

Artificial Intelligence in Classrooms: Pedagogical Dimensions

KEY FINDINGS

- **Learner-centred design and use of AI is a non-negotiable requirement for its integration in the classrooms.** A learner-centred AI requires educational objectives, rather than technological capabilities, to guide its use. It prioritises learners' wellbeing and their cognitive and socioemotional development and supports their autonomy and critical engagement, while fostering competencies such as critical thinking, self-directed learning, creativity and responsible participation (European Commission, 2026; OECD, 2026).
- **Sound pedagogical goals and approaches remain central in AI-mediated learning.** Learning is an effortful process involving motivation, active engagement and reflection. Pedagogical approaches, such as experiential, collaborative, Socratic and project-based learning, allow teachers and learners to emphasise questioning and experimentation (Dewey, 1938; Papert, 1980), and help ensure that AI supports rather than replaces cognitive engagement.
- **AI literacy requires critical understanding.** It emphasises that students should understand how AI systems work, recognise their limitations and reflect on their implications. Pedagogies that encourage students' critical evaluation of AI outputs and experimentation with simplified AI systems can strengthen autonomy and responsible use (Long et al., 2020).
- **AI-enabled assessment raises pedagogical and ethical challenges.** AI-supported assessment can provide personalised feedback but often relies on extensive data collection and behavioural monitoring (OECD, 2026). Such monitoring may reduce students' motivation to experiment and take intellectual risks, potentially affecting play, exploration and creativity practices (Amabile, 1996; Deci & Ryan, 2000).
- **Teachers' role is core for effective pedagogical designs in the integration of AI.** Teachers and school leader are the actors that ensure that the classroom is a safe environment for students. Strategic orchestration of training and support of all stakeholders involved in the sector of education is an urgent priority.
- **Governance responsibilities are shared across actors.** Responsible AI integration in education requires pluralism and coordination among governments, education systems, teachers and students, technology designers and providers and researchers. EU initiatives, including the AI Act, the Digital Education Action Plan and AI literacy frameworks, provide foundations for human-centred AI use in education (European Commission, 2024)



Introduction

Objectives

Artificial intelligence (AI) systems are increasingly embedded in educational environments, including generative AI applications, adaptive learning platforms, intelligent tutoring systems and automated feedback tools. Their rapid diffusion is reshaping instructional practices, student learning strategies and assessment methods across education systems, resulting in a systemic transformation in education. This transformation does not happen only within the classrooms but in informal learning environments, too. Evidence indicates that a substantial proportion of young people use generative AI tools for school-related tasks, including homework support, information retrieval and content generation (OECD, 2026; UNESCO, 2025; Giannakos et al., 2025).

Beyond cognitive and ethical implications, the pedagogical dimensions of AI integration are central to its educational impact. A learner-centred approach requires that clearly defined educational objectives, rather than technological capabilities, guide the use of AI in classrooms. The European Commission guidance emphasises that AI in education should remain human-centred and support learners' wellbeing, autonomy and critical engagement with digital technologies.

This briefing examines the pedagogical dimensions of AI use in classrooms, with particular attention to primary and secondary education. Although we acknowledge that developmental and maturity levels among children in primary and secondary education differ significantly, it is beyond the scope of this briefing to provide detailed analysis for specific age-groups; rather, it aims to identify key pedagogical objectives, analyse pedagogical frameworks relevant to AI-mediated teaching and learning and identify the current opportunities and challenges across developmental stages. Finally, the briefing describes the role of teachers and education stakeholders and how pedagogical considerations can be operationalised through policy initiatives. The briefing situates these issues within the European regulatory and policy context, including the AI Act, the Digital Education Action Plan and the emerging AI literacy frameworks (European Commission, 2024; OECD, 2025).

Defining the "Pedagogical Dimensions"

In educational research, pedagogy concerns the structured and purposeful design of learning environments, the organisation of educational processes, curriculum design, feedback processes and assessment strategies, and the design of the relational dynamics between teachers, learners and knowledge (Alexander, 2008). Learning is commonly defined as the effortful process through which individuals acquire knowledge, skills and dispositions through experience, often involving initial struggles, but also emerging through playful activities, undertaken individually or collectively (Vygotsky, 1978; Malone, 1981, Dillenbourg, 1999, Kapur, 2024, Sternberg & Sternberg, 2017).

