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ECONOMETRIC MODELLING AND CONSTRUCTION OF AN EDUCATION QUALITY INDEX (EQI): HUMAN CAPITAL DEVELOPMENT PERSPECTIVES FROM POST-SOVIET COUNTRIES

Indira KHADJIEVA,
Westminster International University in Tashkent



Abstract: This study develops an integrated econometric framework to evaluate secondary education quality in the context of human capital development across post-Soviet countries. Using OECD PISA 2022 microdata from 56,477 students across seven countries, three-level hierarchical linear modeling and confirmatory factor analysis are applied. Instructional quality and digital readiness significantly enhance digital reading performance. The proposed Education Quality Index (EQI) provides an empirically weighted, evidence-based tool for educational governance and human capital monitoring, with targeted implications for Uzbekistan.

Keywords: *Education Quality Index (EQI); human capital development; secondary education; PISA 2022; instructional quality; digital reading literacy; Uzbekistan; multilevel modeling; transition economy; education policy.*

Ta'lim sifati indeksini (EQI) ekonometrik modellashtirish va shakllantirish: Inson kapitali rivojlanishi kontekstida postsovet mamlakatlari misolida

Indira Xadjiyeva,
Toshkent shahridagi Xalqaro Vestminster universiteti

Annotatsiya: ushbu tadqiqot postsovet mamlakatlarida inson kapitalini rivojlantirish va ta'lim sifatini oshirishga yo'naltirilgan integratsiyalashgan ekonometrik yondashuv ishlab chiqilgan. PISA 2022 mikroma'lumotlari asosida ko'p bosqichli modellashtirish va tasdiqlovchi omilli tahlil qo'llanilib, o'qitish sifati va raqamli tayyorgarlik o'quvchilarning raqamli o'qish savodxonligiga ijobiy ta'sir ko'rsatishi aniqlangan. Ta'lim sifati indeksi (EQI) ta'lim siyosatini dalillarga asoslangan holda shakllantirish va inson kapitalini monitoring qilishning samarali vositasi sifatida taklif etiladi.

Kalit so'zlar: *Ta'lim sifati indeksi (EQI), inson kapitali, umumiy o'rta ta'lim, PISA 2022, o'qitish sifati, raqamli o'qish savodxonligi, O'zbekiston, ko'p bosqichli modellashtirish, o'tish iqtisodiyoti, ta'lim siyosati.*

Эконометрическое моделирование и разработка индекса качества образования (eqi): в контексте развития человеческого капитала на примере постсоветских стран

Индира Хаджиева,
Международный Вестминстерский университет в Ташкенте

Аннотация: данное исследование разрабатывает интегрированный эконометрический подход к оценке качества образования в контексте развития человеческого капитала постсоветских стран. На основе микроданных PISA 2022 применяются методы многоуровневого моделирования и конфирматорного факторного анализа. Установлено, что качество преподавания и уровень цифровой подготовки положительно влияют на читательскую грамотность учащихся. Индекс качества образования (EQI) предлагается как инструмент доказательного мониторинга образовательной политики и человеческого капитала.

Ключевые слова: *Индекс качества образования (EQI); человеческий капитал; среднее образование; PISA 2022; качество преподавания; цифровая читательская грамотность; Узбекистан; многоуровневое моделирование; переходная экономика; образовательная политика.*

In all times, human capital has been the primary driver of sustainable economic growth, social mobility, and national competitiveness. The theoretical foundations of this claim trace to the seminal work of Schultz [1] and Becker [2], who demonstrated that investment in education yields measurable returns through enhanced labor productivity, innovation efficiency, and income generation. Contemporary scholarship has further confirmed that the quality — not merely the quantity — of education determines the extent to which schooling translates into human capital accumulation (Hanushek & Woessmann, [3]; OECD,[4]).

For transition economies like Uzbekistan, secondary education is a key component of the national human capital development initiative. Over the past decade, Uzbekistan has made wide-ranging reforms targeting educational governance, teacher professional development, digital infrastructure, and alignment with international quality benchmarks. Nevertheless, learning outcomes remain substantially below international standards: results from the OECD PISA 2022 assessment — Uzbekistan's first participation — revealed that fewer than one-fifth of students achieved minimum proficiency levels in reading, mathematics, and science [4]. This empirical gap between institutional reform and measurable human capital outcomes constitutes the central problem motivating the present study.

