PRELIMINARY MAPPING INSIGHTS

AI IMPLEMENTATION BY (PRE-SERVICE) TEACHERS

RANI VAN SCHOORS

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This report offers a comprehensive overview of the current landscape of Artificial Intelligence in Education (AIED), drawing on both academic research and practical insights from the field.

It contains **1)** an extensive literature review grounded and informed by academic literature and an analysis of European reports and policy guidelines. **2)** An overview of best practices regarding AIED. **3)** An analysis of AI in EU curricula. **4)** An analysis of focus group interviews with teachers.

These analysis of the content of previous chapters result in a **5)** final gap analysis presented at the end of this mapping report.

The aim of this mapping is to better understand how prepared the education sector is for the integration of AI, and to identify the knowledge, needs, and challenges pre-service teachers, in-service teachers, and teacher educators face across various European countries when engaging with AI tools and technologies.

The report seeks to:

- Provide an in-depth understanding of how AIED is currently being adopted and implemented in Europe.
- Analyze existing policies related to AI integration in secondary education.
- Identify current knowledge levels, needs, and challenges faced by educators in different national contexts.
- Map existing teacher training curricula that cover or use AI, with a focus on six countries: the Netherlands, Poland, Belgium, Austria, Norway, and Turkey.
- Clarify the specific support required by pre-service teachers, in-service teachers, and teacher educators to effectively engage with AI in secondary education.

Literature review

Artificial intelligence (AI) is making significant inroads into the educational landscape (Miao et al., 2021; Sperling et al., 2024; World Economic Forum, 2024). On the one hand, schools and educators are being tasked with the responsibility to guide children and youngsters in an AI-driven world and to empower them to critically examine issues like Fake News, Deep Fake Videos, or personalized advertising driven by AI-based algorithms. This responsibility has become increasingly apparent in light of the recent AI push, after ChatGPT made its way into education. As the use of AI tools in education has become irreversible, it requires the necessary support of teachers, ensuring that students can use them responsibly, based on well-informed considerations about benefits of such tools along with their deficiencies (Sperling et al., 2024), such as AI hallucinations, meaning that an AI system can generate unreliable or misleading responses (Miao et al., 2021). At the same time, the widespread availability of AI calls for a fundamental rethinking and redesign of teaching practices. Traditional assignments such as essays may no longer serve as the most effective means of assessing student learning, forcing educators to develop new, more AI-resilient assessment strategies. On the other hand, the integration of AI technologies into education presents significant potential. For instance, AI-driven data analysis can offer educators valuable insights into students' learning processes. The educational sector is increasingly recognizing the opportunities afforded by AI. To effectively navigate both the challenges and the possibilities associated with these technologies, it is crucial that educators receive adequate support. A pivotal component of this support is ensuring that (pre-service) teacher education fosters a balanced and well-informed understanding of AI – an objective that constitutes a central focus of the AI-teach project.

In ***'1. Understanding artificial intelligence (AI) and its place in the classroom'***, the literature review explores how artificial intelligence (AI) is currently understood, applied, and

perceived within the context of education. It begins by clarifying what is meant by AI in education, including a definition and an overview of commonly used technologies.

Next, ***'2. Potential benefits, risks, and challenges of AI in education'*** gives insights into the potential benefits of AI in education, for both learners and teachers, followed by a discussion of the risks and challenges associated with the integration of AI.

The review then highlights the state-of-the-art in the European educational context in **'3. Current State of AI training initiatives for teachers in the European Educational Landscape'**. This section provides an overview of relevant training opportunities, associated policy frameworks, and practices related to AI integration in higher education, with a particular focus on (pre-service) teacher education.

Following, in **'4. Teachers needs related to training according to literature and research'** we focus literature shows concerning (pre-service) teachers recent and actual needs and experience when it comes to the use of AI in schools.

Finally, '***5. Conclusion'*** offers a summary of key insights and reflections, discussing implications for both practice and policy, which can be used as a sound basis for the gap analysis later in this report.

1.1 Understanding artificial intelligence (AI) and its place in the classroom

Artificial Intelligence (AI) is a broad concept that covers a wide range of tools, applications and systems (Holmes et al., 2022). Although teachers and students often use AI technologies in their daily routines - often without even realizing it - many still find it challenging to articulate what AI actually is (Holmes & Tuomi, 2022; Selwyn, 2024).

