International Journal of Contemporary Approaches in Education (IJCAE) 2025
Volume 4 (2) Page 115 - 128
https://doi.org/10.29329/ijcae.2025.1406.3

AI and the Evolution of Learning Theories: From Historical Paradigms to Emerging Models

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Abstract

This opinion paper discusses artificial intelligence (AI) within the historical course of theories of learning and the intersections of pedagogy, technology, and policy. Building on the legacy of behaviorism, cognitivism, constructivism, and critical pedagogy, AI is interrogated not only as a technical tool but also as a transformative force that conceptualizes of educational thought. Starting with a vignette invites readers to analytically question whether AI represents a continuity of earlier patterns or a paradigmatic disagreement, and whether it positions learners as empowered mediators or as datafied objects within algorithmic systems. The study highlights that the future of learning depends on balancing two forces: the historical needs of education and the new technical possibilities created by AI. It argues that AI's strengths—such as personalization, adaptability, and creativity—should be combined with education's long-term commitments to equity, diversity, and democracy. The contribution lies in incorporating theoretical reflection with narrative pedagogy, offering a background for educators to involve with AI not merely as a technical phenomenon but as a socio-political and epistemological challenge restructuring education in the 21st century.

Keywords: Artificial Intelligence, Learning Theories, Behaviorism, Constructivism, Critical Pedagogy.

Received: 27.08.2025 – **Accepted:** 02.10.2025 – **Published:** 31.12.2025

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INTRODUCTION

Vignette: A Seminar on the Threshold of Paradigm Shifts

It was a cold winter morning on campus when a group of doctoral students gathered in a seminar room, their laptops and notebooks open, awaiting the first session of the semester. The professor entered with a single question written on the board: *"What happens when technology does not just support learning, but begins to theorize with us?"* The room grew silent. Students looked at each other, puzzled yet intrigued. The professor began, not with definitions or frameworks, but with a story: "Imagine Paris in the late 18th century. Enlightenment thinkers debate the power of reason and rational inquiry. They reject superstition and authority as the sole sources of truth. From these debates, the very foundations of behaviorist thinking begin to form—a belief that human action can be studied through reason, observation, and evidence. Fast forward a century. The smoke of the Industrial Revolution fills the air. Factories demand efficiency, repetition, and measurable outcomes. Pavlov's conditioning and Skinner's operant chambers mirror this industrial need: workers and students alike are trained, disciplined, and shaped into predictable patterns of response." The professor paused, scanning the faces of the students. "But history does not stop. The mid-20th century brings computers, cybernetics, and psychology's cognitive revolution. Now, the human mind is reimagined as an information processor—coding, storing, retrieving. Piaget, Bruner, and Vygotsky remind us that learners are not machines, but constructors of meaning within cultural and social worlds. At this point, one doctoral student raised a hand. "And what about us? In the 21st century, with AI?"

The professor smiled. "Exactly. Just as industrial machines reshaped behaviorism, AI systems now compel us to rethink the very foundations of learning theory. Reinforcement once came from teachers; today, it comes from adaptive algorithms. Cognitive scaffolds once relied on a human mentor's timely support; now, intelligent agents predict and adapt to our mistakes. Constructivist collaboration once meant dialogue among peers; now, students co-construct knowledge with both humans and machines. And critical pedagogy reminds us that every tool has ideology. What values, biases, and inequities do these systems encode?" The vignette deepened. The students imagined classrooms where AI-driven tutors guided every response, where predictive analytics determined who might fail, where generative systems suggested essay structures or entire arguments. Some felt excitement—efficiency, personalization, innovation. Others felt unease surveillance, homogenization, and the erosion of human agency.

The professor concluded:

"Learning theories are not timeless truths. They are mirrors of their historical moments. Behaviorism answered the call of industrial efficiency. Cognitivism rose with information theory. Constructivism flourished in democratic and social movements. Critical pedagogy emerged in response to inequality and oppression. Today, AI is our new turning point.

The question for us, as scholars and educators,

- Is artificial intelligence a continuation of learning theories, or does it represent a fundamental rupture?
- Is AI a learning actor that subjectivizes the student, or merely a tool that reduces them to data?
- In educational sciences, in what direction will the theory–technology–policy triangle evolves in the future?

The room fell into reflective silence. Each student realized they were not just studying theories of the past but participating in the writing of a new one. The seminar was no longer about observing history, it was about shaping it.