Against this background, the integration of AI systems into education has important implications for pedagogy, and consequently for students' learning. AI systems can be used by teachers to scaffold students' interaction with knowledge through generated explanations or recommendations, structure the pacing and sequencing of learning tasks, shape feedback and assessment practices and redefine the division of roles between teachers and learners (OECD, 2026; World Bank, 2026; Giannakos et al., 2025). However, AI may also negatively affect patterns of cognitive effort, motivational processes and attitudes on societal issues, particularly where automated systems enable task completion with reduced independent reasoning or interaction with AI writing assistants (Wang & Fan, 2025; Kosmyna et al., 2025; Williams-Ceci et al., 2025).

As such, focusing on effective pedagogical approaches is essential to ensure that the use of AI in classrooms serves the educational goals as defined by governments and the corresponding assessment methods; most importantly, well-defined pedagogical approaches can help formulate the criteria by which teachers and educational stakeholders assess the appropriateness of AI applications in classrooms.

Pedagogical Goals and Students' Development in the Age of AI

The integration of AI in classrooms should be guided by clearly defined pedagogical goals rather than by the technological affordances of AI systems (OECD, 2026; World Bank, 2026; UNESCO, 2025). Given the rapid diffusion of AI across education systems, a key policy challenge is determining which pedagogical goals should guide learning in societies increasingly shaped by AI technologies.

Across European and international policy frameworks, education is understood not only as preparation for participation in the labour market but also as the development of autonomous, critically engaged citizens capable of contributing to democratic societies (European Commission, 2026; OECD, 2019). Educational research further emphasises that effective learning environments should foster students' wellbeing, intrinsic motivation, and the joy of learning, factors closely associated with autonomy, sustained engagement, and deep cognitive effort (Deci & Ryan, 2000).

From this perspective, the integration of AI in education should be evaluated in terms of its contribution to the development of key competencies, including:

- a. **Critical thinking and epistemic judgement** Critical thinking is widely recognised as a core educational objective (OECD, 2019). Its importance increases in AI-mediated environments, where generative systems can produce fluent and persuasive outputs that may contain inaccuracies, fabricated information or embedded biases (Bender et al., 2021). Students therefore need the capacity to critically evaluate sources and interrogate claims. Research on epistemic cognition emphasises epistemic judgement, the ability to assess the reliability of knowledge claims and justify conclusions using evidence. Heavy reliance on AI for cognitive tasks may reduce engagement in analytical reasoning if learning activities are poorly designed (Wang & Fan, 2025; Kosmyrna et al., 2025). Educational approaches therefore emphasise that students should develop *techniques* for independent reasoning and domain understanding before relying on AI assistance.
- b. **AI literacy** The growing presence of AI in education requires a broader understanding of AI literacy as a core competence. AI literacy encompasses not only the ability to operate AI systems but also the cognitive, ethical, civic and societal understanding needed to critically evaluate and responsibly use these technologies (Long & Magerko, 2020; Ng et al., 2021; OECD, 2026). Students should therefore be able to understand how AI systems function, recognise their limitations and biases, critically evaluate AI-generated outputs, decide when and how AI tools should be used, reflect on the societal implications of AI technologies and practice their agency. AI literacy also involves recognising *when not to use AI*. Educational frameworks therefore emphasise critical engagement with AI rather than mere functional proficiency (Long & Magerko, 2020; Holmes et al., 2022).
- c. **Creativity and adaptive problem-solving** Creativity and adaptive problem-solving are widely recognised as key competencies for economic resilience and societal innovation (OECD, 2019; World Bank, 2026). Research shows that creativity develops in environments supporting autonomy, intrinsic motivation and intellectual risk-taking (Amabile, 1996; Beghetto, 2007; Deci & Ryan, 2000). In AI-mediated

