Preparing teachers for the AI Development in Education as an Innovative Asset

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PAIDEIA

Preparing teachers for the AI Development in Education as an Innovative Asset

Report on the forecast of future needs in AI education

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The PAIDEIA Project is a groundbreaking initiative funded by the European Commission through the European Agency for Education and Culture (EACEA). Our mission is to revolutionize education by integrating Artificial Intelligence (AI) into teaching and learning, empowering educators, and enhancing student outcomes.

CONSORTIUM

FONDAZIONE HALLGARTEN FRANCHETTI CENTRO STUDI VILLA MONTESCA, an Italian high education research center, coordinates PAIDEIA project. It has been historically founded in 1902 (then institutionally renewed) in the place where the Montessori method was experimented and published for the first time in 1909. It has an international vocation in educative and pedagogic research activities and has a very relevant experience in EU projects management and development. FCSVM has strong partnership with schools and other educational organizations, as well as a solid background in research-actions activities, fostering critical thinking, diversity as a value and innovation from the pedagogical and didactic point of view.

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1. DEFINING AI EDUCATION

1.1 AI EDUCATION PATHWAYS

Artificial Intelligence (AI) education refers to the process through which individuals acquire knowledge, skills, and ethical understanding related to intelligent systems and computational models. The ethical guidelines issued from the European Commission (2022) provides a set of guidelines aimed to raise awareness of ethical issues in AI education and providing practical advice for responsible integration. Xerri, D. (2025) from Malta emphasizes within his commentary the role of AI in personalised learning, teacher collaboration, and ethical concerns.

The widespread integration of AI across industries has changed workforce expectations, skill requirements, and strategic priorities (CEDEFOP, 2023). As AI systems become an everyday part of operational, analytical, and creative industries, the demand for AI-related skills and competencies stopped being a niche specialization and has become a mainstream necessity. AI skills can be learnt through formal, informal, and lifelong pathways, each pathway contributing uniquely to the AI literacy education.

In formal education, AI skills are typically taught within structured institutions such as universities, technical colleges, primary schools, middle schools, secondary schools (or equivalent) and accredited training centres. These environments offer standardized curricula, assessment frameworks, and recognized qualifications focusing on areas such as machine learning, data science, and algorithmic reasoning. Authors such as Luckin et al. (2016) emphasize the importance of formal education as the provider of foundational AI education that prepares students to use AI tools, understand and use them in a responsible and ethical manner.

In contrast, the informal AI education pathways are characterised by self-directed exploration, peer learning, and engagement with digital platforms. This pathway is becoming more accessible through improvements in open-access resources, interactive simulations, and AI-powered educational technologies. Selwyn (2019) argues that informal learning democratizes the access to complex concepts and subject matters especially in the case of learners who have been excluded from the traditional academic pathways.

On the other hand, the lifelong learning AI pathway takes the form of a continuous and adaptive process that extends throughout an individual's career aid in personal development. Due to the fast rate of improvements and rapid innovation of the technological sector, professionals need to continuously update their skills and competencies in order to remain relevant. The UNESCO Institute for Lifelong Learning (2022) argue that lifelong learning is not to be thought of as a response to technological change but a proactive strategy that aids in inclusive and sustainable development. Thus, lifelong AI education plays an important part in workforce reskilling, and interdisciplinary integration. Together, these three pathways of AI education form a framework that can be used by societies to prepare for an AI-driven future.

1.2 THE IMPORTANCE OF FORECASTING FUTURE NEEDS IN AI EDUCATION

Due to the rapid changes in industrial processes, economies, and social structures, it becomes highly important for education policymakers to anticipate the educational demands of the future. Anticipating these demands ensures that curricula, and pedagogical approaches are relevant and satisfy the current and future needs of the industry.

However, integration of AI into education brings about a paradigm shift that requires adaptation. According to the World Economic Forum (2024), the accelerated rate at which AI technologies are advancing is creating both opportunities and risks for global education and in order to take advantage of these opportunities while minimizing risk, institutions need the foresight and ability to pre-empt future demands. Such foresight would enable these educative institutions to align their pedagogical models with emerging competencies such as algorithmic thinking, ethical reasoning, and human/AI collaboration.

Furthermore, forecasting future needs also aids the development of inclusive and equitable education strategies. Policymaker and educator foresight is necessary to identify both skill gaps and AI related demographic disparities in order to design interventions aimed at mitigating these inequalities. Anticipating future needs also helps educational institutions to allocate resources effectively in a way that prioritises curriculum innovation, and prepares students both technically, and ethically for future roles that are likely to emerge within the next few years (Blanuša Trošelj et al., 2024).

