EDITORIAL NOTE

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A triangular alliance of academia, industry, and government for shaping the future AI in education: Speed, scale, and strategy

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Abstract

Artificial Intelligence (AI) is rapidly reshaping the educational landscape, not only as a technological innovation but as a structural force influencing access, equity, and opportunity. Governments and industry actors across regions have begun investing in AI-enabled tutoring systems, adaptive learning platforms, large-scale skills initiatives, and subsidized digital infrastructures designed to reach historically underserved learners. These initiatives signal a shift toward viewing AI as public-interest infrastructure that is capable of extending personalized support beyond traditional resource constraints. Within this evolving ecosystem, academia occupies a uniquely consequential position. Universities hold deep expertise in pedagogy, longitudinal evaluation, ethics, and social impact analysis. Yet the emerging AI–education landscape increasingly operates through cross-sector partnerships, accelerated deployment cycles, and policy-driven implementation models that differ from conventional academic timelines. The opportunity before higher education is not merely to evaluate these transformations, but to actively help shape them. This article argues for a renewed model of engagement in which universities serve as co-designers, long-term impact stewards, and conveners within public–private ecosystems. By embracing interdisciplinary collaboration, embedded partnerships, and applied governance frameworks, academia can contribute intellectual rigor while safeguarding educational values at scale. The future of equitable AI in education will not be determined by any single sector. It will emerge from coordinated, principled collaboration. The central task ahead is to ensure that scholarly insight and public responsibility remain integral to that collective effort.

Keywords: Artificial Intelligence, AI-Enabled Educational Equity, Public–Private Collaboration in Education, Academic Governance and Institutional Reform, Higher Education, Human-Centric AI in Learning Systems, Human-AI Collaboration, Future of Education

Artificial intelligence advances in education

The future of education in the light of technological advances is not shaped solely by the education sector. This is no longer a speculative claim but an observable reality. Artificial intelligence (AI) is developed, deployed, and scaled within complex innovation ecosystems that extend beyond the institutional boundaries of universities. Corporate and governmental actors often operate at a speed and magnitude that differ from, and in some cases exceed, the procedural tempo of traditional academic structures. However, this difference in speed should not be misinterpreted as a deficit in capacity or vision. Universities have historically served as the intellectual engine of technological progress, producing foundational research, cultivating critical inquiry, and educating the very experts who now lead AI innovation across sectors. The current transformation is therefore not a displacement of academia, but a reconfiguration of influence within a multi-stakeholder ecosystem. In this environment, industry and government move decisively in deployment and scaling, while academia continues to provide the epistemic depth, ethical scrutiny, and long-term perspective necessary to ensure that technological advancement aligns with societal values and educational purpose.

A snapshot of corporate investment in AI for education, illustrating the scale of engagement, is presented in Table 1.

Entities including Microsoft, Google, Amazon Web Services (AWS), IBM, and Coursera are investing extensively in AI-enabled educational tools and infrastructures. Microsoft announced a 5-year commitment (2025–2030) and a $4B USD investment in free AI tools and training for students and teachers globally, with a focus on underserved communities (Darley, 2025; Microsoft, n.d.). Google Gemini uses AI to help students who are unable to afford private test preparation for SAT exams (Gomes, 2025; Walport, 2026), while AWS supports underserved learners, students, job-seekers, and underrepresented groups through a number of initiatives and significant investments (Amazon Web Services, n.d., *AWS Education Equity Initiative*; Amazon Web Services, n.d., *AWS Skill Builder*; Sivasubramanian, 2023). These initiatives extend beyond product development, targeting scale, accessibility, workforce readiness, and inclusion across diverse learner populations, including teachers, students, and marginalized communities (Amazon Web Services, n.d., *AWS Education Equity Initiative*; Amazon Web Services, n.d., *AWS Skill Builder*; Coursera, n.d.; Darley, 2025; Gomes, 2025; IBM, n.d.; McLeavey-Weeder, 2025; Microsoft, n.d.; NVIDIA, 2026; Sivasubramanian, 2023; Walport, 2026). The speed of iteration, capital allocation, and global deployment within the private sector is reshaping the learning landscape in real time.

