Journal of Educational Innovation and Transformation Global
Volume 2, Number 1, 2026. pp. 90-99
e-ISSN 3109-6468
e-journal.nusantaraglobal.ac.id/index.php/jeitg/index
DOI: https://doi.org/

Towards an AI-Assisted Transformative Pedagogy Framework for Accelerating Students Critical Thinking Skills

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Article Info

Article history:

Received May 08, 2026
Approved June 19, 2026

ABSTRACT

This study aims to develop a conceptual framework and operational syntax for an AI-Assisted Transformative Pedagogy model as a strategy to accelerate students' critical thinking skills in the era of Generative Artificial Intelligence (Gen-AI). The study employed a conceptual research approach using a systematic literature review method of relevant scholarly articles, books, and academic documents addressing transformative pedagogy, critical thinking, artificial intelligence in education, and human–AI collaboration. Data were analyzed through content analysis and conceptual synthesis techniques to identify relationships among key concepts and construct an integrated learning model. The findings resulted in a conceptual framework that connects transformative pedagogy, artificial intelligence, and critical thinking skills within a mutually reinforcing learning ecosystem. In addition, the study formulated six core learning phases: authentic dilemma identification, AI-assisted perspective exploration, critical reflection on assumptions, argumentative dialogue, perspective reconstruction, and reflective action. The findings indicate that AI can function as a cognitive partner that facilitates critical reflection, multiperspective exploration, and evidence-based argumentation, thereby potentially accelerating the development of students' interpretation, analysis, evaluation, inference, explanation, and self-regulation skills. The proposed model also emphasizes that teachers remain central actors in guiding cognitive transformation and ensuring that AI is utilized in pedagogically sound, ethical, and meaningful ways. Theoretically, this study contributes to the growing body of knowledge on the integration of AI into transformative instructional design. Practically, it provides a reference framework for educators in designing learning environments that are responsive to technological advancements while fostering students' critical thinking capacities.

Keywords: Artificial Intelligence, Transformative Pedagogy, Critical Thinking, Generative Artificial Intelligence, Instructional Design

How to cite: Salam, A., Ubaidillah, A., & Saputri, H. (2026). *Towards an AI-Assisted Transformative Pedagogy Framework for Accelerating Students' Critical Thinking Skills*. *Journal of Educational Innovation and Transformation Global, 2*(1), 90–99. https://doi.org/10.55681/jeitg.v2i1.196

INTRODUCTION

The global educational landscape of the twenty-first century is undergoing an unprecedented transformation driven by the convergence of digital technological disruption and the urgent need to restructure human competencies (Schwab, 2016; Luckin et al., 2016; Yusuf et al., 2024). Education is no longer merely a medium for knowledge transmission; rather, it has evolved into a platform for reconstructing consciousness and fostering critical thinking capacities (Freire, 1970; Mezirow, 1997). Within this dynamic context, the emergence of Generative Artificial Intelligence (Gen-AI) technologies, particularly Large Language Models (LLMs), has fundamentally reshaped the instructional landscape (Kasneci et al., 2023; Chiu, 2023). The instant and abundant accessibility of information has created a new paradox in educational settings. On the one hand, these technologies offer remarkable opportunities for learning efficiency and personalization; on the other hand, uncontrolled dependence on AI may diminish cognitive rigor when students use technology merely as an instant answer-generating tool without engaging in meaningful reflective processes (Dwivedi et al., 2023; Perkins, 2023).

This situation necessitates a radical reorientation of how learning activities are designed, implemented, and evaluated (Holmes et al., 2022; Luckin et al., 2016). Conventional pedagogical models based on memorization and one-way knowledge transfer—the so-called banking concept of education—have proven insufficient and increasingly obsolete in addressing contemporary educational challenges (Freire, 1970; Zhao, 2021). As digital technologies are now capable of generating data and analyses within seconds, the distinctive value of human intelligence no longer resides in the amount of information that can be retained, but rather in the ability to filter information, critically analyze it, evaluate its validity, and synthesize it into innovative solutions (OECD, 2023; Partnership for 21st Century Learning, 2019). Consequently, the acceleration of critical thinking skills must be positioned as a central priority and a primary instructional objective across all educational levels (Facione, 1990; Paul & Elder, 2019).

