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Artificial Intelligence Competency Frameworks in Education: An Analytical Review

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Abstract

The rapid integration of Artificial Intelligence (AI) into education has generated an urgent need for structured competency frameworks guiding ethical adoption, pedagogical transformation and governance alignment. However, comparative global analysis of AI competency frameworks remains limited. This study conducts a systematic comparative policy review of six major AI competency frameworks developed by UNESCO, OECD-European Commission, the European Digital Education Hub, India and Lebanon. Using a structured screening and analytical comparison approach (PRISMA-informed document analysis), frameworks were examined across competency domains, progression levels, ethical orientation, governance emphasis, technical depth and implementation strategies. Findings reveal strong convergence around AI literacy, human-centered ethics, pedagogical integration and professional development. Divergences emerge in regulatory embedding, governance centrality and technical specialization. The study identifies critical gaps in empirical validation, assessment design, contextual adaptation and measurable proficiency benchmarks. The findings contribute to AI education policy scholarship by proposing a structured comparative model for evaluating AI competency frameworks and offering implications for global AI literacy governance.

Keywords: AI in Education, Competency, AI Competency Frameworks, Analytical Review

Introduction

AI has been applied across sectors (e.g., health, business and education) to enhance both innovation and efficiency (Ng et al., 2021). Various initiatives and reports are being developed in education systems across the world, including the United States, Finland and the Netherlands, to prepare young learners for the AI age (Chiu et al., 2023). Artificial Intelligence (AI) has brought transformative changes in education, offering innovative tools and approaches that can enhance teaching and learning (Chakravorti, 2022; Gill et al., 2023; Grubaugh & Levitt, 2023). AI in education promises to support students with special needs, reduce school dropout, personalize learning, support decision- making, generate feedback, assess new skills, etc. (Bentley et al., 2018; Brundage, 2019; Vincent-Lancrin & van der Vlies, 2020).

A recent UNESCO global survey, which included over 450 schools and universities, revealed that fewer than 10% of them have established institutional policies or formal guidance regarding the use of generative AI applications (UNESCO survey, 2023). The rise of AI in education has provided food for discussion on teachers' AI competencies.

Artificial Intelligence (AI) has rapidly transitioned from a specialized technological innovation to a structural force reshaping educational ecosystems. Generative AI tools, adaptive learning systems, predictive analytics platforms and automated decision-making systems are increasingly embedded across teaching, assessment, administration and policy domains. This transformation extends beyond technological enhancement; it reconfigures epistemic authority, pedagogical agency and governance responsibility. The educational implications of AI are multidimensional. At the classroom level, AI reshapes teacher-student interaction dynamics, introducing new mediating agents in knowledge production. At the institutional level, AI influences curriculum design, assessment practices and learning analytics systems. At the policy level, AI demands regulatory oversight, ethical safeguards and strategic workforce preparation.

In response, international organizations and national governments have developed AI competency frameworks aimed at guiding responsible integration and structured skill development. These frameworks seek to articulate the knowledge, skills, attitudes and ethical

dispositions necessary for educators, learners and public officials to operate effectively within AI-mediated environments.

Despite this proliferation of frameworks, scholarly analysis remains fragmented. Most studies examine individual frameworks or explore AI literacy conceptually without systematic cross-framework comparison. There is limited research evaluating structural convergence, divergence, governance embedding and policy maturity across global AI competency models. This study addresses that gap by conducting a systematic comparative policy analysis of six major AI competency frameworks. The research is guided by the following questions:

This study addresses that gap.

Research objective of the review

1. What structural similarities exist across major AI competency frameworks?
2. Where do frameworks diverge in governance emphasis and technical depth?

To address the research objectives and research questions, we searched for the AI CFs in with the key words 'Artificial Intelligence', 'Competence framework' or 'Competence models', 'for education' or 'for teacher, students, educators'. Next, the papers were screened to check their suitability for the topic and analysed according to the Construct Claim (Child & Shaw, 2023). By addressing these research objectives and research questions, this study aimed to provide a classified over view of AI competence frameworks that are designed. Furthermore, it high lights the existing similarty in these frameworks, thereby contributing to the ongoing dialogue on how these can best prepare for AI in education.

By synthesizing global frameworks through a structured analytical lens, this study contributes to emerging scholarship on AI governance in education and advances theoretical integration between competency-based education, AI literacy theory and policy convergence frameworks.

