Toward GenAI-driven pedagogy

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Abstract: *This paper reviews research on Generative Artificial Intelligence (GenAI) and its roles in education to establish a conceptual framework for GenAI-driven pedagogy. It begins by examining the distinctive features of GenAI in education based on a literature review, analysing psychological, pedagogical, and ethical concerns, and exploring key aspects that could define the scope of GenAI-driven pedagogy. The article then explains the global transition from modern/postmodern pedagogy to GenAI-driven pedagogy and emphasizes that GenAI-driven pedagogy can be understood as encompassing metasystems (systems of systems) within educational theory, curriculum theory, assessment theory, and general didactics. The article is based on the assumption that AI cannot replace teachers or teaching but can serve as a powerful assistant by saving teachers' time on lesson planning, providing insights for affordable didactic materials that match the proficiency levels of learners.*

Keywords: Digital pedagogy, AI-driven pedagogy, GenAI-driven pedagogy, Educational metasystemology, Metasystems learning design thinking.

1. Introduction

Artificial Intelligence (AI) is defined as "a field of research focused on the development and implementation of computer systems capable of performing tasks that typically require human intelligence" (Baillifard et al., 2025). In the context of education, AI refers to the use of artificial intelligence technologies to support, enhance, or transform teaching, learning, and assessment processes by analysing data, personalizing learning, providing feedback, and automating tasks. From this perspective, AI in education can be categorized into profiling and prediction, adaptive personalization, intelligent tutoring systems, and AI-based assessment, each of which enhances instructional and learning effectiveness.

Mollick & Mollick (2023) highlight that AI can assume multiple roles in education, such as tutor, coach, mentor, teammate and simulator, supporting instruction, reflection, feedback, collaboration, task completion, practice, and even learning from the learner. Across all these roles, AI can also serve as a critical thinking partner, helping students analyse ideas from multiple perspectives, uncover assumptions, identify weaknesses, and generate counterarguments.

However, there are also several disadvantages. As noted by Railean,

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Pavalachi & Ceobanu (2023), the drawbacks of AI are more related to patterns of thinking. While AI can enhance teachers' ability to monitor students' learning through learning analytics, the diversification of learning environments can create a collapse of reality in students' minds. AI in education is also unable to compete with human soft skills such as curiosity, critical thinking, metacognition, problem-solving, and innovation driven by insight. Intelligent individuals will always be able to communicate, experiment with new ideas, evaluate feedback, observe and solve problems "outside the box," and apply creative solutions to pressing issues.

This paper argues that research on GenAI should prioritize principles of GenAI-Driven Pedagogy to better harness AI's potential for effective teaching, learning, and self-assessment. As research in educational metasystemology evolves, it is crucial to focus on metacognition and assessment within an ecosystem of learning and communication. In this article, we aim to bridge the gap between principles of pedagogy and practical application of GenAI tools in formal education.

2. Perspectives and potential of GenAI tools in formal education

GenAI offers various perspectives and potential in formal education, even as it continues to evolve and reshape traditional teaching and assessment methods. It is effectively integrated in a global ecosystem of learning and communication.

2.1 Perspectives on GenAI in formal education

GenAI is used widely. Students use GenAI tools for writing, research, and projects support. Usually, they use Elephas for writing assistance, Otter.ai for lecture transcription, and various applications for note-taking, document analysis, and interactive learning, such as Google Notebook LM. AI is also utilized for vocabulary building and language learning, with tools like Knowji. Additionally, students use Grammarly for writing improvement, Perplexity for information retrieval, and Kickresume to create tailored resumes and cover letters. Other tools, such as Notion AI, support brainstorming, while Ideogram facilitates visual narrative creation. ELSA Speak, HelloTalk, Talkpal, and EF HelloAI help students practice speaking and listening through real-world conversation simulations.

According to Ng, Chan & Lo (2025), generative artificial intelligence (GenAI) has emerged as a disruptive technology in education, providing new possibilities for personalized learning, content creation (such as images, audio, and video), data analysis, and program code generation instead of traditional AI. GenAI leverages vast amounts of unstructured data from the internet, generates human-like responses across various formats, supports interactive and personalized exchanges, and enables more complex problem-solving. It requires skills such as critical thinking, metacognition and prompt engineering.