1.3 AIM AND OBJECTIVES

This report explores the landscape of AI education with a particular focus on teacher training. It is framed within the context of the Paideia Project [1] and draws upon a review of academic literature, policy documents, and institutional reports from both European and international sources. The report is guided by established frameworks such as DigCompEdu and UNESCO's AI Competency Framework. The aim is to identify emerging competencies, curricular gaps, and strategic priorities that can inform the integration of AI into teacher education and seeks to contribute to a shared European vision for AI literacy, ethical awareness, and pedagogical innovation in teacher preparation.

[1] The Paideia Project is an Erasmus+ initiative focused on equipping educators with AI literacy, ethical reasoning, and pedagogical integration skills. It emphasizes comparative analysis across EU promoting structured teacher training aligned with DigCompEdu and the AI&DComp Framework

2.CURRENT LANDSCAPE OF AI EDUCATION

2.1 CURRENT LANDSCAPE & IMPLEMENTATION OF AI EDUCATION IN THE EU

AI education is a strategic priority across the European Union, curricula at all levels. However, despite a growing strategic intent, the integration of AI into education systems has been progressing unevenly across member states.

In most cases, the introduction of AI in secondary curricula, has been introduced through broader digital literacy and STEM programmes. Initiatives such as the European School Education Platform have started to incorporate AI and digital literacy into teaching materials and at the same time emphasising other transversal skills such as ethical awareness and critical thinking. On the other hand, formal AI modules are still uncommon and often limited to pilot programmes or extracurricular activities (European School Education Platform, 2024). Moreover, despite EU-wide efforts, there are still disparities amongst states and regions which result in uneven teacher preparedness and student exposure. For example, while Finland and Estonia have integrated AI into secondary curricula, other countries continue to treat AI as optional or restrict it to pilot initiatives.

The above mentioned efforts are in line with the European Commission's Digital Education Action Plan (2021–2027), a strategic plan for preparing learners for the demands of a digital society through the integration of digital competencies such as AI skills and data literacy into formal education systems (European Commission, 2021). The Action Plan also encourages education institutions to embed AI competencies transversally not just as a component in IT or STEM courses. The push for the integration of AI in secondary education has been aided by various EU-funded initiatives with the goal of introducing AI curricula tailored to students and educators with limited prior exposure. For example, countries like Lithuania, Finland, Slovenia, Italy, and Spain benefited from AI+, an Erasmus+ project that developed a two-year curriculum for secondary schools. This curriculum focuses on practical applications of embedded intelligence using smartphones with the goal of teaching basic AI concepts to students aged between 14 and 18 (AI+ Erasmus+, 2019). The inclusion of AI curricula also reflects the industry's demand for these skills (Walter, 2024). Complementary projects such as AI4T and AIware have also provided resources such as model lesson plans, teacher training modules, and ethical frameworks to support AI in European classrooms. These initiatives also emphasise the importance of human-centred and inclusive approaches to AI education while ensuring that learners are taught about the ethical and societal implications of AI technology (European Schoolnet, 2023).

In tertiary education, universities across Europe are offering specialised degrees in artificial intelligence, machine learning, and data science. Some of these courses are also supported by European funding and/or national digital strategies. These programmes generally include interdisciplinary components such as AI ethics and human-computer interaction which are in line with the EU's commitment towards responsible innovation (Dragomir, 2025). The implementation of the EU AI Act has impacted higher education institutions, classifying them as providers of high-risk AI systems. This label has forced these institutions to adopt strong risk management policies

and procedures, data governance, and quality assurance protocols for the use of AI tools in both teaching and research (European Commission, 2023). Some national education strategies have also pushed AI literacy by embedding it as a form of continuous education, starting from upper secondary and continuing through to higher education.

At the same time, several national strategies are encouraging collaboration between academia and industry seeing them as a crucial partner to bridge the gap between education and employment (Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, 2021).

Vocational education and training (VET) institutions are also actively adapting to the demands of the industry, where AI plays a major role in reshaping the future of employment. These programmes are incorporating AI in various ways, including personalising learning pathways, simulating real-world scenarios, and automating administrative tasks. Projects such as AIVET have analysed AI integration strategies in countries such as Italy, Spain, and Poland to identify both opportunities and challenges (AI4T Project, 2023). Similarly, AI4VET4AI and research by UNESCO-UNEVOC have developed AI literacy frameworks specifically tailored to vocational learners. These curricula focus on the practical applications of AI in sectors such as manufacturing, logistics, and healthcare, and support the development of the confidence necessary for AI-enhanced environments (UNESCO-UNEVOC, 2025; AI4VET4AI, 2024). Findings show that while AI offers the potential to improve learner engagement and workforce readiness. Several EU initiatives also emphasise the need for training to go beyond technical skills and promote the ethical use of AI and human-centric design, ensuring that learners are equipped with the critical thinking and digital citizenship competencies needed to evaluate and adapt to current and future AI technologies.

