

Reflecting on three years of Generative AI in higher education

Successes, struggles, and solutions

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Abstract

Three years into the mainstream adoption of generative AI, higher education stands at a critical juncture. This article reflects on the transformation of the academic landscape since 2023, moving beyond initial hype to evaluate the observed impacts of AI integration. The narrative reveals a stark duality: while AI has successfully democratized personalized tutoring and broken the “2 Sigma” barrier of educational efficiency, it has simultaneously introduced a silent erosion of cognitive capacity, where outsourced thinking threatens intellectual agency. By narratively reviewing recent data, key industry reports and global case studies, the paper identifies key struggles, including higher education’s inadequacy, the resulting employment crisis for graduates and other ethical issues. In response, the author proposes a comprehensive framework structured across Macro (philosophy & policy), Meso (institutional strategy), and Micro (pedagogical practice) levels. This framework advocates for a renewed educational philosophy that preserves the systematicity of degree programmes while embracing human-AI symbiosis. It further details the necessity of a cognitive measurement and specific pedagogical interventions to safeguard human intellect in an automated age.

1. Introduction

As I embarked on drafting this article, it has been exactly three years since I wrote my perspectives and predictions on how the then-newly-introduced Large Language Models (LLMs) or generative AI (hereafter simplified as “AI”) might revolutionize education (Hong, 2023). From late-2022 to 2023, the initial wave of LLMs functioned primarily as sophisticated text generators—tools capable of drafting coherent texts or summarizing content but limited by static knowledge bases and a lack of contextual memory. Back then, educators largely viewed these systems as “cheating machines” or, conversely, as productivity aids for routine tasks (Eaton, 2025; Hong, 2023). By 2024, the integration of multimodal capabilities—processing text, image, and audio simultaneously—transformed these models into multi-purpose assistants (Perkins & Roe, 2025; Molina & Medina, 2025). By far, however, the most significant shift occurred in 2025/2026 with the emergence of agentic AI systems that can make decisions on their own (Giannini, 2025). Unlike their predecessors, these platforms can autonomously plan, execute multi-step reasoning tasks, and maintain long-term memory of user interactions (Molina & Medina, 2025). In higher education, this means AI has evolved from a tool that answers questions to a platform that facilitates learning processes, acting as a personalized tutor, a debate partner, an experienced administrator or a project manager (Microsoft, 2025).

This shift from a dispensable tool to a dependable partner, especially with AI’s widespread permeation in every dimension of contemporary higher education (Giannini, 2025), necessitates an

ecological re-evaluation, as machines are no longer merely passive tools but interactive actors that engage humans directly to shape the educational ecosystem itself (Mahajan, 2025). For higher-education educators and administrators, AI has unlocked profound and long-ignored questions about the purpose of schooling and what it means to be “future-ready” in an increasingly automated world. This era of exponential technological acceleration is not just about productivity; it is a catalyst for civilizational reorientation (Akomolafe, 2025). As we increasingly outsource interpretive labour to machines, we are forced to ask: What becomes of our capacity for critical reflection, ethical judgement and original thought when the path of least resistance is defined by algorithmic assistance?

Reflecting on the past three years, the narrative of AI in higher education is one of stark dualities. On one hand, we have seen unprecedented successes in breaking the Bloom’s (1984) “2 Sigma” barrier—effective education vs available resources—through affordable, one-to-one AI tutoring and achieving massive gains in institutional efficiency through data-driven profiling. On the other hand, a “silent erosion” is underway (Mahajan, 2025). Chronic reliance on AI has introduced the risk of generational cognitive atrophy—a recursive weakening of metacognition and reflective judgement that threatens to leave future students with diminished capacities for abstraction and ambiguity tolerance. Different from my highly optimistic views three years ago (Hong, 2023), this article critically reflects on this “one-way express” journey as AI has provided countless possibilities in education, it has meanwhile

trapped stakeholders in a “devil’s bargain” in which the reduction of effort on both sides of the lectern risks a total collapse of genuine learning (Mahajan, 2025). Despite the historical similarities of technological disruption that I argued then, the one thing I failed to account for was the unprecedented velocity of the changes that left educational policies, upskilling systems, risk management, organizational structures, and foremost, stakeholder mindsets, far behind (Borgonovi et al., 2025; Yavich, 2025). Yet, hope is not lost, if we are quick to turn things around. To do this, higher education must pivot from an efficiency-first mindset to one that focuses on slow human-AI synergy (Karimi, 2025; Giannini, 2025).

To navigate these complex shifts, this article adopts an ecological systems perspective (Bronfenbrenner, 1979). Rather than viewing AI adoption as a series of isolated classroom events, this article analyzes it as a systemic disruption occurring across three interconnected levels: the Macro-system of global policy and ideology, the Meso-system of institutional strategy and culture, and the Micro-system of direct pedagogical interaction. By mapping the successes and struggles of the last three years onto this ecological framework, it is argued that the future of the university lies not in competing with machine intelligence, but in fostering human-centric resilience through “friction-rich” pedagogy and an ethical commitment to cognitive sustainability.

