

Using AI Responsibly, Critically, Ethically, and Flexibly: A Situational and Andragogical Framework for Learning Autonomy

Viktor Wang, (<https://orcid.org/0000-0001-9557-0054>),
California State University, San Bernardino, USA

Abstract

This article proposes a theory-driven framework for integrating generative artificial intelligence in education through four modes of engagement: responsibly, critically, ethically, and flexibly. Rather than framing AI as a tool to be either banned or adopted uncritically, the article argues that AI use should be guided by pedagogical intent, learner readiness, and institutional accountability. The framework is grounded in situational leadership, Knowles' andragogy, and Grow's stages of learning autonomy, linking AI use to developmental readiness and problem-centered learning. The discussion examines AI as a structural alignment mechanism that exposes weaknesses in curriculum, assessment, and governance while also creating risks related to superficial learning, academic integrity, and credential dilution. Practical implications are presented for faculty, students, and institutions, with attention to policy, assessment design, and accreditation. The article concludes that sustainable AI integration depends on intentional, theory-informed practices that balance innovation with academic rigor, ethical responsibility, and workforce relevance in contemporary education.

Keywords: Generative artificial intelligence; AI pedagogy; learner autonomy; situational leadership; andragogy; curriculum governance; higher education innovation

Introduction

The rapid expansion of generative artificial intelligence in education has fundamentally reshaped teaching, learning, and assessment practices within a remarkably short period. Since the public emergence of large language models such as ChatGPT, higher education institutions have experienced a significant shift in how knowledge is produced, accessed, and evaluated (Dwivedi et al., 2023; Kasneci et al., 2023). Generative AI is now integrated into a wide range of educational activities, including writing support, tutoring, curriculum development, and research assistance, signaling a transition from traditional instructional models toward more technology-mediated learning environments (UNESCO, 2023; Zawacki-Richter et al., 2019). This rapid adoption, however, has outpaced the development of coherent pedagogical frameworks and institutional policies, creating uncertainty among educators, students, and administrators regarding appropriate and effective use. In addition, recent cross-national analysis shows that institutional adoption policies and guidelines for generative AI remain uneven across higher education systems, reinforcing the need for clearer, theory-driven frameworks for implementation (Jin et al., 2024; Chen & Patel, 2025).

Despite its transformative potential, the discourse surrounding generative AI in education remains highly polarized. On one end, some institutions and faculty advocate for strict restrictions or outright bans, citing concerns about academic integrity, authorship, and the erosion of critical thinking skills (Cotton et al., 2023). On the other end, there is a growing tendency toward uncritical adoption, where AI tools are embraced primarily for efficiency and productivity gains without sufficient attention to pedagogical, ethical, or epistemological implications (Dwivedi et al., 2023). This binary framing—ban versus blind adoption—oversimplifies AI integration in education. It reflects a broader tension within higher education systems that are simultaneously expected to innovate while maintaining academic rigor, quality assurance, and accreditation standards.

The consequences of this polarized discourse are increasingly evident. Institutions often implement inconsistent or fragmented policies, leaving both faculty and students without clear guidance on how to engage with AI in academically meaningful ways (UNESCO, 2023). Students, meanwhile, are already using generative AI extensively, frequently without structured expectations or understanding of ethical boundaries (Kasneci et al., 2023). Faculty members report uncertainty in designing assignments, assessing student work, and integrating AI into instruction in ways that align with learning outcomes (Zawacki-Richter et al., 2019). This disconnect has led to what may be characterized as unstructured or informal AI use, where technological capability advances faster than pedagogical intentionality. Such conditions risk undermining the integrity of learning while also missing opportunities to leverage AI for deeper engagement and skill development.

At the center of this challenge is a critical gap in the literature and practice: the absence of a structured, theory-driven framework for AI use in education. While existing scholarship has examined the opportunities and risks of generative AI, there is comparatively limited work that integrates these insights into coherent models grounded in established theories of learning and leadership. Much of the current discourse remains tool-focused or policy-oriented, rather than pedagogically grounded and developmentally informed. As a result, institutions often oscillate between restrictive and permissive approaches, neither of which adequately addresses the complexities of AI-mediated learning environments.

This article responds to this gap by proposing a four-adverb framework for AI use in education: responsibly, critically, ethically, and flexibly. Rather than framing AI as a tool to be either adopted or rejected, this framework conceptualizes AI use as a set of intentional practices that guide how learners and educators engage with technology. Each adverb represents a distinct dimension of engagement. Responsibility emphasizes accountability, transparency, and alignment with academic standards. Criticality focuses on analytical thinking and the interrogation of AI-generated outputs. Ethics addresses issues of bias, authorship, fairness, and academic integrity. Flexibility highlights the need for adaptive, context-sensitive use of AI across different learning environments and levels of learner readiness. Together, these dimensions provide a comprehensive approach to structuring AI use in ways that are pedagogically sound and institutionally aligned.

Importantly, this framework is grounded in established theoretical traditions, including situational leadership (Hersey et al., 2013), principles of andragogy (Knowles et al., 2020), and

Grow's (1991) staged self-directed learning model. Situational leadership emphasizes adapting instructional strategies based on learner readiness, while andragogy highlights the importance of problem-centered, experience-based learning. Grow's model provides a developmental perspective on learner autonomy, offering a lens through which AI use can be aligned with different stages of independence. By integrating these theories, the proposed framework moves beyond descriptive accounts of AI adoption and toward a normative, developmentally informed model of practice.

Research Questions

The purpose of this article is to develop and articulate this four-adverb framework and to demonstrate its relevance for contemporary educational contexts. In doing so, the article seeks to address several guiding research questions: How can generative AI be integrated into education in ways that support, rather than undermine, learning outcomes? What principles should guide the responsible, critical, ethical, and flexible use of AI across different levels of learner autonomy? How can established theories of leadership and adult learning inform the development of structured approaches to AI use? What implications does such a framework have for pedagogy, institutional governance, and workforce preparation?

The significance of this work extends beyond classroom practice. As higher education institutions face increasing pressure to demonstrate accountability, maintain accreditation standards, and prepare students for AI-integrated workplaces, there is a growing need for frameworks that align pedagogy with governance and workforce expectations. International policy guidance emphasizes the importance of human-centered, ethical, and context-sensitive integration of AI in education (UNESCO, 2023). At the same time, employers increasingly expect graduates to possess not only technical proficiency but also critical thinking, ethical reasoning, and adaptive learning capabilities (World Economic Forum, 2024). The proposed framework responds to these demands by offering a structured yet flexible approach that bridges instructional practice, institutional policy, and workforce alignment.