- contexts, generative systems may support ideation and exploration. However, reliance on AI-generated outputs may also encourage conformity and reduce original cognitive effort if students adopt algorithmic suggestions uncritically (OECD, 2026). Educational goals should therefore balance productive augmentation with preserving students' capacity to generate original ideas and independently evaluate solutions.
- d. **Ethical reasoning and value-based citizenship** Ethical reasoning and value-based citizenship are central educational goals in AI-mediated societies. Students should understand how AI systems embed values, shape decision-making and influence social structures. Research in AI ethics highlights risks such as algorithmic bias, opacity and discrimination, underscoring the need for critical evaluation of automated systems (Mittelstadt et al., 2016; Floridi et al., 2018; Bender et al., 2021). Democratic citizenship further requires the capacity to assess information systems, recognise power asymmetries and engage responsibly in digital public spheres (Kahne & Bowyer, 2017). Developing ethical reasoning in this context involves cultivating the ability to evaluate AI's implications for fairness, accountability and human rights (Holmes et al., 2022).
 - e. **Socio-emotional competencies** Learning is inherently social and develops through interaction with teachers and peers (Vygotsky, 1978; Bruner, 1996). Dialogue, collaboration and shared inquiry play an important role in cognitive and socio-emotional development. Increasing reliance on AI-mediated interaction may alter these dynamics. Educational frameworks therefore emphasise that AI technologies should complement rather than replace human interaction in classrooms (European Commission, 2026; OECD, 2026). Emerging research also raises questions about emotional attachment to conversational AI systems among younger users and possible implications for dependency and social development. Maintaining meaningful human interaction therefore remains a key pedagogical principle in AI-mediated learning environments.
 - f. **Inclusive and differentiated learning environments** AI may support inclusive pedagogical practices. Adaptive learning systems and intelligent tutoring technologies can facilitate differentiated instruction by adjusting content difficulty, pacing and feedback to learners' needs (Steenbergen-Hu & Cooper, 2014). For learners with disabilities, neurodevelopmental differences or language barriers, AI systems may provide personalised scaffolding and multimodal representations, including speech interfaces and simplified explanations. However, these benefits depend on careful pedagogical oversight. Without safeguards, algorithmic systems may narrow curricular exposure or reinforce deficit-based profiling. Governance frameworks therefore emphasise transparency, accountability and alignment with inclusive educational principles (OECD, 2026).

These competencies are widely recognised as essential for participation in knowledge-based and AI-mediated societies (UNESCO, 2025; Holmes et al., 2022). European Commission guidance emphasises that AI integration in education should remain human-centred and support learners' wellbeing, autonomy and critical engagement with digital technologies (European Commission, 2026). From a pedagogical perspective, this implies prioritising the development of durable cognitive and social capabilities rather than short-term task performance.

Opportunities and Challenges of AI in Classrooms from a Pedagogical Perspective

From a pedagogical perspective, AI systems present both opportunities to enhance teaching and learning as well as risks that require careful governance. Ensuring that AI integration supports core educational goals, such as learner autonomy, critical thinking, and inclusive learning, requires evaluating these technologies not only in terms of technical capabilities but also their pedagogical implications. Below we list potential opportunities of the integration of AI in Classrooms from a pedagogical perspective and the challenges this integration might bring. This is not meant to be an exhaustive list but indicative potential directions of how the design, development and use of AI applications might influence classrooms in a positive or negative ways.

Potential Opportunities

- a. Accessibility and scaling of effective pedagogical practices** AI systems can help teachers and students with scaffolding strategies, disseminate high-quality instructional resources and feedback mechanisms and scale across classrooms and education systems. Adaptive learning platforms can support differentiated instruction and help address learning gaps when used alongside teacher guidance.
- b. Increased agency for teachers.** AI systems can assist teachers with tasks such as lesson preparation, resource generation, and analysis of learning patterns, reduce administrative workload and allowing them to focus on higher-value pedagogical tasks while enabling students to take greater ownership of their learning.
- c. AI literacy and active participation in the design of future AI-mediated societies.** Given appropriate pedagogical approaches, teachers can use AI systems for their own and students' AI literacy involving their participation not only as consumers but as builders of AI systems. Deep understanding how AI can be used for new scientific discoveries and advancement of our societies.
- d. Creative pedagogical experimentation** AI technologies can support experimentation with new learning formats, including interdisciplinary projects, inquiry-based learning, and human-machine co-creation. Generative AI tools can facilitate idea generation and elaboration when embedded in structured pedagogical activities potentially involving new forms of innovative approaches.
- e. Personalised formative assessment** AI-enabled tools can support continuous formative assessment, which has related to the development of metacognitive skills. AI assessment systems provide timely feedback tailored to individual learners, and potentially improving learning outcomes when integrated with broader pedagogical strategies.
- f. Global collaboration, democratisation and pluralism** AI-supported platforms can facilitate collaboration across classrooms and institutions, exposing students to diverse perspectives and knowledge networks. Digital learning environments increasingly enable cross-border educational exchanges and collaborative learning experiences.