The Triple Helix perspective

The evolving landscape of AI in education increasingly requires collaboration that transcends traditional institutional boundaries. A useful theoretical lens for understanding such collaboration is the Triple Helix model of innovation, first articulated by Etzkowitz and Leydesdorff (2000). The model conceptualizes innovation as the outcome of dynamic interactions among universities, industry, and government, each contributing distinct yet complementary capabilities. Universities generate knowledge and cultivate human capital, industry translates knowledge into technological applications and scalable solutions, and government establishes regulatory frameworks and public policy environments that enable responsible development and deployment. Rather than operating within isolated domains, the Triple Helix framework emphasizes overlapping roles and hybrid partnerships in which knowledge creation, technological implementation, and societal governance evolve together. Within the context of AI and education, this perspective offers a crucial approach to interpret emerging initiatives where public institutions, technology developers, and academic researchers jointly shape new learning infrastructures. It also highlights the importance of positioning universities not only as evaluators of technological change, but as active participants in the co-design, governance, and long-term

Table 1: Corporate entities' investments in AI to make education more accessible and inclusive

Corporate entity	AI-for-education initiative	Primary beneficiaries	Inclusion & access mechanism	Public scale/ commitment	Duration of implementation/ impact	References
Microsoft	*Microsoft Elevate for Educators*: AI tools for schools	Students & teachers globally, with an emphasis on underserved communities	Free AI tools, educator training, partnerships	$4B commitment toward education and skills	5-year commitment (2025–2030); specific targets include 20M learners trained within 2 years	(Darley, 2025; Microsoft, n.d.)
Google	*Gemini + Princeton Review SAT preparation*	Students unable to afford private test preparation	Free AI-powered SAT practice and feedback	National rollout announced	NA (no public end date or impact horizon stated)	(Gomes, 2025; Walport, 2026)
Amazon (AWS)	*AWS Education Equity Initiative*	Underserved learners via partner organizations	Cloud credits, AI infrastructure, and technical support	Up to $100M in AWS credits	5-year program; individual awards typically have 12-month credit periods	(Amazon Web Services, n.d., *AWS Education Equity Initiative*)
	AI Ready (free AI skills education)	Students, job-seekers, and underrepresented groups	Free AI courses and training	2M learners targeted	Through 2025 (publicly stated training goal)	(Amazon Web Services, n.d., *AWS Skill Builder*; Sivasubramanian, 2023)
IBM	*IBM SkillsBuild* (AI-focused credentials)	Learners from underrepresented communities	Free AI learning paths and credentials	2M learners trained in AI	Through the end of 2026 (within the broader SkillsBuild 2030 strategy)	(IBM, n.d.)
Coursera	*Coursera Coach* (AI learning assistant)	Global learners	AI support at scale, offering affordability	Platform-wide deployment	Ongoing product integration	(Coursera, n.d.)
NVIDIA	*Deep Learning Institute (DLI)* free courses	Students, educators, and workforce entrants	Free AI courses; educator enablement	Global availability via partners	Ongoing program with no stated duration	(NVIDIA, 2026)
Duolingo	*Duolingo* AI-based Duolingo English Test (DET)	Low-income students seeking higher-education access	Fee waivers for AI-scored English tests	117,000+ students supported	Ongoing program	(McLeavey-Weeder, 2025)

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assessment of AI-enabled educational systems. Viewed through this lens, the alliance of academia, industry, and government is not merely a practical collaboration but a structural condition for innovation in knowledge-based societies.