Literature Review

The evolution of Artificial Intelligence (AI) competency frameworks in education must be situated within the broader transition from digital competence toward AI-mediated epistemic governance. Early digital competence models such as DigComp 2.2 (European Commission, 2022) conceptualized digital proficiency around information literacy, communication, safety and content creation; however, the emergence of AI introduces qualitatively distinct characteristics including algorithmic inference, probabilistic reasoning, automated decision-making, generative content production and predictive analytics, thereby requiring expanded competence articulation (Mikeladze et al., 2024; Long & Magerko, 2020). Scholars argue that AI competence extends beyond ICT skills to encompass data literacy, algorithm literacy, computational reasoning, design thinking and AI ethics (Mikeladze et al., 2024; Chiu et al., 2024). Long and Magerko (2020) define AI literacy as a set of competencies enabling individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI systems and use AI responsibly across personal, educational and workplace contexts, organizing these competencies around five foundational questions concerning the nature, capabilities, mechanisms, applications and societal perceptions of AI. They further clarify that computational literacy is not a necessary prerequisite for AI literacy, distinguishing user competence from developer expertise (Long & Magerko, 2020). Building upon this foundation, Chiu et al. (2024) differentiate AI literacy (knowledge-oriented) from AI competency (application-oriented), incorporating confidence, collaboration, ethical reasoning and self-reflective mindset as performance dimensions and proposing a five-component framework—technology, impact, ethics, collaboration and self-reflection—co-designed with experienced teachers. This distinction aligns with competency-based education (CBE) theory, which conceptualizes competence as the integrated deployment of knowledge, skills, attitudes and dispositions demonstrated through observable performance (Milini, 2025). Drawing on Blömeke and Kaiser's spectrum of teacher competence, Milini (2025) emphasizes that competence emerges from the interaction between professional knowledge, affective

motivation, situation-specific cognitive skills and observable behavior, a model particularly relevant in AI contexts where educators must interpret algorithmic outputs, evaluate reliability and make pedagogical decisions under uncertainty. Empirical synthesis further supports structural convergence across AI competency models: Zhou et al. (2024), in a systematic review of 20 peer-reviewed studies, classify teacher AI competency frameworks into AI literacy frameworks, TPACK-based frameworks, AI readiness frameworks and professional competency frameworks, identifying recurring constructs such as AI cognition, AI application, AI ethics, AI evaluation and professional development. Similarly, Mikeladze et al. (2024) categorize AI competence frameworks into five modeling approaches within Competence Construct Claims theory (Child & Shaw, 2023)—existing competence model-oriented, competence domain-oriented, process-driven, AI systems-driven and competence level-driven—highlighting both structural diversity and early-stage fragmentation. AI literacy is also grounded in broader information and data literacy traditions; George (2023) demonstrates that evaluative and analytical capacities developed through information literacy education are foundational for critical AI engagement, particularly in contexts where algorithmic bias, data training limitations and automated inference shape knowledge production. Chiu et al. (2024) similarly emphasize data literacy and algorithmic literacy as emerging research priorities in AI education, reinforcing the interdependence between AI competence and data-informed reasoning. Across the literature, human-centered AI (HCAI) principles—including fairness, transparency, accountability, human oversight, data protection and non-discrimination—emerge as normative anchors embedded within AI competency articulation (Mikeladze et al., 2024; Chiu et al., 2024; Milini, 2025). In generative AI contexts, Milini (2025) identifies practical, ethical and critical competences as distinct but interrelated domains, reinforcing the governance-oriented nature of contemporary AI competence. Despite strong thematic convergence around ethical integration, staged progression models and professional development domains (Zhou et al., 2024; Mikeladze et al., 2024), scholarship consistently highlights fragmentation, limited empirical validation, absence of standardized assessment instruments and variability in regulatory embedding across frameworks (Mikeladze et al., 2024; Zhou et al., 2024). Existing research largely analyzes individual frameworks or conceptual definitions rather than conducting structured cross-framework policy comparison, leaving unresolved questions regarding governance centrality, technical depth differentiation, contextual adaptation mechanisms and maturity progression. Consequently, AI competency frameworks should be understood not merely as pedagogical guides but as evolving governance instruments responding to socio-technical transformation, situated within a convergence-divergence dynamic shaped by global normative alignment and national regulatory adaptation (Mikeladze et al., 2024; Zhou et al., 2024; Chiu et al., 2024).