Current Challenges

- a. Misalignment between technological design and pedagogical goals** The integration of AI tools in classrooms often is based on technological capabilities rather than educational objectives, requiring teachers to adapt their pedagogical practices to the constraints of the technology. This misalignment not only limits the effectiveness of AI tools in supporting

meaningful learning, but it *shapes* the pedagogical approaches and ultimately what and how students learn.

- b. Commercial influence on educational ecosystems** Most educational AI systems are developed by private technology companies whose incentives (e.g. maximizing users' engagement) shape platform design, data governance, learning pathways, curriculum exposure, data practices, and the prioritisation of scalable solutions over pedagogically grounded approaches.
- c. Platformisation and reduced pedagogical autonomy** The growing platformisation of education concentrates control over learning infrastructures. Scholars warn that this may constrain educators' pedagogical independence and limit institutional oversight of teaching and learning processes while introducing new forms of dependency, surveillance, and inequality (Moreno-González et al. 2025).
- d. Influence on students' attitudes and behaviour** AI-driven recommendation systems and feedback mechanisms shape how students engage with knowledge and learning tasks. Algorithmic environments may influence learners' motivation, epistemic beliefs, and attitudes about social issues, especially when interacting with AI assistants (Williams-Ceci et al. 2026).
- e. Amplification of existing societal biases and introduction of new challenges.** The use of AI and recommender systems in education, if poorly designed, can amplify existing societal biases and potentially introduce new challenges such as social isolation or the frictionless interactions with customized AI agents that impede the development of students' socio-emotional development.
- f. Insufficient safeguards and pedagogical guidance** Many AI tools used in classrooms lack clear guardrails, transparency, or alignment with educational standards. Policy reports emphasise the need for stronger governance frameworks to ensure that AI systems deployed in education are safe, accountable, and pedagogically appropriate (OECD, 2026).
- g. Fragmentation of teaching and learning practices** AI tools may encourage simplified instructional formats that fit technological capabilities rather than coherent pedagogical frameworks while complex learning processes may be reduced to discrete, automated tasks.
- h. Over-reliance on AI and limited critical engagement** Heavy reliance on AI-generated outputs may reduce engagement in analytical reasoning and weaken students' critical thinking, if learning activities are poorly designed.

The Catalytic Role of Teachers and School Leaders

In the context of the potential opportunities and emerging challenges associated with AI in education, teachers remain the central pedagogical designers and decision-makers regarding how AI systems are integrated and used in classrooms. Their professional judgment is essential in determining when and how AI tools can support learning goals, balancing automated recommendations with pedagogical expertise and maintaining oversight of AI-generated educational content. School leaders also play a critical role in shaping these decisions, as they determine which AI systems are adopted and how they are implemented within educational institutions. Strengthening institutional capacity for informed decision-making at both classroom and school levels is therefore essential for ensuring that AI supports educational objectives rather than constraining them.

Supporting this role requires strengthening teachers' involvement in curriculum design that integrates epistemic knowledge and value-based competencies, empowering their agency in shaping AI-supported pedagogical practices, and ensuring that educators have the knowledge and tools necessary to critically evaluate AI applications in terms of safety, regulatory compliance, and their implications for children's rights and wellbeing.

Equally importantly, teachers do not only design pedagogical interventions and environments for students cognitive flourish, but their socio-emotional development, sensing the social dynamics in the classrooms, exhibiting understanding, empathy and support while recognizing and celebrating students' autonomy and agency. These are qualities and processes fundamental for children's holistic development while they are integrated and exercised by the teachers and the school leaders within current pedagogical contexts.

