

Cognitive Augmentation or Cognitive Offloading? Artificial Intelligence in Education and Lifelong Learning

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Abstract:

Research on artificial intelligence (AI) and education has developed across largely separate domains, including learning outcomes, academic integrity, institutional governance, and lifelong-learning demand. This study integrates these domains through a common framework distinguishing cognitive augmentation, where AI supports human thinking, from cognitive offloading, where it substitutes for it. It synthesizes 2025–2026 evidence from the OECD, UNESCO, MIT, RAND Corporation, UC Berkeley, HEPI, Gallup, the Walton Family Foundation, official Türkiye sources, and triangulated market data. PISA 2025 findings covering approximately 760,000 students across 91 countries and economies provide cross-national evidence: students who did not use AI to draft assignments outperformed those who did, while frequent users trained to critically evaluate AI-generated information performed better than those without such training. Additional evidence shows short-term AI-supported performance gains without equivalent retained learning, discipline-specific patterns of AI-assisted academic misconduct, rapidly increasing AI-generated coursework, and widespread teacher AI use despite limited formal governance. Türkiye is examined as a policy case linking economy-wide and education-specific AI strategies. Overall, the findings indicate that AI's educational impact depends less on the technology itself than on pedagogical design, assessment redesign, and institutional governance capacity.

Keywords: artificial intelligence, educational technology, lifelong learning, digital pedagogy, learning analytics, academic integrity, international assessment (PISA)

1. Introduction

Artificial intelligence in education is no longer a future scenario; it is the everyday reality of classrooms, universities, and lifelong-learning programs. The rapid diffusion of generative AI (GenAI) tools after 2023 is simultaneously transforming learning processes, the nature of the teaching profession, and the business models of educational institutions [19]. This study statistically synthesizes international reports, national surveys, and market data published in 2025–2026 to assess AI's impact on education and lifelong learning, presenting both its contributions and its risks.

Existing evidence on this topic has accumulated largely along four separate tracks. Research on student learning outcomes documents short-term performance gains that are not reflected in retained learning [19], [24]. Research on academic integrity documents rising, discipline-specific rates of AI-assisted misconduct [6], [27]. Research on teacher and institutional governance documents a widening gap between adoption and formal oversight [10]. Research on lifelong learning and platform markets documents accelerating demand alongside considerable measurement uncertainty [11], [7]. These four literatures rarely engage with one another: studies of student misconduct seldom cite teacher-governance data, and market-sizing reports seldom engage with pedagogical-outcome evidence, even though all four describe symptoms of the same underlying condition—whether AI use is structured to support human thinking or to substitute for it. This study addresses that gap by synthesizing evidence from all four domains within a single analytic frame, the distinction between cognitive augmentation and cognitive offloading, and by testing this frame, for

the first time in this literature, against a cross-nationally representative dataset (PISA 2025) rather than national or institutional samples alone [20].

Guided by this gap, the study addresses four research questions: (RQ1) How is AI use associated with student learning outcomes, and does this relationship differ between short-term performance and retained learning? (RQ2) To what extent do the PISA 2025 findings [20] support the distinction between cognitive augmentation and cognitive offloading proposed in the literature? (RQ3) What is the extent of the gap between AI adoption and institutional governance capacity among teachers and educational institutions, and how does this gap manifest across national contexts (Türkiye, the United States, and the United Kingdom)? (RQ4) What do these findings imply for the design of lifelong-learning policy, including Türkiye's own national AI-literacy initiatives?