This vignette is not only a rhetorical starting point but also a reflection of the central purpose of this study: to explore how AI reshapes the foundations of learning theories while remaining deeply intertwined with educational values such as equality, diversity, democratic education, and ethics.

Throughout history, educational theories have evolved in close interaction with socio-political and technological contexts. Behaviorism aligned with the industrial need for efficiency, cognitivism drew on the metaphors of information processing, constructivism highlighted social meaning-making, and critical pedagogy emphasized empowerment and justice. Today, AI emerges as another turning point, extending and disrupting these traditions at the same time. The question that arises is not only whether AI continues or ruptures learning theories but also whether it contributes to—or undermines—education's long-term commitments to equity and democracy.

The aim of this paper is therefore twofold: first, to situate AI within the historical trajectory of learning theories, and second, to critically examine its potential to foster inclusive, democratic, and ethical education. By integrating classical and contemporary perspectives with narrative vignettes, the study seeks to provide both analytical depth and reflective engagement for readers

Above vignette briefly summarizes the following flow of opinions of the researchers regarding AI and learning theories. Throughout history, educational philosophies and learning theories have consistently reflected the broader intellectual, technological, and political transformations of their time. The Enlightenment emphasized reason, rationalism, and scientific inquiry, providing the epistemological foundation for behaviorist approaches in the 19th and early 20th centuries. The Industrial Revolution, with its demand for disciplined, efficient, and large-scale workforce training, reinforced the rise of behaviorism and its focus on measurable outcomes. Later, the cognitive revolution and constructivist perspectives emerged in response to developments in psychology, information theory, and technology, highlighting the roles of memory, social interaction, and learner agency. In the late 20th and early 21st centuries, digital technologies and global connectivity gave rise to connectivism and networked learning, expanding the boundaries of educational theory.

Today, artificial intelligence (AI) represents another profound shift in education, comparable in magnitude to the Enlightenment or the Industrial Revolution in its ability to restructure how knowledge is produced, transmitted, and consumed. AI-enabled systems are not only reshaping the tools of learning but are also challenging the theoretical frameworks through which educators, policymakers, and researchers understand teaching, cognition, and pedagogy. Much like the Industrial Revolution necessitated the adoption of behaviorist training techniques to produce a disciplined, efficient, and rapidly trainable workforce suited to machine-based production systems, the AI revolution compels us to reconsider how human and machine intelligence interact in shaping learning processes (Luckin et al., 2016; Schiff, 2022). The emergence of machine learning, adaptive feedback algorithms, and generative models disrupts the assumption that cognition and instruction are exclusively human-centered activities. Instead, AI introduces new forms of distributed agency in which knowledge is increasingly co-constructed between learners, educators, and intelligent systems.

When situated within the historical path of learning theories, the implications of AI become clearer. Behaviorism emphasized observable outcomes and reinforcement (Watson, 1913; Skinner, 1953), while cognitivism redirected attention to internal mental processes, schema, and problem-solving (Piaget, 1970; Bruner, 1960). Constructivism and socio-cultural theories further emphasized learner-centered environments, social interaction, and the co-construction of meaning (Vygotsky, 1978; von Glasersfeld, 1995). Finally, critical pedagogy challenged the neutrality of education, framing it as a site of ideological struggle, empowerment, and democratic transformation (Freire, 1970; Giroux, 2011). AI, however, compels a re-reading of these traditions: reinforcement principles are now operationalized by adaptive tutoring systems; cognitive supports are delivered through personalized knowledge graphs and retrieval-based learning; constructivist scenarios are simulated within immersive, AI-driven environments; and critical pedagogy finds new urgency in interrogating algorithmic bias, surveillance, and the commodification of student data.

In this context, AI can be understood as representing both continuity and rupture in educational theory. It continues the route of prior paradigms by extending their logics through digital means, yet it also represents a rupture because it introduces non-human actors into the very heart of pedagogy. For example, in behaviorist terms, reinforcement is no longer administered solely by a teacher but by an algorithm capable of real-time, data-driven feedback loops (Siemens & Long, 2011). In cognitivist terms, memory supports and scaffolds are increasingly delivered by intelligent agents capable of predicting learner errors and adapting instruction accordingly. In constructivist practice, AI-driven simulations allow students to engage in experiential learning with virtual peers or mentors, blurring the line between authentic human collaboration and machine-mediated co-construction of knowledge. In this context, critical pedagogy cautions that unexamined AI innovations can reproduce inequities, for example by disadvantaging students from minority groups, underestimating learners from low socio-economic backgrounds, or perpetuating racial stereotypes in educational data systems (Williamson et al., 2020).