The development of AI curricula across EU education systems has become a shared strategic vision, with various coordinated efforts aimed at preparing learners for a rapidly changing technological landscape. Despite these developments, future projects will need to tackle the lack of harmonisation across member states, persistent infrastructure gaps in certain regions, and ongoing concerns about ethics and educator preparedness. However, the EU's regulatory and funding mechanisms are increasingly adopting a more cohesive and inclusive approach to AI education across all levels of learning. There is a growing commitment from member states to promote responsible, accessible, and skills-oriented AI education that is aligned with both societal values and labour market needs.

2.2 THE ROLE OF ONLINE PLATFORMS IN AI EDUCATION

Online platforms have become an important channel of AI course delivery by offering scalable, adaptive, and inclusive learning environments. The integration of these platforms into educational systems is a shift from traditional pedagogical models of learning as they provide the options of personalized instruction, efficient curriculum management, and enhanced learner engagement.

One of the most significant contributions of online platforms to the AI education landscape is their ability to facilitate personalized learning through AI analytics. Adaptive learning platforms such as Century Tech and Educake use algorithms to assess student performance in real time. This enables the learner to receive tailored content according to their skill and preferences. These systems can identify individual strengths and weaknesses and in turn provide targeted support while still allowing the students to progress at their own pace (Capitol Technology University, 2023).

Online platforms such as Coursera and Khan Academy actively integrate AI into their systems to deliver customized learning paths, quizzes, and feedback. For example, Coursera uses an AI-powered recommendation engine to suggest courses based on the learner's specific behaviour and performance. Another example is Khan Academy, which makes use of insights derived from the learner's patterns to adjust difficulty levels and provide a scaffolded instruction (Science News Today, 2025). These and similar features are particularly valuable when used in large online courses as without these tools it would be very challenging for tutors to provide individualized attention.

These platforms can also be applied to K12 education as part of the curriculum. Some countries such as Malta have investing in tailormade software solutions which make use of adaptive learning platforms that enable self-assessment. In this case this was done under the One Device per Child project which is an EU funded project (ESF+) part of which included the provision of tailormade K12 software platforms for various subjects.

AI also enhances curriculum delivery by automating administrative tasks, streamline grading and feedback, reducing the educator's workload and improving consistency. AI chatbots like ChatGPT and Copilot can also be used to provide real-time tutoring and support to helping students navigate complex topics and assignments, however, not without their challenges (European Schools, 2025; Tilburg AI, 2024). These virtual assistants can simulate human interaction, making learning more accessible and responsive. Some countries in the EU have made agreements with AI chatbot providers to aid in the widespread use of these systems. For example, Estonia partnered with OpenAI to deploy ChatGPT Edu, a customized version of ChatGPT designed for educational use across all secondary schools, and Malta making a deal with Microsoft to actively integrating Microsoft Copilot into the public sector (including Education).

In vocational and tertiary education, platforms like LinkedIn Learning and edX are now providing AI-enhanced modules that align with industry standards. These platforms make use of predictive analytics to support lifelong learning and career development (Adobe eLearning, 2024). Furthermore, AI-powered simulations and virtual labs can provide learners with the opportunities to engage in safe and controlled real-world scenarios. Online platforms also contribute to inclusive education through the integration of assistive technologies such as speech-to-text, real-time

translation, and screen readers.

Despite these opportunities, there are risks which still need to be addressed at various levels such as data privacy concerns, algorithmic bias, and an over-reliance on automation. These concerns increased the need for ethical guidelines, policy frameworks, and transparent governance. At the educator level, there is a need for educators to be equipped with the right skills to critically evaluate AI tools and integrate them responsibly into their practice (Ayeni et al., 2024).

2.3 STRATEGIC IMPORTANCE OF AI SKILLS

AI competencies are now considered crucial across various industry sectors. According to Pluralsight (2025), 95% of organizations factor AI skills into hiring decisions, and 84% are prepared to outsource or replace roles lacking sufficient AI proficiency. These statistics indicate a strategic shift where AI literacy in the workplace has become essential for maintaining competitiveness, productivity, and innovation. PwC (2025) corroborates this trend, they report that sectors with high AI exposure experienced exponential growth in revenue per employee when compared to less AI-integrated sectors. This shows that AI skills are directly contributing to value creation and can be considered as economic multipliers.

PwC (2025) also report that AI related roles are evolving 66% faster than those in non-AI related sectors thus pushing for the importance continuous upskilling and curricular responsiveness. In the Pluralsight (2025) report, the findings showed the existence of a confidence vs capability gap. Despite 93% of executives participating in the study reporting that their teams were AI proficient, when tested, only 17% demonstrate basic proficiency. To address this gap and misalignment there is a need for validated training, robust assessment mechanisms, and industry recognized certifications.