Governments constitute a major force in this transformation (Central Institute of Educational Technology, National Council of Educational Research and Training, n.d.; European Commission, 2025; Government Technology Agency of Singapore, 2025; Kendall & Phillipson, 2026; McCrea, 2025; Petrone, 2025; The United States Government, 2025; U.S. Department of Education, 2025). National strategies and policy frameworks demonstrate that AI in education is now a matter of state-level priority (Table 2). The European Commission has introduced EU-wide frameworks and action plans addressing AI integration across member states (European Commission, 2025). The United Kingdom government has launched initiatives to equip hundreds of thousands of pupils with AI-related competencies (Kendall & Phillipson, 2026). Estonia has implemented nationwide digital education infrastructures, integrating AI-enabled systems across schools (Petrone, 2025). In the United States, both the U.S. Department of Education and the White House have issued federal guidance and national commitments concerning AI in education (The United States Government, 2025; U.S. Department of Education, 2025). Singapore is piloting AI-enabled personalized learning models across its educational system (Government Technology Agency of Singapore, 2025; McCrea, 2025). The Ministry of Education in India is deploying AI-focused programs to support public school students, including rural learners (CIET, NCERT, n.d.).

These efforts reflect a coordinated mobilization of financial, technological, and regulatory capital. Corporate actors scale tools while governments shape policy and infrastructure. Together, industry and government are actively engineering the conditions under which the next generation of learners will operate. However, much of academia has been slower to match the pace and scale. The critical question, therefore, is not whether AI will redefine education. It already is. The question is whether academia will position itself as a central architect of this transformation or remain a reactive observer of systems designed elsewhere.

Table 2: Government-led AI initiatives to make education more accessible and reduce inequality

Government/ public authority	AI-for-education initiative	Primary beneficiaries	Inclusion & access mechanism	Public scale/ commitment	Duration of implementation/ impact	References
European Union (European Commission)	AI in Education Action Plan (Digital Education Action Plan)	Learners and educators across member states	Policy coordination, funding, and standards	EU-wide framework	2021–2027 (aligned with Digital Education Action Plan period)	(European Commission, 2025)
United Kingdom (Department for Education)	AI tutoring tools for disadvantaged pupils	Disadvantaged pupils	Free, personalized AI tutoring to complement teachers	Up to 450,000 pupils targeted	Pilots in 2026; intended rollout by the end of 2027 (no long-term horizon stated beyond rollout)	(Kendall & Phillipson, 2026)
Estonia (Ministry of Education and Research)	*AI Leap* national education program	All students and teachers nationwide	Universal access to AI tools + teacher training	Nationwide public-school coverage	NA (program launched in; no fixed end date or quantified impact target publicly stated)	(Petrone, 2025)
United States (U.S. Department of Education)	Federal guidance on AI in education	K–12 students and educators, with equity emphasis	Policy framework to enable safe, equitable AI adoption	National guidance (non-mandatory)	NA (guidance-based intervention; no time-bound impact targets)	(U.S. Department of Education, 2025)
United States (White House	National commitments to AI education access	Students and workers nationwide	Public–private commitments to AI learning access	National scope via partnerships	NA (commitment-based; no single implementation timeline)	(The United States Government, 2025)
Singapore (Ministry of Education)	AI-enabled personalized learning pilots	Public-school students	AI-supported adaptive learning in public schools	System-wide pilots	NA (pilot-based; duration not publicly specified)	(McCrea, 2025; Government Technology Agency of Singapore, 2025)
India (Ministry of Education)	AI integration via national digital education platforms (e.g., DIKSHA, NEP-aligned initiatives)	Public-school students, teachers, and rural learners	AI-supported digital learning at scale	National platform reach	NA (ongoing integration; no explicit AI impact timeline stated)	(CIET, NCERT, n.d.)
European Union (European Commission)	AI in Education Action Plan (Digital Education Action Plan)	Learners and educators across member states	Policy coordination, funding, and standards	EU-wide framework	2021–2027 (aligned with Digital Education Action Plan period)	(European Commission, 2025)

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Academia's response to the rapidly evolving educational landscape

Academia is systematically progressing in intellectual depth and scholarly rigor. However, it is increasingly challenged by the rapid pace and scale of AI advancement. While a subset of leading institutions has responded to the evolving educational landscape with strategic urgency and institutional commitment, much of the academic ecosystem remains structurally reactive rather than anticipatory.