Overview of AI Frameworks

The six Artificial Intelligence (AI) competency frameworks analyzed in this study represent distinct international and national approaches to structuring AI literacy and professional capacity within education systems. While they converge around ethical AI literacy and applied engagement, they differ in domain architecture, progression structures, governance embedding and technical emphasis.

The **UNESCO AI Competency Framework for Teachers (2024)** organizes teacher competencies into five domains: human-centered mindset, ethics of AI, AI foundations and applications, AI pedagogy and AI for professional learning. These domains are structured across three developmental levels—Acquire, Deepen and Create—resulting in fifteen structured competency articulations. The framework is globally oriented and designed for adoption across UNESCO Member States, emphasizing human rights, inclusion, sustainability and teacher agency. Its architecture reflects a staged mastery model but does not prescribe formal assessment instruments.

The **UNESCO AI Competency Framework for Students (2024)** complements the teacher model and structures student AI literacy across four domains: human-centered mindset, ethics of AI, AI techniques and applications and AI system design. Competencies are organized through three progression stages—Understand, Apply and Create—allowing developmental scaling across age groups. The framework emphasizes ethical awareness, algorithmic understanding and active AI co-creation rather than passive use.

The **OECD-European Commission AI Literacy Framework (2025 draft)** adopts a Knowledge-Skills-Attitudes (KSA) architecture and organizes AI literacy into four domains: Engaging with AI, Creating with AI, Managing AI and Designing AI. Unlike the UNESCO frameworks, it does not employ a three-stage mastery model but instead structures competencies along a continuum aligned with measurable assessment. The framework is closely linked to European regulatory developments, including alignment with the EU AI Act and future PISA assessment integration, reflecting strong regulatory embedding.

The **European Digital Education Hub AI Competency Framework (2024)** takes a pedagogically operational approach. Rather than domain-based staging, it differentiates teacher competence across three instructional dimensions: teaching for AI (developing student AI literacy), teaching with AI (integrating AI into classroom practice) and teaching about AI (building technical and conceptual understanding). This framework bridges AI literacy with instructional design and professional development, emphasizing classroom implementation rather than regulatory alignment.

The **India AI Integration Competency Framework (2024)** adopts a governance-centered model structured into three clusters: behavioural competencies, functional competencies and domain-specific competencies. Its primary focus is institutional and administrative capacity rather than classroom pedagogy. The framework emphasizes AI lifecycle management, strategic decision-making and public-sector transformation, positioning AI competence within national digital governance priorities.

The **Lebanon National AI Education Framework (CRDP, 2025)** presents an integrated national model combining AI education policy with teacher and student competency articulation. Student competencies are organized across two levels—Understand and Apply—while teacher competencies follow a two-stage structure—Understand and Cultivate. Unlike purely normative international frameworks, Lebanon's model embeds AI competency directly within national education reform and digital transformation strategies, reflecting strong governance integration and contextual adaptation.

Collectively, these six frameworks share emphasis on ethical AI engagement, applied literacy and professional development. However, they diverge in structural design, progression levels, regulatory embedding, governance centrality and technical specialization. International frameworks prioritize normative guidance and global scalability; regional European models integrate regulatory and assessment alignment; and national frameworks emphasize sovereignty-driven governance and contextual implementation.

Analytical Dimensions

To enable systematic and theoretically grounded comparison across heterogeneous Artificial Intelligence (AI) competency frameworks, this study operationalizes six analytical dimensions derived from competency-based education theory, AI literacy scholarship and governance-oriented policy analysis. These dimensions are informed by prior typological classifications of AI competency frameworks (Mikeladze et al., 2024; Zhou et al., 2024), AI literacy conceptualization models (Long & Magerko, 2020; Chiu et al., 2024) and teacher competence theory (Milini, 2025). Together, they provide a structured lens for examining convergence, divergence and maturity variation across international and national AI competency models.

- **Competency Domain Architecture**

The first dimension examines the structural organization of competencies within each

framework, specifically the number, scope and thematic orientation of domains or clusters. Competency frameworks typically articulate structured domains to organize knowledge, skills and dispositions (Mikeladze et al., 2024). In their critical review of AI competence frameworks for educators, Mikeladze et al. (2024) identify domain-oriented and competence-level-driven architectures as dominant modeling approaches, reflecting theoretical assumptions about how AI capability should be structured. Similarly, Zhou et al. (2024) observe recurring constructs—AI cognition, AI application, AI ethics, AI evaluation and professional development—across 20 reviewed studies. Domain architecture therefore reveals whether AI competence is framed primarily as technical literacy, pedagogical integration, ethical reasoning, or governance capacity.