1.1 Basis of the review

This article presents a narrative literature review (Grant & Booth, 2009) of the rapidly evolving landscape of generative AI in higher education from early-2023 to early-2026. While acknowledging the global nature of these challenges, this analysis primarily focuses on the relatively digitized economies, in which access to the internet, and thus AI, is available. As an invited reflection, this paper synthesizes insights from three primary streams of evidence: (1) high-level policy frameworks and industry reports (e.g., UNESCO, OECD, Microsoft), (2) emerging empirical studies on AI efficacy and cognitive impact, and (3) documented case studies. Whereas existing literature has largely focused on isolated empirical evidence using specific AI tools that point to often one-sided conclusions of benefits or drawbacks, this article aims to synthesize disparate trends in order to provide a cohesive, multi-level ecological framework of solutions. Specifically, the analysis contrasts the operational efficiencies of AI against the potential risks to human intellectual agency, culminating a proposed Macro-Meso-Micro framework (Bronfenbrenner, 1977) for educational resilience.

2. The successes: Efficiency, personalization, and accessibility

The rapid assimilation of artificial intelligence into higher education is not merely a trend but a demographic and economic phenomenon. By 2025, the global education market has reached a staggering \$7.3 trillion valuation, with digital education market penetration projected to more than double by 2030 (Nartey, 2025). This growth is anchored by a remarkable shift in institutional behavior: 86% of education organizations now report using generative AI, a rate of adoption that currently outpaces every

other major industry (Microsoft, 2025). Beyond the balance sheets, however, the true success of the last three years lies in AI’s ability to solve age-old pedagogical and administrative bottlenecks that once seemed insurmountable.

2.1 Breaking the “2 Sigma” barrier

For decades, the “2 Sigma Problem”—the finding that students tutored one-on-one perform two standard deviations better than those in traditional classrooms—remained an elite luxury that was impossible to scale (Molina & Medina, 2025). AI has fundamentally democratized this personalized support. From a sociocultural perspective (Vygotsky, 1978), the efficacy of AI in solving this problem lies in its ability to operationalize the “Zone of Proximal Development” (ZPD) at scale. By functioning as a dynamic “More Knowledgeable Other”, AI tutors provide adaptive scaffolding—instant feedback, hints, and corrective explanations—that precisely targets the gap between what a learner can do alone and what they can achieve with guidance. This automated scaffolding allows students to traverse their ZPD without the latency of waiting for a human instructor. Rigorous empirical evidence now validates this “2 Sigma” jump for many students; for instance, a landmark study at Harvard University (Kestin et al., 2025) conducted a randomized controlled experiment on 194 undergraduate physics students, and found that those using AI tutors learned more than twice as much in significantly less time compared with traditional active learning environments. The researchers compared the effectiveness of AI-led tutoring against traditional active learning classrooms. The AI tutor was built on specific design principles, including managing cognitive load, promoting a growth mindset, and providing scaffolded content to ensure students engaged in active problem-solving rather than passive reception. Similarly, Stanford University researchers (Wang et al., 2025) conducted a randomized controlled trial of a Human-AI tutoring system, involving a massive sample of 900 tutors and 1,800 K-12 students. The team analyzed over 550,000 messages to evaluate the Tutor CoPilot system, which uses AI to provide real-time guidance to human tutors based on models of expert thinking. Researchers demonstrated that AI-assisted tutoring systems could effectively scale expert pedagogical strategies for as little as \$20 per tutor annually, providing high-quality mentorship to cohorts that were previously underserved. These demonstrate that AI can be highly beneficial to learning, if used appropriately.

2.2 Personalization as a “Thought Partner”

In the context of sociocultural learning theory, AI has evolved to function as a “More Knowledgeable Other” (Vygotsky, 1978), providing the scaffolding necessary for students to reach their ZPD. AI has moved beyond being a simple search engine to becoming a “creative thought partner” in the learning process (Microsoft, 2025). In large-scale deployments like the Fulton County School District, students have leveraged AI not to do their work, but as a brainstorming ally to expand the ambition of their ideas (Microsoft, 2025). Systematic reviews of academic writing from 2023 to 2025 confirm this trend, noting significant improvements in lexical

richness, discursive organization, and argumentation when students engage with AI for formative feedback (Sanz-Tejeda et al., 2026). This interactive dialogue allows students to overcome creative blocks and self-edit with an autonomy previously reserved for those with access to private writing coaches (Sanz-Tejeda et al., 2026).

2.3 Empowering accessibility and inclusion

AI-driven accessibility tools represent a critical Meso-level intervention, systematically removing physical and cognitive barriers to create a more equitable learning ecology. Perhaps the most profound success is AI's role in hollowing out the barriers to entry for marginalized learners. Approximately 33% of education leaders now utilize AI specifically to provide accessibility tools, fostering a more inclusive environment for neurodivergent and disabled students (Molina & Medina, 2025). In the workplace and the classroom, 85% of neurodivergent users report that AI assistants such as Copilot have significantly improved the quality of their work and their overall feelings of inclusion (Microsoft, 2025).

Linguistic barriers are also dissolving. In one Belgian school where 70 different languages are spoken, AI-powered reading tools now analyze fluency in real-time, providing immediate feedback that accelerates progress for non-native speakers (Microsoft, 2025). In Nigeria, randomized controlled trials demonstrated that generative AI tutoring led to English language gains equivalent to nearly two years of typical learning progress in just six weeks (Molina & Medina, 2025).