Modular and micro credentials are becoming a more popular method for AI upskilling due to their short timeframes and their ability to support lifelong learning and workforce agility. These courses give educators and professionals the ability to acquire targeted competencies without committing to a full degree program (Zawacki-Richter et al., 2019).

2.4 WAGE PREMIUMS AND JOB MARKET DYNAMICS

The economic value of AI skills can also be seen in present wage structures. PwC (2025) reports that industry roles that require AI skills, such as prompt engineering, offer a significant wage premium. Furthermore, there was a notable increase in the wages compared to those of 2024 especially in those occupations that are undergoing rapid transformations such as financial analysis, marketing, and software development.

2.5 SECTOR-WIDE ADOPTION AND TRANSFORMATION

AI adoption is not confined to high-tech or data intensive sectors. PwC (2025) reports that even industries seen as traditionally low tech such as mining and construction, are expanding their adoption of AI technologies. This is a global paradigm shift where the use of AI technology is increasingly being perceived by industry as a growth strategy that can facilitate the creation of new revenue streams, market expansion, and competitive differentiation.

There is a common misconception that AI will replace human labour with pure automation, however, the current trends are showing that the use of AI is to amplify human capabilities and fostering hybrid workflows that combine AI's computational power with human judgment (Pluralsight, 2025).

2.6 IMPLICATIONS FOR POLICY AND EDUCATION

After taking into consideration the current state of education and industry demands, the following are some recommendations that have direct implications for modern workforce development, educational policy, and strategic planning.

- Curriculum alignment: Educational institutions must integrate practical AI literacy, ethical reasoning, and interdisciplinary applications into core curricula.
- Validated upskilling: Organizations should adopt standardized assessments and certification frameworks that ensure genuine/provable proficiency.
- Inclusive access: Policymakers must address barriers to AI education including the issue of access to AI education resources in underrepresented groups and those living in low resource areas.
- Ethical governance: There is a need for the implementation of transparent AI usage protocols which take into consideration attribution, and accountability in order to maintain trust and responsible use of AI tools.

The demand for AI skills in 2025 reflects a structural shift in labour markets, organizational strategy, and educational priorities. As AI continues to redefine productivity and value creation, the challenge will be the preparation of the workforce that is able to use AI tools responsibly, equitably, and effectively.

3. DRIVERS OF FUTURE DEMAND FOR AI SKILLS

3.1 TECHNOLOGICAL ADVANCEMENTS

The main technological advancements that are driving the demand of AI competencies include the rapid evolution of generative AI tools, robotics, and edge computing. All of these have seen a drastic improvement over the past few years.

Generative AI systems, such as large language models and multimodal transformers, are increasingly becoming part of industry workflows across various sectors and have enabled content creation, decision support, and automation on a large scale (Pluralsight, 2025). Robotics and autonomous systems are expanding into areas such as logistics, manufacturing, and healthcare. This is a trend which brings with it a higher demand for interdisciplinary skills which blend AI with mechanical engineering and human-computer interaction (PwC, 2025). Edge computing which facilitates real-time AI processing at the device level, is creating a demand for decentralized AI deployment skills in sectors such as transportation, agriculture, and smart infrastructure (IEEE Spectrum, 2025).

These technological advancements are changing traditional job roles and the skill sets required for various positions. In healthcare, AI is being used for triage, diagnostics, and personalized treatment planning; in finance it is being used for fraud detection, credit scoring, and algorithmic trading; and in education it is being used for adaptive learning, feedback, and personalised training (PwC, 2025; Pluralsight, 2025). These changes increase the demand for skills which include the knowledge to design, implement, and govern AI systems. Furthermore, AI is also being used along other emerging technologies such as quantum computing, synthetic biology, and extended reality which in turn is another driver for the demand of adaptive and cross-domain skills and expertise.

3.2 LABOR MARKET TRENDS AND SKILL GAPS

The current situation in the labour market shows a growing mismatch between the speed at which technology is evolving and the availability of skilled professionals. PwC in their Global AI Jobs Barometer (2025) reported that AI related jobs are changing at a faster rate and skills such as data literacy, model interpretability, and ethical reasoning are becoming highly sought after by the industry. Despite this 65% of organizations participating in a separate study have reported that they were forced to abandon AI initiatives due to a deficiency in internal skill (Pluralsight, 2025).

Highly skilled AI-proficient professionals especially those that combine domain expertise with AI literacy, such as financial analysts using predictive models, educators deploying adaptive learning systems, and healthcare professionals who can make use of AI diagnostic algorithms are still scarce and of high strategic value (PwC, 2025). Pluralsight (2025) also reported that more than the majority of employees participating in their study engage with AI tools at their workplace informally, without formal attribution or oversight which suggests that there is a growing need for structured training, transparent skill recognition and ethical frameworks.