A widely used definition is provided by UNICEF (p. 16), which states: *"AI refers to machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations, or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either directly or indirectly. Often, they appear to operate autonomously and can adapt their behavior by learning about the context."*

Holmes and colleagues (2022) consider this definition particularly relevant because it reflects the broad variety of AI: a differentiation can be made between generic AI tools (e.g., translation tools or recommendation systems), generative AI (e.g., ChatGPT, Co-Pilot) that creates new content based on prompts, and AI specifically designed for educational purposes (educational AI), such as adaptive learning platforms or automated feedback systems. In AI-teach we focus on how all three forms of AI impact teaching and learning practices. The definition of UNICEF (2021) is also relevant because it underscores the broad scope of AI and emphasizes that AI systems do not, and should not, operate in isolation. This is especially important in education, where it is essential to consider the human actor who will implement and interact with technology. As AI becomes increasingly present in educational settings, understanding who uses these tools, what tools are being used and how they are integrated is crucial. In line with this, the European Union's AI Act classifies the use of AI in education as "high-risk." This classification reinforces the importance of human oversight, transparency, and

accountability when implementing AI tools in schools and universities, especially those that function autonomously or significantly impact learning trajectories.

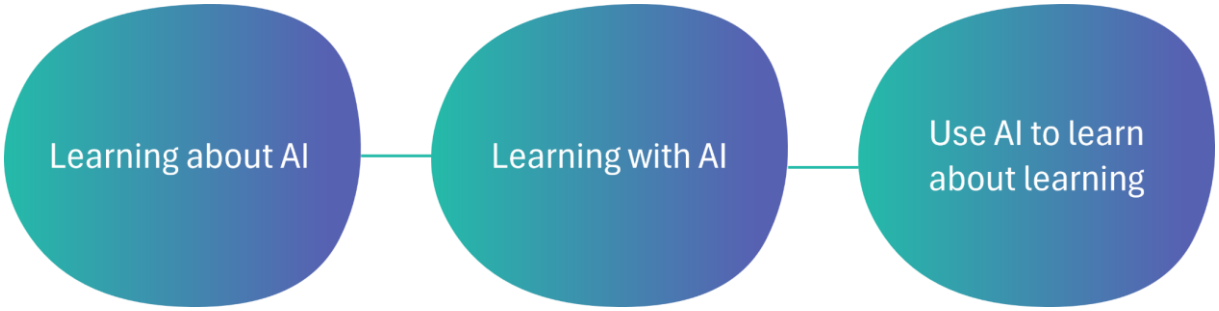
To make sense of the wide variety of AI tools in education, Holmes and Tuomi (2022) propose a helpful classification based on the primary user within the educational system. They identify three main categories in Artificial Intelligence in Education (AIED): (1) **Student-focused AIED**, including tools such as chatbots, intelligent tutoring systems, AI-assisted simulations and AI applications that support learners with disabilities. (2) **Teacher-focused AIED**, which involves tools like plagiarism detection software, classroom monitoring systems, orchestration tools and AI teaching assistants. (3) **Institution-focused AIED,** such as course planning software, admission and enrollment systems and AI tools that help identify students at risk of dropping out.

As the authors themselves note, this categorization is an initial attempt to structure AI systems that are being used in education, and there are many tools that do not fit neatly into one category—or may span several. Additionally, some of the mentioned tools are still in early development stages and are not yet widely implemented in practice (Holmes & Tuomi, 2022).

When looking into these AI systems, a growing question is: how do (pre-service) teachers integrate them into their daily practice? Holmes and colleagues (Holmes & Tuomi, 2022; Holmes et al., 2019; Holmes et al., 2022) have outlined various ways in which AI can be linked to education. In their 2019 framework, they proposed four key categories: (1) Prepare for AI, (2) Learning about AI, (3) Learning with AI and (4) Use AI to learn about learning.

These categories have evolved over time. For instance, "Prepare for AI" is now often seen as part of "Learning about AI," emphasizing not only technical knowledge but also broader competencies such as AI literacy. The term "Learning about AI" is therefore now frequently used interchangeably with "AI literacy" (Holmes et al., 2022).

For the purposes of this project, we have chosen to adopt the updated three-part categorization (see Figure 1). In the sections that follow, each of these dimensions will be briefly explained.