Critical thinking is not merely an optional higher-order cognitive skill; it has become an existential competency within a digital ecosystem characterized by information overload and post-truth phenomena (Facione, 1990; Paul & Elder, 2019). In digital societies, the ability to evaluate information objectively has become increasingly essential because artificial intelligence can generate texts, images, and arguments that appear highly convincing despite not always being accurate (Kasneci et al., 2023). Students' capacities to identify biases, assess the strength of evidence, detect logical fallacies, and verify information credibility serve as critical safeguards against the growing complexities of misinformation and disinformation (Jakesch et al., 2023; Chiu, 2023). Without adequate critical thinking skills, students risk becoming passive consumers of information who accept AI-generated outputs as unquestionable truths without engaging in appropriate validation processes (Dwivedi et al., 2023).

Nevertheless, empirical realities continue to reveal a substantial gap between curricular aspirations and instructional practices (Selwyn, 2022). Although numerous educational policies have identified critical thinking as a core twenty-first-century competency, its implementation in classroom practice remains constrained by various challenges. Many educational institutions continue to operate within linear, teacher-centered instructional paradigms, thereby limiting opportunities for students to engage in exploration, argumentation, reflection, and independent knowledge construction (Holmes et al., 2022). Simultaneously, the integration of AI into educational environments is often approached through extreme positions, ranging from complete prohibition due to concerns about plagiarism to unrestricted adoption without clear pedagogical guidance (Chiu, 2023; Yusuf et al., 2024). Both approaches are problematic because neither provides adequate opportunities for students to develop the

collaborative competencies required in the emerging era of human–AI collaboration (World Economic Forum, 2023).

Within this context, there is a pressing need to formulate pedagogical approaches that can leverage the potential of AI without undermining students' intellectual autonomy. Artificial intelligence should be positioned not as a substitute for human thinking but as an instrument capable of stimulating higher-order cognitive processes. From this perspective, technology functions as a tool for extending human intellectual capacities through dialogue, reflection, argumentation, and the exploration of diverse perspectives (Luckin et al., 2016). Accordingly, the utilization of AI in education should move beyond efficiency-oriented objectives toward the cultivation of sustainable and meaningful critical thinking capacities.

To address this need, the paradigm of Transformative Pedagogy offers a highly relevant theoretical foundation (Mezirow, 1991; Cranton, 2016). Rooted in Jack Mezirow's Transformative Learning Theory and Paulo Freire's Critical Pedagogy, this approach emphasizes that genuine learning should transform learners' frames of reference, habits of mind, and mental schemas through deep critical reflection (Mezirow, 1997; Freire, 1970). Learning is not solely intended to acquire new knowledge; rather, it should encourage learners to question the assumptions underlying their beliefs, explore alternative perspectives, and construct understandings that are more inclusive, reflective, and rational (Cranton, 2016).

When transformative pedagogy is integrated with the capabilities of artificial intelligence, new opportunities emerge for creating learning environments that are dialogic, reflective, and oriented toward cognitive transformation (Lee et al., 2023). In this context, AI can function as a Socratic partner that actively challenges students' assumptions through critical questioning, counterarguments, case simulations, and the presentation of multiple perspectives (Eager & Brunton, 2023; Steele, 2023). AI may also be utilized to generate cognitive conflict that encourages learners to re-evaluate their existing beliefs and understandings. Such processes of meaning negotiation, critical reflection, and cognitive dissonance resolution are believed to accelerate the development of critical thinking skills more effectively than conventional teacher-centered approaches (Mezirow, 1997; Lee et al., 2023).

Despite the promising potential of integrating AI and transformative pedagogy, the current body of scholarly literature continues to exhibit significant research gaps (Yusuf et al., 2024). Most studies on AI in education remain dominated by technocentric perspectives focusing on adaptive learning systems, learning analytics, automated assessment, and the enhancement of instructional efficiency (Holmes et al., 2022; Zawacki-Richter et al., 2024). Research specifically examining how AI can be designed as an instrument of cognitive transformation and an accelerator of critical thinking development remains relatively limited. Furthermore, there is still a lack of studies investigating how interactions among students, teachers, and AI can be systematically designed to produce transformative learning experiences (Wang et al., 2024).

Another significant gap concerns the absence of operational and practical instructional syntaxes that educators can readily implement to integrate AI effectively and responsibly. Many teachers and lecturers continue to experience difficulties in designing learning activities that capitalize on AI capabilities while preserving students' active roles as knowledge constructors (Chan & Lee, 2023). This challenge highlights the urgent need to develop learning models capable of bridging the technical capabilities of AI with the fundamental educational goals of fostering critical consciousness, reflective inquiry, and transformative thinking among learners (Chauncey & McKenna, 2023).