2. Literature Review

2.1 Learning Outcomes and the Performance–Retention Divide

UNESCO's [30] and the OECD's [19] flagship reports converge on a single normative claim despite different starting points: UNESCO frames AI as a catalyst that forces education systems to rethink their goals and values, while the OECD's Digital Education Outlook 2026 [19] focuses on the practical conditions under which GenAI use translates into learning. Read together, both conclude that AI's potential to strengthen learning is conditional on pedagogical intent rather than on access to the technology itself—a claim empirically supported by the OECD's own Turkish field data, in which short-term exercise performance rose sharply with GenAI access, but this gain did not carry over into exam results [19]. RAND Corporation [24] nationally representative U.S. panel data extend this finding temporally rather than merely cross-sectionally: AI use for homework rose from 48% to 62% of students within seven months, and the share of students who believe this use harms critical thinking rose in parallel (from 54% to 67%), suggesting that the performance–retention divide identified in the Turkish sample is not a local artifact but a pattern that intensifies as adoption accelerates. What neither source can establish, because both are single-country or single-report findings, is whether this divide holds under cross-nationally representative conditions—a gap this study addresses using PISA 2025.

2.2 Academic Integrity: Convergent Findings and Disciplinary Variation

Three independent evidentiary strands converge on the same qualitative conclusion while disagreeing on mechanism and magnitude. UC Berkeley's Science-published study of 95,513 undergraduates finds a strong positive association between AI-use frequency and estimated misconduct, but its authors explicitly caution that the design cannot distinguish causation from a shared underlying trend [6]. RAND's [24] data show that U.S. secondary-school students' own definitions of misconduct are narrowing more slowly than their AI use is expanding—a normative rather than behavioral mechanism entirely absent from the Berkeley design. HEPI's [27] three-wave UK undergraduate panel isolates a third, temporal mechanism: the share of students submitting AI-generated text directly as coursework quadrupled between 2024 and 2026, tracking the growth of overall AI use almost exactly, which suggests a diffusion process rather than a step change in student ethics. None of the three sources, taken alone, could support a claim about mechanism; read together, they indicate that rising misconduct reflects some combination of behavioral diffusion, shifting norms, and possibly a shared confound—and that the risk is concentrated in disciplines and assessment formats that reward writing-heavy, single-draft output [6].

2.3 Teacher and Institutional Governance: A Cross-National Adoption–Governance Gap

A comparatively underexplored strand of the literature concerns the teacher- and institution-side of AI adoption, as distinct from student-side usage examined above. Here the U.S., UK, and Turkish evidence base converge on a single structural finding despite covering different actors and institutions. In the United States, a Gallup survey conducted with the Walton Family Foundation finds that most K–12 teachers already use AI weekly, yet only a small minority work in a school with a formal AI policy or have received any structured training [10], [25]. In the United Kingdom, HEPI's [27] panel finds the mirror image on the student side: near-universal personal AI use coexists with limited institutional encouragement or provision of AI tools. In Türkiye, the Ministry of National Education's own AI in Education Policy Document and Action Plan (2025–2029) [16] formally commits to teacher training as one of its four strategic goals, yet Şişman's [28] independent policy assessment of that same rollout finds that teacher-facing materials remain concentrated on introducing AI tools rather than on classroom-level pedagogical application—the same adoption-ahead-of-governance pattern documented quantitatively in the U.S. and UK data, now observed qualitatively

even where a formal governance framework already exists. This convergence across three institutionally very different national contexts is one of this study's central synthesized findings, developed further in Section 4.4 and Section 4.6.

2.4 Conceptual Framework: Cognitive Augmentation and Cognitive Offloading

The three syntheses above point to a single underlying distinction that this study adopts as its analytic framework. Cognitive augmentation describes AI use in which the technology supports a learner's own thinking process—requesting alternative explanations of a concept, using AI as an interlocutor to identify gaps in an argument, or checking the grammar of an already-drafted text—a pattern the OECD explicitly links to genuine learning gains when guided by clear pedagogical intent [19]. Cognitive offloading describes AI use in which the technology substitutes for the learner's own thinking—submitting AI-generated work as one's own, bypassing the research and question-formation process that underlies genuine knowledge internalization [19]. TEDMEM's [28] synthesis of the Turkish and international evidence describes the same substitution pattern under the closely related term “cognitive transfer/offloading” and extends it to a second, less-discussed risk: young people's offloading of emotional and belief-formation processes onto AI systems. A nationally representative U.S. survey conducted by RAND Corporation researchers with Harvard Medical School, published in *JAMA Pediatrics*, found that 19.2% of adolescents and young adults (approximately 8.2 million people) turned to AI chatbots for emotional support when feeling sad, angry, or anxious in 2025, up more than 40% from 13.1% a year earlier, with almost two-thirds never disclosing this use to anyone [14], [24].