Teachers use GenAI to create lesson plans and curricula, design personalized learning activities, provide real-time feedback, and assess student progress. For

instance, tools like ChatGPT can assist in generating lesson content, while platforms like Google Classroom or Edmodo can help with grading and feedback. Additionally, AI-driven tools like Quizlet can help design customized quizzes and flashcards, and Otter.ai can transcribe and summarize lectures. These intelligent tools enable educators to enhance overall teaching effectiveness.

As noted by Hidayat, Armiati & Noviani (2026), the application of AI in education has immense potential to enhance quality of the learning process by facilitating adaptive, effective, and inclusive learning. It is argued that AI influences learning outcomes, learner engagement, automated assessments, and the ethical considerations surrounding its use in education. However, the application of AI in education also presents challenges, such as privacy concerns, and the need for proper teacher training to effectively integrate these novel technologies.

2.2 Potential of GenAI tools in formal education

AI is becoming firmly embedded within contemporary education systems. In formal educational contexts, generative AI (GenAI) tools offer significant potential to support teaching and learning processes and are increasingly used for a range of tasks, including lesson planning, instructional design, and the generation of educational content within digital learning platforms.

First, GenAI tools are used to create and edit presentations (e.g., EduCafe AI, Slides AI, Canva, Tome.app) and to develop lesson plans (e.g., Teacherbot, Piktochart AI Lesson Plan Generator, Monsha AI Lesson Plan Generator, AI.EduKit, LessonPlans.ai, Easy-Peasy AI Lesson Plan Generator, SmartPrep.ai, Wayground AI Lesson Plan Generator, as well as to generate images (e.g., Krea.ai). GenAI tools are used to create audio materials. Some tools convert written text into spoken audio (e.g., Murf.ai, ElevenLabs, Play.ht, NaturalReader, Notevibes), others function as AI-based audio or narration generators (e.g., Synthesia, Lovo.ai, Resemble.ai, Speechify), and still others support foreign language learning and pronunciation practice (e.g., Duolingo Stories & Voice AI, Rosetta Stone AI Tutor). But it is important to use AI as a collaborative/ creative partner, allowing learners to critically reflect and decide.

Second, there are GenAI-powered coding games for kids, which introduce computational thinking and programming concepts through interactive, game-based environments. These tools often use AI to adapt task difficulty, provide real-time feedback, and personalize learning pathways, thereby supporting early engagement with coding skills in an age-appropriate and motivating manner (Petula et al., 2025). Despite their benefits, there are some risks. These include excessive screen time and overreliance on AI support, which may limit the development of independent problem-solving and critical thinking skills. Data privacy and security concerns are particularly significant, given the collection and processing of children's personal data. Additionally, algorithmic bias and opaque decision-making processes may influence learning pathways in ways that are not transparent to learners or educators.

Third, AI may be used to enhance motivation through video. This way can be used as instructional videos, video tutorials, or video-recorded lessons. Instructional videos are video resources used to enhance the teaching and learning process, supporting the acquisition of information, knowledge, and skills through structured and purposeful use of video materials (Beheshti et al., 2018). Video tutorials are instructional videos designed to guide learners through specific concepts, skills, or tasks, often combining visual, auditory, and interactive elements to enhance understanding and engagement. These pedagogical resources can be created by AI video creation tools. The most used video tools are Synthesia, Pictory.ai, Designs.ai Videomaker, Veed.io, InVideo, Lovo.ai, ElevenLabs, and Runway ML (Ou, Joyner & Goel, 2019). The other type is video-recorded lessons (Kure, Blikstad-Balas & Brevik, 2025), where AI tools like Synthesia, Pictory.ai, or InVideo can be integrated in multiple ways, transforming lesson scripts into fully narrated video lessons with avatars, animations, and visuals, or/and AI can adjust tone, speed, or style depending on the target audience. AI can also analyze student interactions with the video (e.g., pause points, rewinds, quiz results) to provide insights for teachers on which parts of the lesson are challenging or can suggest improvements for future video lessons based on student performance.

Fourth, AI enhances visual aids for activity-based learning. Visual aids, including images, diagrams, charts, infographics, videos, animations, and presentations, facilitate understanding by summarizing complex information and supporting participatory learning (Lopez, 2005). AI extends these tools beyond traditional methods by generating educational illustrations, suggesting effective layouts, and creating interactive diagrams such as Venn diagrams and mind maps. The most commonly used AI tools for this purpose include MidJourney and Digibyte for image generation, Canva AI and Microsoft Designer for slide and infographic design, and Notion AI for structuring content and generating diagrams.