- **Progression and Mastery Structure**

The second dimension evaluates how frameworks conceptualize developmental progression and mastery. Competency-based education (CBE) theory emphasizes staged performance levels that move learners from foundational knowledge toward applied creation and innovation (Milini, 2025). UNESCO's Acquire-Deepen-Create model exemplifies structured mastery progression, while other frameworks adopt continuum-based approaches. The presence or absence of staged development reflects assumptions about professional growth and learning trajectories. Chiu et al. (2024) differentiate literacy (knowledge acquisition) from competency (applied mastery with confidence), reinforcing the importance of progression models. Thus, this dimension assesses whether AI competency frameworks incorporate explicit performance levels aligned with CBE principles.

- **Ethical and Governance Integration**

Ethical reasoning and governance embedding constitute a critical third dimension. AI literacy literature consistently identifies fairness, transparency, accountability and bias awareness as foundational components of AI competence (Long & Magerko, 2020; Chiu et al., 2024). Mikeladze et al. (2024) further argue that AI competence frameworks increasingly integrate human-centered AI principles, reflecting global normative convergence. However, governance embedding varies substantially across frameworks, with some aligning explicitly with regulatory regimes such as the EU AI Act, while others maintain normative ethical articulation without regulatory integration. This dimension therefore assesses whether ethics functions as a standalone domain, a cross-cutting principle, or a governance-embedded regulatory structure.

- **Technical Depth and AI Literacy Scope**

The fourth dimension evaluates the technical specificity and depth of AI knowledge articulated within each framework. Long and Magerko (2020) conceptualize AI literacy as including recognition of AI systems, understanding machine learning mechanisms and evaluating system limitations. Chiu et al. (2024) extend this to include algorithmic literacy, data literacy and generative AI awareness. However, frameworks differ in whether they emphasize conceptual awareness, applied tool use, system design literacy, or AI lifecycle management. Mikeladze et al. (2024) identify variation between AI-systems-driven models and domain-oriented literacy frameworks, highlighting differences in technical ambition. This dimension therefore captures the degree to which frameworks articulate foundational AI concepts versus advanced system-level competencies.

- **Pedagogical Integration Orientation**

The fifth dimension examines how AI competence is positioned relative to instructional practice. AI competency frameworks often intersect with pedagogical models such as TPACK or digital competence frameworks (Zhou et al., 2024). Some frameworks distinguish between teaching with AI (instructional integration), teaching for AI (developing student literacy) and teaching about AI (conceptual understanding), reflecting layered pedagogical orientation. Milini (2025) emphasizes that teacher competence emerges through situation-specific decision-making and classroom performance, reinforcing the importance of pedagogical alignment. This

dimension therefore evaluates whether AI competence is framed primarily as classroom practice transformation, professional development enhancement, or administrative governance capability.

- **Implementation and Assessment Maturity**

The final dimension assesses operational readiness and policy maturity. Mikeladze et al. (2024) highlight fragmentation and limited empirical validation across AI competence frameworks, noting the absence of standardized assessment instruments in many models. Zhou et al. (2024) similarly observe that while conceptual convergence exists, implementation clarity and measurement tools remain underdeveloped. In contrast, frameworks embedded within regulatory or assessment initiatives demonstrate higher implementation maturity. This dimension evaluates whether frameworks provide measurable indicators, policy embedding mechanisms, scalability guidance, or empirical validation evidence, thereby enabling comparison of maturity progression across international and national models.

Result

- **Domain Convergence**

All frameworks articulate AI literacy as foundational competence. Core recurring domains include: Human-centered AI orientation, Ethical reasoning, Technical AI foundations, Applied AI engagement and Professional development.