Pedagogical Approaches as Teachers' Tools for Effective AI Integration in Classrooms

Well-established pedagogical approaches remain central in AI-mediated learning and are powerful tools for educators regarding the design of educational activities. Experiential, inquiry- and project-based learning, Socratic and constructionist approaches, emphasise experimentation, questioning, reflection and practical implementation of knowledge which are structural processes for active learning (Dewey, 1938; Papert, 1980). AI technologies may influence these processes by transforming how knowledge is accessed, generated and evaluated (Luckin et al., 2016; Zawacki-Richter et al., 2019). AI integration should therefore reinforce, not replace, these processes.

For example, teachers can use AI to effectively support their teaching (e.g., differentiation, feedback, planning) and learning (e.g., explanation, drafting, ideation). Meta-analyses of intelligent tutoring systems show positive effects when feedback is structured and pedagogically integrated (Steenbergen-Hu & Cooper, 2014). However, without pedagogical framing, AI risks substituting core learning processes, reducing generative cognitive effort and weakening self-regulation (Chi & Wylie, 2014; Wang & Fan, 2025; Kosmyna et al., 2025). The central pedagogical question is therefore how AI can strengthen inquiry, collaboration, metacognition and ethical reasoning. To address this question, below we elaborate on three examples of pedagogical approaches (i) constructionism and experiential learning (ii) collaborative and inquiry learning and (iii) value-based learning.

Pedagogical approach 1: Constructionism - From AI Consumption to AI Building

Current classroom practice often positions students as consumers of AI-generated outputs, particularly through generative systems used for drafting or problem solving (OECD, 2026). Learning sciences research indicates that passive exposure to worked solutions limits constructive engagement and transfer of knowledge (Chi & Wylie, 2014). Constructionist theory argues that deep learning occurs when students construct artefacts that embody conceptual principles (Papert, 1980). Computational thinking research similarly emphasises abstraction, decomposition and algorithmic reasoning as foundational competencies (Wing, 2006). Project-based learning further supports sustained inquiry, authentic problem framing and iterative refinement, which are associated with higher-order understanding (Thomas, 2000).

Integrating AI within project-based contexts, such as analysing simple datasets or building simplified classifiers or robotic systems, shifts students from prompt users to critical investigators and inventors. AI literacy frameworks highlight that meaningful engagement requires technical understanding but also understanding bias and model limitations through practice (Long & Magerko, 2020; Ng et al., 2021).

This shift from AI consumption to AI interrogation and construction strengthens:

- Epistemic agency, by positioning learners as evaluators of knowledge claims (Greene et al., 2018).

- Conceptual understanding and creativity, through generative and elaborative processing (Chi & Wylie, 2014; Papert, 1980).
- Ethical awareness, by foregrounding bias, opacity and accountability in socio-technical systems (Mittelstadt et al., 2016; Floridi et al., 2018; Bender et al., 2021).

Pedagogical Approach 2: Collaborative and Inquiry-based Learning

Collaborative and inquiry-based pedagogies provide strong frameworks for AI integration. Research in computer-supported collaborative learning shows that structured peer dialogue and shared problem-solving improve conceptual understanding and transfer (Dillenbourg, 1999; Johnson & Johnson, 2009). Social interaction supports cognitive development through scaffolding and co-construction (Vygotsky, 1978; Bruner, 1996). Inquiry-based learning promotes hypothesis generation, evidence evaluation and iterative reasoning (Dewey, 1938). Socratic dialogue remains particularly relevant in AI-mediated contexts. However, recent research, suggests that the design of collaborative AI chatbots, even when informed by pedagogical approaches, such as the Socratic method, does not necessarily lead to sustained learning (Blasco & Charisi, 2024). These findings suggest that for students' motivation and sustained learning additional pedagogical considerations are needed. In addition, research on metacognition further highlights the importance of monitoring and self-regulated learning (Zimmerman, 2002). Comparing AI-generated outputs with students' own reasoning may support metacognitive processes when independent thinking precedes AI use.