This article therefore situates AI within the long arc of educational thought. While classical theories have emphasized concepts such as reinforcement and feedback, the integration of AI introduces new concerns and possibilities. On the one hand, AI provides unprecedented opportunities for personalization, adaptivity, and democratization of access. On the other hand, it raises pressing questions of equity, agency, and democratic education that demand both theoretical and practical attention. Without a critical and historically grounded approach, AI risks becoming not a tool for empowerment but an instrument of surveillance, commodification, and ideological reproduction. To harness its full potential, scholars and practitioners must reconceptualize learning theories in ways that safeguard human agency, promote inclusivity, and maintain education’s enduring role as a cornerstone of democratic society.

The concept of learning in the field of educational sciences has continuously been redefined throughout history under the influence of social, cultural, and technological transformations. In the early 20th century, the dominant behaviorist paradigm conceptualized learning as observable changes in behavior. Pavlov's classical conditioning experiments, Thorndike's law of effect, and Skinner's principles of operant conditioning collectively shaped systematic instructional models based on the stimulus–response–reinforcement chain. This approach, with its emphasis on measurable and standardized outcomes, directly informed the early examples of computer-assisted instruction. Even today, the traces of behaviorism remain visible in practices such as the immediate provision of feedback to students' responses and the reinforcement of correct answers (Sanal et al., 2019). From the 1950s onward, cognitive theory emerged in response to behaviorism's focus on external behavior, advocating instead that learning should be explained through mental processes. Piaget's stages of cognitive development, Bruner's discovery learning, and Ausubel's meaningful learning theory collectively underscored the central role of prior knowledge and mental schemata in learning. This paradigm highlighted the processes through which information is transferred from short-term memory to long-term storage, organized within cognitive structures, and retrieved when necessary. In AI-supported learning environments, this cognitive emphasis has found renewed resonance. For instance, research has shown that summarization strategies embedded in augmented reality applications reduce cognitive load while enhancing long-term retention (Özbay & Seferoğlu, 2023).

By the 1980s, constructivist approaches gained traction, framing learning as an active process of construction through experience and social interaction. Dewey emphasized that learning should be directly connected to life, while Vygotsky pointed to the decisive role of social interaction and cultural context. Typical applications of this paradigm include project-based, problem-based, and collaborative learning. With the integration of artificial intelligence, constructivist practices have expanded, particularly in disciplines such as experimental design and interior architecture, where AI tools have enhanced students' technical competencies, algorithmic thinking, and schema development (Sarica, 2023; Buldaç, 2024). Similarly, gamification and adaptive learning systems have been shown to increase motivation and facilitate schema accommodation (Çöpgeven, Özkaya, & Aydın, 2023).

Classical theories should not be viewed as obsolete but rather as evolving frameworks that need to be updated in the age of AI to encompass dimensions of individualization, flexibility, and creativity (Yavuzalp & Gürol, 2017; Gültekin & Burak, 2019; Yeşilyurt et al., 2024). Evidence from AI-enabled e-learning environments supports this view; for example, artificial neural networks have been able to predict learning styles with an accuracy of 91.7%, which highlights the importance of models that are sensitive to cognitive flexibility and individual differences.In the information age, learning has ceased to be a fixed or linear process and has instead become dynamic, flexible, personalized, and continuously evolving. With the proliferation of the internet, access to information has been reduced to seconds, yet

this very immediacy risks positioning students as passive consumers of knowledge. This phenomenon manifests as a tendency toward ready-made knowledge dependency. While this tendency reduces cognitive load in the short term, it weakens schema formation and the transfer of knowledge across contexts in the long term (Yeşilyurt et al., 2024). Properly designed AI-assisted learning scenarios, however, can counteract this risk by fostering schema development alongside surface-level knowledge acquisition. For instance, robotics and AI modules have enabled students to build more complex and realistic cognitive schemata (Eskici, Özdemir, & Öztürk, 2020; Turkaya & Özdemir, 2024).