Despite the growing body of literature on education quality in OECDcountries, post-Soviet and Central Asian education systems remain comparatively underexplored, particularly with respect to the mechanisms through which instructional processes shape student competencies relevant to human capital formation. Existing national monitoring frameworks in Uzbekistan rely predominantly on

examination scores and school inspection outcomes, which are insufficiently sensitive to classroom-level processes and inadequate for benchmarking human capital development across schools and regions.

This study addresses these gaps through two interconnected contributions. First, it develops a multilevel econometric framework linking instructional quality to digital reading literacy — a competency increasingly recognized as foundational for human capital in knowledge economies [5]. Second, it proposes an evidence-based Education Quality Index (EQI) whose dimensional weights are derived from empirical multilevel modeling rather than expert opinion, thereby providing a more valid tool for monitoring human capital inputs in secondary education. While the empirical analysis covers seven post-Soviet countries, particular attention is given to Uzbekistan's position within the regional landscape.

The remainder of the manuscript is structured as follows. Section 2 reviews theoretical frameworks and empirical literature. Section 3 describes data, variables, and analytical methods. Section 4 presents and discusses empirical results. Section 5 proposes the EQI as a policy instrument for human capital governance. Section 6 concludes with theoretical and practical implications.

Human Capital Theory, as formalized by Schultz [1] and Becker [2], conceptualizes education as an investment that augments the productive capacity of individuals and, in aggregate, determines the trajectory of national economic development. The empirical literature has consistently demonstrated that improvements in cognitive skills — particularly literacy and numeracy — are more strongly associated with economic growth than years of schooling alone [3]. This distinction between the quantity and quality of human capital is particularly salient for transition economies, where rapid expansion of educational enrollment has not always translated into proportional improvements in student competencies.

Extending this logic, Education Production Function Theory [6] models student achievement as the output of a production process in which inputs (teacher qualifications, school resources, socioeconomic background) are transformed by institutional processes (instructional quality, school climate, governance) into measurable outcomes. This framework provides the micro-economic foundation for identifying the determinants of education quality and, by extension, the mechanisms through which schooling contributes to human capital formation.

Complementary perspectives include Systems Theory, which situates student learning within multilevel institutional environments [7]; the Capability Approach, which broadens quality assessment beyond cognitive outcomes to include equity, agency, and human development [8]; and School Effectiveness Theory, which focuses on institutional and classroom-level determinants of learning [9]. This study adopts an integrated framework synthesizing these perspectives to capture the multidimensional nature of education quality as a determinant of human capital.

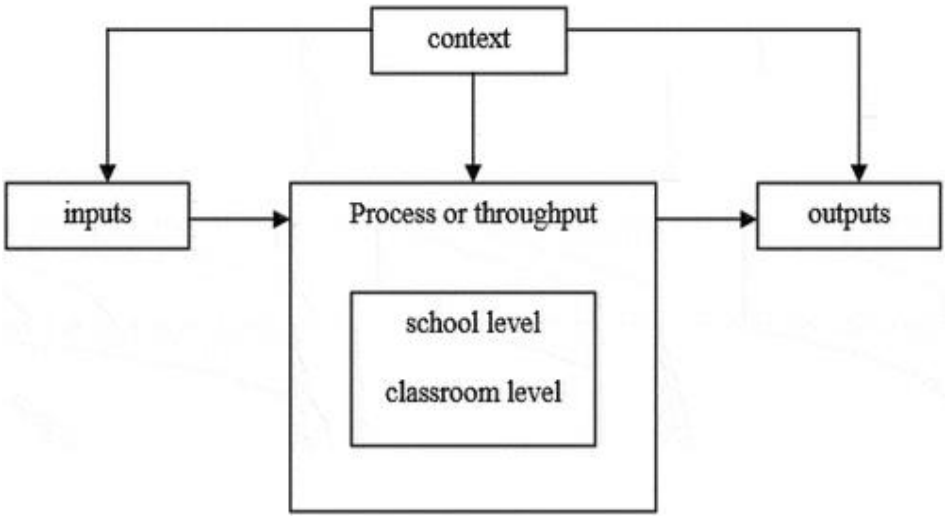


Figure 1. Integrated model of secondary education quality as a human capital determinant

Source: Author's elaboration synthesizing Hanushek & Woessmann [3], Garira [7], and UNESCO[5].The model was constructed by drawing theoretical dimensions from each framework onto a four-layer schema (inputs, processes, outcomes and equity) and shows how they connect to each other based on theories in Section 2.