Based on the aforementioned background and identified research gaps, this article focuses on the development of an AI-Assisted Transformative Pedagogy model as a strategy for accelerating students' critical thinking skills. Specifically, this study seeks to address several fundamental questions: How can transformative learning syntax be reconstructed through AI integration? What forms of cognitive interaction emerge among students, teachers, and AI throughout the learning process? To what extent does such a model have the potential to accelerate the development of students' critical thinking indicators? The primary objective of this study is to formulate a conceptual framework and operational learning syntax that are valid, practical, and effective for implementation in twenty-first-century educational contexts. Theoretically, this research is expected to enrich the fields of instructional design and educational technology through the development of a human-centered, reflective, and emancipatory model of AI integration. Practically, the findings are anticipated to provide guidance for teachers, lecturers, and curriculum developers in constructing learning ecosystems that are adaptive to technological advancements while remaining firmly committed to strengthening learners' critical thinking capacities (OECD, 2023; World Economic Forum, 2023).

METHODS

This study employed a conceptual research approach using a systematic literature review method to develop a conceptual framework and operational syntax for an AI-Assisted Transformative Pedagogy model aimed at accelerating students' critical thinking skills. A conceptual research approach was selected because the primary objective of the study was not to empirically test the effectiveness of the proposed model through field experimentation, but rather to establish a robust theoretical foundation, identify relationships among key variables, and formulate a learning model characterized by conceptual coherence and practical relevance to the challenges of twenty-first-century education (Jaakkola, 2020).

The research process was conducted through several interconnected stages. The first stage involved the identification and exploration of literature relevant to the focus of the study. Literature searches were performed across internationally recognized academic databases, including Scopus, Web of Science, ERIC, ScienceDirect, SpringerLink, Taylor & Francis Online, Wiley Online Library, and Google Scholar as a supplementary source. The search process utilized a combination of keywords, including "transformative pedagogy," "transformative learning," "critical thinking," "artificial intelligence in education," "generative AI," "large language models," "AI-assisted learning," "human–AI collaboration," "Socratic dialogue," and "instructional design." The search was primarily limited to publications published between 2015 and 2025 to capture recent developments in the integration of artificial intelligence in education while retaining seminal works that constitute the theoretical foundations of this study, particularly those of Freire and Mezirow.

The second stage involved the selection of literature based on predetermined inclusion and exclusion criteria. The inclusion criteria comprised: (1) journal articles indexed in Scopus or Web of Science; (2) publications addressing transformative pedagogy, critical thinking, artificial intelligence in education, or AI integration in learning; (3) studies available in full-text format; and (4) publications written in English or Indonesian. Conversely, the exclusion criteria encompassed studies lacking direct relevance to the research focus, articles addressing solely the technical development of AI without educational implications, and documents that had not undergone a peer-review process.

The third stage consisted of content analysis of the selected literature. A thematic analysis approach was employed to identify major concepts, patterns of relationships among variables, pedagogical principles, AI integration strategies, and critical thinking indicators

frequently discussed in previous studies. The analytical process followed a conceptual synthesis approach aimed at integrating diverse theoretical perspectives into a coherent and comprehensive framework (Snyder, 2019). During this stage, the findings were organized into five major themes: (1) characteristics of transformative pedagogy; (2) the role of AI in learning; (3) mechanisms for accelerating critical thinking; (4) forms of interaction among teachers, students, and AI; and (5) instructional design implications for AI-enhanced learning environments.

The fourth stage involved the construction of the conceptual model. Based on the results of the literature synthesis, a conceptual framework was developed to explain the relationships among transformative pedagogical components, artificial intelligence functions, and the processes underlying the development of students' critical thinking skills. Model development was undertaken through a process of theoretical deconstruction and reconstruction intended to generate a learning syntax capable of systematically integrating critical reflection, dialogue, cognitive conflict, multiperspective exploration, and human–AI collaboration. Within this framework, AI was positioned as a dialogic partner that stimulates reflection, challenges assumptions, and expands students' cognitive horizons through adaptive and responsive interactions.

The fifth stage involved conceptual validation. Validation was conducted using a theoretical triangulation technique, which entailed comparing and confirming the alignment of the proposed model with relevant theories and findings from previous studies. This process aimed to ensure that each component of the model possessed a strong theoretical foundation, remained consistent with contemporary scholarly developments, and demonstrated realistic potential for implementation in twenty-first-century learning contexts. Furthermore, conceptual validity was strengthened through an analysis of the alignment between the proposed learning syntax and the core dimensions of critical thinking identified by Facione (1990), namely interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The final outcome of this study is a conceptual framework and operational syntax for an AI-Assisted Transformative Pedagogy model designed to support the development of students' critical thinking skills. The proposed model is expected to provide a theoretical foundation for future empirical and experimental investigations while simultaneously serving as a practical reference for educators seeking to integrate artificial intelligence into teaching and learning processes in a pedagogically sound, ethically responsible, and transformative manner.