Framework	Core Domains	Human-Centered	Ethics	Pedagogy	Technical Design	Governance
UNESCO Teachers	5 domains	✓	✓	✓	Moderate	Moderate
UNESCO Students	4 domains	✓	✓	✓	Moderate	Low
OECD-EU AILit	4 domains	✓	✓	Moderate	Strong	Strong (Regulatory)
EU Digital Hub	Teaching for/with/about AI	✓	✓	✓	Moderate	Moderate
India	Behavioural/Functional/Domain	Moderate	✓	Low	Low	Strong
Lebanon	Policy + Student + Teacher	✓	✓	✓	Moderate	Strong

Despite structural variation, these domains demonstrate substantial thematic convergence.

All six frameworks articulate AI literacy as a foundational competence, demonstrating substantial thematic convergence despite structural variation. Recurring domains include human-centered AI orientation, ethical reasoning, technical AI foundations, applied AI engagement and professional development. UNESCO's teacher framework structures these across five domains, while the student framework adopts four domains emphasizing ethical and design-oriented literacy. OECD-EU similarly employs four domains but integrates evaluative and regulatory elements. The EU Digital Education Hub operationalizes domain logic through instructional distinctions (teaching for, with and about AI), while India organizes competencies into behavioural, functional and domain-specific clusters aligned with governance capacity. Lebanon integrates policy, teacher and student competency domains within a unified national structure.

Despite differences in terminology and architectural design, all frameworks explicitly include human-centered orientation and ethical reasoning as structural components. Pedagogical integration is present in most models, though India demonstrates comparatively limited classroom emphasis. Governance articulation varies, with OECD-EU and national frameworks embedding stronger policy integration.

The observed domain convergence suggests global stabilization of core AI competency components.

- **Progression Structures**

Most frameworks adopt staged progression models. These models typically move from awareness to applied integration and ultimately to innovation or design-level mastery.

Three-stage developmental models dominate. This reflects shared mastery logic. The recurrence of three-stage progression structures across frameworks suggests shared pedagogical logic aligned with mastery-based competency development.

Framework	Level 1	Level 2	Level 3
UNESCO Teachers	Acquire	Deepen	Create
UNESCO Students	Understand	Apply	Create
OECD-EU	KSA continuum	—	—
Lebanon Students	Understand	Apply	—
Lebanon Teachers	Understand	Cultivate	—

Convergence: staged developmental mastery.

Divergence: number of levels and assessment clarity.

Progression analysis reveals widespread adoption of staged mastery logic. UNESCO frameworks implement three-stage developmental models (Acquire-Deepen-Create; Understand-Apply-Create), reflecting competency-based education principles. Lebanon adopts two-stage developmental articulation for both student and teacher frameworks.

In contrast, OECD-EU employs a Knowledge-Skills-Attitudes continuum rather than discrete stages, while India and the EU Digital Hub do not formally articulate staged mastery progression.

The recurrence of three-stage models across international frameworks indicates shared pedagogical logic aligned with mastery-based competency development. Divergence emerges in level quantity and assessment clarity, particularly in regulatory-embedded versus normative models.

- **Ethical Integration as Structural Core**

All frameworks embed: Fairness, Transparency, Human oversight, Data protection, Accountability, Non-discrimination. However, UNESCO explicitly anchors ethics in human rights discourse, while EU aligns ethics with regulatory compliance. The universal presence of ethical domains signals global normative alignment regarding responsible AI integration. Ethical integration is universally present across all six frameworks, establishing it as a structural core dimension of AI competency articulation. Recurring ethical principles include fairness, transparency, accountability, data protection, non-discrimination and human oversight.

However, ethical anchoring differs in orientation. UNESCO explicitly grounds ethics in human rights discourse and global normative frameworks. OECD-EU aligns ethics with regulatory compliance mechanisms and AI Act alignment. India and Lebanon embed ethics within governance and policy implementation responsibilities. The universal presence of ethical domains signals strong global normative alignment regarding responsible AI integration in education.

- **Governance Spectrum**

A governance continuum emerges across frameworks:

Normative → Operational → Regulatory → Sovereignty-Driven

International frameworks such as UNESCO primarily provide normative guidance. The EU Digital Education Hub demonstrates operational orientation toward classroom implementation. OECD-EU reflects regulatory embedding aligned with legislative frameworks. National frameworks such as India and Lebanon exhibit sovereignty-driven governance integration, embedding AI competency within institutional transformation and policy reform.

(i) Low → UNESCO (normative guidance)

(ii) Moderate → EU Hub
(iii) High → India, Lebanon
(iv) Regulatory Embedded → OECD-EU (AI Act alignment)
This spectrum illustrates increasing centralization of governance responsibility as frameworks move from global normative models to national implementation models.