In recent years, international debates on AI and education have highlighted its multifaceted implications. An article in The Atlantic titled "The AI Takeover of Education Is Just Getting Started" emphasized that ChatGPT is rapidly spreading across classrooms, easing teachers' administrative burdens while leaving regional inequalities largely intact (Thompson, 2025). Another article, "College Students Have Already Changed Forever", noted that the widespread use of AI tools among university students compels faculty to redesign their pedagogical approaches (Friedman, 2025). Similarly, the New York Post has published warnings that AI shortcuts may erode students' attention spans and critical thinking skills (New York Post, 2025).

At the policy level, the U.S. Department of Education has issued guidelines on the safe and ethical use of AI, while major corporations such as Microsoft, OpenAI, and Anthropic have launched large-scale teacher training initiatives on AI (U.S. Department of Education, 2024; TIME, 2025). Estonia, for example, offers another illustrative case. Rather than banning phones, it has promoted integration-focused strategies by providing students with personalized AI accounts that deliver individualized learning experiences (The Guardian, 2024). Furthermore, Columbia University's report on AI literacy identifies curiosity, critical thinking, and lifelong learning as the most critical educational goals of the era (Columbia University, 2025).

AI should not be regarded merely as a pedagogical tool but also as a multi-layered theoretical framework that is transforming learning itself. Foundational constructs such as the Turing test, Hebb's neural learning model, fuzzy logic, expert systems, and big data analytics illustrate the crucial intersections of AI and education (Ünsal, 2024). Reinterpreting learning theories in the age of AI has therefore become both a pedagogical and technological imperative, making it necessary to examine how these classical constructs connect to broader issues of equity, diversity, and democratic education.

The purpose of this paper is to situate AI within the historical trajectory of learning theories and to critically explore its potential to foster inclusive, democratic, and ethical education. The study contributes to the literature by linking classical theoretical perspectives with contemporary AI-driven practices, thereby offering a holistic understanding of how technology and pedagogy intersect. To achieve this, the paper discusses the evolution of learning theories from behaviorism to critical

pedagogy, examines the reconfiguration of these theories in the age of AI, and highlights the ethical and socio-political implications for future educational practices.

From Behaviorism to Cognitivism: Learning in the Age of Industrial and Cognitive Revolutions

Behaviorism emerged as a dominant paradigm during the late 19th and early 20th centuries, a period characterized by rapid industrialization and the need for efficient workforce training. Scholars such as Ivan Pavlov with his classical conditioning experiments, Edward Thorndike with the law of effect, and B. F. Skinner with operant conditioning provided scientific frameworks for understanding learning as a process of stimulus–response reinforcement. Watson's manifesto, Psychology as the Behaviorist Views It, epitomized this perspective, reducing learning to observable, measurable behaviors while excluding internal mental processes. The industrial context—factories, mechanized production, and assembly lines—mirrored the behaviorist emphasis on control, repetition, and efficiency (Ornstein & Hunkins, 2004).

However, by the mid-20th century, limitations of behaviorism became evident. It could not adequately explain complex cognitive processes such as language acquisition, problem-solving, or abstract reasoning. The "cognitive revolution" in psychology, inspired by the advent of computer technologies and information-processing models, shifted attention to internal mental structures. Jean Piaget's stage theory of cognitive development emphasized schema construction and developmental readiness, while Jerome Bruner highlighted discovery learning and scaffolding. Vygotsky's sociocultural theory introduced the concept of the zone of proximal development (ZPD), underlining the centrality of social interaction and cultural tools in learning. Cognitivism reframed learners not as passive recipients of reinforcement but as active processors of information, constructing meaning through memory, attention, and problem-solving.

This shift was deeply tied to historical developments. The rise of information technology and cybernetics after World War II provided metaphors of the brain as a computer, capable of encoding, storing, and retrieving information (Miller, 1956). Educational psychology began to explore strategies such as chunking, metacognition, and retrieval practice, aligning with the broader context of the information age. Cognitivism thus represented both a scientific and cultural departure from mechanistic behaviorism, embedding learning within the structures of the human mind.

Constructivism, Social Learning, and Critical Pedagogy

By the late 20th century, constructivism gained traction as a response to both behaviorist reductionism and cognitivist individualism. Rooted in the works of Piaget and Vygotsky, constructivism

emphasized that learners actively construct knowledge through interaction with their environment and social communities. Learning was understood not as the transmission of fixed knowledge but as the co-construction of meaning. Bandura's social learning theory expanded this paradigm, demonstrating that observational learning, modeling, and self-efficacy were critical components of education.