Pedagogical Approach 3: Value-based Pedagogies and Democratic Education

AI integration requires pedagogies that prioritize ethical reasoning, civic awareness and socio-technical critique. Value-based education frameworks emphasise democratic participation, critical media literacy and reflective judgement (Kahne & Bowyer, 2017). In AI contexts, this includes critical examination of algorithmic bias, opacity and power asymmetries (Mittelstadt et al., 2016; Floridi et al., 2018; Bender et al., 2021). Participatory and critical digital pedagogies encourage learners to analyse datasets, question system design choices and evaluate societal trade-offs (Holmes et al., 2022). Embedding AI within discussions of fairness, accountability and human rights connects classroom practice to democratic formation. Such value-based pedagogies align with evidence that intrinsic motivation and autonomy support deeper engagement and reflection (Deci & Ryan, 2000). They position learners not merely as users of AI systems but as reflective citizens capable of shaping socio-technical futures.

Assessment, Datafication and Pedagogical Surveillance

Assessment practices strongly shape how learning activities are organised in educational systems. In AI-mediated environments, assessment is increasingly supported by automated grading, predictive analytics and learning analytics dashboards that analyse fine-grained student interaction data (OECD, 2026). These technologies may enable rapid formative feedback, adaptive learning pathways and earlier identification of learning difficulties. However, AI-enabled assessment also expands the datafication of educational processes. Continuous behavioural tracking, interaction logging and predictive modelling can transform classroom environments into systems of pervasive measurement and monitoring (Williamson, 2017). While such systems promise improved evaluation and personalised support, they also raise pedagogical and ethical questions regarding transparency, proportionality and the effects of surveillance on students' learning behaviour. Below we elaborate on three examples of AI-mediated assessment (i) Assessment criteria and AI technical affordances, (ii) Datafication and surveillance risks, and (iii) misalignment of assessment with long-term learning goals.

Assessment Criteria and AI Technical Affordances

Assessment frameworks shape which competencies educational systems prioritise. When educational goals emphasise critical thinking, creativity, and ethical reasoning, assessment methods must be designed to capture these complex capabilities. Over-reliance on automated grading risks privileging outputs that are easily measurable by algorithmic systems, thereby narrowing educational priorities toward quantifiable performance indicators aligned with current technological affordances rather than broader pedagogical goals (OECD, 2026). Complex learning outcomes, including creative thinking, collaborative problem-solving and ethical judgement, are difficult to capture through purely automated metrics. Designing assessment systems that reflect these broader educational goals therefore remains a central challenge in AI-mediated education.

Datafication and Surveillance Risks

AI-based assessment frequently relies on continuous data collection and behavioural monitoring. From a pedagogical perspective, such environments may influence students' motivation and learning strategies. Research on creativity and motivation shows that environments characterised by strong external monitoring can reduce autonomy and intellectual risk-taking (Amabile, 1996; Deci & Ryan, 2000; Beghetto, 2007). When students realize that drafts, behavioural patterns or interaction data are continuously analysed by algorithmic systems, they may prioritise compliance with expected patterns rather than exploratory thinking. Studies of data-driven educational governance suggest that such monitoring may shift learning behaviour from mastery-oriented engagement toward performance-oriented optimisation (Williamson, 2017).

Misalignment of Students' Assessment with Long-term Learning Goals

A key pedagogical challenge is balancing the potential benefits of AI-supported feedback with the need to preserve learning environments that support experimentation and intellectual risk-taking that often relate to long-term learning goals. While data-driven assessment can improve feedback precision, excessive monitoring may constrain the creative and exploratory processes that underpin deep learning. Educational frameworks therefore increasingly emphasise the distinction between short-term task performance and durable, sustained learning outcomes (OECD, 2026). Assessment systems in the AI era must avoid reinforcing short-term output optimisation and instead support the development of transferable competencies such as critical reasoning, creativity and collaborative problem-solving. From a pedagogical perspective, this raises an important question: **whether assessment frameworks are being designed around educational goals or around the measurement capabilities of AI systems**. Ensuring that assessment remains aligned with long-term human development rather than data availability will be a central consideration for responsible AI integration in education.

Policy Context and Implementation in the European Union

The previous sections of this briefing elaborated on how the design, development and use of AI in the context of education currently influences how students' learn and develop in formal education. In addition, this analysis aimed to highlight the importance of a pedagogical stance regarding the design, development and use of AI in classrooms. While teachers and education leaders are the core stakeholders to take important decisions regarding the integration of AI in classrooms, several questions remain currently open, such as:

- Who defines, controls and evaluates the pedagogical principles embedded in AI tools?
- How schools evaluate AI tools before adoption?
- How teachers maintain authority over learning processes in the classrooms?