- **Technical Depth Variation**

Technical depth varies significantly across frameworks. OECD-EU demonstrates strong emphasis on AI system interaction, evaluation and design literacy. The EU Digital Hub differentiates teaching about AI, supporting conceptual and technical awareness. UNESCO balances ethical reasoning with foundational technical literacy. India prioritizes governance capacity over algorithmic depth, while Lebanon integrates applied literacy within policy reform contexts.
(i) OECD-EU: Strong AI system interaction and design orientation
(ii) EU Hub: Differentiates teaching about AI
(iii) UNESCO: Balanced ethical-technical
(iv) India: Governance-focused
(v) Lebanon: Policy-integrated
This divergence reflects differing stakeholder priorities: regulatory assessment, pedagogical transformation, institutional governance, or systemic reform. Technical depth therefore corresponds closely with policy objectives and intended audience.

Framework	Domain Architecture	Progression Structure	Ethical & Governance Integration	Technical Depth	Pedagogical Orientation	Implementation Maturity
UNESCO Teachers (2024)	5 domains (human-centered mindset, ethics, AI foundations, pedagogy, professional learning)	3 levels (Acquire-Deepen-Create)	Strong normative ethics; human rights anchored	Conceptual + applied	Strong classroom + professional development	Normative guidance; limited formal assessment
UNESCO Students (2024)	4 domains (mindset, ethics, techniques, design)	3 levels (Understand-Apply-Create)	Ethical + child protection orientation	Conceptual + design literacy	Student-centered AI literacy	Normative; developmental scaling
OECD-EU AILit (2025)	4 domains (Engage, Create, Manage, Design)	Continuum (KSA model)	Regulatory embedded; EU AI Act alignment	Moderate-high; evaluative focus	Mixed (student + system evaluation)	High assessment alignment (PISA-linked)
EU Digital Education Hub (2024)	3 instructional clusters (for/with/about AI)	No staged mastery model	Moderate ethics integration	Applied literacy focus	Strong pedagogical operationalization	Implementation-oriented; PD-focused

Framework	Domain Architecture	Progression Structure	Ethical & Governance Integration	Technical Depth	Pedagogical Orientation	Implementation Maturity
India AI Integration (2024)	3 clusters (behavioural, functional, domain)	No staged model	Governance-centered; sovereignty emphasis	System-level management focus	Administrative governance orientation	High institutional embedding
Lebanon National AI (2025)	Integrated policy + teacher + student models	2 levels (Understand-Apply / Understand-Cultivate)	Strong governance embedding	Applied + contextualized literacy	Integrated national reform orientation	High national policy integration

Discussion

The findings show strong domain convergence across all six AI competency frameworks. All include human-centered orientation, ethical reasoning, technical foundations, applied AI engagement and professional or institutional capacity. Ethical principles—fairness, transparency, accountability, human oversight and data protection—form a universal structural core, though anchored differently: UNESCO in human rights, OECD-EU in regulation and India and Lebanon in governance reform.

Progression structures partially converge. UNESCO adopts three-stage mastery models; Lebanon uses two stages; OECD-EU applies a KSA continuum; India and the EU Digital Hub lack formal staged progression. This indicates shared competency logic but uneven assessment clarity.

A governance spectrum emerges from normative (UNESCO) to operational (EU Hub), regulatory (OECD-EU) and sovereignty-driven integration (India, Lebanon). Technical depth aligns with policy priorities, ranging from system design literacy (OECD-EU) to governance management (India).Despite normative alignment, implementation maturity remains uneven due to limited empirical validation and assessment benchmarks.

Conclusion

This study reveals clear global convergence across AI competency frameworks in education, particularly around human-centered orientation, ethical reasoning, foundational AI literacy and applied engagement. Despite structural differences, ethical principles such as fairness, transparency, accountability and human oversight form a shared core across all models. However, significant divergence persists in governance embedding, progression structures, technical depth and implementation maturity. International frameworks emphasize normative guidance, regulatory models demonstrate stronger assessment alignment and national frameworks embed AI competency within sovereignty-driven reform agendas. While conceptual stabilization is evident, measurable proficiency benchmarks, standardized assessment tools and empirical validation remain limited. Advancing operational maturity is therefore essential to ensure effective, scalable and context-sensitive AI integration in education systems.

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