Constructivism coincided with broader cultural and technological transformations, particularly the rise of student-centered pedagogies and progressive education movements. John Dewey's pragmatism had earlier laid the groundwork by emphasizing experiential learning and democratic classrooms. Constructivist pedagogies such as problem-based learning, inquiry-based learning, and project-based learning became extensive, aligning with the increasing complexity of knowledge economies. Rather than training obedient workforces, the goal was to foster critical thinkers, problem-solvers, and cooperative students.

Together, critical pedagogy appeared as a fundamental extension of constructivism. Paulo Freire's Pedagogy of the Oppressed outlined education as a practice of liberty, emphasizing dialogue, reflection, and action (praxis) as means for students to challenge oppression and transform society. Henry Giroux (2011) claimed that teachers should act as public intellectuals, nurturing critical consciousness and democratic involvement. Michael Apple (2006) correspondingly emphasized the ways in which curriculum and pedagogy reproduce social inequalities and called for education as a site of encounter. These perspectives surrounded education not merely as cognitive improvement but as an extremely political act, implanted in structures of power, ideology, and social justice. Thus, by the end of the 20th century, educational philosophy was marked by diversity, behaviorist productivity, cognitivist structures, constructivist meaning-making, and critical pedagogy's call for liberation. This multiplicity set the stage for the next transformation: the digital age.

Digitalization, Networked Learning, and the Rise of Connectivism

The late 20th and early 21st centuries carried out the digital uprising, reshaping both knowledge and learning. The explosion of computers, the internet, and Web technologies fundamentally transformed how information was produced, shared, and consumed. Learners gained access to gigantic global knowledge networks, while educators faced the experiment of teaching in environments where information was abundant but critical evaluation was uncommon.

In this context, connectivism emerged as a new knowledge theory. George Siemens (2005) argued that traditional theories—behaviorism, cognitivism and constructivism—were lacking in explaining learning in a digital age characterized by distributed networks, swift information flow, and continuous change. Connectivism theorized learning as the ability to form, direct, and nurture networks of knowledge, both human and technical. Knowledge was seen as residing in networks, and the capacity

to know was more critical than the possession of static knowledge. Learning, consequently, involved connecting particular nodes and sources of information, often facilitated by technology.

Digital pedagogies also underlined collaboration, online communities of practice, and peer-to-peer learning. Wenger's (1998) notion of "communities of practice" exemplified how learners form identities through participation in shared activities. MOOCs (massive open online courses), virtual learning milieus, and open educational resources embodied these theories in practice. Yet digitalization also brought contests such as information overload, digital divides, and questions of authenticity and authority in networked spaces.

Significantly, this period set the stage for AI's incorporation into education. Adaptive learning platforms, data analytics, and early intelligent tutoring systems implied at a paradigm where algorithms could personalize learning experiences in ways previously unimaginable.

Artificial Intelligence and the Reconfiguration of Learning Theories

Connections between Learning Theories and AI Applications

Learning Theory	AI-Related Practices	Critical Issues
Behaviorism	Adaptive tutoring, gamified feedback	Over-mechanization, less agency
Cognitivism	Memory aids, retrieval practice, knowledge grap	Algorithmic dependence, loss of critical thinking
Constructivism	AI simulations, VR, collaboration platforms	Authenticity issues, ethical concerns
Critical Pedagogy	Bias analysis, equity-focused AI design	Inequality reinforcement, surveillance risks

Figure 1. Learning Theories and AI Application

In the 21st century, artificial intelligence appeared as a transformative power in education. AI systems, driven by machine learning, natural language processing, and predictive analytics, extend the capabilities of earlier digital technologies by not only delivering data but also interpreting, adapting, and producing knowledge. Unlike previous technologies, AI introduces autonomous agencies into educational processes, fundamentally reshaping theoretical frameworks.

From a behaviorist perspective, AI-powered adaptive learning systems replicate reinforcement principles by delivering immediate feedback, gamified rewards, and personalized drill exercises. Intelligent tutoring systems operationalize Skinnerian reinforcement on a massive scale, offering individualized instruction while tracking performance data (Anderson et al., 1995). However, AI

transcends traditional behaviorism by continuously adjusting to learner profiles, enabling more nuanced, data-driven reinforcement loops.