Fifth, AI can be used to create educational games, flashcards, and quizzes. These interactive tools combine learning with play, helping students grasp concepts engagingly, memorably, and critically reflect. AI enhances them by generating content, adapting difficulty to student performance, providing real-time feedback, and creating immersive simulations or virtual environments in subjects like science, mathematics, and history. Common AI tools include Kahoot! AI for quizzes, Socrative for assessments, Minecraft Education Edition with AI mods for virtual learning, Labster for science simulations, Gradescope for automated grading, Audiopen.ai for voice-to-text and note-taking, Brainly for collaborative learning, and Smart Sparrow for personalized interactive learning. Overall, AI-powered educational games enhance comprehension, motivation, collaboration, interactivity, and learning outcomes.

GenAI supports the *education of students with disabilities* by adapting and personalizing learning (Pieriboni, Buzzi & Leporini, 2026). Tools such as conversational agents, AI tutors, and chatbots enable interaction via voice or text, helping students with sensory, cognitive, or physical impairments access learning

more effectively. AI also facilitates accessible materials, promotes deep thinking through interactive assessment, and improves learning outcomes. Examples of GenAI tools for students with disabilities include Microsoft Immersive Reader for reading support, Voiceitt for speech recognition for non-standard speech, Otter.ai for transcription and note-taking, Kurzweil 3000 for text-to-speech and study aids, and ChatGPT or other adaptive AI tutors for personalized instruction.

3. Concerns of adopting GenAI in formal education

Recent articles and reports have identified several concerns related to the integration of AI in education. These concerns can be grouped into implementation and technical challenges, psychological issues, pedagogical limitations, and ethical considerations, including infrastructure constraints, learner dependence, alignment with instructional goals, assessment validity, data privacy, and algorithmic bias. These concerns could be represented as an integrity of psychological, pedagogical and ethical concerns driven by technology.

Implementation of AI in education is conditioned by actions that schools, universities, or educators face when introducing AI tools into teaching, learning, curriculum, and management of educational organisations. “Artificial intelligence (AI) offers potential solutions by identifying learning gaps and providing targeted improvements” (Verma et al., 2025). An important issue concerns schools’ readiness to integrate AI into education through the development and implementation of conceptual frameworks and institutional guidelines. As emphasized by UNESCO, educational institutions must establish clear policies that guide AI adoption, ensure alignment with pedagogical goals, protect learners’ rights, and promote teachers’ professional development (UNESCO, 2023).

3.1 Psychological concerns

Psychological concerns relate to the potential impact of AI on learners’ mental and emotional well-being, including motivation, critical thinking, creativity, and active engagement in learning activities, which is multifaceted and context-dependent. For example, Kundu & Bej (2025) provide empirical evidence from 24 relevant studies across seven reliable databases, demonstrating that the use of AI in schools can have both positive and negative impacts on students’ psychological well-being. Benefits include increased engagement, cognitive achievement, self-efficacy, learning autonomy, and reduced frustration. However, drawbacks include over-reliance, anxiety, stress, social isolation, unstable mental health, and moral dilemmas such as privacy concerns, bias, and issues of fairness.

However, GenAI also has "the potential to produce false or inaccurate data and avoid plagiarism detection in situations where originality is crucial" (Emakporuena et al., 2026). AI can be used in foreign language education, as noted by Klimova & Pikhart (2026), but there are multiple issues related to time, learning strategies, and frequency of feedback. Similar issues exist when artificial

intelligence is integrated into computer-based assessment / digital assessment.

One may observe that the widespread adoption of GenAI in education is indirectly related to the global shortage of teachers (Arruda & Arruda, 2026). However, while AI can help address staffing gaps, it raises concerns about the depersonalization of teaching, role of teacher in face of students, pedagogical communication and the potential loss of human insight in the learning process.

3.2 Pedagogical concerns

Pedagogical concerns involve the implications of AI for teaching and learning processes. Ethical concerns focus on fairness, privacy, and accountability. AI systems can perpetuate biases present in training data, compromise student privacy, and operate as "black boxes," making it difficult to understand or challenge automated decisions. Karatas, Ericok, & Tanrikulu (2025) note that a national curriculum cannot be uniformly applied in all classrooms. Teachers used AI to omit unnecessary content, add more relevant and personalized material, and revise or replace existing content. These findings highlight AI's transformative potential in curriculum adaptation, making education more relevant and personalized.