(Figure 1: An overview of the three-part categorization, visualizing the possible connections between AI and Education).

1.1.1 Learning about AI

This involves both the human and technological dimensions of AI. On the one hand, it means preparing students and teachers to recognize the challenges and potential impacts of AI on society (human dimension). On the other hand, it involves a basic understanding of how AI works "under the hood"—the technical functioning of algorithms and systems (technical dimension). Together, these areas are also often referred to as *AI literacy*.

1.1.2 Learning with AI

This category refers to the use of AI systems to support both students and teachers. It includes tools that enable personalized learning, streamline administrative tasks, and assist in classroom management (Holmes et al., 2022).

1.1.3 Use AI to learn about learning

Through data analysis, most commonly via learning analytics, AI can provide valuable insights into students' learning processes (Long & Siemens, 2011). In doing so, the goal is to inform and

support both learners and teachers by better understanding how learning unfolds (Holmes et al., 2022).

Although these categories offer a helpful framework, research has yet to fully clarify how AI is being integrated across different layers and levels of education. Many teachers explain that they are still searching for practical and sustainable ways to introduce AI-related topics and systems in their classrooms (Yim & Su, 2025). Using the framework of Holmes and colleagues (2022), we will further examine this and aim to build capacity but also critical understanding on how to exploit the opportunities offered by AI for teaching and learning.

1.2 Potential benefits, risks, and challenges of AI in education

AI has great potential to transform the design of future teaching and learning processes. A growing enthusiasm for AI in general is observed (Maslej et al., 2023; Miao et al., 2021; OECD, 2020, 2021). This surge in interest stems from the many anticipated benefits of AI for students. To start, there are expectations regarding positive impact on learning outcomes (Holmes & Porayska-Pomsta, 2023; Zhai et al., 2021; Zhang & Aslan, 2021). In addition, many believe that AI enables more personalized learning -offering tailored exercises, adaptive scaffolding, and customized assessments- which allows learners to progress at their own pace, moving away from the traditional 'one-size-fits-all' model (OECD, 2020; Selwyn, 2024). Others also see AI as a valuable tool for supporting students with special needs, for example through applications like speech-to-text or text-to-speech systems that assist with reading and writing (OECD, 2020).

It is important to note that AI does not only benefit students, but also teachers (Holmes et al., 2023; Holmes & Tuomi, 2022; Sperling et al., 2024; World Economic Forum, 2024). AI can support them before, during, and after lessons by preparing lesson content, organizing classes (e.g., creating student groups or assignments), generating exercises and tests, visualizing

abstract content, providing feedback, grading automatically, and monitoring student engagement and performance (Holmes et al., 2019; Holmes et al., 2022; Selwyn, 2024; World Economic Forum, 2024). One emerging area of interest is the use of teacher dashboards—intelligent interfaces that visualize student learning data. These dashboards can support more informed decision-making and improve teaching efficiency (Knox, 2023; OECD, 2021). In summary, many argue that AI has the potential to automate routine tasks, thereby freeing up time for teachers (Breines & Gallagher, 2020).

Although there's increasing excitement and numerous advantages associated with integrating AI into education across different levels, there are also a number of important questions and challenges also emerge, not only for the current context, but especially when looking ahead to the future (Holmes & Tuomi, 2022; World Economic Forum, 2024). The following section explores some of these complexities in more detail.

1.2.1 Technical complexities

Although AI is often presented as being intelligent enough to replace teachers, this is far from reality when it comes to currently available technologies (Selwyn, 2024). In practice, several technical obstacles still stand in the way, particularly at the level of hardware and software (Selwyn, 2024). These include limited access to high-quality equipment and compatibility issues between AI tools and existing educational content (Filiz et al., 2025; Pritawi et al., 2025; Selwyn, 2024). In this same regard, personalization is frequently cited as one of AI's key strengths, yet it is not always accurate or sufficient. As Selwyn (2024) explains, AI systems rely heavily on data, and when that data is flawed or incomplete, the risk of errors increases. For this reason, teacher agency and professional judgment remain crucial (Holmes et al., 2022; Selwyn, 2024).

Moreover, while there is no shortage of ambitious promises surrounding AI in education, many tools are still in their early development stages. For example, although adaptivity is often

highlighted as a benefit for individuals, collaboration is equally vital for a meaningful learning process. Nonetheless, AI-supported collaborative learning environments have mostly been explored in academic settings and have yet to be widely implemented in everyday classroom practice (Holmes et al., 2022).