In this context, the four-adverb framework provides a scalable and theoretically grounded model for guiding AI use across diverse educational settings. By shifting the focus from whether AI should be used to how it should be used, the framework contributes to a more nuanced and constructive discourse on AI in education. It offers a pathway toward intentional, coherent, and developmentally appropriate integration of generative AI, addressing both the opportunities and challenges that define the current educational landscape.

Methods

This study adopts a conceptual and theory-building approach. Rather than employing empirical data collection, it synthesizes existing literature on generative artificial intelligence in education, adult learning theory, and leadership models to develop an integrative framework. Conceptual research is appropriate for emerging phenomena with limited empirical evidence and where theoretical clarity is needed to guide future inquiry and practice (Jaakkola, 2020).

The study draws on three established theoretical foundations: situational leadership, Knowles' principles of andragogy, and Grow's staged self-directed learning model. These frameworks are used to interpret current challenges in AI integration and to construct a four-adverb model that aligns AI use with learner development. The process involves identifying gaps in current AI discourse, synthesizing interdisciplinary scholarship, and proposing a structured framework for application across educational contexts.

This approach allows for the development of a theoretically grounded model that can inform both future empirical research and practical implementation. The framework is intended as a foundation for subsequent validation through empirical studies across disciplines and learner populations.

The Problem: Unstructured AI Use in Education

The rapid integration of generative artificial intelligence into educational settings has not been matched by the development of coherent, structured approaches to its use. As a result, institutions are navigating a fragmented landscape characterized by inconsistent policies, uneven pedagogical practices, and unclear expectations for both faculty and students. While some universities have implemented restrictive guidelines or temporary bans, others have adopted permissive or decentralized approaches, leaving decisions to individual instructors or departments (UNESCO, 2023; Dwivedi et al., 2023). This variability reflects a broader lack of consensus regarding the role of AI in education and contributes to confusion across institutional contexts. In many cases, policies are reactive rather than proactive, emerging in response to perceived risks rather than grounded in established pedagogical principles or theoretical frameworks.

This inconsistency is particularly evident in how institutions define acceptable AI use. Some policies focus narrowly on academic integrity, framing AI primarily as a potential tool for misconduct, while others emphasize innovation and encourage experimentation without sufficient safeguards (Cotton et al., 2023). The absence of shared standards creates an environment in which students encounter conflicting expectations across courses and programs. For example, AI-assisted writing may be prohibited in one class while encouraged in another, leading to ambiguity about what constitutes appropriate academic practice. Faculty members, likewise, often lack clear guidance on how to design assignments or assessments that meaningfully integrate AI while maintaining rigor and alignment with learning objectives (Kasneci et al., 2023). This fragmentation undermines the coherence of educational programs and weakens the alignment between institutional policies and instructional practice. Recent comparative evidence also suggests that educators and students often perceive the impact of generative AI on assessment differently, which further complicates institutional efforts to establish coherent standards and expectations (Kizilcec et al., 2024; Rodriguez & Kim, 2025).

A central consequence of unstructured AI use is the growing misalignment between AI-assisted activities and intended learning outcomes. When AI is used without intentional design, it can bypass key cognitive processes that education is meant to cultivate, such as critical analysis, synthesis, and problem-solving. Research suggests that overreliance on AI tools may contribute

to cognitive offloading, where learners delegate thinking processes to technology rather than engaging deeply with the material (Zawacki-Richter et al., 2019). In such cases, students may produce outputs that meet formal requirements but lack genuine understanding or intellectual engagement. This disconnect raises important questions about the validity of assessment practices in AI-mediated environments and the extent to which academic credentials continue to reflect actual competence.

The risks associated with this misalignment extend beyond individual learning outcomes to broader concerns about academic integrity. Generative AI challenges traditional notions of authorship and originality, complicating efforts to distinguish between student-generated and AI-assisted work. While detection tools have been proposed as a solution, their reliability remains limited, and their use raises additional ethical concerns related to surveillance and false accusations (Dwivedi et al., 2023). Consequently, institutions face increasing difficulty in enforcing academic integrity policies that were designed for pre-AI contexts. This situation has led to a shift from detection-based approaches to more process-oriented strategies, yet many institutions have not fully adapted their policies or practices to reflect this transition. Without clear frameworks, both students and faculty are left navigating ambiguous ethical terrain.

Another significant concern is the potential for credential dilution, whereby academic degrees and certifications lose their signaling value due to weakened alignment between assessed performance and actual capability. If students are able to complete assignments or assessments with minimal cognitive engagement through AI assistance, the credibility of academic credentials may be compromised. This issue is particularly salient in professional and technical fields, where employers rely on educational qualifications as indicators of skill and readiness (World Economic Forum, 2024). The widespread, unstructured use of AI risks creating a disconnect between formal credentials and real-world competence, thereby undermining trust in educational institutions and their outputs.

These challenges are not isolated to AI alone but are deeply intertwined with longstanding issues in higher education, including outdated pedagogical models, governance gaps, and instructional inconsistency. Many educational practices remain rooted in traditional, content-centered approaches that emphasize information transmission rather than critical engagement or problem-based learning (Knowles et al., 2020). In such contexts, the introduction of AI can exacerbate existing weaknesses rather than resolve them. For example, assignments that prioritize recall or surface-level understanding are particularly vulnerable to AI substitution, highlighting the need for pedagogical redesign rather than technological restriction.

Governance structures also play a critical role in shaping how AI is integrated into education. In many institutions, decision-making related to curriculum design, technology adoption, and academic policy is decentralized, leading to variability in implementation and oversight. This decentralization can result in gaps between institutional intentions and classroom practices, as well as inconsistencies across programs and departments. Moreover, the pace of technological change often exceeds the capacity of governance processes to respond effectively, creating a lag between innovation and regulation (UNESCO, 2023). Without coordinated, theory-informed approaches, institutions risk perpetuating fragmented and reactive responses to AI.

Instructional inconsistency further compounds these issues. Faculty members differ widely in their familiarity with AI tools, their attitudes toward technology, and their willingness to integrate new approaches into their teaching. Some instructors actively experiment with AI-enhanced pedagogy, while others resist or avoid its use altogether. This variability creates unequal learning experiences for students and contributes to disparities in skill development. In the absence of shared frameworks or professional development, the integration of AI becomes dependent on individual initiative rather than institutional strategy.

Taken together, these factors illustrate that the problem of AI in education is not simply technological but fundamentally structural and pedagogical. The lack of structured, theory-driven approaches to AI use has resulted in a fragmented landscape characterized by inconsistency, misalignment, and risk. Addressing these challenges requires moving beyond reactive policies and toward intentional frameworks that align AI use with learning outcomes, ethical standards, and institutional goals. Such frameworks must account for the complexity of educational environments and the developmental needs of learners, providing guidance that is both principled and adaptable.