Within the education production function, instructional quality represents the most proximate and controllable process input affecting student learning outcomes. The influential framework developed by Klieme et al. [10] identifies three interrelated dimensions: instructional approach (the quality and appropriateness of pedagogical strategies), classroom management (the orderliness and time efficiency of the learning environment), and supportive climate (the quality of teacher–student relationships and emotional support). These dimensions collectively determine the extent to which educational resources are effectively converted into student competencies and, ultimately, human capital.

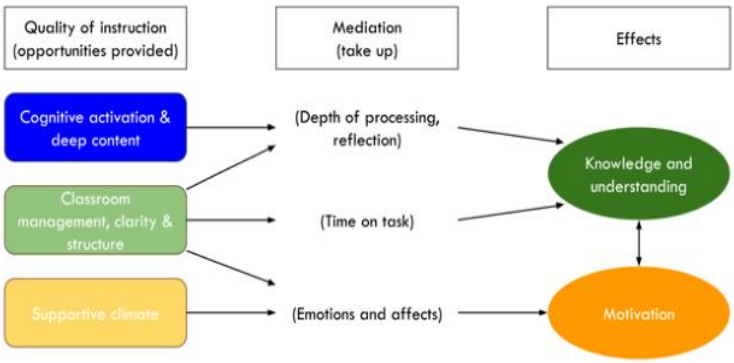


Figure 2. Theoretical model of instructional quality dimensions and effects on student learning —Source: Klieme et al. [10], p. 140

The relationship between instructional quality and digital reading literacy has gained particular relevance as digital competencies are increasingly recognized as core constituents of human capital for knowledge economies. Digital reading requires not only decoding and comprehension skills but also the ability to navigate non-linear information structures, evaluate source credibility, and integrate multimodal content [11]. These competencies are directly implicated in the capacity to participate effectively in digitally mediated labor markets, thereby linking instructional processes to long-term human capital outcomes [5]. International reading studies also support this finding. IEA PIRLS data from many countries consistently demonstrate that clear teaching and teacher support are among the strongest school-level factors linked to better reading results [12].

Post-Soviet education systems present a distinctive context for examining these relationships. Characterized by historical legacies of centralized governance, standardized curricula, and examination-oriented instruction, these systems have undergone rapid digital transformation while retaining institutional inertia that may moderate how instructional quality affects student competencies. Understanding these dynamics is essential for developing context-sensitive policies to strengthen human capital development in transition economies. By analyzing seven post-Soviet countries using harmonized PISA 2022 data, this study generates comparative evidence relevant to this underexplored context.