1.2.2 Ethical complexity

Within the field of ethics, human rights play a central role (Holmes & Tuomi, 2022). This is also a key concern when it comes to AI in education (Filiz et al., 2025). For example, the principle of human dignity emphasizes that education should never be fully delegated to AI systems. Similarly, the right to data privacy and protection implies that student and teacher data should be safeguarded and that any data collected should serve the benefit of the individual (Holmes et al., 2022). We often recognize similar concerns and worries among teachers, raising questions around data privacy, fairness and transparency (Filiz et al., 2025; Holmes et al., 2022). In this respect, SURF (2022) created the Human Values Compass for educational technology, a practical tool designed to help various stakeholders in education reflect on ethical use of technology as well as concepts such as autonomy, human dignity, and justice.

It is also important to reflect on how increased data visibility serves the interests of learners. For instance, student-at-risk detection systems aim to identify students who may be struggling, but raise ethical concerns: How far should we go in collecting data without becoming intrusive? How and when should we inform students about such systems without undermining their motivation? And what happens when technology makes incorrect judgments (Holmes et al., 2022; Selwyn, 2024)?

Thus, questions around learner and teacher agency are becoming critical. How do we ensure that the boundaries of both actors are respected in AI-supported environments? How do

we make clear what AI can and cannot do, and where human oversight must remain (Holmes et al., 2022)?

1.2.3 Implementation complexity

AI is rapidly developing in the educational technology industry, but its integration into education is progressing rather slowly. The implementation of new technology in education is often influenced by various stakeholders of the broad educational ecosystem that need to be taken into account. With regard to students' use of AI, teachers express concerns about learners becoming overly reliant on technology (Filiz et al., 2025). They fear this dependence might reduce creativity and effort among students (Filiz et al., 2025), as well as weaken the focus on critical thinking and human creativity within the learning process (Sperling et al., 2024; Miao et al., 2021; Zhai et al., 2021; Molenaar, 2022). A study of Feliz and colleagues (2025) further shows that teachers worry about the difficulty of detecting plagiarism and students' reduced critical engagement with accurate versus inaccurate information (Filiz et al., 2025).

For teachers, one of the biggest issues is the lack of time and the high workload experienced by teachers, leaving them with limited capacity to engage in the search for sustainable AI integration (Filiz et al., 2025). Many teachers experience uncertainty about how to effectively incorporate AI tools into their teaching practice — not only in terms of selecting the most suitable tools, but also in deciding which pedagogical strategies to adopt (Yim & Su, 2025). They are also challenged by the question of how to balance the roles between themselves and the AI tools (who will take control over what in the learning process of students). Teachers genuinely worry about the implications. In a study by Pratiwi and colleagues (2025), a majority of teachers expressed concern about how AI might complement (or in some cases, replace) aspects of their professional role. While they acknowledge that AI can be a contribution for humans in certain tasks, they also emphasize the importance of retaining a sense of ownership

or agency and highlight the value of human contributions to education, such as providing emotional support, which they see as ever essential to the learning process.

Teachers sometimes express negative feelings such as frustration or distrust, often stemming from experiences with tools that are not user-friendly or fail to support their needs. These perceptions are also fueled by a sense of inadequacy in technical or pedagogical knowledge, (Filiz et al., 2025; Pratiwi et al., 2025;Yue et al., 2024). Due to limited knowledge and a lack of trust in AI tools, teachers often feel under pressure to make pedagogical decisions that are expected to be evidence-based and grounded in student data generated by these technologies (Sperling et al., 2024; Holstein et al., 2020).

A qualitative study by Filiz et al. (2025) on teachers' perceptions of AI implementation in Turkey highlights the importance teachers place on addressing the barriers mentioned above through appropriate support and resources. These barriers can shape their perceptions, which in turn influence how and whether they integrate AI into their teaching practice (Guan et al., 2025). In line with this, Kim and Kim (2022) emphasize that successful AI integration relies heavily on experience; teachers need opportunities to engage with AI technologies in order to understand and appreciate their potential. This highlights a clear need for targeted training aimed at strengthening teachers' technical as well as pedagogical knowledge and skills. The following section presents an overview of the current state of such training initiatives and guidelines in Europe, based on recent reports and policy documents.