Conceptual Foundation: The Four-Adverb Framework

The integration of generative artificial intelligence in education requires a conceptual shift from viewing AI as a tool to understanding it as a mode of engagement. Much of the current discourse remains centered on what AI can do, rather than how learners and educators should interact with it. This tool-centric perspective limits pedagogical development and contributes to inconsistent practices across educational contexts. By reframing AI use as a set of engagement modes—responsibly, critically, ethically, and flexibly—this framework emphasizes intentionality, learner development, and alignment with educational goals. Such an approach aligns with emerging scholarship that calls for human-centered and pedagogically grounded integration of AI in education (UNESCO, 2023; Kasneci et al., 2023). Each adverb represents a distinct but interconnected dimension of practice, collectively offering a structured yet adaptable model for guiding AI use.

Responsibly

Using AI responsibly centers on accountability, transparency, and alignment with course objectives. In educational settings, responsibility involves clearly defining when and how AI may be used, ensuring that its use supports rather than replaces intended learning outcomes. This includes expectations for disclosure, appropriate attribution, and alignment with assessment design. Without such clarity, AI use can easily become disconnected from instructional goals, leading to superficial compliance rather than meaningful learning. Research indicates that institutions are increasingly recognizing the need for explicit guidelines that articulate acceptable AI practices, particularly in relation to academic integrity and assessment validity (Cotton et al., 2023; Dwivedi et al., 2023).

Responsibility also extends beyond the classroom to institutional governance and accreditation. Accrediting bodies and regulatory frameworks emphasize the importance of demonstrating that learning outcomes are achieved through valid and reliable means. Unstructured or opaque use of

AI complicates this requirement, as it becomes difficult to determine the extent to which student work reflects independent learning. As a result, institutions must develop policies that ensure transparency in AI use while maintaining alignment with accreditation standards and program integrity (UNESCO, 2023). Responsible AI use, therefore, is not merely an individual practice but a systemic requirement that connects pedagogy with governance and accountability.

Critically

Critical engagement with AI involves treating AI outputs as objects of analysis rather than authoritative sources of knowledge. Generative AI systems are capable of producing coherent and persuasive responses, yet they are not infallible and may generate inaccuracies, biases, or fabricated information. As such, learners must be equipped to interrogate AI-generated content, evaluate its validity, and situate it within broader knowledge frameworks. This aligns with long-standing educational goals related to higher-order thinking, including analysis, evaluation, and synthesis.

In advanced academic contexts, particularly at the graduate and doctoral levels, critical engagement becomes essential. Students are expected not only to use information but to question its origins, assumptions, and implications. When AI is used uncritically, there is a risk of cognitive offloading, where learners delegate intellectual effort to technology rather than engaging deeply with content (Zawacki-Richter et al., 2019). This can undermine the development of critical thinking skills and reduce the depth of learning. By emphasizing criticality as a mode of engagement, the framework reinforces the role of AI as a catalyst for inquiry rather than a substitute for thinking. Educators play a key role in designing tasks that require students to critique, compare, and contextualize AI outputs, thereby fostering intellectual rigor in AI-mediated environments.

Ethically

Ethical engagement with AI addresses issues of bias, authorship, academic integrity, and the broader implications of AI use in educational contexts. Generative AI systems are trained on large datasets that may reflect existing social biases, raising concerns about fairness and representation in AI-generated content (Dwivedi et al., 2023). Students and educators must be aware of these limitations and consider how AI outputs may reproduce or amplify inequities. Ethical use also involves questions of authorship and ownership, particularly when AI contributes to the creation of academic work. Clear guidelines are needed to define the boundaries between acceptable assistance and misconduct.

Academic integrity remains a central concern, as AI challenges traditional definitions of originality and independent work. Rather than relying solely on detection or prohibition, ethical engagement encourages a shift toward transparency and process-oriented assessment. This includes acknowledging AI use, documenting how it contributed to the work, and demonstrating independent understanding. Beyond individual behavior, ethical considerations extend to issues of power and equity. Access to AI tools, digital literacy, and institutional support vary across contexts, potentially creating disparities in how students benefit from AI (UNESCO, 2023).

Addressing these issues requires a commitment to fairness and inclusivity in AI-mediated learning environments.

Flexibly

Flexibility represents the adaptive dimension of the framework, emphasizing the need to align AI use with learner readiness, disciplinary context, and instructional goals. Rigid or one-size-fits-all policies are insufficient in addressing the diverse ways in which AI can be integrated into education. Learners vary in their levels of autonomy, prior knowledge, and capacity for critical engagement, necessitating differentiated approaches to AI use. Flexibility allows educators to scaffold AI integration, providing more structure for novice learners and greater autonomy for advanced students.

This adaptive approach is consistent with theories of adult learning and learner development, which highlight the importance of tailoring instruction to individual needs and contexts (Knowles et al., 2020). It also reflects the dynamic nature of AI technologies, which continue to evolve rapidly. Policies and practices must therefore be responsive rather than static, allowing for ongoing adjustment as new capabilities and challenges emerge. Flexibility does not imply a lack of standards but rather the capacity to apply principles in contextually appropriate ways. By incorporating flexibility as a core dimension, the framework ensures that AI use remains aligned with both pedagogical intent and learner development.

Together, the four adverbs—responsibly, critically, ethically, and flexibly—form an integrated conceptual foundation for AI use in education. They shift the focus from technological capability to human engagement, emphasizing the importance of intentional, reflective, and context-sensitive practices. This framework provides a structured approach to navigating the complexities of AI integration while supporting the development of competent, ethical, and adaptive learners.

While existing frameworks on AI in education emphasize ethics, policy, or technological adoption, the proposed four-adverb model extends this literature by integrating learner development, instructional strategy, and governance into a single coherent framework. This positions the model not only as a set of guiding principles but as a developmentally aligned pedagogical approach.

Theoretical Integration

The integration of generative artificial intelligence in education requires not only practical guidelines but also a strong theoretical foundation that accounts for differences in learner readiness, motivation, and autonomy. The four-adverb framework—responsibly, critically, ethically, and flexibly—can be more effectively operationalized when grounded in established theories of leadership and adult learning. Situational leadership, andragogy, and Grow’s staged self-directed learning model provide complementary lenses through which AI use can be aligned with learner development. Together, these theories offer a structured yet adaptive approach to integrating AI in ways that are pedagogically sound and responsive to diverse educational contexts.

Situational leadership

Situational leadership, developed by Hersey and Blanchard, emphasizes the importance of adapting leadership or instructional strategies based on the readiness level of learners (Hersey et al., 2013). Readiness is defined by a combination of competence and commitment, suggesting that learners require different levels of direction and support depending on their development. This framework is particularly relevant to AI integration, as students vary widely in their familiarity with AI tools, their critical thinking abilities, and their capacity for self-directed learning.