Duke University, United States, has joined OpenAI's NextGenAI consortium to integrate frontier AI research into academic practice (Deep Tech, 2025). This partnership is part of a consortium that convenes 15 universities, including Harvard, MIT, and Oxford, to explore the role of AI in addressing specific scientific challenges (Deep Tech, 2025). Purdue University in the United States has established a strategic collaboration with Google Public Sector to embed AI infrastructure across research and teaching. This places Purdue's students and researchers at the forefront of an AI-driven future that is ahead of us (Mills, 2026). The University of the Southwest has partnered directly with OpenAI to operationalize AI tools campus-wide (University of the Southwest, 2024), while Northeastern University has collaborated with Anthropic to incorporate advanced AI systems into its curriculum and research (Nordman, 2025). Moreover, institutions within the State University of New York system are developing coordinated AI research and credentialing initiatives (State University of New York, 2026). Researchers at the University of Oulu, Finland, investigated human–AI collaboration in academic writing using ChatGPT and applied AI-driven learning analytics methods (Nguyen et al., 2024).

These cases demonstrate that proactive institutional alignment with AI is feasible. Yet, they remain exceptions rather than the norm, highlighting a systemic asymmetry between technological acceleration and institutional adaptation within higher education. If AI is reshaping the architecture of education, then the conversation must be collective, interdisciplinary, and forward-looking. This journal exists to facilitate that convergence.

Speed and scale mismatch

Academia may fall behind strategically, but not rhetorically. The first structural challenge is the mismatch in speed and scale (Lauritsen et al., 2024). Governments and firms operate on deployment timelines of 12 to 36 months. Universities operate on multi-year research cycles. A typical academic pathway requires securing competitive grants in an increasingly constrained funding environment, navigating institutional and ethical review processes, conducting data collection, analyzing results, and entering publication pipelines that may extend the timeline to 3, 5, or even 7 years (Van Quaquebeke et al., 2025). By contrast, AI-enabled pilots are deployed before peer-reviewed evaluations exist. By the time findings are published, the tools under investigation have already undergone multiple iterations. The consequence is clear: academia is often commenting on systems rather than shaping them at inception.

Ownership of infrastructure

The second structural limitation concerns infrastructure ownership. AI-enabled education now depends on large-scale models, proprietary platforms, cloud architectures, and continuous streams of real-time learner data (Caspari-Sadeghi, 2022). These infrastructures are not controlled by universities. Most academic research relies on restricted datasets, post-hoc access agreements, or simulated environments designed to approximate real-world conditions (Li et al., 2025). Evaluation is often conducted after deployment decisions have already been made. Without ownership or meaningful participation in infrastructure design, academia has limited leverage over core technical architectures, data governance standards, and product design decisions (Williamson, 2019). It studies implementation, but rarely influences the blueprint.

Late to the table

The third dimension is the policy influence gap. Governments increasingly rely on industry white papers, consultancy reports, and internal task forces when forming AI strategies (Organisation for Economic Co-operation and Development, 2023). Academic expertise is often invited late in the process, primarily to validate, critique, or ethically assess decisions that are already structurally embedded. This positioning reframes universities as external reviewers rather than co-architects. The result is diminished agenda-setting power in shaping regulatory frameworks, procurement standards, and long-term national strategies for AI in education (Stix, 2021).

Taken together, these three dynamics (temporal lag, infrastructure asymmetry, and policy marginalization) create a structural disadvantage for academia. Academia remains intellectually central but operationally peripheral. If this trajectory continues, universities risk becoming evaluators of externally designed systems rather than strategic partners in their conception and governance.

What may be causing academic hesitation?

Beyond structural disadvantages, academia must also examine its own self-imposed constraints. The limited cooperation with industry and government is not solely the result of external exclusion. It is partly a consequence of internal design.