The other issue is curriculum development. AI-driven curriculum development is shaped by curriculum approach and its adoption by the community, learning design model of the innovative programs for teacher training, as well as institutional support, while challenges remain in training, tool familiarity, and curriculum bias (Abbasi, Wu & Luo, 2025). A specific issue is the development of AI-supported curricula for early childhood education, which have the potential to enable personalized learning (Qayyum et al., 2025).

Bauer et al. (2025) highlight that AI can influence students' motivation, creativity, critical thinking, and active engagement in learning, but improper use may undermine knowledge and skill acquisition. Hybrid intelligence seeks to combine human and AI strengths, yet over-reliance on AI can diminish critical thinking, problem-solving abilities, and the development of expertise, especially if students struggle to ask meaningful questions or seek help effectively. Moreover, when using GenAI for content presentation and practice exercises, key challenges include ensuring output accuracy, alignment with curriculum objectives, and maintaining high pedagogical quality, which are critical across all applications.

3.3 Ethical concerns in the adoption of AI in education

Wider adoption of AI in education is constrained also by ethical concerns, including threats to academic integrity, plagiarism, potential biases and falsified information, copyright and intellectual property issues, privacy and data protection risks, and the possible reduction of meaningful human interaction (Perifanou & Economides, 2025; Salloum, 2024). These concerns also encompass broader principles of transparency, justice and fairness, responsibility, autonomy, and accountability in AI-supported educational settings.

According to Saylam et al. (2023, 2025), integration of AI into education has raised ethical challenges driven by misuse of the technology for teaching and learning. UNESCO (2023) found that fewer than 10% of 450 schools and universities have formal policies or guidelines for AI use in education and management, highlighting the risk of unethical practices and difficulty for educators in adapting to AI's expansion. Ethical AI adoption in education requires attention to pedagogical appropriateness, children's rights, AI literacy, and teacher well-being. Pedagogical appropriateness ensures teachers retain professional autonomy while promoting supportive practices. AI literacy emphasizes the need for students to be critically informed about AI benefits and risks.

Ethical concerns in education may be addressed through the integration of AI in teacher education. Kohout-Diaz (2026) emphasizes the importance of sustainable training for future educators, noting that while AI can be a valuable tool in teacher preparation, its use remains inconsistent and often unclear. The lack of structured pedagogical guidance around AI tools places the responsibility on trainees to improvise. Addressing ethical dilemmas in AI requires strengthening both critical and professional literacy, and inclusive-minded trainees call for training that is locally relevant and responsive to their specific needs.

3. GenAI-Driven Pedagogy

Pedagogy is still centered around structured, teacher-directed instruction, with an emphasis on clear content delivery, memorization, and assessment. Thus, in theory, classical pedagogy evolves into modern pedagogy, which emphasizes objectivity, rationality, and hierarchical structures (Baykent, 2025), but the pedagogical triangle remains incorporated within the classical interdependencies between the teacher, student, and content (Bocos & Jucan, 2022, p. 25). Its counterpart, postmodern pedagogy, reveals dynamics, exclusions, and biases within educational systems (*Ibidem)*.

The metasystems transition from modern / postmodern pedagogy to GenAI-Driven Pedagogy can be represented, as follows (Figure 1).

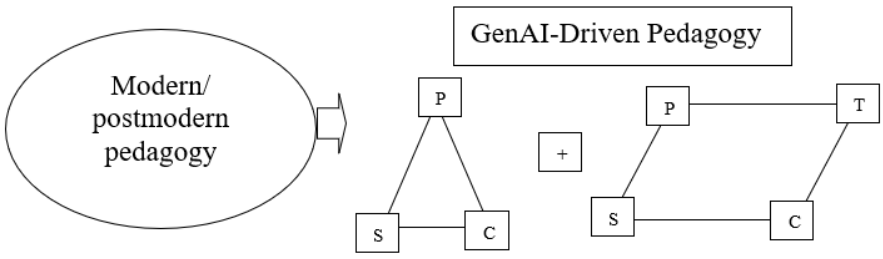

Figure 1. Transition from modern/postmodern to GenAI-Driven Pedagogy, where P-professor, S-student, C-content, T-technology

Moreover, from the perspective of Metasystems Learning Design Theory,

each individual has own capacity to think, adapt, and demonstrate resilience through lifelong learning in response to challenges, while engaging with data, information, knowledge and risks. The problem is how to engage all learners to learn in classroom. One solution is the integrity of effective methods (Railean et al. 2014). Moreover, the capacity to learn is shaped by metacognition and assessment approach and this, highlight a unique role of learner within global ecosystem of learning and communication. In our understanding, educational metasystemology emphasizes metacognition, digital assessment in a global ecosystem of learning and communication (Railean, 2019; Railean, 2022; Railean et al, 2023).