Applying situational leadership to AI use involves aligning expectations and instructional strategies with learner readiness. For learners with low competence and low confidence, a more directive approach is appropriate. In this context, instructors may provide explicit guidelines on how AI can be used, including step-by-step instructions, structured prompts, and clear boundaries regarding acceptable practices. This aligns with responsible and ethical engagement, ensuring that learners develop foundational understanding without misusing AI. As learners gain competence and confidence, instructional strategies can shift toward a more supportive approach, encouraging exploration, reflection, and independent application.

The distinction between directive and supportive strategies is critical in preventing both underuse and misuse of AI. Overly directive approaches may limit innovation and learner autonomy, while overly permissive approaches may lead to uncritical or unethical use. Situational leadership provides a dynamic model for balancing these tensions, allowing educators to adjust their approach as learners progress. This adaptability aligns closely with the principle of flexibility within the four-adverb framework, reinforcing the need for context-sensitive AI integration.

Andragogy and orientation to learning

Andragogy, as articulated by Knowles, emphasizes the characteristics of adult learners, including their need for autonomy, relevance, and problem-centered learning (Knowles et al., 2020). One of the central principles of andragogy is orientation to learning, which suggests that adults are more motivated when learning is organized around real-world problems rather than abstract content. This principle has significant implications for AI use in education.

Generative AI can serve as a powerful tool for supporting problem-centered learning by enabling learners to engage with authentic tasks, generate ideas, and explore multiple perspectives. However, without intentional design, AI use may reinforce passive or surface-level engagement, particularly if learners rely on AI to produce answers rather than to support inquiry. Aligning AI use with andragogical principles requires framing AI as a means for addressing real-world challenges, rather than as a shortcut for completing assignments.

For example, instead of asking students to generate content using AI, instructors might design tasks that require learners to evaluate, refine, and apply AI-generated outputs to complex problems. This approach encourages critical engagement and ensures that AI use contributes to deeper learning. It also enhances relevance, as learners can see the direct application of AI in professional and practical contexts. Research suggests that when technology is integrated in

ways that support authentic, problem-based learning, it is more likely to enhance motivation and knowledge retention (Merriam & Bierema, 2014).

Andragogy also highlights the importance of learner autonomy and self-direction, which are closely linked to ethical and responsible AI use. Adult learners are expected to take responsibility for their learning, including making informed decisions about how and when to use AI. By grounding AI integration in andragogical principles, educators can promote intentional, reflective, and contextually appropriate use of technology.

Grow's stages of learning autonomy

Grow's staged self-directed learning model provides a developmental framework for understanding how learners progress from dependence to autonomy (Grow, 1991). This model identifies four stages of learner development, each requiring different instructional strategies. Integrating AI into this framework allows educators to align AI use with learners' evolving capacities for independence and critical thinking.

At Stage 1, learners are dependent and require high levels of structure and guidance. In this stage, AI use should be tightly controlled, with clear instructions and limited scope. Educators may provide predefined prompts, demonstrate appropriate use, and emphasize responsible and ethical practices. The goal is to build foundational skills and awareness while minimizing the risk of misuse.

At Stage 2, learners become interested and begin to develop some degree of competence. In this stage, AI use can be scaffolded, allowing learners to experiment within structured boundaries. Instructors may encourage students to compare AI-generated responses with other sources, reflect on their accuracy, and begin to engage critically. This stage supports the transition from passive use to more active engagement.

At Stage 3, learners are involved and demonstrate greater confidence and skill. AI use can become more collaborative, with students using AI as a partner in problem-solving and knowledge construction. Tasks may involve co-creation, iterative refinement, and peer discussion of AI outputs. At this stage, critical and ethical engagement becomes more prominent, as learners are expected to evaluate and justify their use of AI.

At Stage 4, learners are self-directed and capable of independent, critical engagement. AI use in this stage is characterized by autonomy, intentionality, and sophistication. Learners can independently determine when and how to use AI, critically assess its outputs, and integrate it into complex tasks. Ethical considerations, such as transparency and fairness, are internalized, and learners are able to navigate AI-mediated environments with confidence and responsibility.

Grow's model underscores the importance of aligning AI use with developmental readiness. Treating all learners as equally capable of managing AI independently ignores the variability in skills and experience, potentially leading to misuse or disengagement. By incorporating this staged approach, educators can design AI-integrated learning experiences that support progression toward autonomy while maintaining alignment with pedagogical goals.

Together, situational leadership, andragogy, and Grow’s model provide a robust theoretical foundation for the four-adverb framework. They emphasize the importance of adapting AI use to learner readiness, promoting problem-centered and relevant learning, and supporting the development of autonomy. This integration moves AI pedagogy beyond static policies and toward dynamic, learner-centered practices that are both theoretically grounded and practically applicable.

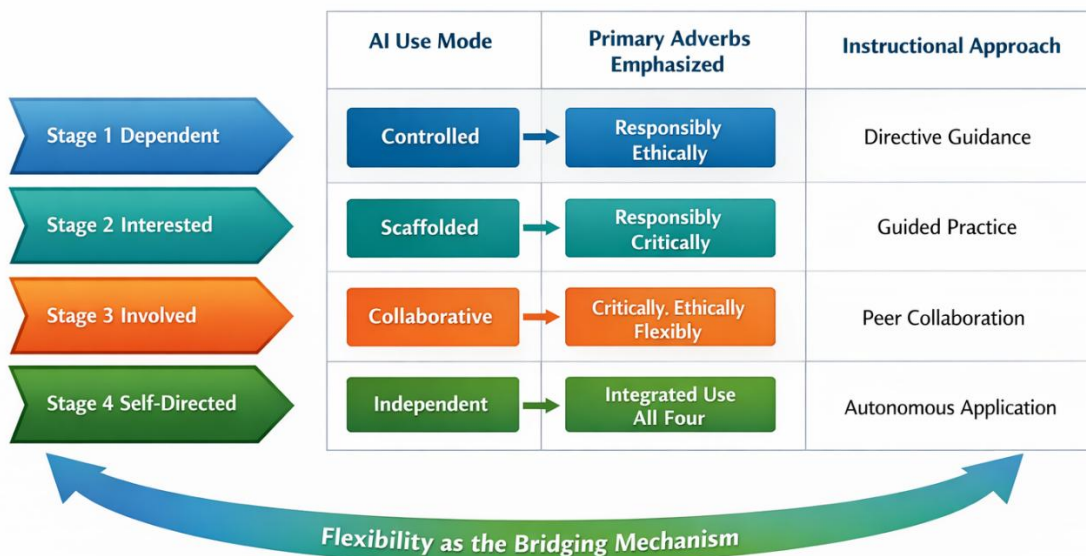
Integrative Model: Aligning the Four Adverbs with Learner Development

The effective integration of generative artificial intelligence in education requires alignment between modes of AI engagement and stages of learner development. The four-adverb framework—responsibly, critically, ethically, and flexibly—can be operationalized through a developmental lens by mapping each dimension onto stages of learner autonomy. Drawing on Grow’s staged self-directed learning model, this integrative approach emphasizes progression from structured, instructor-guided AI use to independent, self-directed engagement. Such alignment ensures that AI supports, rather than disrupts, the development of cognitive, ethical, and metacognitive capacities.