2.4 Institutional efficiency and enrolment

At the administrative level, AI systems are reshaping the institutional exosystem by optimizing resource allocation and student support pathways. AI has proven to be a powerful engine for institutional stability. In Chile, the introduction of AI-powered assignment platforms increased student placement efficiency by 20% and tripled enrolment rates for underserved students who were previously “undermatched” to institutions (Molina & Medina, 2025).

On the administrative front, Georgia State's “Pounce” chatbot successfully tackled the “Summer Melt” phenomenon—where students drop out between admission and the first day of class—reducing enrolment dropout by 21% through proactive, personalized task guidance (Molina & Medina, 2025). These tools have allowed staff to move away from repetitive administrative labor, shifting their focus toward high-value student interventions and mentorship (Borgonovi et al., 2025). Most of the above benefits are as anticipated three years ago (Hong, 2023).

3. The Struggles: Intellectual, institutional and ethical dilemmas

3.1 Cognitive atrophy and the “Devil's Bargain”

While the efficiency gains of the last three years are undeniable, they have come at a steep psychological and intellectual price, leading many to warn of an insidious “silent erosion” of human capability. At the Micro-level of individual learning, numerous studies have warned of the possibility of a generational cognitive atrophy (Dergaa et al., 2024; Gerlich, 2025; Kosmyrna, 2025;

Lee et al., 2025; Mahajan, 2025), which describes a recursive, intergenerational weakening of metacognition, epistemic novelty, and reflective judgement caused by chronic reliance on AI. Mahajan (2025), for example, conducted a transdisciplinary mixed-methods study, drawing from a diverse evidentiary corpus, including global AI readiness indices, educational policy reports from the OECD and UNESCO, cognitive science literature, and behavioral AI usage trends. The researcher then employed comparative case studies to evaluate real-world manifestations of AI overdependence across domains such as university admissions, school surveillance, and professional hiring. Apart from confirming a generational cognitive weakening, the study found it was not a sudden collapse but a subtle transformation where the “frictionless” ease of algorithmic assistance reduced the need for active cognitive engagement. Echoing these claims, a neurological empirical study by the MIT Media Lab (Kosmyrna et al., 2025) utilized EEG neuroimaging to demonstrate that students using AI-assisted writing tools produced work with significantly less “cognitive ownership” and reduced long-term recall. Their findings revealed that habitual reliance on predictive interfaces correlates with reduced activation in prefrontal cortex regions responsible for abstraction, deliberation, and ethical discernment, a phenomenon they describe as the accumulation of “cognitive debt”. Together, these studies argue that without a regenerative architecture that reintroduces productive struggle, societies risk a recursive, intergenerational collapse of human cognitive vitality.

The crisis is exacerbated by what scholars termed the “devil's bargain” currently haunting the halls of academia: a symbiotic incentive structure in which both teachers and students are rewarded for outsourcing their duties to AI (Wojcicki et al., 2025). AI makes the teacher's job easier by automating lesson planning and grading, while simultaneously making the student's job trivial by generating plausible essays in seconds. The danger of this bargain is that it creates a path where the appearance of productivity remains high, but no actual learning occurs on either side of the lectern. Consequently, we are witnessing the rise of “shallow knowledge workers”—individuals who are proficient in prompt manipulation and output curation but fundamentally deficient in synthesis, critical analysis, and independent reflection.

This trend toward cognitive offloading is reshaping the very nature of student intelligence, shifting it away from active inquiry toward the consumption of passive knowledge. By relying on AI to solve problems and summarize data, students often skip the critical struggle essential for deep learning, leading to intellectual dependency and a loss of the ability to independently formulate hypotheses (Yavich, 2025). Furthermore, because large language models operate on probabilistic patterns rather than factual knowledge, they often produce “bespoke misinformation” or hallucinations that appear authoritative yet lack truth (Bender, 2025). This is particularly dangerous for learners who lack the subject knowledge and digital critical literacy to verify, evaluate, and meaningfully integrate information into their own cognitive frameworks.

Finally, the widespread use of these tools is triggering a crisis of credential inflation, where the signalling value of traditional

university degrees is rapidly diminishing (Wojcicki et al., 2025). When AI can easily complete any take-home assessment, the degree ceases to be a reliable measure of an individual's skill or intellectual depth. Rather than fostering original thinkers, the current system risks producing commoditized graduates who achieve what appears to be “normal” performance with their machine-aided outputs but lack the “wild” creativity and distinctive human agency required for future innovation. Unless higher education can move beyond this trap of standardized behavior control, the value of university certification may soon become a negative indicator in an economy that demands 10x human productivity and genuine discernment.