3.3 POLICY SHIFTS AND NATIONAL AI STRATEGIES

Country strategies and new policy frameworks are also driving and shaping the demand for AI skills. The European Union's Artificial Intelligence Act, along with national strategies such as Malta's Digital Education Strategy are showing a regulatory turn toward responsible AI implementation, data management, and algorithmic transparency. These strategies and policies are pushing for AI readiness in technical domains as well as legal, ethical, and societal dimensions.

Policy-driven AI adoption is expanding in public administration of various countries, as well as education and justice systems (Stanford HAI report, 2025). This is creating a demand for professionals who can navigate compliance, risk management, and stakeholder engagement. Several countries are also investing in national AI research, improving their infrastructure, build AI innovation hubs, and courses promoting digital skills. Due to this, there is an increasing demand for inclusive AI training models that are scalable.

3.4 SOCIETAL ADOPTION OF AI TOOLS

The mainstreaming of AI tools into various consumer devices and aspects of everyday life is also acting as a cultural and economic catalyst contributing to AI skill demand. As everyday citizens are increasingly interacting with AI systems, the demand for digital literacy and AI literacy has extended beyond specific roles in the workforce. This societal adoption has also brought about questions of equality, access, and identifying trustworthy applications.

4. FORECASTING FUTURE NEEDS

4.1 PROJECTED GROWTH IN STUDENT ENROLMENT IN AI-RELATED PROGRAMS

Global enrolment in AI-related education is projected to expand over the next decade driven by institutional investment, Labor market demand, and technological innovation. According to the OECD (2023), tertiary-level programs in data science, machine learning, and AI ethics have seen exponential growth since 2020, with projections indicating continued expansion through 2035. This growth is reinforced by the rise of modular credentials and micro degrees that offer alternative and flexible pathways into AI-related fields (Zawacki-Richter et al, 2019).

However, this expansion is not uniform across countries and regions as high-income countries are rapidly scaling AI programs while lower income countries face infrastructural and policy barriers. UNESCO (2023) has emphasized the need for inclusive digital education strategies that ensure equal access to AI learning opportunities, especially for marginalized populations and linguistically diverse communities.

4.2 ANTICIPATED DEMAND FOR AI EDUCATORS AND CURRİCULUM DEVELOPERS

The integration of artificial intelligence into European education systems is expected to create a sustained demand for educators, curriculum developers, and professionals who can navigate the intersection of technological fluency, ethical reasoning, and inclusive instructional design.

Holmes, Bialik, and Fadel (2022) argue that AI literacy needs to include pedagogical, ethical, and sociocultural dimensions. Due to increase proliferation of AI tools, educators will be increasingly expected to critically evaluate AI tools, identify and mitigate algorithmic bias, and facilitate collaborative human-AI learning environments. These competencies are considered as essential competencies within European policy frameworks. The European Commission's Digital Education Action Plan (2021–2027) already outlines strategic objectives for enhancing digital capacity in education, and these including the development of AI-related teaching competencies as well as the promotion of ethical technology use in classrooms (European Commission, 2020).

Laak and Aru (2025) have proposed a hybrid instructional model that combines generative AI with teacher-led facilitation. This model prioritizes cognitive engagement and human-centered design which is compatible with the broader European trends of adaptive learning and personalized instruction. Erasmus+ initiatives such as AI4T (Artificial Intelligence for Educators) and PAIDEIA are working to champion and push these principles by providing educators with training in AI tools, ethical frameworks, and classroom implementation strategies (Boldrini et al, 2024) (France Éducation International, 2024). PAIDEIA Consortium, 2024)

However, there are still concerns regarding the over-reliance on automation. Luckin (2018) argues that AI systems lack the contextual sensitivity and relational depth of human educators. This critique has also been debated at the Council of Europe's Framework Convention on Artificial Intelligence, which advocates for human rights-based approaches to digital transformation and advocates to be cautious against the uncritical adoption of algorithmic systems in pedagogical contexts (Council of Europe, 2024).

Feedback from educators across EU member states has revealed the need for more professional development related to ethical AI use, data literacy, and pedagogical integration (Attwell et al., 2025). These findings show a pressing need to equip educators with both technical skills needed to make use of AI tools as well as the critical skills needed to interpret, contextualize, and adapt AI tools to various learning environments. In the short-term future, educators and curriculum developers will face a multidimensional challenge due to the growing need for professionals capable of designing lesson plans and initiatives which are inclusive, ethical, and pedagogically sound. European policy, research initiatives, and practitioner networks urge the need for addressing this demand through coordinated investment, reforms, and sustained professional support.