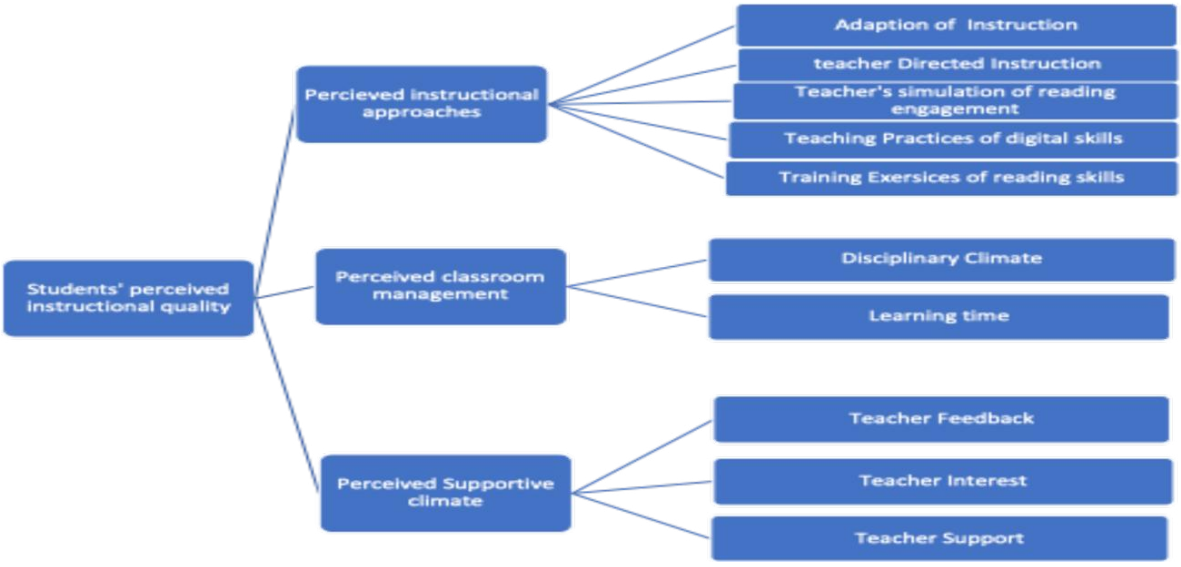


Figure 3. Theoretical framework linking instructional quality to digital reading performance and human capital outcomes
Source: Author's elaboration based on Klieme et al. [10], OECD[4], and UNESCO[5]

On the basis of the theoretical framework and empirical gaps identified above, this study tests the following research questions:

RQ1: To what extent do students' perceptions of instructional approaches predict digital reading performance in post-Soviet countries?

RQ2: To what extent do classroom management practices relate to digital reading outcomes?

RQ3: To what extent does a supportive classroom climate influence digital reading performance?

One important limitation of using student surveys to measure teaching quality is that students' views of their teachers may not match what actually happens in the classroom. Fauth et al. [13] found that students and independent observers often rate teaching quality differently — students tend to give higher scores for teacher support but lower scores for the cognitive challenge of lessons. This means that PISA-based results, including those in this study, reflect how students perceive their teachers, not necessarily what teachers actually do.

The empirical analysis uses microdata from the 2022 Programme for International Student Assessment (PISA), the largest internationally comparable assessment of 15-year-old students' literacy in reading, mathematics, and science, conducted by the OECD [14]. Uzbekistan participated in PISA for the first time in 2022, providing a nationally representative sample of 7,293 students from 202 schools. This study focuses on seven post-Soviet countries that participated in the computer-based reading assessment and provided complete data at student, school, and country levels. The final analytical sample comprises 56,477 students from 2,495 schools (Table 1).

Table 1

. Sample composition by country (PISA 2022)

Country	Schools	Students	Female (%)		Male (%)
Estonia	573	5,315	49.9		50.1
Kazakhstan	616	19,487	49.1		50.9
Lithuania	362	6,885	49.1		50.9
Latvia	308	5,303	50.6		49.4
Moldova	236	5,367	48.8		51.2
Azerbaijan (Baku)	198	6,827	47.8		52.2
Uzbekistan	202	7,293	50.0		50.0
Total	2,495	56,477	48.9		51.1

Source: Author's calculations based on PISA 2022 microdata (OECD[14]).

The study's outcome variable is digital reading literacy, operationalized using students' scores on the PISA 2022 computer-based reading assessment. Student achievement is represented by ten plausible values (PV1–PV10) generated through Item Response Theory (IRT) by the OECD. Consistent with methodological guidelines [4], all ten plausible values are used and combined via Rubin's rules:

$$\bar{\beta} = \frac{1}{M}\sum_{m=1}^{M}\beta_m$$

$$T = \bar{U} + \left(1 + \frac{1}{M}\right)B$$

where β_m denotes the coefficient estimated using plausible value m, $\bar{U}$ is the average within-imputation variance, and B is the between-imputation variance. This approach yields unbiased parameter estimates and correctly reflects inferential uncertainty, addressing a common methodological shortcoming in educational survey research.

Following and extending the model of Klieme et al. [10], instructional quality is operationalized using three composite dimensions drawn from the PISA 2022 student questionnaire (Table 2). Each dimension is measured as a weighted likelihood estimate (WLE), a continuous scale score derived from item response modeling.

Table 2

Instructional quality dimensions, indicators, and PISA constructs

Dimension	Conceptual definition	PISA 2022 constructs
Instructional approaches	Clarity, adaptation, and engagement quality of teaching strategies, encompassing both teacher-directed and constructivist practices	ADAPTIVITY, DIRINS, STIMREAD, DIGTEACHER
Classroom management	Orderliness, discipline, and efficient use of instructional time in the learning environment	RPRACTICE, LEARNINGTIME
Supportive climate	Quality of teacher–student relationships, emotional and academic support, and feedback provision	PERFEED, TINCHINT, TEACHSUP

Source: Author's elaboration based on Klieme et al. [10] and PISA 2022 Technical Standards (OECD [14]).