GenAI-Driven Pedagogy is an emerging field within educational and management sciences that examines how AI can support the teaching, learning and assessment process and how learners can use AI responsibly. The focus of AI pedagogy is twofold: the object of study is the didactic processes in which AI is integrated; the subject of study is the learner and the community. In other words, GenAI-Driven Pedagogy does not implement the technology itself, but analyse how the human being, learning processes and outcomes are influenced by AI. GenAI-driven pedagogy can be understood as comprising metasystems in educational theory, curriculum theory, assessment theory, and general didactics (Figure 2).

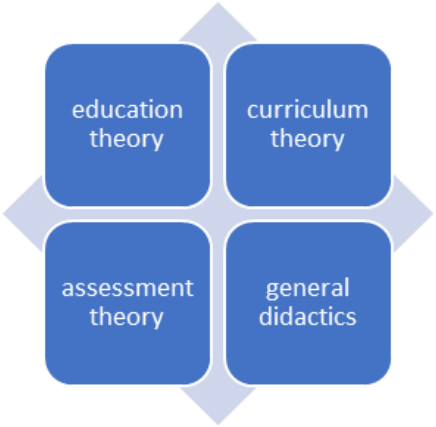

Figure 2. The holistic approach of GenAI-driven pedagogy

In this context, educational theory is focused on sustaining the lifelong capacity to learn across diverse learning environments, emphasizing adaptability, resilience and continuous development of metacognitive knowledge and experience. Curriculum theory centers on the management of data and metadata, as well as their integration into learning pathways to support personalized, flexible and dynamic curricula. Assessment theory incorporates digital assessment methods, addressing both their psychopedagogical dimensions and the implications for learner growth, feedback, motivation and active engagement in exploring the world. General didactics focus on the holistic design of teaching, learning and assessment processes, considering the interconnectedness of cognitive, affective, and social dimensions in the global learning and communication ecosystem. This

holistic approach considers also psychological, pedagogical, and ethical risks. The issue of the pedagogical integration of AI in teacher education, identified by European Schoolnet (Kohout-Diaz, 2026), teacher education can focus not only on the technological aspects of AI but also on metacognition, digital assessment and ecosystem of learning and communication.

4. Conclusion

Pedagogy should come before educational technology. However, education has increasingly adopted generative AI (GenAI) tools due to their potential to support adaptive and personalized learning, enhance student engagement and outcomes, improve understanding of complex concepts, provide individualized feedback, enable innovative assessment practices, and facilitate research and data analysis. A prompt is a natural language input or request given to an AI model to generate a response, and a prompt-based methodology can be used to support collaborative learning, encouraging students to engage actively with AI-generated content. Another important consideration is the impact of AI tools on human thinking. AI can provide a range of resources to enhance metasystem learning design and support higher-order cognitive processes, including critical thinking, problem-solving, and reflective decision-making. This means that AI is not merely a content-generation tool but a mechanism to foster deeper learning, a useful partner for collaborative and creative tasks that help learners navigate complex systems, and support sophisticated reasoning and design-thinking skills.

The question "*Shaping AI or Being Shaped by It?"* was highlighted in a Fireside Forum hosted by the Global Smart Education Network during the 30th World Conference of the International Council for Open and Distance Education. The forum emphasized that AI should support, not replace, pedagogy. Teachers remain crucial for guiding critical thinking, fostering creativity, and preserving the human dimension of education. As Mr. Maxim Jean-Louis, CEO, warned, AI should not reduce learners to mere prompts. AI must remain grounded in human values, dignity, professional responsibility, and social justice. It requires deliberate strategies to ensure fair and inclusive use of AI in formal education. However, GenAI-Driven Pedagogy cannot be uniform; its effective adoption must be tailored to specific design of learning environments, due to its potential to accelerate personalized, just-in-time learning, as well as collaborative learning strategies.

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