This augmentation/offloading distinction functions as this study's central analytic lens: each of the four domains reviewed above—learning outcomes, academic integrity, teacher governance, and lifelong-learning demand—is read as evidence of where, and under what institutional conditions, AI use tips toward one pole or the other.

The literature approaches the impact of artificial intelligence on education from two distinct normative frameworks. UNESCO's [30] report, “AI and the Future of Education: Disruptions, Dilemmas, and Directions,” argues that artificial intelligence should not be treated merely as an automation tool but as a catalyst that forces education systems to rethink their goals and values. The OECD [19], by contrast, focuses more on the practical “how” question, examining effective uses of generative AI for learning in its Digital Education Outlook 2026 report. Read together, the two reports show that AI's potential to strengthen learning depends on pedagogical intent, a critical framework, and structural design.

MIT's institutional report “AI and Education,” published in 2026 (13), comprehensively examines the effects of generative AI on teaching, learning, and research processes. According to the report, students use generative AI intensively; alongside curiosity and creativity, this process is also accompanied by negative feelings such as anxiety, isolation, and loss of self-confidence. RAND Corporation's 2026 study [24] finds that a large majority of middle- and high-school students used AI for their homework throughout 2025. The most comprehensive study to date on undergraduate students, published by UC Berkeley in May 2026, reports a striking correlation: as the frequency of AI use increases, so do academic-integrity violations; however, the researchers caution that it remains unclear whether this reflects causation or a shared underlying trend [6].

Another key distinction in the literature is that AI's impact on learning depends on how it is used: “cognitive augmentation” versus “cognitive offloading.” Cognitive augmentation refers to students using AI as a tool to support their own thinking—asking it to explain a concept through different examples, debating with it to identify gaps in an argument, or having it check the grammar of a text—and it strengthens learning. Cognitive offloading, by contrast, means students hand over the thinking itself to AI, submitting an assignment as generated; in this case no research process takes place, no question-forming skill develops, and knowledge is not genuinely internalized [4].

There is also notable movement at the institutional and policy level. The African Union has adopted the Continental Education Strategy for Africa 2026–2035 (CESA 2026–2035), which establishes a continent-wide framework for advancing inclusive, equitable, and quality education over the coming decade [2]. In Kenya, nearly 400,000 children are using EIDU, a structured-pedagogy solution highlighted by the World Bank in the broader context of AI-enabled educational technology in Africa [2]. In Nigeria, a six-week after-school intervention combining generative AI-based tutoring with teacher guidance produced statistically significant learning gains. A randomized evaluation reported an overall improvement of approximately 0.31 standard deviations across English, AI knowledge, and digital skills, while participating students also demonstrated gains in regular curricular examinations [8]. These developments suggest that the growing role of AI and digital technologies in education is occurring alongside, rather than independently of, teacher involvement and pedagogical design.

3 Data and Method

3.1 Research Design

This study follows a desk-research, secondary-data-synthesis design rather than a primary empirical study. This choice follows directly from the research gap identified in Section 1: because the relevant evidence is already scattered across international policy reports, national surveys, discipline-representative institutional studies, and market-research publications, the analytical contribution of this study lies in systematically compiling, cross-checking, and synthesizing that evidence within a single conceptual frame—cognitive augmentation versus cognitive offloading—rather than in generating new primary data.