Figure 1

Alignment of AI engagement modes (responsibly, critically, ethically, flexibly) with stages of learner autonomy adapted from Grow’s model and situational leadership principles.

Four-Adverb AI Framework Across Learner Development



Across all stages → Flexibility acts as the bridging mechanism enabling progression

The model illustrates how AI engagement evolves in alignment with learner development, progressing from controlled to independent use. In early stages, responsible and ethical use dominate, as learners require structure and clear boundaries to prevent misuse and support foundational skill development. As learners gain competence and confidence, critical engagement becomes central, enabling them to evaluate AI-generated outputs and move beyond passive consumption. In advanced stages, all four dimensions converge, with learners demonstrating autonomous, context-sensitive, and ethically grounded use of AI. Flexibility operates across all stages as the bridging mechanism, allowing educators to adjust expectations and instructional strategies based on learner readiness. Without flexibility, the model collapses into either rigid control or unstructured autonomy, both of which undermine effective learning. This integrative alignment reinforces the importance of developmental scaffolding in AI pedagogy and positions AI as a tool that supports, rather than replaces, intellectual growth.

For example, in a graduate-level course, an instructor may initially require students to use AI within structured prompts and provide explicit disclosure statements (responsibly and ethically). As students progress, they may be asked to critique AI-generated outputs against peer-reviewed literature (critically). At advanced stages, students can independently determine how AI supports their research design, argumentation, and synthesis while maintaining transparency and ethical integrity (flexibly). This staged application demonstrates how the framework operates in practice across levels of learner autonomy.

At early stages of learner development, where students are dependent and require significant guidance, responsible and ethical use of AI are primary. In this phase, learners benefit from clear expectations, explicit boundaries, and structured tasks that define how AI may be used. Instruction focuses on transparency, appropriate attribution, and alignment with learning objectives. Ethical considerations, including academic integrity and awareness of bias, are introduced as foundational principles. At this stage, AI is tightly integrated into the instructional design, often through predefined prompts or guided activities. The emphasis is not on autonomy but on developing disciplined and accountable engagement with AI.

As learners progress to intermediate stages, characterized by increasing interest and involvement, critical engagement becomes more central. Students begin to move beyond procedural use of AI toward analytical interaction with AI-generated outputs. They are encouraged to question accuracy, identify limitations, and compare AI responses with scholarly sources. This stage reflects a shift from dependence to active participation, where learners are no longer passive recipients of information but active evaluators. Ethical and responsible practices remain important, but criticality becomes the primary driver of engagement. Research suggests that such structured critical interaction is essential in mitigating risks of cognitive offloading and promoting deeper learning (Kasneci et al., 2023).

At advanced stages of learner development, where students demonstrate higher levels of autonomy and competence, AI use becomes more independent and integrative. Learners are

capable of determining when and how to use AI to support complex tasks such as research, synthesis, and problem-solving. In this phase, all four adverbs converge. Responsibility is reflected in intentional and transparent use, criticality in rigorous evaluation, and ethics in principled decision-making. Flexibility becomes increasingly important, as learners adapt their use of AI to different contexts, disciplines, and objectives. This stage aligns with expectations for graduate and professional education, where learners must demonstrate independence, judgment, and adaptability.

The progression from controlled to independent AI use underscores the importance of flexibility as the bridging mechanism across stages of development. Flexibility enables educators to adjust expectations, instructional strategies, and levels of autonomy based on learner readiness. Without flexibility, rigid policies may either constrain advanced learners or overwhelm novice learners. For example, granting unrestricted AI access to dependent learners may lead to misuse or superficial engagement, while overly restrictive policies for advanced learners may limit innovation and critical inquiry. Flexibility allows for differentiated approaches that support both structure and autonomy, ensuring that AI use evolves in tandem with learner development.

This integrative model also highlights the interconnected nature of the four adverbs. While each dimension may be emphasized differently at various stages, they are not discrete or sequential. Responsible and ethical use are foundational and persist across all stages, while critical engagement and flexibility increase in prominence as learners develop. The model, therefore, is not linear but dynamic, reflecting the complex interplay between learner characteristics, instructional design, and technological capability.

For practical application, this framework can be represented through a visual or tabular model that maps each adverb to stages of learner autonomy. Such a model would illustrate, for example, how structured guidance and explicit rules dominate early stages, while adaptive, self-directed use characterizes advanced stages. It would also demonstrate how flexibility operates across all levels, enabling transitions and adjustments. Visual representation enhances clarity and usability, making the framework accessible to educators, researchers, and policymakers.

By aligning AI use with learner development, this integrative model provides a coherent approach to navigating the complexities of AI in education. It reinforces the need for intentional, theory-informed practices that support progression toward autonomy while maintaining academic rigor and ethical integrity. In doing so, it contributes to a more structured and sustainable model of AI integration that is responsive to both learner needs and institutional expectations.

Pedagogical Applications

The integration of generative artificial intelligence into education requires not only conceptual clarity and theoretical grounding but also practical application across multiple levels of the educational ecosystem. The four-adverb framework—responsibly, critically, ethically, and flexibly—can be operationalized through intentional pedagogical strategies that guide faculty, support student development, and inform institutional policy. Effective implementation depends

on aligning instructional design, learner engagement, and governance structures with these principles to ensure that AI enhances rather than diminishes educational quality.

For faculty

Faculty play a central role in shaping how AI is used within the classroom. One of the most important pedagogical shifts involves designing assignments that require critical engagement with AI rather than passive reliance on it. Instead of asking students to generate content using AI, instructors can create tasks that require evaluation, comparison, and refinement of AI-generated outputs. For example, students may be asked to critique the accuracy of an AI-generated response, identify biases or omissions, and revise the output based on scholarly sources. Such approaches reinforce higher-order thinking and align with expectations for analytical rigor, particularly in graduate and doctoral education (Kasneci et al., 2023).

Setting clear expectations for responsible and ethical AI use is equally essential. Faculty should articulate guidelines regarding when AI use is permitted, how it should be disclosed, and what constitutes acceptable assistance. Transparency is critical in maintaining academic integrity and ensuring that AI use aligns with learning objectives. Rather than relying solely on prohibitive policies, instructors can adopt a process-oriented approach that emphasizes documentation of AI use, reflection on its role in the learning process, and demonstration of independent understanding (Cotton et al., 2023). This approach shifts the focus from detection to intentional use, fostering accountability and ethical awareness.