To isolate the association between instructional quality and digital reading performance, the analysis controls for variables identified in prior PISA-based research as significant confounders [11], [15], [16] (Table 3).

Table 3

Variable definitions and sources

Level	Variable	Description
Student	ESCS	Index of economic, social and cultural status (OECD composite)
Student	Gender	Student gender (binary, standardized)
Student	ICTRES	ICT resources available at home (WLE)
School	ICTSCH	ICT availability and infrastructure at school level
Family	HISEI	Index of highest parental occupational status
Family	EMOSUPS	Parental emotional support as perceived by student (WLE)

Source: Author's elaboration based on PISA 2022 (OECD[4]).

Missing data were addressed using multiple imputation (MI), reflecting the rotational booklet design of PISA. The dimensionality and convergent validity of the DIGTEACHERand RPRACTICEconstructs were verified through confirmatory factor analysis (CFA), yielding satisfactory fit (CFI: 0.935–0.997) across all countries.

Given the three-level hierarchical structure of the data (students within schools within countries), three-level hierarchical linear models (HLM) were estimated.

This approach appropriately accounts for non-independence of observations and partitions variance across levels, consistent with best practice in PISA-based multilevel research [15], [16]. Predictor variables were grand-mean centered to reduce multi-collinearity. The null (unconditional) model is:

$$Y_{ijk} = \gamma_{000} + \varepsilon_{ijk} + r_{0jk} + u_{00k}$$

where Y_{ijk} is the digital reading score for student i in school j in country k; γ_{000} is the grand mean; and ε_{ijk}, r_{0jk}, u_{00k} are residuals at student, school, and country levels respectively. The full model, estimated sequentially by introducing predictors at each level (retaining those significant at $p < .05$), is:

$$Y_{ijk} = \gamma_{000} + \gamma_{a00}Stduent_{ijk} + \gamma_{0b0}School_{ojk} + \gamma_{00c}Country_{ook} + \varepsilon_{ijk} + r_{0jk} + u_{00k}$$

All models were estimated in Stata 17 using the mixed command with Restricted Maximum Likelihood (REML) estimation. The final model was checked for multicollinearity (all inter-predictor correlations < 0.8) and residual normality.

The null model confirmed significant variance at all three levels. Specifically, 32.8% of total variance in digital reading scores was attributable to between-school differences, while 0.4% was explained by country-level variation — the latter reflecting the comparative homogeneity of post-Soviet institutional arrangements. These intraclass correlation coefficients confirm the

statistical necessity of multilevel modeling and indicate that school-level processes, particularly instructional quality, are primary determinants of student learning outcomes in this context. This finding aligns with School Effectiveness Theory and underscores the importance of classroom-level human capital inputs relative to national-level policy variation [9].

Table 4

Three-level HLM results: predictors of digital reading literacy (N = 56,477 students, 2,495 schools, 7 countries)

Variable	Model 1 β	SE	Model 2 β	SE	Model 3 β	SE
FIXED EFFECTS						
STUDENT LEVEL						
ADAPTIVITY	—	—	—	—	0.109***	0.004
DIRINS	—	—	—	—	0.076***	0.005
STIMREAD	—	—	—	—	0.123***	0.008
DIGTEACHER	—	—	—	—	0.230***	0.009
RPRACTICE	—	—	—	—	−0.054***	0.012
LEARNINGTIME	—	—	—	—	−0.051***	0.009
DISCLIMA	—	—	—	—	0.031***	0.015
TEACHINT	—	—	—	—	0.073***	0.008
TEACHSUP	—	—	—	—	0.054***	0.009
GENDER	—	—	0.321***	0.021	0.288***	0.034
ESCS	—	—	0.434***	0.027	0.354***	0.027
SCHOOL LEVEL						
SCHTYPE	—	—	−0.127***	0.008	−0.109***	0.006
SCHLOC_3	—	—	0.009***	0.043	0.005*	0.040
SCHLOC_5	—	—	0.121*	0.068	0.009*	0.063
CLSIZE	—	—	0.124***	0.034	0.119***	0.029
RANDOM EFFECTS	Variance	ICC	Variance	r^2	Variance	r^2
Student level	0.673	0.632	0.612	4.678%	0.597	8.156%
School level	0.317	0.328	0.236	33.511%	0.209	44.770%
Country level	0.011	0.004	0.152	1.789%	0.194	11.116%