4.3 EMERGING DISCIPLINES IN AI EDUCATİON

New academic fields are also emerging and gaining importance as a response to the ethical, epistemological, and relational challenges created by the technological advancement of AI. Disciplines such as explainable AI (XAI), human-AI interaction, and AI ethics are becoming more popular in postgraduate curricula and research agendas (Floridi & Chiriatti, 2020). These domains investigate the transparency, accountability, and trustworthiness of AI systems and are essential for helping learners to be prepared to engage critically with future AI developments and emerging technologies.

Ibitoye, Nkwo, and Orji, (2025), argue that current AI systems are limited in the support of higher-order thinking and complex problem solving and thus it is crucial to have educational frameworks in place that promote human agency and ethical co-design.

4.4 REGIONAL DISPARITIES AND GLOBAL TRENDS

Global trends in AI education also shed light on existing global regional disparities in access, infrastructure, and policy alignment. The OECD (2023) reports that while North America and Western Europe have made significant strides towards AI curriculum integration other global regions such as Sub-Saharan Africa and parts of Southeast Asia are lagging behind. Future technological advancement risks exacerbating these existing inequities unless they are addressed through inclusive policy frameworks and international cooperation. To this end, UNESCO (2023) is pushing for multilingual AI resources, community-based training models, and cross-border research initiatives in hopes of increasing equitable AI education.

Regional differences in AI adoption are shaped not only by technological capacity but also by societal narratives and policy frameworks. According to recent research, European countries cluster into distinct groups based on factors such as digital literacy, public trust, and infrastructure readiness. Nations with strong digital ecosystems and supportive policies tend to lead in AI integration, while others face challenges due to weaker regulatory structures and limited resources. These disparities highlight how cultural perceptions and governance approaches influence curriculum priorities, teacher training, and public confidence in AI. Tailored strategies are therefore essential to bridge adoption gaps and ensure inclusive, sustainable technological development. Manta, E.-M., Geambasu, M. C., & Birlan, I. (2025).

5. CHALLENGES AND BARRIERS

5.1 EQUITY AND ACCESS IN AI EDUCATION

As previously mentioned, the integration of AI in education brings with it equity-related challenges and there is a risk that existing disparities are exacerbated unless equality and access are addressed in a systematically manner (OECD, 2024; UNESCO, 2023).

The digital divide remains a barrier when it comes to socio-economic status and geographic location both of which influencing the access to AI-powered tools and infrastructure (Vesna et al., 2025). Schools in rural or underfunded areas often lack the technological capacity or infrastructure necessary to implement AI systems effectively, resulting in an uneven adoption and possible widening of student achievement gaps. Some European governments are trying to curtail this problem through large infrastructure investments (some of which are EU funded). One such project is the Maltese One Device Per Child through which all children aged between 8 and 12 are receiving a laptop or tablet with the aim of reducing this divide.

Algorithmic bias can also be an issue. Without careful oversight, AI systems may replicate discriminatory patterns in assessment and recommendation with students from minority backgrounds or underrepresented linguistic groups being the worst affected (OECD, 2024; Council of Europe, 2024).

Another barrier is teacher preparedness, many educators still lack training in ethical AI use, data literacy, and culturally responsive pedagogy. All these are essential for the equitable integration of AI tools (Roshanaei, Olivares, & Lopez, 2023). However, this barrier can be tackled through professional development courses and will be a significant driver towards the increase in these personal development courses.

Privacy and data concerns are a large issue especially when it concerns student data, data which may be considered as surveillance, and data that requires consent. The enforcement of the AI Act also drives the need to address these concerns in the near future.

To overcome this barrier, there need to be frameworks in place which prioritise Human rights that guarantee learner agency and focus on AI system transparency (Council of Europe, 2024). Addressing these barriers will require coordinated policy interventions, the integration of inclusive design principles, and a sustained investment in infrastructure and training (European Commission, 2020). If such measures are not in place, the use of AI in education may result in exacerbating exclusion rather than equality.

6. TEACHER PREPAREDNESS AND PROFESSIONAL DEVELOPMENT

6.1 PROFESSIONAL DEVELOPMENT

As artificial intelligence continues to become more embedded in educational environments, teacher readiness to engage with these technologies is becoming more of a pedagogical and ethical priority. Across Europe, educators are expected to understand the technical dimensions of AI and to critically evaluate its implications for learning, assessment, and equity. For this to happen, there should be a shift to rethink professional development models and ensure that educators are equipped with the right competencies, confidence, and reflective capacity.

Current research suggests that most educators do not feel able or prepared enough to integrate AI in a meaningful way within their classrooms. While digital literacy has improved in recent years, specific knowledge such as understanding algorithmic bias, data privacy, and the actionable opportunities AI resource can provide are still limited (Donlon & Tiernan, 2024). The Paideia Project's comparative analysis of teacher training across EU member states highlights significant variation in how AI is tackled in different countries, with some systems embedding it within a broader digital competence framework, while others treat it as a specialist or elective topic.