From a cognitivist perspective, AI functions as a cognitive amplifier. Tools such as AI-driven memory aids, retrieval practice platforms, and personalized scaffolding simulate and extend information-processing models (Siemens & Long, 2011). Generative AI systems, such as large language models, can provide learners with immediate explanations, summaries, and problem-solving strategies, effectively augmenting metacognition and self-regulation.

Constructivist paradigms are also being redefined. AI-driven simulations, virtual reality, and scenario-based environments allow learners to construct knowledge through immersive experiences, often co-created with intelligent agents. Vygotsky's ZPD is now extended by AI systems that can provide real-time scaffolding tailored to individual needs (Luckin et al., 2016). Collaborative platforms supported by AI facilitate peer interaction across global contexts, reinforcing social constructivist ideals in hybrid human–machine environments. At the same time, AI also requires new theoretical frameworks. Scholars have proposed concepts such as "AI-augmented constructivism" and "algorithmic pedagogy" (Holmes, Porayska-Pomsta, & Holstein, 2021), which emphasize human–AI co-agency in learning. Dellermann et al. (2019) describe "hybrid intelligence," where humans and machines collaboratively solve problems, blending human creativity with algorithmic efficiency. These perspectives move beyond human-centered cognition to conceptualize learning as distributed across networks of biological and artificial agents. Beyond questions of equity and democratization, ethical considerations also emerge, requiring closer examination.

Ethical Tensions and Critical Perspectives

As with previous historical transformations, the integration of AI into education brings both opportunities and risks. Just as industrialization risked reducing learners to mechanized workers, AI risks reducing learners to data points within surveillance-based educational systems. Williamson et al. (2020) caution against *datafication in education*, where algorithmic metrics supplant holistic human judgment. Algorithmic bias, privacy concerns, and inequitable access pose significant threats to democratic and equitable education.

Critical pedagogy perspectives remain vital in this context. Freire's (1970) insistence on dialogue and humanization challenges the technocratic tendencies of AI-driven education. Giroux (2011) warns against depoliticized views of technology, urging educators to see AI as embedded within broader ideological and power structures. Without critical frameworks, AI risks reinforcing structural inequalities, privileging affluent learners with access to cutting-edge tools while marginalizing disadvantaged communities.

At the same time, AI offers potential for advancing equity if deployed thoughtfully. Adaptive technologies can support learners with disabilities, language barriers, or diverse learning needs. Cross-cultural collaborations enabled by AI can foster pluralism and global citizenship. The challenge, therefore, lies in ensuring that AI is bound with democratic, inclusive purposes rather than for control and regularization.

CONCLUSION

The advancement of learning theories reflects a dialectic between historical necessity and technological possibility. The Enlightenment foregrounded reason, science, and rationality, shaping the emergence of behaviorism as a systematic endeavor to study human action through measurable indicators of stimulus and response. The Industrial Revolution, with its demand for efficiency and uniform training, reinforced behaviorist practices by emphasizing external reinforcement and the replicability of learning results (Skinner, 1953). These historical shifts demonstrate how political and technological developments have consistently framed the parameters of educational thought and practice.

The cognitive revolution redirected attention to internal procedures, memory structures, and schema, reframing learning as an active mental construction rather than a passive reaction to stimuli (Piaget, 1970; Bruner, 1960). Constructivism further emphasized the learner's agency and the role of cultural and social interaction in knowledge production (Vygotsky, 1978). Critical pedagogy introduced an emancipatory dimension, underscoring the need to interrogate power, ideology, and inequality in education (Freire, 1970; Giroux, 2011). Together, these paradigms illustrate that learning theories have historically developed not in isolation but in response to broader socio-political and technological forces.

The late 20th and early 21st centuries saw the emergence of digital technologies, which reshaped learning into networked, collaborative, and distributed processes. Connectivism, for instance, positioned knowledge as fluid and located across networks rather than within individual minds (Siemens, 2005). This paradigm acknowledged the increasing importance of digital literacy, interconnectivity, and lifelong learning in an era characterized by the exponential growth of information. Yet, even this digital turn did not anticipate the radical challenges posed by artificial intelligence (AI).