3.2 Data Sources and Inclusion Criteria

Sources were included if they met three criteria: (i) a publication or data-collection window of January 2025 to September 2026, capturing evidence contemporaneous with the post-2023 acceleration of generative AI adoption; (ii) a stated, reportable methodology (a defined sample, survey instrument, or market-sizing methodology) allowing the reader to assess evidential weight, which excludes purely anecdotal or promotional material; and (iii) direct relevance to at least one of the study's four thematic domains. Four categories of sources met these criteria: (a) international policy reports and cross-national assessments (OECD Digital Education Outlook [19] and PISA 2025 [20]; UNESCO, [30]; (b) peer-reviewed and peer-institution research [6], [14], [13]; (c) nationally representative panel surveys [24], [10], [27]; and (d) official national policy documents and market-sizing reports (Türkiye's national AI Action Plan and the Ministry of National Education's AI-in-Education Policy Document; Grand View Research, Mordor Intelligence, and Research and Markets [23], triangulated rather than treated as a single authoritative figure) [15], [16].

Sources were excluded or replaced, where a claim could not be traced to a primary or official publication. This applied to three claims retained in earlier drafts of this synthesis: a general-media report of global AI market size was replaced with the underlying Statista Market Insights forecast, which was itself citing Statista [26]; a general-media summary of a Turkish teacher-training program was replaced with the Ministry of National Education's own official AI in Education Policy Document and Action Plan [16] and a general-media commentary piece on Turkish AI-education policy was replaced with the underlying TEDMEM [28] policy report it was reporting on, together with the official Turkish Statistical Institute bulletin underlying its demographic claim [29]. Commercial market-sizing reports were retained despite their lower academic standing because no official or peer-reviewed alternative exists for AI-in-education market size; their inherent uncertainty is addressed directly, rather than concealed, through the triangulation strategy reported in Table 4.

3.3 Data Extraction and Harmonization

For each source, the study extracted the reported sample size, data-collection window, and point estimate(s) relevant to the four thematic domains. Where multiple sources reported estimates for conceptually similar indicators (for example, global AI-in-education market size), estimates were harmonized into a common comparison table (Table 4) rather than averaged or reconciled into a single figure, since the underlying providers apply different scope definitions. Where a single source reported a trend across more than one wave (e.g., RAND's 2025 panel [24] or HEPI's 2024–2026 panel [27]), both endpoints were retained to preserve the direction and magnitude of change rather than collapsing them into a single cross-sectional value.

3.4 Analytical Strategy

Given the desk-research design, the analytical strategy is descriptive and comparative rather than inferential: percentage changes, growth rates, and cross-source ratio comparisons are reported directly from the underlying sources, and no new significance testing was performed on data the study did not itself collect. The comparative step consists of reading each domain's evidence against the cognitive augmentation/offloading framework to classify whether the reported pattern is consistent with AI use supporting learner thinking or substituting for it, and, where a single domain contains evidence of both—as in the PISA 2025 findings on guided versus unguided AI use—reporting the conditioning variable that distinguishes the two.

3.5 Limitations

Three limitations follow directly from this design. First, because the study synthesizes existing correlational evidence rather than collecting original experimental data, its conclusions are associative rather than causal; where a source

itself identifies this limitation (for example, Chirikov et al. [6], caution that AI use and misconduct may share an unobserved underlying cause), this study reports that caveat rather than overriding it. Second, the market-sizing literature (Table 4) shows that even ostensibly quantitative indicators are sensitive to provider-specific scope definitions, so cross-source comparisons in this domain should be read as bounding a plausible range rather than converging on a precise value. Third, Türkiye is examined here as a single, purposively selected national case rather than as one of a representative sample of countries: it was selected because it is the only national context in the reviewed evidence for which both an economy-wide AI Action Plan and a sector-specific AI-in-education policy document are simultaneously observable, allowing the two governance levels to be compared directly. The generalizability of the Turkish findings to other national contexts is accordingly not assumed and is flagged as a direction for future comparative research in Section 6.