RESULT AND DISCUSSION

Conceptual Framework of AI-Assisted Transformative Pedagogy

The results of the literature synthesis indicate that the integration of artificial intelligence in education requires an approach that is not solely technology-oriented but is also grounded in a strong pedagogical foundation. Numerous studies suggest that the use of Generative Artificial Intelligence (Gen-AI) in learning environments has the potential to enhance the quality of learning experiences when designed to support higher-order thinking, critical reflection, and meaningful knowledge construction (Luckin et al., 2016; Holmes et al., 2022; Kasneci et al., 2023; Chiu, 2023). Based on the conceptual analysis, this study develops an AI-Assisted Transformative Pedagogy framework through the integration of transformative learning theory, critical pedagogy, and the concept of human–AI collaboration in learning.

The proposed model consists of three interrelated components: transformative pedagogy as the philosophical foundation, artificial intelligence as a cognitive facilitator, and critical thinking skills as the intended learning outcome. Transformative pedagogy positions critical

reflection as the primary mechanism for transforming learners' frames of reference (Mezirow, 1991; Cranton, 2016). Simultaneously, artificial intelligence functions as a dialogic partner that assists students in exploring multiple perspectives, evaluating assumptions, and constructing more rational and evidence-based arguments (Lee et al., 2023; Eager & Brunton, 2023). The interaction among these three components creates a learning ecosystem that enables cognitive transformation to occur more effectively and rapidly than conventional instructional approaches centered primarily on information transmission (Molenaar, 2022; Wang et al., 2024).

Within this framework, teachers continue to play a central role as facilitators, mediators, and guides of the learning process. The presence of AI is not intended to replace the teacher's role; rather, it serves to strengthen pedagogical capacity by providing adaptive and responsive cognitive support (Holmes et al., 2022; UNESCO, 2023). Consequently, AI-Assisted Transformative Pedagogy positions technology as an instrument for fostering students' critical consciousness and intellectual autonomy.

Operational Syntax of the AI-Assisted Transformative Pedagogy Model

Drawing upon the synthesis of relevant theories and previous empirical studies, the AI-Assisted Transformative Pedagogy model is structured into six integrated learning phases. The learning process begins with the identification of an authentic dilemma or problem relevant to students' lived experiences. This phase aims to create conditions that stimulate intellectual uncertainty or a disorienting dilemma, as described in transformative learning theory (Mezirow, 1997). To support this process, AI can be utilized to generate complex case scenarios, social phenomena, or contextual problems capable of stimulating curiosity and encouraging student engagement in learning activities (Kasneci et al., 2023).

Once the problem has been introduced, students are encouraged to explore multiple perspectives through interactions with AI. During this phase, AI functions not only as a source of information but also as a provider of alternative viewpoints, enabling learners to examine issues from diverse perspectives. Previous studies have demonstrated that the capacity of Generative AI to produce multiple arguments and interpretations can broaden students' intellectual exploration and enrich inquiry-based learning processes (Chiu, 2023; Yusuf et al., 2024).

The next phase involves critical reflection on assumptions. At this stage, AI is utilized as a Socratic partner that poses reflective questions designed to help students examine the beliefs, assumptions, and thought patterns they employ when interpreting a particular issue (Eager & Brunton, 2023; Steele, 2023). This reflective process is subsequently extended through argumentative dialogue involving students, teachers, and AI in the co-construction of deeper and more comprehensive understandings. Through such dialogue, students are encouraged to evaluate evidence, test logical consistency, and defend arguments through rational reasoning (Dwivedi et al., 2023; Wang et al., 2024).

The outcomes of reflection and dialogue lead to perspective reconstruction, characterized by a modification or expansion of students' existing frames of reference. This phase represents the primary indicator of transformative learning because students begin to develop new understandings that are more reflective, inclusive, and evidence-based (Mezirow, 1997; Cranton, 2016). Subsequently, these newly developed understandings are translated into reflective action, enabling learners to apply their learning outcomes within different contexts. As a result, the transformative process extends beyond cognitive change and becomes reflected in more rational decision-making and actions (Freire, 1970).

The Contribution of the Model to Accelerating Critical Thinking Skills

The conceptual analysis suggests that the AI-Assisted Transformative Pedagogy model possesses considerable potential for accelerating the development of students' critical thinking skills. According to Facione (1990), critical thinking encompasses six core dimensions: interpretation, analysis, evaluation, inference, explanation, and self-regulation. All of these dimensions are supported through the interactions among students, teachers, and AI embedded within the proposed model.