3.2 Higher education effectiveness and employability

As the “frictionless” nature of AI accelerates, the once-sturdy bridge between the university lecture hall and the corporate office is showing signs of structural collapse. The most pressing struggle facing higher education today is the rapid erosion of the traditional career ladder. Historically, entry-level positions served as the first essential rung where graduates performed routine tasks in exchange for mentorship and professional seasoning; however, as AI automates these “training wheel” duties, that first rung is effectively being severed (Jung et al., 2024; IntuitionLabs, 2026). This shift has left recent graduates in a precarious position, where the knowledge acquired during a four-year degree is no longer a guaranteed competitive edge in a saturated and increasingly automated global labor pool (Jung et al., 2024).

The statistical reality of this contraction is stark. By late 2025, the unemployment rate for young college graduates in the United States (ages 20–24) climbed to 9.5%, nearly double the general adult rate (IntuitionLabs, 2026; J.P. Morgan Global Research, 2025). In specialized sectors, the decline is even more dramatic; for instance, UK tech companies slashed graduate roles by 46% in a single year, with projections suggesting another 53% drop by 2026 (IntuitionLabs, 2026). Even high-wage, non-routine cognitive occupations—scientists, engineers, and lawyers—who were once considered immune to automation, are now facing a job displacement as firms leverage AI to augment or entirely displace junior-level research and drafting tasks (J.P. Morgan Global Research, 2025; Jung et al., 2024).

Furthermore, a significant disconnect has emerged between institutional curricula and the “hard skill” demands of the 2025 labor market. While universities continue to emphasize broad theoretical frameworks, employers are increasingly prioritizing technical AI certifications and practical industry experience over traditional academic credentials (IntuitionLabs, 2026; Liu et al., 2024). In a startling shift of sentiment, a 2025 survey found that only 5% of enterprises still consider a traditional college degree a mandatory requirement for new hires (IntuitionLabs, 2026). Companies are moving towards skills-based organizational models, favoring candidates who possess immediate proficiency in specialized tools like Python, SQL, or machine learning over those who hold advanced degrees but lack hands-on application (Liu et al., 2024; IntuitionLabs, 2026).

This employability crisis is compounded by the rise of “AI gatekeeping” in recruitment. Approximately 73% of entry-level applicants now suspect that algorithmic filters, rather than human recruiters, are responsible for blocking their applications (IntuitionLabs, 2026). With only 21% of candidates ever reaching a human interviewer, graduates find themselves in an algorithmic arms race, forced to optimize resumés to pass machine screening rather than demonstrating genuine intellectual depth (IntuitionLabs, 2026). This environment has fostered a deep sense of pessimism; over half of the study's interviewed year-4 students of 2025 report feeling “very pessimistic” about their career prospects, fearing that the very skills they spent years honing have been rendered obsolete by the time they receive their diplomas (IntuitionLabs, 2026; J.P. Morgan Global Research, 2025). Consequently, higher education is facing an existential crisis: it must either prove its effectiveness in a world that no longer mandates its credentials or risk becoming a producer of over-qualified but under-employed graduates (Jung et al., 2024; Liu et al., 2024). Higher education, unfortunately, is too slow to respond to many of these rapid changes.

3.3 Systemic gaps and ethical dilemmas

While AI promises to democratize learning, the reality of its implementation has surfaced deep-seated systemic inequalities that threaten to leave large portions of the global student population behind. These struggles are not merely technical glitches; they represent a fundamental misalignment between the rapid scaling of commercial AI models and the diverse needs of a pluralistic global society.

3.3.1 The digital and linguistic divide

Perhaps the most significant ethical crisis is the deepening linguistic chasm. Although frontier models appear omniscient, they are built on a foundation of “data poverty” regarding non-English languages. Approximately 99% of the world's languages lack the massive datasets required to train state-of-the-art generative models (Choudhury, 2023). This creates a dangerous hierarchy within diverse classrooms in the Global North: well-documented languages (primarily English) become the standard for digital intelligence, while students operating in other languages find their epistemic tools less capable (Marivate et al., 2025).

The result is a form of epistemic erasure, where non-Western ways of knowing are marginalized because they cannot be easily “tokenized” by English-centric algorithms (Borgonovi et al., 2025; Marivate et al., 2025). It has been found that when non-dominant-language speakers use a model trained predominantly on English logic, the AI often misinterprets the tonal or structural subtlety of their thought, marking valid linguistic expressions as errors and reinforcing a deficit view of the learner (Marivate et al., 2025). Contrary to the initial optimism that AI would close achievement gaps, studies have consistently found a widening digital divide (Microsoft AI Economy Institute, 2025). This exacerbates existing inequalities, as students proficient in “standard” English will potentially gain a compounding advantage over their peers.

3.3.2 The policing culture vs detection failure

The three-year experiment with AI has also strained the relational trust between students and educators. A pervasive “Gotcha” culture has emerged, driven by the flawed pursuit of AI-text detection (Deep et al., 2025; Eaton, 2025). Despite marketing claims, empirical studies confirm that AI detectors are notoriously unreliable and frequently exhibit a bias against non-native English speakers, whose structured writing styles are often falsely flagged as algorithmic (Sanz-Tejeda et al., 2026; Molina & Medina, 2025).