Differentiating AI use based on learner readiness is another key consideration. Not all students possess the same level of digital literacy, critical thinking ability, or familiarity with AI tools. Drawing on principles of adult learning, faculty can tailor AI integration to match learner needs and developmental stages (Knowles et al., 2020). For novice learners, more structured guidance may be necessary, including predefined prompts and explicit instructions. For more advanced learners, greater autonomy can be granted, allowing them to determine how AI can support their inquiry and problem-solving. This differentiated approach ensures that AI use supports learning progression rather than creating disparities in skill development.

For students

Students must be equipped with practical guidelines that help them understand when and how to use AI effectively. Clear expectations regarding appropriate use can reduce confusion and promote responsible engagement. For instance, students can be encouraged to use AI for brainstorming, outlining, or generating alternative perspectives, while being cautioned against relying on it for final submissions without critical review. Providing examples of appropriate and inappropriate use can further clarify these expectations and support informed decision-making.

Developing autonomy and judgment is central to effective AI use. As learners progress, they must move beyond procedural use of AI toward more intentional and reflective engagement. This involves evaluating the reliability of AI-generated content, recognizing its limitations, and integrating it with other sources of knowledge. Research suggests that students often overestimate the accuracy of AI outputs, highlighting the need for explicit instruction in critical

evaluation (Dwivedi et al., 2023). By fostering metacognitive awareness, educators can help students become more discerning users of AI. This need is reinforced by emerging work emphasizing AI literacy, prompt engineering, and critical thinking as interconnected competencies for contemporary learners navigating AI-rich educational environments (Walter, 2024).

Ethical considerations also play a critical role in student development. Students must understand issues related to authorship, attribution, and academic integrity in AI-mediated environments. Encouraging transparency in AI use, such as acknowledging when and how it was used in the learning process, can promote ethical behavior and reduce ambiguity. Additionally, students should be made aware of broader concerns related to bias and fairness in AI systems, enabling them to engage with technology in a socially responsible manner (UNESCO, 2023).

Ultimately, the goal is to support students in becoming self-directed learners who can navigate AI-rich environments with confidence and responsibility. This aligns with principles of andragogy, which emphasize autonomy, relevance, and problem-centered learning (Knowles et al., 2020). By providing structured guidance and opportunities for reflection, educators can facilitate the development of judgment and independence in AI use.

For institutions

At the institutional level, the integration of AI requires a shift from prohibition-based policies to structured, principle-driven guidance. Early responses to generative AI often focused on restricting its use due to concerns about academic integrity. However, such approaches are increasingly unsustainable given the widespread availability and evolving capabilities of AI tools. Institutions must move toward policies that define acceptable use, provide clear expectations, and support faculty and students in integrating AI effectively (UNESCO, 2023).

Policy development should be aligned with broader goals related to accreditation, curriculum design, and program integrity. Accrediting bodies require evidence that learning outcomes are achieved through valid and reliable assessment practices. Unstructured AI use can complicate this requirement, making it difficult to determine whether student work reflects genuine learning. By establishing guidelines that promote transparency, accountability, and alignment with learning objectives, institutions can ensure that AI integration supports rather than undermines accreditation standards.

Curriculum design must also evolve to reflect the realities of AI-mediated learning. This includes incorporating AI literacy into program outcomes, redesigning assessments to emphasize critical thinking and application, and ensuring that learning experiences remain relevant to contemporary workforce demands. Employers increasingly expect graduates to possess not only technical skills but also the ability to evaluate information, make ethical decisions, and adapt to rapidly changing environments (World Economic Forum, 2024). Integrating AI into the curriculum in a structured and intentional manner can help bridge the gap between education and workforce expectations.

Institutional support is essential for effective implementation. Faculty development programs can provide training on AI tools, pedagogical strategies, and ethical considerations, enabling

instructors to integrate AI with confidence. At the same time, institutions must ensure equitable access to AI resources and support services, addressing potential disparities in digital literacy and technological access. Without such support, the benefits of AI integration may be unevenly distributed, exacerbating existing inequalities.

In sum, the pedagogical applications of the four-adverb framework extend across faculty practice, student development, and institutional policy. By aligning instructional design, learner engagement, and governance with principles of responsibility, criticality, ethics, and flexibility, education systems can move toward more coherent and effective integration of AI. This approach not only addresses current challenges but also positions institutions to adapt to future developments in AI and education.

Discussion

The integration of generative artificial intelligence into education is often framed as a technological disruption; however, a more productive interpretation is to view AI as a structural alignment mechanism within educational systems. When used intentionally, AI has the potential to expose and correct longstanding misalignments among curriculum design, instructional practice, assessment, and learning outcomes. These misalignments have historically persisted due to institutional inertia, fragmented governance, and outdated pedagogical models (Zawacki-Richter et al., 2019). AI, by its very nature, challenges these inconsistencies because it can perform many of the tasks traditionally used to measure learning, such as content generation and information recall. As a result, educators are compelled to reconsider what constitutes meaningful learning and how it should be assessed.

In this sense, AI functions as a forcing mechanism that reveals weaknesses in educational design. Assignments that can be easily completed by AI highlight a reliance on lower-order cognitive tasks, while assessments that fail to distinguish between AI-assisted and independently produced work raise questions about validity and rigor. Rather than viewing these challenges solely as threats, they can be understood as opportunities to realign educational practices with higher-order learning objectives. This includes emphasizing critical thinking, problem-solving, and the application of knowledge in complex, real-world contexts. Such a shift aligns with broader calls for transforming education to meet the demands of an increasingly dynamic and AI-integrated workforce (World Economic Forum, 2024).

However, the effectiveness of AI as a structural alignment mechanism depends on how it is integrated into educational systems. Without intentional frameworks, AI may reinforce existing misalignments rather than resolve them. For example, if educators continue to design assessments that prioritize output over process, students may use AI to produce acceptable work without engaging in meaningful learning. Similarly, if institutional policies focus primarily on detection and control rather than guidance and development, they may fail to address the underlying pedagogical issues. The four-adverb framework—responsibly, critically, ethically, and flexibly—provides a structured approach to aligning AI use with educational goals, ensuring that technology supports rather than undermines learning.

A critical factor in this alignment is the recognition of developmental readiness. Learners differ in their ability to engage with AI in ways that are responsible, critical, and ethical. Ignoring these differences can lead to significant risks, both for individual learners and for educational systems as a whole. For novice learners, unrestricted access to AI may result in overreliance, superficial understanding, and limited development of foundational skills. Cognitive offloading, in which learners delegate thinking processes to AI, is particularly problematic at early stages of learning, as it can hinder the development of essential competencies (Kasneci et al., 2023). In contrast, more advanced learners may benefit from greater autonomy in AI use, using it as a tool for exploration, synthesis, and innovation.