Incentive misalignment

The first constraint is incentive misalignment. Academic reward systems prioritize novelty, theoretical contribution, disciplinary purity, single-authored works, and authorship credit within relatively small research teams. Prestige is attached to first authorship, high-impact publications, and individual intellectual distinction (Ellemers, 2020). Implementation work, large-scale system deployment, policy co-design, and long-term industry embedding rarely carry equivalent weight in tenure and promotion evaluations. Yet AI-enabled education, particularly when framed around equity and large-scale inclusion, requires interdisciplinary teams, sustained implementation research, iterative field testing, and direct engagement with ministries and

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product developers. There is little formal recognition for shaping a national pilot, co-designing infrastructure with a ministry, or spending two years embedded within a company to understand operational constraints. The academic incentive structure, therefore, discourages the forms of collaboration that large-scale AI transformation demands.

Ethical absolutism

The second constraint is ethical absolutism. Ethical vigilance is one of academia's greatest strengths, but it can also become immobilizing when framed in categorical or idealized terms. Some academic responses to AI in education rely on worst-case scenario projections or conditional engagement, insisting that participation is contingent upon ideal safeguards being fully established in advance (Dabis & Csáki, 2024; Simpson, 2025). Governments and school systems, however, operate under immediate pressures: teacher shortages, inequities in tutoring, budget constraints, and political timelines. Policymakers are required to act in the face of uncertainty. When academic engagement is framed primarily in terms of prohibition or delay, decision-makers may proceed without a sustained academic partnership to maintain operational momentum. This does not imply that ethical concerns are misplaced. Instead, it suggests that ethical discourse must be integrated with the realities of implementation rather than positioned in opposition to them.

Data governance expectations

The third constraint concerns data governance expectations. Academia typically demands comprehensive data access, open models, full reproducibility, and methodological transparency as prerequisites for engagement. Industry and government actors operate under privacy legislation, procurement frameworks, commercial confidentiality, and national security considerations (Bommasani et al, 2021). These regimes limit data sharing and model transparency in ways that are often incompatible with traditional academic standards. The resulting impasse is predictable: no data, no study; no study, deployment proceeds regardless. This divergence in epistemic and legal assumptions creates a stalemate that slows collaborative research and reinforces mutual mistrust.

Taken together, these internal dynamics contribute to academia's marginalization in shaping AI-enabled educational systems. The question is not whether these norms emerged for legitimate reasons. Many did. The more pressing question is whether they remain fit for purpose in a landscape defined by rapid technological iteration and cross-sector interdependence.

If academia seeks to become a co-architect of the future of education, it must critically reassess its own structures. Incentive systems may need recalibration. Ethical frameworks may require operational integration. Data partnerships may demand new models of controlled access and shared governance

The paradox

The deepest paradox lies here: academia may fear reputational contamination.

Engagement with large technology firms, ministries, or applied AI initiatives is frequently framed as a compromise. Collaboration is interpreted as a loss of independence. Proximity is equated with intellectual capture. The result is a false binary: one is either a critic or a participant. This binary is strategically flawed. The most influential position is not external opposition, but embedded critique. Critical distance does not require institutional isolation. On the contrary, influence over system design often depends on proximity to it. If academia withdraws to preserve purity, it simultaneously relinquishes its leverage.

This is the paradox: universities are uniquely qualified to assess long-term learning outcomes. They possess methodological depth in equity analysis. They hold institutional legitimacy in ethical evaluation. No other actor combines longitudinal research capacity, theoretical grounding, and normative authority as effectively.

Yet structurally, academia remains slow, fragmented across disciplines, risk-averse in institutional decision-making, and weakly incentivized to engage in early-stage system design. The actors shaping AI infrastructures in education are not waiting for alignment. Governments and firms are moving forward under political and market pressures. Strategic decisions are being made, architectures are being embedded, and standards are being normalized. The trajectory will not pause for academic readiness. Other actors will move forward to shape the future of education, with or without academic involvement.

The inaugural issue of Artificial Intelligence Advances in Education

In this context, we open the pages of the *Journal of Artificial Intelligence Advances in Education* (AIAIE) with a clear intention: to reposition academia at the center of the AI-education transformation. Our aim is to narrow the gap between scholarship, industry, and government, and to encourage academia to engage proactively rather than defensively with the realities of AI as an integral component of the future of learning.