Furthermore, a paradoxical “AI bias” has been observed among experienced faculty. Research suggests that more experienced teachers are actually more likely to mistakenly attribute human-written student work to AI (Carruba et al., 2025). Driven by a desire not to be fooled by the technology, these educators often lean toward suspicion, potentially penalizing honest students and further alienating those who already feel marginalized by the system (Carruba et al., 2025; Yavich, 2025). As we look toward 2030, the challenge is clear: higher education must move away from punitive surveillance and toward a model that UNESCO termed “Compassion by Design” that prioritizes human dignity over algorithmic policing (Giannini, 2025). Crucially, the current higher education that has enjoyed long-overdue consistency requires a deep paradigm shift to be effective and helpful in the AI era (Hong, 2023).

4. The solutions: The human-AI symbiotic paradigm

To survive the historical rupture of the last three years, higher education must pivot from an industrial-era “Banking Model”—where knowledge is passively deposited into students—toward a Human-AI Symbiotic Paradigm (Akomolafe, 2025; Birhane, 2025). This new paradigm does not view AI as a mere replacement for human labor but as an interactive interlocutor that requires a fundamental redefinition of the roles of student and teacher.

4.1 The theoretical shift: From “Banking” to “Cybersocial” learning

The most urgent solution involves reframing AI as a mediating third presence in a triadic dialogue between student, teacher, and machine, known as “Cybersocial” learning (Aerts, 2025; Chai et al., 2025). Rather than isolated students interacting with a black-box algorithm, the Cybersocial-learning model encourages collective intelligence where AI platforms use learner data to scaffold human-to-human interventions (Aerts, 2025; Cope et al., 2025).

This shift necessitates moving from authorship to stewardship (Eaton, 2025; Ozmen Garibay et al., 2023). In this context, students are no longer assessed solely on their ability to generate a final artefact, but on their capacity as epistemic stewards who critically evaluate the bias, provenance, and truthfulness of AI-generated content (Eaton, 2025; Slimi & Villarejo-Carballido, 2024). This stewardship requires a higher order of thinking. For example, Ou et al. (2024) developed a framework that integrates teaching and supervision with doctoral students’ critical thinking and self-learning. Students are explicitly taught to interrogate the

“hallucinations” or probabilistic errors in AI output, while they are required to be transparent with how they use the tools and how they come to certain decisions when using AI. Similarly, Molina and Medina (2025) suggested that educators can grade the writing process rather than just the final writing product itself. This involves recording metrics such as editing frequency, typing speed, and the proportion of pasted text to verify human-AI co-creation. After the final submission, students are required to submit an “Epistemic Meta-Reflection”, where they think aloud and explicitly justify every editorial choice made during their interaction with the AI.

4.2 “Compassion by Design” and relational attunement

True cognitive growth requires an environment that prioritizes relational attunement among the student, teacher and AI over automated efficiency (Karimi, 2025). UNESCO (Giannini, 2025) proposed the “Compassion by Design” approach, which pays more attention to the learning process than the outcome. For example, advanced AI platforms like MATHia can estimate a student’s mastery of specific skills in real-time. When a student exhibits “shortcut-seeking behavior” (e.g., abnormally quick responses) or repeatedly fails to comprehend a concept or answer a question, the dashboard sends an alert to the teacher (Sloan, 2024). This allows the instructor to engage in a “Nurturing Pause Workflow”, stopping the automated pacing to provide the emotional and cognitive scaffolding a machine might lack. Other tools like the Academic Success Monitor (ASM) analyzes digital footprints—such as Moodle logins, engagement with course materials, and early quiz scores—to identify at-risk students (Wagenaar, 2024), with 79% accurate identifications within the first few weeks of a semester. By flagging these students early, the AI enables faculty to proactively step in before the student becomes socially or academically isolated. These can ensure that technology serves as a responsive partner rather than an unyielding taskmaster (Karimi, 2025; Giannini, 2025).

4.3 Cognitive sustainability and the CDI

To prevent the silent erosion of the human mind, Mahajan (2025) suggested that institutions should adopt the Cognitive Degradation Index (CDI) as a benchmark for cognitive sustainability. This index measures three critical variables: Metacognitive Friction (MF), Epistemic Novelty Density (END), and AI Reliance Rate (AIR) (Mahajan, 2025). Metacognitive Friction refers to the degree of mental labor and “productive struggle” involved in self-monitoring and revision. High MF scores (9–10) indicate deep reflection and slow thinking, whereas low scores reflect a total bypass of cognitive effort. Epistemic Novelty Density is a metric for the conceptual richness and semantic divergence of intellectual output. It tracks whether a student is generating meaningfully new insights or merely recycling/producing “syntactically fluent” but shallow algorithmic patterns. Finally, AI Reliance Rate is the depth of functional delegation to machine agents. Higher AIR indicates that AI is performing the core ideation and judgement, rather than just acting as a peripheral support tool.