Today, AI represents another profound transformation in education. AI-enabled systems are not only redesigning the tools of education but also challenging the theoretical foundations through which we understand teaching, cognition, and pedagogy (Luckin et al., 2016; Holmes et al., 2022). Just as the Industrial Revolution demanded behaviorist training techniques, the AI revolution compels educators

to reexamine how human and machine intelligence interact in shaping learning ecologies. Intelligent tutoring systems, adaptive platforms, and generative AI expand the horizons of personalized education by providing continuous assessment, individualized feedback, and scalable mentorship. These innovations resonate with Vygotsky's zone of proximal development while also transcending its human-centered expectations. However, the integration of AI into education is not purely a technical development but also a philosophical and ethical turning point. The challenge for contemporary education is to integrate the unprecedented affordances of AI—personalization, adaptivity, and generativity—with long-term commitments to equity, cultural diversity, and democratic participation. Without careful attention, AI risks replicating the mechanistic drawbacks of industrial-era behaviorism, reducing learners to data points within algorithmic feedback loops (Williamson, 2020). This danger calls for critical pedagogy frameworks to ensure that AI-enhanced education supports fairness, inclusion, and human agency.

The political economy of AI in education must also be scrutinized. Data privacy, algorithmic bias, and surveillance-driven learning environments present significant risks to both learners and educators (Zuboff, 2019). Policy agendas, therefore, must balance innovation with protections for equity and democratic values. International discussions reveal both promise and tension: while AI can democratize access to education through personalized tools, it may also exacerbate inequalities by privileging those with greater access to digital infrastructure (OECD, 2021).

In this context, AI-enhanced pedagogy must be conceived not simply as a technological upgrade but as a transformative opportunity to reimagine learning. If guided by comprehensive, ethical, and research-based frameworks, AI can function as a catalyst for creativity, inclusivity, and social transformation. Conversely, if left unchecked, it risks narrowing educational practice to utilitarian goals aligned with political control and market-driven priorities.

The future of learning, therefore, depends on striking a balance where AI contributes to equity, adaptivity, and democratization. Equity requires ensuring that AI tools reduce rather than deepen inequalities, providing fair opportunities for all learners. Adaptivity underscores AI's potential to personalize learning pathways while protecting human agency and critical engagement. Democratization highlights the necessity of keeping education as a public good, where AI fosters participation, pluralism, and democratic values.

As scholars argue, education must theorize beyond human-centered cognition toward hybrid ecologies of learning where humans and machines co-construct knowledge (Holmes et al., 2022; Dellermann et al., 2019). AI should not replace traditional theories but extend them, offering opportunities to reinterpret behaviorism, cognitivism, constructivism, and critical pedagogy in light of

new technological realities. Ultimately, the sustainability of democratic education requires ensuring that AI systems remain tools for empowerment rather than instruments of control.

Vignette – From the Students' Voices

As we walked out of today's seminar, the corridor seemed a little different buzzing, not just with casual chatter but with a kind of intellectual unease. One of us murmured, *"So, is AI the next behaviorism, another tool to discipline learners? Or is it closer to constructivism, co-creating meaning with us?"* Another responded, *"Maybe it's both. Maybe it's neither. Maybe it's something that forces us to redefine what learning itself means."*

We kept returning to the professor's question: *Is AI a continuation or a rupture?* Some of us leaned toward continuity, seeing algorithms as the new "reinforcement schedules" or the latest scaffolding device. Others insisted it was a rupture—machines now participating as actors, not just tools, in the learning process. That thought was both exciting and unsettling.

There was also the unease about power: *"If AI tracks my every click, every hesitation, am I still a learner or just data?"* someone asked. Silence followed, until another added, *"That's where critical pedagogy matters. We have to ask: Who designs these systems? Who benefits from them? Whose values are coded in?"* It was clear that the discussion had shifted from theory to lived reality: not just *what* AI can do, but *what it does to us.*

By the time we reached the campus café, the conversation had turned aspirational. *"If we—future researchers, policymakers, educators—don't engage critically, AI will be imposed on us, not shaped by us,"* one student said, almost as a collective resolution. *"Maybe our role is to make sure AI doesn't silence agency but amplifies it."*

Leaving the seminar, we didn't feel we had answers. But perhaps that's the point of doctoral study: to carry good questions forward. Questions that travel with us into our research, our teaching, and our futures.

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