The inaugural issue extends an invitation to establish a triangular alliance of stakeholders committed to collaborative engagement in shaping the future of education for future generations. We welcome rigorous empirical studies, theoretical contributions, systematic reviews, data papers, and methodological innovations. At the same time, we extend this invitation beyond traditional academic boundaries. Policymakers, philosophers, and industry leaders are equally encouraged to contribute to the formation of AIAIE. The future of education is being shaped across sectors, and the intellectual discourse must reflect that plurality.

This editorial note, therefore, seeks to initiate a structured dialogue among three decisive forces: academia, industry, and government. Each holds distinct assets. Academia contributes epistemic rigor and ethical reflection. Industry brings scale, infrastructure, and the capacity for rapid implementation. Governments provide regulatory frameworks, national strategies, and public accountability. The alignment of these domains is not optional; it is strategic.

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The journal positions itself as a platform where these perspectives intersect; not to dilute disciplinary standards, but to elevate them through cross-sector engagement; not to replace critique with enthusiasm, but to ground innovation in evidence. For the inaugural issue of the journal, we have received substantial contributions from Denmark, China, Greece, Mexico, Nigeria, Jordan, the United Kingdom, and Spain. An overview of these contributions is presented below.

Article 1. AI and the Existential Crisis of Higher Education: A Self-examination

We open this inaugural issue with a philosophical intervention. In her contribution, Dr. Pia Laurison confronts a question that many institutions hesitate to articulate directly: has AI precipitated an existential crisis in higher education? When knowledge generation, explanation, and personalization are available at the click of a button, the traditional justification for universities becomes unsettled. If information is ubiquitous and adaptive tutoring systems can individualize instruction at scale, what remains distinctive about formal higher education? What remains distinctive about the teaching profession? Much of the current research on AI in higher education focuses on adaptation: integrating tools, regulating use, detecting misuse, and redesigning assessment. Far less attention is given to a more foundational question: what is the renewed purpose of education in an era of cognitive automation? In a landscape where knowledge is abundant and searchable across platforms, the central question is no longer merely how to access or transmit information. It becomes a question of how to orient oneself within it. How do learners cultivate discernment in environments saturated with generated content? How do they remain intellectually grounded amid accelerating change? How do they develop the capacity to engage uncertainty without paralysis? In this context, the educator's role necessarily shifts. The teacher is no longer primarily a transmitter of information. Information is already available. The emerging responsibility is interpretive and formative rather than distributive. Educators become guides in judgment, stewards of epistemic responsibility, and facilitators of reflective engagement. Their task is to help students navigate ambiguity, evaluate claims, confront ethical tensions, and construct meaning in increasingly fluid conditions. AI transforms access to knowledge; it does not eliminate the need for education. It reframes it.

Article 2. Comparative Analysis of Hybrid and Single Classification Algorithms for Student Academic Performance Forecasting

The contribution by Dr. Najah Al-Shanableh et al. advances the discussion by demonstrating that educational data mining can serve as a strategic tool for early detection of academic risk in higher education. Drawing on a large dataset and evaluating ten machine learning models, the study compares single classifiers with hybrid approaches for predicting student performance. The findings indicate that ensemble approaches provide deeper and more reliable predictive power than standalone classifiers. The study identifies several significant predictors of academic performance, with cumulative GPA, high school average, academic year in high school, and course load emerging as the most influential factors. By enabling the timely identification of at-risk students, this approach offers universities a data-driven mechanism for targeted intervention, quality assurance, and proactive academic planning. As such, the work illustrates how machine learning can function not merely as an analytical tool but as an operational guardrail within university management systems, supporting more responsive and equitable student support strategies. The authors further caution that practitioners must remain attentive to the computational demands associated with ensemble methods, as well as the need for regular model retraining to sustain predictive accuracy over time. They emphasize that such predictive systems should function as decision-support tools rather than deterministic classifiers. Human oversight remains essential in educational decision-making processes, ensuring that algorithmic outputs are interpreted within broader pedagogical and institutional contexts. In this respect, the study reinforces the importance of a human-centric approach to AI deployment, where technological capability is balanced with professional judgment and ethical responsibility.