These indicative questions require the coordinated support of policy institutions, governments and the European Union together with end-users, such as school leaders, teachers and students.

The starting point to address these and similar questions is the legal compliance of AI systems and their alignment with the relevant European policy frameworks at the intersection of AI and Education. Below, we provide an initial overview of some of the relevant frameworks and propose some directions for policy implementation.

European Policy Frameworks for AI in Education

The integration of artificial intelligence in education involves shared governance across governments, education systems (including end users), technology developers and providers and the research community. Effective oversight therefore requires coordination between regulatory frameworks, education policy and pedagogical guidance. Within the European Union, several initiatives provide the framework for responsible AI use in education. The **Artificial Intelligence Act (AI Act)** establishes a risk-based regulatory approach for AI systems, including safeguards for applications that may affect educational evaluation or access to education and regulates General-purpose AI models (which includes generative AI models). Complementary provisions in **the Digital Services Act** address transparency obligations for online platforms and the protection of minors in digital environments.

EU education policy initiatives further support the development of digital competences and responsible technology use. **The Digital Education Action Plan** promotes digital skills, teacher training and educational infrastructure, while the **European Education Area** encourages cooperation between Member States in building inclusive and resilient education systems. The **Better Internet for Kids Strategy** similarly focuses on empowering and protecting children online.

In addition, the European Commission has issued **guidance for educators on the ethical use of AI and digital technologies in teaching and learning**. These guidelines emphasise human oversight, transparency and the promotion of digital and media literacy. At the parliamentary level, the European Parliament Committee on Culture and Education has highlighted the importance of integrating digital, media and AI literacy into education systems and ensuring coherence between regulatory frameworks and educational policy (European Parliament resolution, 2021). These initiatives align with international standards such as **General Comment No. 25 on children's rights** in relation to the digital environment, which emphasises the protection of children's rights in digital contexts (United Nations Committee on the Rights of the Child. (2021).

Implementing Responsible AI in Education

The above-mentioned policy context is a catalyst for the operationalization of the pedagogical considerations as fundamental principles for a pedagogically- aligned design, development and integration of AI in education that would be a valuable tool for teachers and students.

Effective implementation of AI in education requires coordination across governance levels and across actors. Multistakeholder coordination, especially in the field of AI, is a complex process involving actors with often conflicting agendas and requires a framework that will guide such coordination and governance.

Multistakeholder coordination and governance, especially in its initial stages, can benefit from the use of regulatory sandboxes, which enable the relevant stakeholders to test and evaluate AI application for safety and alignment with responsible, ethical and pedagogical principles. Equally importantly, a sandbox approach can support end-users and the wider public to understanding the

effect of AI and where appropriate raise demands for further safeguards (Charisi and Dignum, 2024). Figure 1 shows an example with a framework for the operationalization of sandboxes for age-appropriate AI systems which could potentially be adapted for the implementation of responsible AI in Education considering the current policy context in the European Union.