Failure to account for developmental readiness can also exacerbate inequalities in education. Students with higher levels of digital literacy or prior experience with AI may be better positioned to use these tools effectively, while others may struggle to navigate them or misuse them unintentionally. This disparity can lead to uneven learning outcomes and reinforce existing gaps in achievement. Moreover, without structured guidance, students may develop habits of AI use that prioritize efficiency over understanding, potentially undermining their long-term intellectual growth.

From a pedagogical perspective, aligning AI use with developmental readiness requires differentiated approaches that consider learner competence, motivation, and autonomy. This aligns with theories of adult learning and leadership that emphasize the need for adaptive instruction based on learner characteristics (Knowles et al., 2020; Hersey et al., 2013). By scaffolding AI use and gradually increasing learner autonomy, educators can support the development of critical and ethical engagement. This approach not only enhances learning outcomes but also prepares students to navigate AI-rich environments beyond the classroom.

At the same time, institutions must address the broader challenge of balancing innovation with academic rigor. The rapid adoption of AI has created pressure to integrate new technologies into teaching and learning, often driven by expectations of increased efficiency and competitiveness. While innovation is essential, it must be guided by clear principles that ensure the integrity and quality of education. Uncritical adoption of AI risks prioritizing convenience over rigor, leading to diminished expectations for student performance and reduced emphasis on deep learning.

Maintaining academic rigor in the context of AI requires a redefinition of assessment practices. Traditional forms of assessment, such as essays and take-home assignments, may need to be redesigned to account for AI capabilities. This could involve incorporating more process-oriented assessments, such as reflective writing, oral examinations, or project-based tasks that require sustained engagement and demonstration of understanding. By focusing on how students arrive at their conclusions, rather than solely on the final product, educators can better evaluate learning in AI-mediated environments (Singh & Alvarez, 2026).

Recent scoping review evidence further indicates that generative AI is already transforming assessment practices in higher education, underscoring the urgency of redesigning assignments toward more process-oriented, authentic, and reflective approaches (Xia et al., 2024).

Ethical considerations are also central to balancing innovation and rigor. The use of AI raises questions about authorship, accountability, and fairness, particularly when access to technology and support varies across contexts (UNESCO, 2023). Institutions must ensure that policies and practices promote equity and transparency, providing all students with the resources and guidance needed to use AI effectively. This includes investing in faculty development, student support services, and infrastructure that facilitates responsible and ethical AI integration.

Ultimately, the challenge is not whether to adopt AI, but how to integrate it in ways that enhance rather than compromise educational quality. This requires a shift from reactive to proactive approaches, grounded in theory and informed by practice. The four-adverb framework offers a pathway for achieving this balance by emphasizing intentionality, adaptability, and alignment with core educational values. By viewing AI as a structural alignment mechanism, recognizing the importance of developmental readiness, and maintaining a commitment to academic rigor, educators and institutions can navigate the complexities of AI integration with greater clarity and purpose.

Implications for Research and Practice

The rapid integration of generative artificial intelligence into education has outpaced the development of systematic research and evidence-based practices. While conceptual frameworks and policy discussions have expanded, there remains a pressing need for empirical studies that examine how AI is used across different stages of learner development. The four-adverb framework—responsibly, critically, ethically, and flexibly—offers a structured lens through which such investigations can be conducted, but its effectiveness must be validated through rigorous research. Understanding how learners at varying levels of autonomy engage with AI is essential for designing pedagogical strategies that are both developmentally appropriate and educationally meaningful.

A key area for future research involves examining AI use across learner stages, particularly in relation to developmental models such as Grow’s staged self-directed learning framework. Empirical studies are needed to explore how dependent, interested, involved, and self-directed learners interact with AI tools, and how these interactions influence learning outcomes. For instance, researchers might investigate whether structured AI guidance improves foundational skill acquisition among novice learners, or whether increased autonomy in AI use enhances critical thinking and problem-solving among advanced learners. Such studies can provide insights into how instructional strategies should be adapted to support progression from dependence to autonomy in AI-mediated environments.

Additionally, research should examine the potential risks associated with AI use at different stages of learning. Cognitive offloading, for example, may have different implications depending on learner readiness. While it may hinder skill development among novice learners, it could serve as a strategic tool for managing cognitive load among more experienced learners engaged in complex tasks (Kasneci et al., 2023). Understanding these nuances requires longitudinal and experimental research designs that capture both short-term and long-term effects of AI use. Without such evidence, educational practices may remain based on assumptions rather than data-driven insights. At the same time, recent scholarship on higher education assessment argues that

generative AI requires a reconsideration of originality, authorship, and the design of evaluative tasks, especially when conventional assumptions about independent student production no longer hold (Luo, 2024).

Another important dimension of research involves cross-disciplinary applications of AI in education. The use of AI varies significantly across fields, reflecting differences in epistemology, assessment practices, and professional expectations. For example, in disciplines such as engineering or computer science, AI may be integrated as a tool for problem-solving and simulation, while in the humanities, it may be used for text generation, analysis, and critique. These differences necessitate discipline-specific approaches to AI integration, as well as comparative studies that identify common principles and contextual variations.

Cross-disciplinary research can also illuminate how the four-adverb framework applies across diverse educational contexts. While responsibility, criticality, ethics, and flexibility are broadly relevant, their specific manifestations may differ depending on disciplinary norms and learning objectives. For instance, ethical considerations in AI use may be particularly salient in fields such as healthcare or law, where decisions have direct implications for human well-being. Similarly, critical engagement with AI may take different forms in scientific versus interpretive disciplines. By examining these variations, researchers can refine the framework and enhance its applicability across fields.

From a practical perspective, cross-disciplinary collaboration is essential for developing comprehensive approaches to AI integration. Faculty from different disciplines can share insights, strategies, and challenges, contributing to a more holistic understanding of how AI can be used effectively in education. Institutions can support such collaboration through interdisciplinary research initiatives, professional development programs, and communities of practice focused on AI pedagogy. These efforts can help bridge the gap between theory and practice, ensuring that research findings are translated into actionable strategies.

The global relevance of AI in education further underscores the need for research that extends beyond local or national contexts. Generative AI is not confined to specific regions or institutions; it is a global phenomenon that intersects with diverse educational systems, cultural norms, and economic conditions. As such, research must account for variations in access to technology, digital literacy, and institutional capacity. Studies conducted in different regions can provide valuable insights into how AI is adopted and adapted in varied contexts, highlighting both opportunities and challenges.