4 Findings and Statistical Analysis

4.1 Learning Outcomes

The reviewed evidence shows a consistent performance–retention divide rather than an unconditional benefit. In the Turkish field study, short-term math-exercise performance rose sharply with GenAI access, but this gain did not carry over proportionally into exam results [19], [3]. RAND's [24] U.S. panel data corroborate this at a larger scale and over time: reported homework AI use rose from 48% to 62% of students within seven months, with the increase concentrated among middle- and high-school students. Table 1 reports these and related indicators; addressing RQ1, the pattern across both sources is that AI access reliably raises immediate output but does not reliably raise retained learning.

4.2 International Assessment Evidence: PISA 2025

The OECD's PISA 2025 results, released on 8 September 2026 and based on approximately 760,000 15-year-old students across 91 countries and economies, provide the first large-scale, cross-nationally representative test of the augmentation/offloading framework (RQ2). Consistent with the offloading hypothesis, students who reported not using AI to draft text for writing assignments outperformed those who did; consistent with the augmentation hypothesis, among frequent AI users specifically, those taught to critically assess the quality of AI-generated information outperformed those who received no such guidance [20]. The same assessment found that more than one in four students reported frequent classmate distraction by digital devices during science lessons, itself associated with lower performance, lower engagement, and weaker school connectedness [20b]. Table 1 situates the PISA 2025 sample alongside the study's other market and assessment indicators. Together, these findings provide the cross-national validation this study's literature review identified as absent and directly confirm that the conditioning variable separating augmentation from offloading is guidance quality rather than AI access per se.

Table 1. Global AI-in-Education and Lifelong-Learning Market Indicators (2026)

Metric	Figure	Source
Global AI market size (2026)	\$617.62 billion	Statista [26]
Global AI market CAGR (2026-2032)	~14.8%	Statista [26]
Global e-learning services market (2024 → 2030 projected)	\$299.67B → \$842.64B	Grand View Research [11]
Coursera cumulative registered learners (Q1 2026)	205 million	Coursera, Inc. [7]
Duolingo daily active users / paid subscribers (Q1 2026)	56.5M / 12.5M	Duolingo, Inc. [9]

Metric	Figure	Source
PISA 2025 sample (student assessment used in Section 4.2)	~760,000 students, 91 countries/economies	OECD [20]

4.3 Academic Integrity

The three converging strands identified in Section 2.2 are quantified in Table 2. The Berkeley Science study finds that roughly two-thirds of undergraduates used generative AI during the 2023–2024 academic year, with 37% reporting frequent or regular use, and with estimated misconduct rates varying by discipline from approximately 17% in economics and 16% in journalism to markedly lower rates in biology [6]. HEPI's [27] UK panel finds that the share of students directly incorporating AI-generated text into submitted coursework rose from 3% in 2024 to 12% in 2026, a fourfold increase tracking the growth of overall undergraduate AI use from 66% to 95% over the same period. RAND's [24] U.S. secondary-school data show that only 45% of students consider AI-generated direct homework answers to be cheating, with far fewer extending that judgment to AI-assisted brainstorming or fact-checking, and that only about one-third of schools have adopted a schoolwide AI policy. Read together, these figures confirm the discipline- and format-specific concentration of integrity risk identified in Section 2.2.

Table 2. Learning Outcomes and Academic Integrity Indicators

Indicator	Value	Source
Short-term increase in math-exercise performance with GenAI access (Turkey sample, ~1,000 students)	+48%	OECD [19]
Improvement in exam results relative to the exercise-performance gain	Not proportional	OECD [19]
US students (middle/high/college) using AI for homework, May→Dec 2025	48% → 62%	Schwartz & Diliberti, [24]
US students believing weekly AI use harms critical thinking (vs. ~10 months earlier)	67% (up from 54%)	Schwartz & Diliberti, [24]
Undergraduate GenAI use, 20 US public research universities, 2023–24 (n = 95,513)	~66% (37% frequent)	Chirikov et al. [6]
Estimated AI-assisted misconduct rate, highest-risk disciplines (Economics / Journalism)	~17% / ~16%	Chirikov et al. [6]
UK undergraduates including AI-generated text directly in assessed work, 2024→2026	3% → 12%	HEPI [27]
Teacher training as a strategic goal, AI in Education Policy Document (Türkiye, 2025–2029)	4 goals / 15 policies / 40 actions	Ministry of National Education of Türkiye [16]