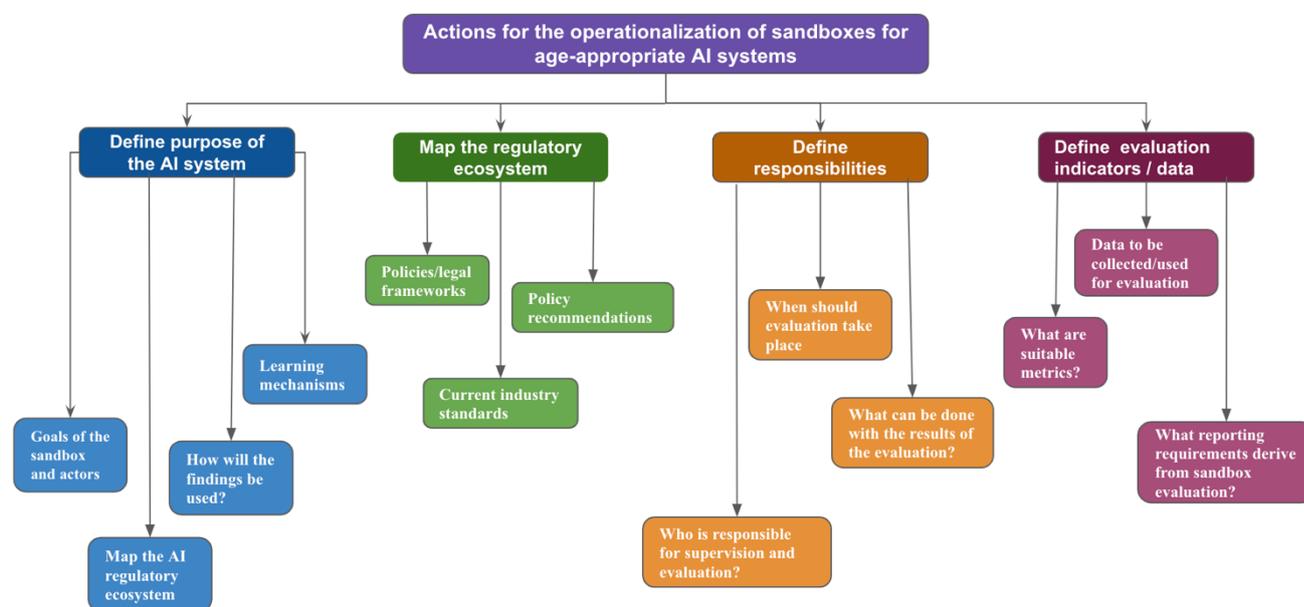


Figure 1. Stages for the operationalization of sandboxes for age-appropriate AI systems (adopted by Charisi and Dignum, 2024).

Public authorities and education systems strategically orchestrate the governance of AI in Education with student-centred approaches, in a transparent way while taking accountability of their actions. They define regulatory frameworks, curriculum standards and procurement policies ensuring that AI technologies support educational goals and safeguard students' rights. This includes teacher training and continuous support, curriculum development and evaluation mechanisms for AI-based educational tools.

Technology developers and providers are responsible for ensuring transparency, accountability and responsible student-centred design of AI systems used in educational environments, including compliance with obligations under the Artificial Intelligence Act and the Digital Services Act.

Research and evaluation remain essential for assessing the educational impact of AI technologies on learning outcomes, motivation, equity and student wellbeing.

Together, EU regulatory instruments, policy initiatives and educational guidance provide the foundation for student-centred AI integration in education. Lastly, effective implementation can be amplified by the alignment of legislation, education policies and classroom practices across Member States.

Conclusions

Artificial intelligence is transforming classroom practices, but its educational value depends on integration within pedagogical frameworks that prioritise human development. AI use should therefore be guided by clearly defined educational goals centred on students' wellbeing, critical thinking, creativity, ethical reasoning and responsible participation in digital environments. Established pedagogical approaches, including inquiry-based, collaborative, constructionist and value-based learning, remain essential to ensure that AI supports active engagement rather than replacing cognitive effort. At the same time, AI-enabled assessment and datafication raise important challenges related to surveillance, student autonomy and the measurement of complex competencies. Within the European Union, regulatory and policy frameworks, including the Artificial Intelligence Act, the Digital Services Act and the Digital Education Action Plan, provide a foundation for human-centred and trustworthy AI use in education (European Parliament and Council of the European Union, 2022; European Parliament and Council of the European Union, 2024). The time-sensitive operationalization of those frameworks for the support of learner-centered AI requires immediate coordinated action with the cooperation of all the involved stakeholders. Regulatory sandboxes have been proposed as one of the actionable directions which can potentially provide a transparent framework for the coordination of different actors and eventually the effective governance of AI in Education.

Crucially, effective implementation also requires sustained support for teachers, including training and professional development that enables educators to critically integrate AI tools into pedagogically meaningful learning activities and become key actors for the design, development and implementation of AI in classrooms providing valuable feedback. Achieving these objectives will require coordinated action, at an initial stage in the form of sandboxes, across governments, education systems, technology providers and the research community to ensure that AI integration strengthens learning, protects students' rights and supports the development of future European citizens capable of critically and responsibly engaging with AI-mediated societies.

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Administrator responsible: Anastasia MITRONATSIU

Editorial assistant: Anne DE CONINCK

Contact: poldep-just-a@europarl.europa.eu

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