The ability of AI to generate multiple perspectives enables students to engage in deeper interpretation and analysis of information. Simultaneously, the availability of counterarguments and reflective questions generated by AI encourages learners to evaluate the validity of evidence and the quality of their own reasoning processes (Kasneci et al., 2023; Dwivedi et al., 2023). Furthermore, sustained interactions among learners, teachers, and AI facilitate the development of inference and explanation skills through more systematic and structured argumentation processes (Lee et al., 2023).

Another important contribution of the model lies in strengthening self-regulation. Through continuous reflective engagement, students are encouraged to monitor, evaluate, and improve their own thinking processes. This finding is consistent with the concept of hybrid intelligence, which emphasizes the importance of collaboration between human intelligence and artificial intelligence in generating higher-quality learning outcomes (Molenaar, 2022). Therefore, the proposed model contributes not only to the enhancement of critical thinking skills but also to the development of learners' metacognitive awareness.

Pedagogical Implications

The AI-Assisted Transformative Pedagogy model offers several important implications for the development of twenty-first-century learning. First, the model demonstrates that AI integration in education should not be limited to improving instructional efficiency; rather, it should be directed toward fostering students' critical and reflective thinking capacities (Holmes et al., 2022; UNESCO, 2023). In other words, the success of AI utilization should not be measured solely by its ability to generate rapid responses, but by its capacity to enrich students' cognitive processes and intellectual engagement.

Second, the model underscores the necessity of shifting the teacher's role from information provider to facilitator of cognitive transformation. Within AI-enhanced learning environments, teachers are responsible for designing learning experiences that encourage reflection, dialogue, and multiperspective exploration, ensuring that students remain the primary agents in the process of knowledge construction (Luckin et al., 2016; Holmes et al., 2022).

Third, the model provides a foundation for the development of instructional designs that are more adaptive to technological advancements. By positioning AI as a dialogic partner and facilitator of reflection, learning processes can be designed to become more personalized, interactive, and oriented toward the development of higher-order thinking skills required in contemporary digital societies (Chiu, 2023; Wang et al., 2024).

Challenges and Future Directions

Despite its considerable potential, the implementation of AI-Assisted Transformative Pedagogy also faces several challenges. One of the primary concerns is the risk of cognitive dependency that may emerge when students rely on AI passively without engaging in independent analytical processes (Perkins, 2023; Chan & Lee, 2023). Such conditions may inhibit the development of critical thinking abilities, which constitute the central objective of the proposed model.

Another challenge relates to the phenomenon of AI hallucination, referring to the tendency of AI systems to generate information that appears convincing but may not be accurate or supported by valid evidence (Jakesch et al., 2023; Dwivedi et al., 2023). Consequently, AI literacy and information evaluation skills must be developed alongside the implementation of this model.

Furthermore, the successful implementation of the model depends heavily on teachers' readiness to integrate technology into educational practice. Pedagogical competence, digital literacy, and the ability to design reflection-oriented learning activities are critical factors determining the effectiveness of implementation in authentic educational settings (Yusuf et al., 2024; UNESCO, 2023). Therefore, future research should focus on developing implementation instruments, conducting empirical validation of the model, and examining its effectiveness across different educational levels and learning contexts..

CONCLUSION

This study developed a conceptual framework and operational syntax for AI-Assisted Transformative Pedagogy as a learning model that integrates transformative pedagogy with artificial intelligence to accelerate students' critical thinking skills. The proposed model positions AI as a cognitive partner that facilitates critical reflection, multiperspective exploration, argumentative dialogue, and knowledge reconstruction, while teachers continue to serve as the primary facilitators of the learning process.

The findings indicate that the model's learning syntax, consisting of authentic dilemma identification, AI-assisted perspective exploration, critical reflection, argumentative dialogue, perspective reconstruction, and reflective action, has the potential to support the development of students' interpretation, analysis, evaluation, inference, explanation, and self-regulation skills. These findings suggest that the educational use of AI becomes more meaningful when it is directed toward strengthening critical thinking processes rather than merely generating instant answers.

From a theoretical perspective, this study contributes to the growing body of knowledge on the integration of artificial intelligence into instructional design aimed at fostering cognitive transformation. From a practical perspective, the proposed model may serve as a reference for educators in designing learning environments that are responsive to technological advancements while maintaining a strong focus on the development of students' critical thinking capacities. Future research should undertake empirical validation to examine the effectiveness of the model across diverse educational contexts..

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