4.4 Teacher Capacity and Institutional Governance

Addressing RQ3, Table 3 summarizes teacher- and institution-side indicators across the three national contexts reviewed in Section 2.3. In the United States, Gallup's survey with the Walton Family Foundation finds that 60% of

K–12 teachers used some form of AI during the 2024–2025 school year, with weekly users saving close to six hours per week, yet only 19% worked in a school with a formal AI policy and 68% received no formal training [10]. Teachers' own risk assessments were more cautious than their usage rates suggest: 57% believed weekly student AI use would decrease independent thinking, and 52% believed it would decrease critical thinking, even as similar shares reported concrete instructional benefits. In the United Kingdom, only 36% of undergraduates felt institutionally encouraged to use AI and only 38% reported being provided with institutional AI tools, despite near-universal personal use [27]. In Türkiye, the Ministry of National Education's AI in Education Policy Document and Action Plan (2025–2029) commits formally to teacher training as one of its four strategic goals, structured around 15 policies and 40 action steps, including a dedicated AI Ethics Board and in-service training programs delivered through the national Teacher Information Network platform [16]. Yet TEDMEM's [28] independent assessment of this same rollout finds that teacher-facing materials remain concentrated on introducing AI tools rather than on classroom-level pedagogical application—the same adoption-ahead-of-governance pattern documented quantitatively in the U.S. and UK data, now observed even where formal policy architecture already exists.

Table 3. Teacher-Side and Institutional AI Governance Indicators (2026)

Indicator	Value	Source
US K-12 teachers using some form of AI, 2024-2025 school year	60%	Gallup / Walton Family Foundation [10]
US teachers working at a school with a formal AI policy	19%	Gallup / Walton Family Foundation [10]
US teachers reporting no formal AI training (self-taught)	68%	Gallup / Walton Family Foundation [10]
UK undergraduates feeling institutionally encouraged to use AI	36%	HEPI [27]
Turkish AI-in-Education Policy Document: strategic goals / policies / actions	4 / 15 / 40	Ministry of National Education of Türkiye [16]
Turkish teacher materials assessed as “tool-introduction” level rather than pedagogical	Qualitative finding	TEDMEM [28]

4.5 Lifelong-Learning Market

The global AI market is projected to reach \$617.62 billion in 2026 [26], and the broader e-learning services market is projected to grow from \$299.67 billion in 2024 to \$842.64 billion by 2030 [11]. Platform-level data corroborate this trajectory (Table 1): Coursera reached 205 million cumulative registered learners in Q1 2026 [7], and Duolingo reached 56.5 million daily active users and 12.5 million paid subscribers over the same period [9]. However, triangulating across four independent market-research providers reveals substantial disagreement in sizing the AI-in-education segment specifically, with 2025 base-year estimates ranging from \$6.90 billion to \$8.3 billion and long-run forecasts ranging from \$42.5 billion (by 2030) to \$136.8 billion (by 2035) depending on provider scope (Table 4). This divergence is best interpreted not as measurement error but as evidence that vendor-revenue-based market sizing in this segment remains highly scope-dependent (Section 3.5).

Market-size growth also diverges from near-term private investment behavior: global EdTech venture funding rose to approximately \$2.6 billion in 2025 but fell to \$512 million across 63 deals in the first quarter of 2026, a 24% quarter-on-quarter decline [12]. At the platform level, the sector shows bifurcation consistent with the augmentation/offloading distinction: Duolingo, structured around guided, gamified practice, reported USD 1,037.6 million in FY2025 revenue and continued double-digit user growth [9], while Chegg, historically associated with direct homework-answer

provision, reported substantially lower FY2025 revenue of USD 376.9 million [5]—consistent with freely available general-purpose GenAI tools disrupting answer-provision business models more severely than structured-practice models.