Note: β = standardized coefficient; SE = cluster-robust standard error (clustered at school level); ICC = intraclass correlation coefficient; r^2 = proportion of variance explained relative to null model. Significance: * p < .05, ** p < .01, *** p < .001. All continuous predictors grand-mean centered. Models estimated in Stata 17 using REML.Plausible values combined via Rubin's rules (M = 10)

The first research question asked whether teaching approaches affect students' digital reading scores. Study revealed that all four teaching approach variables in the model had a positive and significant effect on reading performance. The final HLM model confirmed that all three dimensions of instructional quality were significantly associated with digital reading performance. Among instructional approach indicators, perceived adaptation of instruction ($\beta = 0.109$, $p < .001$), teacher-directed instruction ($\beta = 0.076$, $p < .001$), digital skills instruction by teachers ($\beta = 0.230$, $p < .001$), and stimulation of reading engagement ($\beta = 0.123$, $p < .001$) each demonstrated positive associations, consistent with prior PISA-based evidence [11], [15].

The magnitude of the digital skills instruction effect ($\beta = 0.230$) is particularly noteworthy. This finding suggests that teachers' capacity to model and scaffold digital literacy practices represents a critical human capital input — one that amplifies students' ability to engage with digital information environments central to knowledge-economy participation [5]. It is worth noting that this result is an average across all seven countries, and the strength of the effect varies by country. In Estonia, which had the highest reading scores in the sample, the link between digital teaching and reading performance was stronger. In Uzbekistan, the same link was positive but weaker. This difference is likely because Uzbekistan's schools have fewer digital tools and less teacher training in digital skills compared to the Baltic countries. This shows that good digital teaching alone is not enough — schools also need the right equipment and trained teachers to make it work. Adaptive instruction and reading engagement further reflect pedagogical orientations associated with deeper processing and autonomous learning, competencies closely linked to human capital formation in contemporary labor markets.

The second research question asked whether classroom management is linked to digital reading outcomes. The results are mixed. An orderly classroom (DISCLIMA) helped students perform better, but more time spent on reading drills (RPRACTICE) and longer class hours (LEARNINGTIME) were linked to lower scores. This suggests that how class time is used matters more than how much time students spend in class.

Two indicators exhibited negative associations: reading skill exercises ($\beta = -0.051$, $p < .001$) and weekly learning time ($\beta = -0.054$, $p < .01$). The negative result for reading exercises (RPRACTICE: $\beta = -0.054$, $p < .001$) does not mean that reading practice is bad for students. The PISA question asks whether students do reading exercises in class —it does not measure how good those exercises are. In many post-Soviet schools, reading exercises often mean repeating texts, memorizing passages, or doing mechanical drills rather than practicing real reading and thinking skills [17]-[20]. Students who spend more time on these types of exercises may have less time for the kind of open, exploratory reading that PISA tests. The problem, therefore, is not the amount of reading practice but the quality of it.

The third research question asked whether teacher support affects digital reading performance. The answer is yes: students who felt their teachers were interested in them and supportive of their learning scored higher in digital reading. This shows that the relationship between teacher and student is important, not

just the content taught.

Within the supportive climate dimension, teacher interest (β = 0.073, p < .001) and teacher support (β = 0.054, p < .001) exerted positive effects, consistent with Toropova et al. [21] and Wang et al. [22], who demonstrate that relational dimensions of instruction enhance student motivation and persistence. Disciplinary climate (β = 0.031, p < .001) also showed a positive association, indicating that orderly learning environments facilitate the cognitive engagement necessary for digital literacy development.

School-level effects were substantially stronger than student-level effects, reinforcing the conclusion that institutional processes — particularly instructional quality — are more influential determinants of human capital outcomes than individual background characteristics in this context. This finding has direct implications for Uzbekistan's education reform agenda, which has historically prioritized infrastructure inputs over pedagogical process improvement.

Uzbekistan scored 399 points in PISA 2022 digital reading —well below the average of the seven post-Soviet countries in this study (471 points) and below the OECDaverage (476 points) [4]. Among the countries studied, only Moldova scored similarly low.