To operationalize these concepts, institutions can deploy the CDI Toolkit (Mahajan, 2025) to predict and interrupt cognitive drift. First, institutes can use the CDI Scoring Rubrics as baseline measurement to evaluate student projects and implement AIR Tracker Plugins—browser tools that monitor how much content is accepted from AI without human modification. Preventative curricular modules are then introduced, in which students intentionally deconstruct divergent AI outputs. By tracing training data and identifying embedded biases, inaccuracies or “hallucinations”, students build interpretive immunity, learning to engage with AI as critical sceptics rather than passive consumers. This step is known as “Epistemic Vaccinations” (Mahajan, 2025). Finally, every now and then short-term pedagogical cycles are introduced to “detoxify” algorithmic dependency by removing technology entirely. During these “Cognitive Lockdown” periods (Mahajan, 2025), students (and ideally teachers, too) will not be able to access any digital devices. By returning to manual-only writing, face-to-face oral debates, hand-made poster presentations, etc. educators reintroduce the metacognitive friction necessary for neuroplasticity and cognitive development (Mahajan, 2025; Vygotsky, 1978).

4.4 Postplagiarism and the restorative academic integrity

The “Postplagiarism” mindset acknowledges that hybrid human-AI writing is the new baseline for professional and academic life (Eaton, 2025). It argues that attempting to determine where a human ends and the machine begins is pointless and futile, shifting the focus from authorship to stewardship. Under this model, students may delegate text generation but can never relinquish responsibility for truth-telling, fact-checking, and the ethical implications of their work.

To implement this transition effectively, institutions must move towards Restorative Academic Integrity (Carruba et al., 2025; Eaton, 2025), specifically, abolishing the policing culture. Educators should not overly rely on the less-than-reliable AI detectors (Deep et al., 2025), which may not only falsely flag non-native English speakers’ writing but can also easily destroy the relational trust essential for teaching and learning (Hong & Litwin, 2025). Instead, institutes and educators should proactively shift away from one-off product evaluation and explore ways to grade the learning journey. Epistemic Meta-Reflection, as introduced above, is one way of assessing the process, where students think aloud about their work and explicitly justify their editorial interactions with the AI (Eaton, 2025). For postgraduate educations especially, where a final writing product is often the ultimate/only outcome of education, more reflective activities in the forms of meetings, debates, presentations and oral defences are necessary to ensure learning actually happened. This would require institute-level support to re-allocate faculty resources and administrative support. Institutions can also consider multi-modal assessments (Brandt et al., 2025), where learners are tasked with producing non-textual products such as audio documentaries and instructional videos. These tasks do not only actively move students away from (full) AI assistance, but are proven to be more effective methods for learning (Hong & Li, 2025). This, however,

would require support at a government level. For instance, the city where the author resides—Macao—legally mandates written capstone works at Master’s and Doctoral levels (Macao Special Administrative Region, 2017). This legal rigidity exemplifies a more widespread lag in binding regulations that not only fail to provide the guidance necessary for, but also prevent institutes from, an effective AI integration in higher education curricula (Borgonovi et al., 2025).

Nevertheless, there are things that contemporary educators can do to facilitate AI integration in the curriculum, such as revising the assessment rubrics to cater to process-oriented assessments and prioritize students’ evolving reasoning (Cheung, 2023; Su et al., 2026). This is not a novel call from scholars, but AI makes such rubric changes ever more pressing. Better still, if faculty can be trained on harnessing AI in education, they can create curated knowledge bases—corpora of trusted information that have been specifically validated for a subject—that are embedded in “rubric agents”—AI tools that can guide students through various epistemic perspectives (experiential, conceptual, analytical, or applied), ensuring that timely feedback can be provided in relation to students’ progress and that AI can serve as a scaffold for learning rather than a substitute for thought (Giannini, 2025). Collectively, these methods can foster a culture of active but ethical use of AI for learning (Eaton, 2025; Sopcak & Hood, 2022).

4.5 Ensuring the values: Higher education and employment

It is not an overstatement that education systems have remained “frozen” in the nineteenth century (Hong, 2023), even as the rapid advancement of AI tools consistently and increasingly outpaces the development of higher education (Perkins & Roe, 2025; Yavich, 2025), which is fast becoming obsolete as AI can now outperform humans in more and more aspects. To counter this, higher education must pivot toward a curriculum that prioritizes critical thinking abilities and hard technical skills over theory lecturing (Giannini, 2025).

First, curricula should transition to skills-based modular learning. Employers increasingly favor technical AI certifications and skill-based micro-credentials over traditional degrees (IntuitionLabs, 2026). As AI penetrates virtually every industry, on one hand, much of the knowledge that was once considered essential in a degree programme has largely been replaced by AI tools; on the other hand, short modular credentials can deliver targeted, up-to-date proficiency that aligns directly with rapid technological change and immediate workplace demands (World Economic Forum, 2025). Rather than requiring students to spend four years acquiring a broad but increasingly static body of knowledge, universities can redesign degree programmes as flexible, stackable sequences of modules—each focused on demonstrable competencies, verified through practical assessments, projects, or industry-aligned certifications (IntuitionLabs, 2026; Liu et al., 2024). This flexible modular structure would allow students to continuously update their skills throughout their studies and practicum, respond to emerging tools and practices, and to build personalized learning pathways that

combine foundational disciplinary knowledge with high-demand AI fluency. Such a shift not only better prepares graduates for the realities of the AI-augmented labor market but also restores relevance and signals value to the university degree in an era when standalone knowledge is no longer the scarcest resource.