Article 3. Reflecting on Three Years of Generative AI in Higher Education: Successes, Struggles, and Solutions

The article by Dr. Wilson Cheong Hin Hong offers a reflective analysis of the first three years following the rapid emergence of LLMs in higher education. Rather than portraying AI integration as a straightforward narrative of technological progress, the work frames it as a complex landscape of trade-offs. On the one hand, AI systems have the potential to shatter long-standing barriers to knowledge access and expand educational opportunities at an unprecedented scale. On the other hand, the author cautions that excessive reliance on these tools may gradually erode human agency and weaken the cognitive processes that define deep learning. The article argues that the future of higher education will not be determined by the capabilities of algorithms alone, but by how academia chooses to respond to them. Rejecting both technological alarmism and uncritical adoption, the author proposes a model of human-AI symbiosis in which AI systems scaffold, rather than replace, human thinking. To operationalize this vision, the paper outlines actions across multiple levels of governance. At the national level, policymakers are encouraged to reconsider educational philosophy, regulatory frameworks, and the role of human expertise in an AI-enabled learning ecosystem. At the institutional level, universities are urged to foster restorative cultures of academic integrity, prioritize transparency over surveillance, and redesign assessment systems to value the learning process rather than purely output-based performance. The work also highlights the importance of preserving faculty autonomy in pedagogical decision-making and promoting evaluation formats that maintain student engagement in the learning process. By linking systemic policy shifts with classroom-level practices, the article calls for a balanced pathway in which universities remain

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spaces for deep thinking while preparing students to engage critically with AI-driven environments. Ultimately, the goal is not to produce efficient operators of intelligent systems, but resilient thinkers capable of asking the kinds of questions that machines cannot yet conceive.

Article 4. Assessing Teachers' AI Literacy for Lifelong Learning: A Systematic Review and Framework Alignment

The review by Konstantinos Tsioukas and Apostolos Kostas examines the current landscape of teacher-oriented AI literacy and competency assessment tools, revealing a significant gap between theoretical frameworks and empirically validated measurement instruments. Drawing on sixteen teacher-focused assessment methods, the study highlights the absence of robust, well-validated tools that align simultaneously with UNESCO's AI Competency Framework for Teachers (AI CFT) and the AILit Framework. The review finds that most existing instruments rely heavily on self-assessment approaches, with relatively few objective or performance-based measures capable of capturing teachers' applied competencies in AI-supported educational contexts. The analysis also reveals uneven alignment with established frameworks. While many instruments address foundational knowledge of AI and its pedagogical applications, fewer incorporate ethical considerations in a systematic manner, and even fewer capture the human-centred mindset or the dimension of AI for ongoing professional development. Similarly, alignment with the AILit framework's knowledge–skills–attitudes structure remains partial: knowledge and skills are commonly represented, while attitudes are often reduced to ethical awareness rather than treated as a distinct construct. In several cases, constructs related to attitudes or professional development are removed during statistical validation processes, illustrating a broader tension between comprehensive theoretical frameworks and psychometric robustness. Beyond conceptual gaps, the review identifies several methodological limitations across the literature, including reliance on self-reported measures, limited cross-sample validation, insufficient evidence of reliability, inconsistent reporting of demographic data, and narrow linguistic and geographic coverage. These shortcomings complicate the comparability of studies and limit the ability to build cumulative knowledge across contexts. By mapping existing assessment tools simultaneously against UNESCO's AI CFT dimensions and the AILit knowledge–skills–attitudes triad, the article provides a structured reference point for researchers and designers of teacher professional development programmes. The findings underscore that incomplete measurement frameworks risk misdiagnosing professional learning needs and may overemphasize technical or ethical aspects of AI while overlooking human-centred perspectives and long-term professional growth. Strengthening the quality and consistency of AI literacy assessment tools is therefore essential for designing effective teacher development initiatives, informing policy decisions, and enabling more reliable cross-context evaluation of AI integration in K–12 education.