Within Uzbekistan, the difference between schools explains about 38% of the total variation in student scores. This is higher than the pooled average of 32.8% across all seven countries. In simple terms, which school a student attends matters more in Uzbekistan than in most other countries in this sample. This means that improving teaching quality in schools could have a large impact on student learning in Uzbekistan.

The data demonstrate that digital teaching (DIGTEACHER)andadaptive instruction (ADAPTIVITY) are positively linked to student reading scores in Uzbekistan, but the effect is weaker than in Estonia, Lithuania, and Latvia. This is likely because digital tools and teacher training in Uzbekistan are still developing. On the other hand, the negative effect of drill-based reading exercises (RPRACTICE) is stronger in Uzbekistan than in the pooled sample. This suggests that rote-based classroom exercises are more common in Uzbek schools and are holding students back from developing strong digital reading skills.

The empirical findings demonstrate that human capital development through secondary education is driven primarily by instructional processes rather than resource inputs or national policy variation. This conclusion exposes a fundamental limitation of conventional education monitoring frameworks in Uzbekistan, which rely predominantly on examination pass rates, school inspection outcomes, and enrollment statistics —measures that are insufficiently sensitive to the classroom-level processes driving human capital accumulation.

In response, this study proposes the Education Quality Index (EQI) as an integrated, empirically grounded composite measure of secondary education quality. The EQI is specifically designed to support evidence-based human capital governance by integrating instructional quality, school climate, equity, and governance dimensions within a unified monitoring framework aligned with the sustainable development of human capital.

A distinctive feature of the proposed EQI

is that dimensional weights are derived empirically from the HLM estimates rather than assigned by expert judgment, ensuring that each dimension's weight reflects its actual contribution to student learning outcomes. The raw weight for dimension d is computed as the sum of absolute standardized HLM coefficients:

$$W_d^{raw} = \sum_{j=1}^{m_d} |\beta_{dj}|$$

where:

- β_dj= the estimated HLM coefficient for indicator j belonging to dimension d,
- md= the number of indicators included under dimension d,
- |β_dj |= the absolute value of the coefficient.

  Absolute values are used because the purpose of weighting is to reflect the strength of association with learning outcomes, regardless
- of whether the relationship is positive or negative. Negative coefficients still indicate substantively important dimensions, but their signs are retained later when interpreting performance.

The normalized weight for each dimension is then calculated as:

$$W_d = \frac{W_d^{raw}}{\sum_{d=1}^{n} W_d^{raw}}$$

so that:

$$\sum_{d=1}^{n} W_d^{\sum_{d=1}^{n} W_d = 1} = 1$$

This produces a set of weights that sum to 1 and can be directly used in the EQI.

The EQI comprises four dimensions whose weights reflect the relative importance of each for human capital development through secondary education (Table 5).

Table 5

EQI dimensions, indicators, and empirically derived weights

Dimension	Key Indicators	Normalized Weight
1. Instructional Quality	Adaptation, teacher-directed instruction, reading engagement, digital teaching, teacher support, teacher interest	0.611
2. School Climate and Safety	Disciplinary climate, bullying prevalence, truancy	0.183
3. Inclusion and Equity	Cooperative learning, parental involvement, support for diverse needs	0.156
4. Governance and Feedback	Teacher feedback quality, institutional effectiveness	0.050

Source: Author's calculations based on HLM results. Weights reflect absolute standardized β coefficients from the final model.

The dominance of Instructional Quality (W = 0.611) confirms that classroom processes are the primary mechanism through which secondary schools contribute to human capital development. This finding directly challenges resource-centric conceptions of education quality and suggests that Uzbekistan's reform agenda should prioritize pedagogical capacity building alongside infrastructure investment.

