomes from isolated interventions (Ibourk & Jabrane, 2013; Chowdhury, 1995).



**Figure 6: Estimated effects of key education indicators on literacy rate, controlling for country and year fixed effects with HC3 robust errors.**

## 6. Policy Implications and Limitations

The results indicate that sustained improvements in literacy rates are most likely when several enabling factors advance together. Countries that reduce pupil–teacher ratios while expanding tertiary enrollment and rapidly adopting digital technologies tend to record stronger and more durable gains ([Whitehurst & Chingos, 2011](#); [Kremer & Holla, 2009](#); [Chand, 2023](#)). This pattern supports international evidence that single-input reforms, such as class-size reduction alone, are rarely sufficient. Lasting progress typically requires integration with broader strategies that strengthen teacher training, enhance instructional quality, and improve system governance ([Filges et al., 2018](#); [Uwezo, 2016](#)). Differences in the strength of associations across countries have clear implications for policy design. Where pupil–teacher ratios and literacy are strongly and negatively correlated, resource allocation is often coupled with broader investments in higher education and digital infrastructure. In contrast, weaker correlations may point to gaps in teacher effectiveness, outdated curricula, or limited school leadership capacity ([Hanushek & Woessmann, 2015](#); [Ibourk & Jabrane, 2013](#)). Addressing these gaps may be necessary before improvements in basic resource indicators translate into literacy gains.

From a methodological perspective, the use of the WDI API enables transparent replication and facilitates timely dataset updates ([WB, n.d.](#)). Missing values were filled only within internal

gaps through linear interpolation, avoiding extrapolation beyond observed endpoints. This approach reduces the likelihood of introducing artificial trends ([Little & Rubin, 2019](#)). Nonetheless, shifts in indicator definitions and data-collection methodologies over time may affect cross-year comparability ([WB, 2008](#)). Although fixed-effects estimation helps mitigate bias from unobserved, time-invariant factors, causal interpretation remains limited by potential omitted variables and measurement error ([Glewwe et al., 2011](#)).

Future research could build on this work by incorporating measures of teacher quality, classroom pedagogy, and student learning outcomes ([UNESCO, 2017](#); [WB, 2022](#)). Such data would provide a more complete picture of how policy levers interact, and whether gains in access and inputs are leading to measurable improvements in learning.

## 7 Summary and Conclusion

This study investigated how teacher availability, measured through pupil–teacher ratios, interacts with other education system factors to shape literacy outcomes in nine Middle Eastern countries over 1990–2023. By integrating harmonized World Development Indicators data via the WDI API, we constructed a multi-indicator panel covering literacy rates, primary completion, tertiary enrollment, education spending shares, and internet penetration. Missing values were addressed conservatively through interpolation within observed gaps, preserving data integrity.

The analysis revealed marked heterogeneity in the strength of associations between key inputs and literacy outcomes. In countries such as the United Arab Emirates and Qatar, reductions in pupil–teacher ratios coincided with rapid gains in tertiary enrollment and digital access, supporting sustained improvements in literacy. In contrast, countries like Egypt displayed weak or negligible links between these factors, suggesting the presence of binding constraints in other dimensions such as instructional quality, curriculum relevance, or governance.

Regression results with country and year fixed effects confirmed that higher tertiary enrollment and broader internet access are positively related to literacy, while higher pupil–teacher ratios are generally associated with lower literacy. Standardized coefficients emphasized the relative importance of digital connectivity and higher education expansion. A high within- $R^2$  indicated that much of the explanatory power stems from persistent country-specific characteristics and shared temporal trends, underscoring the structural nature of literacy improvements.

The findings point to clear policy implications: durable literacy gains are most likely when investments in teacher resources are complemented by broader strategies to expand post-secondary opportunities and digital infrastructure. Isolated reforms, such as class-size reduction alone, are unlikely to yield transformative effects without concurrent improvements in teacher training, instructional quality, and system governance. Future work could deepen these insights by incorporating measures of teacher quality, pedagogical practices, and direct learning outcomes, enabling a richer understanding of how education systems translate resources into sustained human capital development.

### Ethics Statement

The authors affirm that this manuscript is original, not under consideration elsewhere, and prepared with integrity, transparency, and truthfulness. It contributes to academic knowledge within education, respects human dignity and diversity by adhering to ethical

research standards, and discloses any potential conflicts of interest.

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### اتجاهات معدلات الإلمام بالقراءة والكتابة ومحدداتها التعليمية في منطقة الشرق الأوسط

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#### معلومات المقالة

#### المخلص

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نحصر في هذه الدراسة العلاقة بين توافر المعلمين ومكتسبات محو الأمية والمؤشرات التعليمية التكميلية في تسع دول من منطقة الشرق الأوسط، خلال الحقبة الممتدة من عام 1990 إلى عام 2023، وذلك باستخدام بيانات موحدة مستقاة من قاعدة مؤشرات التنمية العالمية الصادرة عن البنك الدولي. تشمل لوحة البيانات المستخدمة كلاً من: معدلات محو الأمية، ونسب التلاميذ إلى المعلمين، ومعدلات إتمام التعليم الابتدائي، ومعدلات الالتحاق بالتعليم العالي، والحصص المخصصة للإفناق على التعليم، ومعدلات انتشار الإنترنت، مع الاستعاضة عن القيم المفقودة بالقيم المستكملة داخلياً حصراً ضمن الفجوات البيئية.

**الكلمات المفتاحية:**  
اتجاهات محو الأمية  
توافر المعلمين  
مكاسب محو الأمية  
مؤشرات التعليم التكميلي في دول الشرق الأوسط

وقد كشف تحليل الارتباط عن تباين واسع بين الدول المشمولة بالدراسة؛ إذ أظهرت الإمارات العربية المتحدة ارتباطاً قوياً بين انخفاض نسب التلاميذ إلى المعلمين وارتفاع معدلات محو الأمية ( $r = 0.926$ ،  $n = 19$ )، في حين اتسمت هذه العلاقة بالضعف الشديد في مصر ( $r = 0.040$ ،  $n = 14$ ). وقد تزامنت الارتباطات الأكثر قوةً عمومًا مع تحسنات متوازنة في معدلات الالتحاق بالتعليم العالي والوصول الرقمي. وأسفرت نماذج الانحدار ذات التأثيرات الثابتة عن وجود علاقات إيجابية بين معدلات محو الأمية من جهة، ومعدلات الالتحاق بالتعليم العالي واستخدام الإنترنت من جهة أخرى، مقابل علاقة سلبية مع نسب التلاميذ إلى المعلمين. وتبرز التأثيرات المعيارية أن الوصول الرقمي والتعليم ما بعد الثانوي يُمثلان المحركين الرئيسيين لتحسين مستوى محو الأمية. فضلاً عن ذلك، يدل ارتفاع معامل التحديد الداخلي ( $R^2$ ) على أن قدرًا كبيرًا من التباين المرصود يعود إلى الخصائص الوطنية الراسخة والاتجاهات الزمنية المشتركة، لا إلى التحولات القصيرة الأمد في مدخل بعينه. تُشير نتائج الدراسة إلى أن التحسينات المستدامة في مستويات محو الأمية تتحقق على الأرجح حين تقترب أحجام الفصول الدراسية القابلة للإدارة بتوسيع فرص التعليم ما بعد الثانوي وتعزيز البنية التحتية الرقمية. وعليه، فإن الإصلاحات المنفردة - كالإقتصار على تخفيض أعداد الطلاب في الفصول الدراسية - لن تُفضي في الغالب إلى مكتسبات سريعة في غياب تحولات منظومية أشمل.

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