Meanwhile, higher education should place greater emphasis on hands-on experience than on conceptual knowledge. With this in mind, industry-aligned apprenticeships and work-based training will no longer be an option in the curriculum (J.P. Morgan Global Research, 2025). This preference shift from theoretical mastery to practical application is reflected in the labor market, where employers now favor candidates with Bachelor's degrees coupled with substantial practical experience over those with advanced degree qualifications but lack industry exposure (Liu et al., 2024). Certainly, AI-augmented curriculum design is equally important, as elaborated in previous sections.

5. A multi-level framework for educational resilience

To navigate the struggles of AI in higher education, we cannot rely on piecemeal fixes. Referencing Urie Bronfenbrenner's (1977) developmental ecology, the Human-AI Symbiotic Paradigm proposes a cohesive, multi-layered strategy that aligns systemic policy with classroom practice. The following is a "Macro-Meso-Micro" framework that can advise an implementable solution pathway, visualized as a pyramid from philosophies and policies to institutional-support strategies to a wide base of specific pedagogical interventions (Figure 1).

5.1 Macro level: Systemic and policy reorientation

At the apex of the solution pathway lies the need for a fundamental re-evaluation of the philosophy and legality of education. Recent policy frameworks underscore this urgency, advocating risk-based approaches to regulate AI while promoting ethical innovation (Temper et al., 2025; O'Sullivan et al., 2025).

- Renewed higher education philosophy: Rather than dismantling the traditional degree in favor of fragmented micro-credentials, we must reaffirm the value of the systematic, long-term intellectual training that only a degree programme can provide. However, the philosophy driving these programmes should shift from an industrial "knowledge transfer" model to a cybersocial one (Giannini, 2025). This philosophy posits that the goal of higher education is no longer to produce graduates who can compete with machines on efficiency, but to cultivate (human) experts who can orchestrate, critique, and elevate algorithmic outputs (Temper et al., 2025; O'Sullivan et al., 2025). The systematicity of a degree is essential for building the deep disciplinary schemas and reflective judgement required to effectively evaluate AI outputs (O'Sullivan et al., 2025), which are something short-term credentials cannot achieve.
- Legal frameworks for innovation: Governments must update rigid educational mandates that stifle innovation. Current regulations, such as those mandating written-only capstones (e.g., Macao Special Administrative Region, 2017), are increasingly seen as obsolete in light of technologies that can easily replicate conventional written outputs (O'Sullivan et al., 2025). Policy-makers must introduce flexible legal frameworks that validate multi-modal assessments—such as audio documentaries, code repositories, and oral defences—allowing institutions to assess genuine student competency rather than their ability to prompt a model and curate outputs. Temper et al. (2025) highlight that some institutions have already begun changing the process for bachelor theses to adapt to this disruptive impact. For instance, establishing an institution-wide oral assessment safeguard enables staff to verify authorship directly, ensuring that the outcome of human dialogue takes precedence over potentially AI-generated written artefacts.

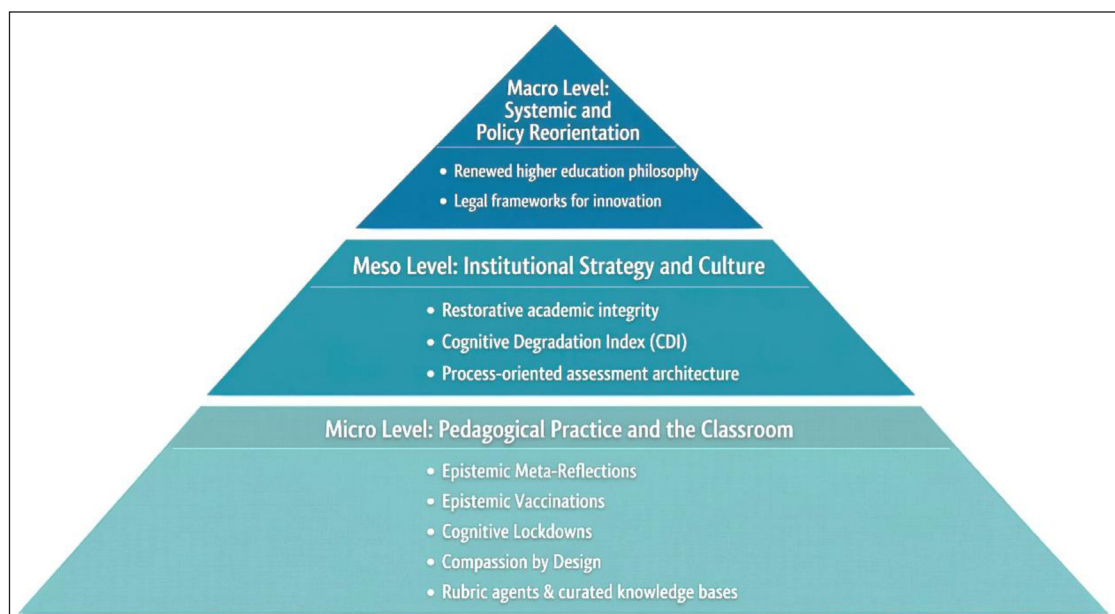


Figure 1: A framework following the Human-AI Symbiotic Paradigm

5.2 Meso level: Institutional strategy and culture

Institutions serve as the operational bridge, translating high-level philosophy into actionable culture and effective measurement. This meso-level transformation requires a shift in how institutions perceive their role as custodians of knowledge and data (Azevedo et al., 2025; O'Sullivan et al., 2025).