Table 4. AI-in-Education Market Size Estimates by Source, 2025-2026 (Illustrating Methodological Divergence)

Source	2025 Estimate	2026 Estimate	Forecast CAGR	Long-run Forecast
Grand View Research [11]	\$8.3B	\$11.4B	25.9% (to 2033)	\$57.2B by 2033
Precedence Research [21]	\$7.05B	\$9.58B	34.5–36.0% (to 2035)	\$136.8B by 2035
Precedence Research [21]	\$7.52B	\$10.6B	40.9–41.5% (to 2030)	\$42.48B by 2030
Mordor Intelligence [18]	\$6.90B	—	—	\$41.01B by 2030

Note: Estimates differ because providers define the “AI-in-education” market boundary differently; the range should be read as an indicator of measurement uncertainty rather than as directly comparable point forecasts.

4.6 Lifelong Learning and National AI Policy in Türkiye

Addressing RQ4, Türkiye offers a purposively selected case in which two governance levels operate simultaneously. At the economy-wide level, the Türkiye Artificial Intelligence Action Plan (2026–2030), in force since 18 August 2026 under Presidential Circular No. 2026/9, sets an explicit lifelong-learning target of AI-literacy training for five million citizens within two years through workshops in all 81 provinces, alongside targets of 10,000 advanced AI specialists and 100,000 AI application professionals (Ministry of Industry and Technology, 2026; Presidency of the Republic of Türkiye, 2026). At the sector-specific level, the Ministry of National Education's AI in Education Policy Document and Action Plan (2025–2029) pursues four goals—building an AI culture, expanding AI content in curricula, supporting AI-assisted management and decision-making, and strengthening technology and data-analytics infrastructure—through 15 policies and 40 action steps, including AI-integrated national platforms (EBA, ÖBA, HEMBA, DiLiM) and an AI Ethics Board [16].

Table 5 summarizes these targets alongside two independent, officially sourced indicators of scale and reach. First, the five-million-citizen AI-literacy target is roughly twelve times larger than the population directly addressed by the education-sector policy document's teacher-training component, indicating that the sector-specific initiative reaches only a fraction of the wider adult and lifelong-learning population the economy-wide plan now targets. Second, official Turkish Statistical Institute data show that 39.4% of AI users in Türkiye are under the age of 25 [29], a demographic skew that TEDMEM's [28] independent assessment interprets as a risk that, absent targeted outreach, the benefits of national expansion may initially accrue to younger, already digitally engaged citizens rather than to the older adult and workforce-re-skilling populations lifelong-learning policy conventionally prioritizes. TEDMEM's [28] comparative assessment further finds that Turkish university students' self-reported AI use roughly doubled in two years (from approximately 30% to 68%), outpacing the development of institutional policy—the same governance lag documented for teachers in Section 4.4, now observed among Turkish higher-education institutions specifically.

Table 5. Türkiye's Two-Level AI Governance Architecture: Lifelong-Learning-Relevant Targets

Target / Indicator	Figure	Source
Citizens to receive AI-literacy training within two years (economy-wide, 81 provinces)	5,000,000	Ministry of Industry and Technology [15]

Target / Indicator	Figure	Source
Advanced AI specialists / application professionals to be trained	10,000 / 100,000	Ministry of Industry and Technology [15]
Projected AI-related economic value by 2030	> 1 trillion TRY	Presidency of the Republic of Türkiye [22]
AI-in-Education Policy Document: goals / policies / actions (education sector only)	4 / 15 / 40	Ministry of National Education of Türkiye [16]
AI users in Türkiye under age 25	39.4%	Türkiye Statistical Institute [29]
University students' self-reported AI use, two-year change	~30% → 68%	TEDMEM [28]