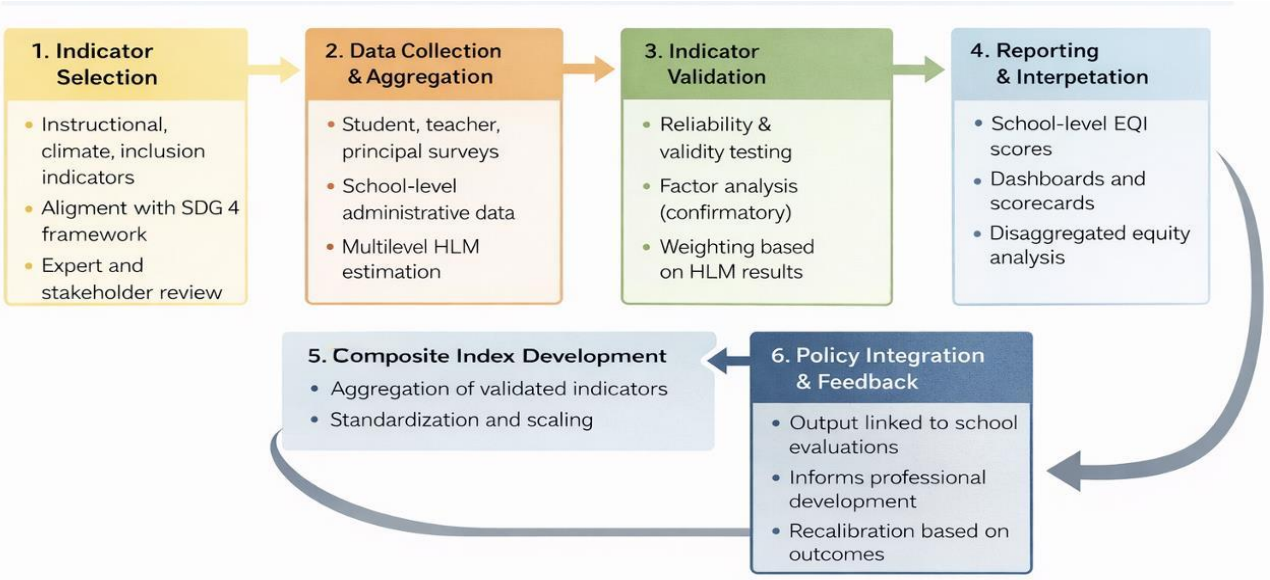


Figure 4. EQI development process: from indicator selection to evidence-based human capital policy —Source: Author's elaboration based on quality assurance frameworks and HLM results

As illustrated in Figure 4, the EQI methodology integrates five stages: (1) indicator selection aligned with SDG4, national human capital development priorities, and PISA frameworks; (2) multilevel HLM estimation to quantify the contribution of each dimension; (3) CFA-based construct validation; (4) standardized composite index construction using normalized weights; and (5) policy feedback through dashboards, school-level scorecards, and regional benchmarking. Embedded within an Evidence-Based Reform Cycle, the EQI enables continuous monitoring, policy adjustment, and institutional learning, thereby constituting an operational governance mechanism for sustainable human capital development.

This study contributes to the literature on education quality and human capital development in transition economies through two primary empirical and methodological advances. Empirically, it provides the first three-level HLM analysis of instructional quality determinants of digital reading literacy across seven post-Soviet countries using PISA 2022 data, demonstrating that school-level instructional processes — particularly digital skills instruction, adaptive teaching, and reading engagement — exert substantially stronger effects on human capital outcomes than student background characteristics or country-level policy variation.

Methodologically, it develops an evidence-based Education Quality Index (EQI) in which dimensional weights are derived from

multilevel econometric estimates, producing a more valid and actionable monitoring instrument than equal-weighted or expert-assigned alternatives. By embedding the EQI within a human capital development framework, the study reconceptualizes education quality assessment as an integral component of national human capital governance rather than a technical accountability exercise.

From a policy perspective, the findings carry direct implications for Uzbekistan and analogous transition economies. The prominence of instructional quality — and particularly teachers' capacity to develop digital literacy — suggests that sustainable improvements in human capital require investment in teacher professional development, adaptive pedagogy, and digitally enriched classroom environments, rather than structural or administrative reforms alone. The negative association between formal learning time and digital reading performance further suggests the need to redesign instructional time to allow for autonomous digital practice.

This study has several limitations that warrant acknowledgment. First, the cross-sectional design prohibits causal inference; longitudinal and quasi-experimental designs are needed to establish causality. Second, reliance on student self-report measures of instructional quality introduces potential subjective bias, as students' perceptions of their teachers do not always reflect actual classroom practice (Fauth et al., 2014) [13]. Third, the EQI has been validated using post-Soviet PISA data, and its generalizability to other national contexts requires further testing. Future research should address these limitations, incorporate teacher- and principal-reported measures of instructional practice, and explore school-level mechanisms mediating the relationship between instructional quality and human capital outcomes.

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