Professional development initiatives are beginning to address this gap for example, frameworks such as DigCompEdu and the AI&DComp model developed within Paideia offer structured pathways for building teacher capacity in areas like AI literacy, prompt engineering, and ethical reasoning. These models emphasize both the technical skills as well as the pedagogical aspects so that educators are encouraged to critically assess when and how AI should be used to support learning. These initiatives also promote collaborative and iterative learning environments where educators can experiment, reflect, and share practice.

Appropriate professional development should be ongoing, context-sensitive, and aligned with both curricular goals and sociocultural values. These support structures should keep evolving as AI technology evolves. The need for continuous professional development is prevalent and the creation of an AI&D comp framework allowed to be incorporated within an online teacher training course, Dewaele, K., & Cams, G. (2025).

6.2 CURRICULUM STANDARDIZATİON AND ACCREDITATION

Providing training is not enough, the training provided should be standardised and accredited. The European Union is pushing initiatives to ensure that AI training is consistent, of good quality, and transferable across educational systems. The European Union is making effort to harmonize digital and AI-related competencies through frameworks such as DigCompEdu and the European Qualifications Framework (EQF). These provide a frame of reference that will allow such courses to be aligned to the national curricula.

However, AI education is still fragmented across EU member states. Some countries have begun to integrate AI modules into secondary and vocational education, while others see AI as a part of broader digital literacy programs. The lack of a unified accreditation standard for AI-specific teacher training creates challenges for mobility, recognition, and professional development. As noted in the Paideia Project's comparative review, the accreditation processes often lag behind curricular innovation. As AI training is increasingly being given through pilot projects and informal training, there is a risk that educators are left without formal recognition for the acquired AI-related competencies (Donlon & Tiernan, 2024).

To address this gap, initiatives such as the AI&D Comp Framework propose structured pathways for validating teacher expertise in AI pedagogy, ethics, and technical fluency. These models push for modular certification schemes that can be embedded within existing teacher education programs and are at the same time aligned with European digital competence benchmarks. Accreditation, in this context, serves as a means of quality assurance and at the same time legitimizing AI education as a core component of professional teaching standards.

As AI continues to evolve, curriculum standardization and accreditation must remain dynamic, inclusive, and responsive to pedagogical shifts. A coordinated European approach will be critical to ensure that educators are not only prepared but also formally recognized for their role in shaping AI enhanced learning environments.

6.3 ETHICAL CONCERNS AND RESPONSIBLE AI LITERACY

The integration of artificial intelligence into education also brings with it several ethical challenges that educators should be prepared to address. As AI systems become more useful in aiding learning through adaptive platforms, automated feedback, and predictive analytics, educators will be required to engage critically with these technologies. Ethical concerns such as algorithmic bias, data privacy, surveillance, and non-transparent AI decision-making are particularly of concern in educational contexts, where the consequences of automated interventions can affect student outcomes and reinforce systemic inequalities.

Responsible AI literacy involves an understanding of the social, cultural, and moral dimensions of intelligent systems. Daher (2025) argues that without a foundation in ethical reasoning there is a risk of unintentionally deepening the digital divide and disadvantaging marginalized learners. The European Commission's Ethics Guidelines for Trustworthy AI (2019) reinforce this by emphasizing

principles such as human agency, fairness, accountability, and explicability. These are values that should be an integral part of teacher training and embedded in teacher education programs with the goal of fostering a human-centric approach towards AI.

Educators should be equipped to question the assumptions behind AI tools, assess their pedagogical appropriateness, and facilitate dialogue with their students. This includes understanding how AI systems are trained, what data they are rely on, and how their outputs may reflect the biases of the sources used. Information and Media Literacy in the Age of AI: options for the Future Tiernan et al (2023) highlights the need for dialogue with students and critical literacy.

7. STRATEGIC RECOMMENDATIONS

7.1 POLICY FRAMEWORKS, FUNDING, & NATIONAL EDUCATION STRATEGIES

Governments and policy makers play an important role in shaping the trajectory of AI education of their respective countries through the development and implementation of policy frameworks, targeted funding mechanisms, and inclusive national strategies. As artificial intelligence continues to transform educational systems, a proactive and coordinated governmental response is essential to ensure that AI integration promotes equity, innovation, and pedagogical integrity.

At policy level, governments should adopt comprehensive frameworks that address both the use of AI in education as well as education about AI. The European Union's Digital Education Action Plan (2021–2027) provides a foundational model which emphasizes the need for digital competence, ethical AI literacy, and teacher preparedness across its member states (European Commission, 2021). National strategies should align with broader EU frameworks while considering the local contexts and priorities. For example, Germany's AI strategy includes provisions for AI literacy in schools and teacher training, while Finland has launched open-access AI courses for citizens and educators as part of its national digital agenda (Tolosa González, 2025).