The findings answer the study's four research questions, but the more analytically important task is explaining why the observed patterns occur. The performance–retention divide (RQ1) is not evidence that AI use is inherently unproductive; PISA 2025's guided-versus-unguided comparison (RQ2) shows that the divide closes when students are explicitly taught to evaluate AI-generated output rather than accept it. In other words, the mechanism is not the technology's capability but the presence or absence of a pedagogical layer that converts AI output into a prompt for further thinking rather than a substitute for it. This is precisely why the academic-integrity findings cluster by discipline and assessment format rather than by student population: writing-heavy, single-draft assessments offer no natural point at which a student's own reasoning must be made visible, so offloading is structurally easier there than in formats requiring iterative, supervised, or oral demonstration of thinking.

The adoption–governance gap (RQ3) is similarly explicable rather than merely descriptive. In all three national contexts, institutional response has lagged individual adoption not because governance was unwanted but because it requires different resources than adoption does: adoption requires only that a tool be available and useful, whereas governance requires dedicated funding for training time, monitoring infrastructure, and revised assessment rubrics—investments that compete with other budget priorities and that are politically harder to justify while the technology's effects remain contested. Türkiye's case is instructive precisely because it shows that a formal governance framework is not sufficient by itself: the Ministry of National Education's policy document commits explicitly to teacher training, yet TEDMEM's [28] assessment finds the resulting materials still concentrated on tool introduction rather than pedagogical integration, suggesting that the binding constraint is not the existence of policy text but the translation of that text into classroom-level practice—the same distinction the OECD [19] draws between AI access and pedagogically guided AI use.

For assessment design specifically, this reasoning implies that the relevant policy lever is not restricting AI access but redesigning what a satisfactory assessment artifact looks like: assessments that require visible intermediate reasoning, iterative revision under supervision, or oral defense of written work restore the conditions under which offloading is structurally difficult, regardless of how capable the underlying AI tools become. This reframes the lifelong-learning implication (RQ4, Section 4.6) as well: Türkiye's five-million-citizen AI-literacy target will only produce the augmentation-consistent outcomes documented in Section 4.2 if its delivery mechanism embeds the same pedagogical guidance PISA 2025 identifies as decisive, rather than treating literacy as equivalent to access.

5 Conclusion

This study set out to address a literature in which student-learning, academic-integrity, teacher-governance, and lifelong-learning evidence had accumulated separately despite describing the same underlying phenomenon. Synthesized within a single cognitive augmentation/offloading framework, the evidence converges on one core finding: AI's contribution to education is conditional rather than unconditional, and the conditioning variable in every

domain examined—learning outcomes, integrity, teacher practice, and national policy—is the presence of pedagogical guidance rather than the technology's capability.

The study's principal analytical contribution is to show that this conditionality, previously argued from national or institutional evidence alone, now holds under cross-nationally representative conditions: PISA 2025 confirms it directly, and Türkiye's two-level governance architecture (an economy-wide AI Action Plan alongside a sector-specific education policy document) illustrates it at the level of national policy design, showing that formal governance commitments do not by themselves guarantee pedagogically guided implementation.

For policy and practice, the implication is that investment should target the guidance layer rather than access alone: assessment redesign toward visible reasoning and iterative, supervised work; teacher training that moves beyond tool introduction to classroom-level pedagogical integration; and lifelong-learning programs, including Türkiye's own five-million-citizen target, that build in the same guided-use conditions PISA 2025 identifies as decisive rather than treating literacy as equivalent to exposure.

This study's associative, secondary-data design means these conclusions describe consistent patterns rather than established causal mechanisms. Future research should prioritize the PISA 2025 Learning in the Digital World assessment, expected in 2027, and the forthcoming ICILS cycle to test these patterns longitudinally; extend the comparative governance analysis in Section 4.6 to national contexts beyond Türkiye; and track whether Türkiye's AI-literacy expansion measurably closes, or instead reproduces, the demographic and governance gaps identified here.

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