The connection between AI in education and workforce development is particularly significant at the global level. Employers increasingly expect graduates to possess not only technical skills but also the ability to think critically, make ethical decisions, and adapt to rapidly changing environments (World Economic Forum, 2024; UNESCO, 2026). AI literacy is becoming a key component of employability, requiring individuals to understand how to use AI tools effectively and responsibly. Educational institutions play a critical role in preparing students for these demands, and research can inform how curricula and instructional practices should evolve to support this goal.

Lifelong learning is another important consideration in the global context. As AI continues to transform industries and professions, individuals will need to engage in continuous learning to remain relevant in the workforce. This shifts the focus from traditional, time-bound education to ongoing skill development and adaptability. The four-adverb framework aligns with this shift by emphasizing practices that support autonomy, critical thinking, and ethical engagement, all of which are essential for lifelong learning. Research can explore how AI supports or hinders these processes, particularly in non-traditional learning environments such as professional development programs and online education.

From a policy perspective, the global nature of AI in education calls for coordinated efforts to develop guidelines and standards that promote responsible and equitable use. International organizations have begun to provide guidance on AI integration, emphasizing the need for human-centered and context-sensitive approaches (UNESCO, 2023). However, translating these principles into practice requires ongoing research and collaboration among educators, policymakers, and industry stakeholders. By contributing empirical evidence and theoretical insights, researchers can inform policy development and support the creation of educational systems that are both innovative and accountable.

In conclusion, the implications of AI integration for research and practice are far-reaching and multifaceted. There is a clear need for empirical studies that examine AI use across learner stages, providing evidence to guide pedagogical design and instructional strategies. Cross-disciplinary research can enhance understanding of how AI operates in different contexts, while global perspectives highlight the importance of aligning education with workforce demands and lifelong learning. By addressing these areas, researchers and practitioners can work together to develop approaches to AI integration that are grounded in theory, informed by evidence, and responsive to the evolving needs of learners and societies.

Conclusion

The rapid emergence of generative artificial intelligence has shifted the central question in education from whether AI should be used to how it should be used in ways that preserve and enhance learning. Framing the debate in binary terms—adoption versus prohibition—fails to address the complexity of AI-mediated environments and the developmental needs of learners. A more productive approach requires intentional, theory-driven integration that aligns technological capability with pedagogical purpose and institutional accountability (UNESCO, 2023).

The four-adverb framework—responsibly, critically, ethically, and flexibly—offers a sustainable model for guiding AI use across educational contexts. By emphasizing accountability, analytical engagement, ethical awareness, and adaptive application, the framework shifts the focus from tools to practices. It provides a structured yet dynamic approach that can be aligned with learner readiness, disciplinary expectations, and evolving technological landscapes.

Ultimately, the future of AI in education depends on the capacity of institutions and educators to move beyond reactive responses toward coherent, principled strategies. Grounding AI integration in established theories of learning and leadership ensures that innovation does not come at the

expense of rigor, equity, or integrity. Intentional adoption, rather than uncritical use, will determine whether AI serves as a catalyst for meaningful educational transformation.

References

- Chen, L., & Patel, R. (2025). Generative AI governance in higher education: Balancing innovation, policy, and pedagogy. *Computers and Education: Artificial Intelligence*, 8, 100412. <https://doi.org/10.1016/j.caeai.2025.100412>
- Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2023). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, 60(6), 1–12.
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, K. A., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., ... Wright, R. (2023). “So what if ChatGPT wrote it?” Multidisciplinary perspectives on opportunities, challenges, and implications of generative conversational AI for research, practice, and policy. *International Journal of Information Management*, 71, 102642. <https://doi.org/10.1016/j.ijinfomgt.2023.102642>
- Grow, G. O. (1991). Teaching learners to be self-directed. *Adult Education Quarterly*, 41(3), 125–149.
- Hersey, P., Blanchard, K. H., & Johnson, D. E. (2013). *Management of organizational behavior: Leading human resources* (10th ed.). Pearson.
- Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review*, 10, 18–26. <https://doi.org/10.1007/s13162-020-00161-0>
- Jin, Y., Yan, L., Echeverria, V., Gašević, D., & Martinez-Maldonado, R. (2024). Generative AI in higher education: A global perspective of institutional adoption policies and guidelines. *Computers and Education: Artificial Intelligence*, 7, 100348. <https://doi.org/10.1016/j.caeai.2024.100348>
- Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, 102274. <https://doi.org/10.1016/j.lindif.2023.102274>
- Kizilcec, R. F., Huber, E., Papanastasiou, E. C., Cram, A., Makridis, C. A., Smolansky, A., Zeivots, S., & Radulescu, C. (2024). Perceived impact of generative AI on assessments:

- Comparing educator and student perspectives in Australia, Cyprus, and the United States. *Computers and Education: Artificial Intelligence*, 7, 100269. <https://doi.org/10.1016/j.caeai.2024.100269>
- Knowles, M. S., Holton, E. F., III, & Swanson, R. A. (2020). *The adult learner: The definitive classic in adult education and human resource development* (9th ed.). Routledge.
- Luo, J. (2024). A critical review of GenAI policies in higher education assessment: A call to reconsider the originality of students' work. *Assessment & Evaluation in Higher Education*, 49(5), 651–664. <https://doi.org/10.1080/02602938.2024.2309963>
- Merriam, S. B., & Bierema, L. L. (2014). *Adult learning: Linking theory and practice*. Jossey-Bass.
- Rodriguez, M., & Kim, S. (2025). Institutional responses to generative AI: Implications for assessment validity and student learning. *Assessment & Evaluation in Higher Education*. Advance online publication. <https://doi.org/10.1080/02602938.2025>
- Singh, A., & Alvarez, J. (2026). Rethinking assessment in the age of AI: Process-based evaluation and authentic learning outcomes. *International Journal of Educational Technology in Higher Education*, 23, 12. <https://doi.org/10.1186/s41239-026>
- UNESCO. (2023). *Guidance for generative AI in education and research*. UNESCO.
- UNESCO. (2026). *Global framework for artificial intelligence in education: Policy, practice, and future directions*. UNESCO.
- Walter, Y. (2024). Embracing the future of artificial intelligence in the classroom: The relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, 21, 15. <https://doi.org/10.1186/s41239-024-00448-3>
- World Economic Forum. (2024). *The future of jobs report 2024*. World Economic Forum.
- Xia, Q., Weng, X., Ouyang, F., Lin, T. J., & Chiu, T. K. F. (2024). A scoping review on how generative artificial intelligence transforms assessment in higher education. *International Journal of Educational Technology in Higher Education*, 21, 40. <https://doi.org/10.1186/s41239-024-00468-z>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education*, 16(1), 39. <https://doi.org/10.1186/s41239-019-0171-0>