Funding is also an important enabler of AI education reform. Governments can allocate resources to support curriculum development, infrastructure upgrades, and professional development programs. This includes investments in teacher training, educational research, and industry partnerships that aid innovation. The Council of Europe's Policy Toolbox (2025) recommends earmarking funds to be specifically used for the ethical integration of AI. In parallel, funding should also be allocated to ensure that there are regulatory safeguards in place that can protect users as technology advances.

National AI education strategies should also prioritize inclusivity and sustainability to bridge regional disparities and support multilingual and culturally responsive content. AI literacy should be embedded across all levels of education starting from early childhood. Governments should also establish monitoring and evaluation mechanisms to assess the impact of AI initiatives and adapt policies accordingly. As mentioned by Europe on Track (2024), when policies do not anticipate and

regulate AI's educational implications, there is a risk that the transformative potential of AI is undermined. In Ireland the AI Advisory Council. (2025, February) published a very concise paper to provide expert guidance and advice on emerging issues to the government related to AI and provide insights on trends, opportunities and challenges.

7.2 CURRICULUM REDESIGN, INTERDISCIPLINARY INTEGRATION

Educational institutions also play a central role in shaping the future of AI education. Due to the growing demand for AI-related competencies across sectors, institutions should proactively redesign curricula to reflect the evolving technological landscapes. This involves updating course content as well as rethinking how AI can be embedded across disciplines.

During curriculum redesign, AI literacy should be viewed as a transversal skill and not a tool for just technical subjects. Students studying education, humanities, health sciences, and economics (amongst other disciplines) should also be able to engage critically with AI systems in an ethical manner (European Commission, 2022).

Interdisciplinary integration will be key to preparing learners of all subjects for a society which is increasingly becoming more AI embedded. Institutions should promote collaboration between departments to develop joint modules, co-taught courses, and interdisciplinary research initiatives. A transversal approach to AI also helps to enhance other transversal skills such as critical thinking, creativity, and ethical awareness which are in themselves indispensable skills. Through such curriculum redesign and interdisciplinary integration, institutions can ensure that AI education is robust, socially responsive, and pedagogically meaningful.

7.3 INDUSTRY PARTNERSHIPS, INTERNSHIPS, AND MENTORSHIP PROGRAMS

Industry partners are stakeholders that impact the advancement of AI in education through their collaborations with educational institutions. Strategic partnerships between companies and education ministries, universities, and vocational training centers can aid AI embedding by providing access to cutting-edge technologies and ensure that learners acquire the right skills which are aligned with real-world applications. For example, technology firms can collaborate with teacher training institutions to develop AI literacy modules, offer guest lectures, and support curriculum innovation. These partnerships act as a bridge between theoretical knowledge and practical implementation ensuring that AI skills are contextually relevant (European Commission, 2022).

Internships and work-based learning opportunities are and will also be important as these collaborations can expose educators to the operational realities of AI systems in a professional setting. This approach enhances technical fluency and critical reflection on the ethical and pedagogical implications of AI use (Cedefop, 2023). Similarly, mentorship programs can be a sustainable way in which industry professionals mentor educators and trainees and provide them with guidance on emerging trends and technologies while fostering cross-sector dialogue.

7.4 EDUCATORS

Strategic support for educators should focus on three aspects, professional training, access to high-quality resources, and peer networks.

Professional development, covered above, should include both technical and ethical aspects of AI integration (Daher, 2025), however there needs to be resources and support. Educators need to be given access to pedagogically aligned and ethically grounded resources which at present are not equally accessible across EU member states and regions (at country level). Holmes et al. (2022) argue that without structured and context sensitive materials, the digital divide risks being reinforced, thus, there is a need for open educational resources, scenario-based learning modules, and integration of AI ethics into subject-specific content.

Sustained peer learning communities are also an essential aspect as help to build educators' confidence along with the learned skills. Zawacki-Richter et al. (2022) argue that collaborative professional networks enable educators to share practices, co-develop resources, foster critical dialogue, aid in collective sensemaking, and joint problem-solving resulting in accelerated learning.

8. CONCLUSION

AI education is a strategic imperative for future-ready societies and will become even more crucial as the demand for a workforce with AI skills increases. The integration of AI into European education systems is also reshaping pedagogical models, workforce expectations, and ethical responsibilities amongst member states. There is also a marked shift towards interdisciplinary and lifelong learning pathways and changes in the way knowledge is acquired and applied.

On the reverse side, various challenges still need to be overcome including equal access, infrastructure limitations, and the need for standardized and validated training frameworks. These need to be addressed through policy and institutional reform and implementation. Bridging the present skills gap and challenges will require coordinated efforts across industry, academia, and government, and a shared commitment to future readiness.

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