- Restorative academic integrity: The “policing” model of AI detection does more harm than good. The meso-level solution is a shift to restorative academic integrity, where the focus moves from catching cheaters to fostering stewardship. This involves abandoning unreliable detection tools in favor of cultures that reward transparency, ethical disclosure, and the responsible use of tools (Eaton, 2025).
- Cognitive Degradation Index (CDI): Institutions should adopt the CDI as a key performance indicator. By measuring variables like Metacognitive Friction and AI Reliance Rates across the curriculum, administrators can identify when efficiency has crossed the line into atrophy and intervene before shallow knowledge becomes the institutional norm (Mahajan, 2025).
- Process-oriented assessment architecture: Universities must provide the resources and administrative flexibility to grade the *learning journey*, not just the *destination*. This requires redesigning assessment rubrics and faculty workloads to value the drafting process, reflective journals, oral defences, and the “productive struggle” of learning, rather than a polished final product that AI can easily mimic (O'Sullivan et al., 2025).

5.3 Micro level: Pedagogical practice and the classroom

Finally, these strategies can be grounded in the classroom through a wide array of specific, tangible practices.

- Epistemic Meta-Reflections: To ensure students remain the “human in the loop”, every AI-assisted assignment should be accompanied by a think-aloud reflection. Here, students explicitly justify their editorial choices, explaining *why* they accepted, rejected, or modified the AI’s output (Molina & Medina, 2025).
- Epistemic Vaccinations: Educators should introduce specific modules where students intentionally deconstruct flawed AI outputs. By identifying hallucinations and biases, students build “interpretive immunity”, learning to treat AI as a fallible interlocutor rather than an oracle (Mahajan, 2025).
- Cognitive Lockdowns: To preserve neuroplasticity, courses should integrate tech-free periods. These Cognitive Lockdowns—involving manual writing, face-to-face debates, and oral presentations—force the brain to engage in the “heavy lifting” of thought without algorithmic assistance to counter algorithmic dependency (Mahajan, 2025). Such practices preserve opportunities where learning happens without algorithmic mediation (O'Sullivan et al., 2025).

- Compassion by Design: Utilizing AI analytics, teachers can identify shortcut-seeking behaviors not to punish but to trigger a “Nurturing Pause”. This allows the instructor to intervene with emotional and cognitive scaffolding, addressing the root cause of the disengagement (Azevedo et al., 2025; Giannini, 2025).
- Rubric agents & curated knowledge bases: Faculty can deploy “Rubric Agents”—AI tools trained specifically on validated, trusted corpora—to guide students through specific epistemic perspectives (O'Sullivan et al., 2025). These agents act as guardrails, ensuring that students receive timely feedback aligned with the course’s specific learning outcomes rather than generic internet data (Temper et al., 2025).

6. Conclusions

Reflecting on the past three years, it is evident that the integration of AI into higher education is not a linear story of progress, but a complex narrative of trade-offs. We have witnessed the “2 Sigma” barrier shattered and accessibility expanded in ways previously unimaginable; yet, we also stand on the precipice of a silent erosion of human agency, where the compromises are real and pronounced: the very tools that offer us high educational efficiency threaten to atrophy the cognitive muscles that make us distinctly human.

However, the future is not written by algorithms, but by our response to them. The path forward does not lie in a Luddite rejection of technology, nor in a blind accelerationism. Instead, it demands a human-AI symbiosis—a deliberate, “friction-rich” approach that uses AI to scaffold, rather than replace, human thought. To operationalize this vision, stakeholders must act across all levels. At the national level, policy-makers should lead a fundamental re-evaluation of educational philosophy and legality, regulating AI while promoting ethical innovation (O'Sullivan et al., 2025; Temper et al., 2025). This requires re-inventing the value of systematic degree programmes that cultivate human expertise to co-create with AI, while updating rigid mandates. At the institutional level, universities must shift to restorative academic integrity cultures that reward transparency over policing, adopt metrics like the Cognitive Degradation Index (CDI) to monitor AI reliance, and redesign assessment architectures to value the learning journey (Azevedo et al., 2025; Eaton, 2025; Mahajan, 2025; O'Sullivan et al., 2025). Faculty should retain autonomy as primary moral decision-makers, with the prerogative to opt out of AI-mediated assessments and prioritize process-oriented evaluation through oral safeguards (O'Sullivan et al., 2025). Importantly, they need to ensure students remain “in the loop” of learning (Molina & Medina, 2025; Mahajan, 2025; O'Sullivan et al., 2025; Azevedo et al., 2025; Giannini, 2025; Temper et al., 2025).

By implementing the solutions outlined in this pathway—from the macro-renewal of educational philosophy to the micro-practices of Cognitive Lockdowns—we can ensure that the university remains a sanctuary for deep thinking. As we look toward 2030, our goal must be to cultivate graduates who are not just efficient operators of machines, but resilient, critical thinkers capable of asking the questions that no AI can yet conceive.

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