Article 5. A Neuro-Symbolic Approach for Automatic Assessment in Ordinary Differential Equations

The article by Garcia and Estradac, A Neuro-Symbolic Approach to Automatic Assessment in Ordinary Differential Equations, introduces a hybrid framework for automating the assessment of mathematical problem-solving by integrating large language models with symbolic computation engines. At the core of this approach is the use of language models as semantic orchestrators capable of interpreting the logic underlying students' solutions, while a deterministic symbolic system ensures mathematical rigor through formal verification. This neuro-symbolic architecture addresses a central limitation of purely generative systems, namely, the risk of hallucination, by grounding probabilistic reasoning within a rule-based computational structure. The results demonstrate that such a framework can support more nuanced evaluation processes, including error carry-over analysis, enabling differentiation between conceptual misunderstandings and consistent algebraic reasoning within the evaluated cases. By bridging probabilistic interpretation with symbolic precision, the proposed system offers a pathway toward automated assessment that preserves both accuracy and pedagogical fairness. The work highlights the potential of neuro-symbolic approaches to move beyond surface-level grading toward deeper analysis of student thinking, positioning AI not only as an efficiency tool but as a means to enhance the quality and interpretability of assessment in mathematically intensive domains.

Article 6. Investigation of Artificial Intelligence as a Tool for Student Learning Outcome: Opportunities, Ethical Challenges, and Mitigation Strategies in the Nigerian Tertiary Context

The study by Oloyede et all. provides context-specific empirical insight into students' perceptions of artificial intelligence, ethical concerns, and academic integrity risks within the Nigerian higher education context. Distinct from technology-focused studies, this work foregrounds the behavioural and governance dimensions of AI integration, addressing a critical gap in understanding how students engage with these tools in practice. Using a qualitative case study design involving undergraduate students and academic staff, the research reveals a dual reality. While AI demonstrates clear potential to enhance personalized learning, generate data-driven insights, and streamline academic tasks, it is also associated with a growing tendency among students to rely excessively on AI systems, often substituting them for independent intellectual effort. This reliance, coupled with the limitations of current detection mechanisms, challenges the effectiveness of traditional academic integrity frameworks, which were not designed for AI-mediated forms of misconduct. The findings underscore the need to redefine academic integrity in the context of AI and to develop governance approaches that balance opportunity with risk. Without careful and deliberate integration, AI may undermine core educational values such as critical thinking, originality, and

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deep learning. At the same time, when appropriately guided, it holds the potential to act as a meaningful enhancer of student learning rather than a replacement for intellectual engagement.

Article 7. From Execution to Judgment: Reconfiguring Higher Education Policy and Outcome-Based Education for the Integration of Youth in the GenAI Economy

The final contribution by Guardiola Ortuño examines the impact of generative artificial intelligence on entry-level employment and its implications for higher education. The study introduces a four-axis framework for classifying entry-level tasks, structured around cognitive complexity, digital intensity, autonomy, and social dimensions. Through this lens, the authors demonstrate how generative AI is increasingly automating routine cognitive activities—such as information processing, report drafting, and debugging that have traditionally served as foundational training grounds for recent graduates. By analysing job market data alongside theoretical task classifications, the study reveals a growing mismatch between technological capabilities and labour market demand. Employers increasingly favour experienced professionals who can supervise and validate AI-generated outputs, rather than hiring and training junior employees. This shift is further reinforced by the cost efficiency of AI systems compared to the investment required to develop early-career talent. The result is a structural barrier to youth employment, compounded by what the authors describe as a "triple transition belt effect," where rapid technological advancement outpaces both corporate adaptation and the slower evolution of university curricula. The findings point to a necessary redefinition of the value proposition of higher education. As routine entry-level tasks become automated, graduates must transition from roles centred on execution to those requiring strategic judgment, oversight, and critical evaluation of algorithmic outputs. The study underscores the urgency for universities to realign curricula with this new reality, preparing learners not only to use AI tools, but to interrogate, supervise, and complement them effectively in increasingly automated professional environments.

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