1.3 Current state of AI training initiatives for teachers in the European educational landscape

Developing effective AI training programs is challenging due to the rapidly evolving and diverse nature of AI technologies, making fixed curricula quickly outdated (Holmes & Tuomi, 2022). However, one key focus for navigating this dynamicity of AI is the promotion of AI literacy among teachers. Holmes et al. (2022, p. 5) define AI literacy as: *"Having competencies in both the human and technological dimensions of artificial intelligence, at a level appropriate for the individual (i.e., according to their age and interests)."*

Recently, the importance of focusing on Teachers' AI literacy has gained recognition from various initiatives led by the European Commission and related educational organizations (Sperling et al., 2024). For instance, the European Commission (2022) convened an expert group to publish guidelines aimed at assisting teachers in understanding AI in general, tackling misconceptions, and promoting considerations regarding ethical risks (European Commission, 2022). These guidelines are integral to the Digital Action Plan (2021-2027) of the European Union (2021), emphasizing the need for increased collaboration on this topic on a European level. Recognizing the impact of limited AI knowledge, these guidelines extend their focus to primary and secondary education, with the aim of providing educators with the necessary support and frameworks (European Commission, 2021). Moreover, the European Digital Education Hub (2023) launched an AI report advocating for the support of teachers in developing knowledge regarding teaching for, with, and about AI (European Commission, 2023). Recommendations include leveraging online courses such as integrating "teaching with AI" into initial teacher education, establishing professional development pathways, and fostering peer teaching initiatives. The need to support teachers' use of AI is also recognized in one of the programs of the education department of the Council of Europe (2024), titled 'Digital Transformation,' which seeks to leverage technological advancements driven by AI to enrich education (Council of

Europe, 2024). This initiative aims to expand knowledge of and access to AI technologies capable of enhancing learning and teaching experiences, as emphasized in the ‘Education Strategy 2030’. In addition, the program underscores the importance of reevaluating pedagogical approaches and nurturing digital literacy among educators and students. Another similar focus is mentioned by UNESCO, as it advocates for a stronger focus on developing AI literacy among teachers, identifying it as a key topic for Digital Learning Week 2024 (UNESCO, 2024). In their report "Guidance for Generative AI in Education and Research," they stress the importance of adopting a human-centered approach to AI use, empowering teachers to confidently integrate AI into their practices and make informed decisions about its implementation (UNESCO, 2023). Finally, the OECD (2023) further echoes this opinion, advocating for teacher agency and professional learning opportunities through initial education and continuous development (OECD, 2024). They particularly emphasize the effectiveness of professional learning communities. One of the benefits described by OECD (2023) is the use of AI-enabled visualizations in deepening teachers' understanding of the learning process. To do so, teachers need to develop data literacy for which they should receive additional support (OECD, 2023). The focus on teacher competence is seen as a foundational step in enabling responsible, effective, and informed integration of AI into education. Furthermore, all these efforts (reports, guidelines, etc.) align with broader European priorities, for example, as documented in the EU AI Act.

That is the reason why the primary objective of this AI-teach project is to enhance the AI literacy of pre-service, in-service and teacher educators, thereby enabling children and youngsters to be maximally prepared through education to participate as active citizens in today’s and tomorrow’s AI-driven world.

When we look specifically at the participating countries in our AI-teach project, we observe that AI is receiving increasing attention in the context of (pre-service) teacher education. The following brief overview illustrates this trend.

1.3.1 Belgium

In Belgium, the Flemish government is increasingly focusing on the integration of AI in education. For example, the Department of Education and Training published the vision document “Responsible AI in Flemish Education”, which provides guidelines for the responsible development and use of AI in schools (Department of Education and Training, 2024). Additionally, the government is mapping teachers’ current use of AI and their needs, in order to develop tailored training programs (Flemish Government, Department of Education and Training, 2025).

Several large-scale initiatives are also making their way into education, such as the Imec Smart Education At Schools program. Through an annual call, teachers from primary, secondary, and adult education submit ideas to tackle classroom challenges with educational technology. An example is the KIKS project, which simplifies AI for high school students through an accessible online platform (imec, 2024). Another large-scale initiative is the ‘AI/XR in Your School’ Bootcamps: an example of how Flanders is investing in sustainable, practice-oriented professional development around artificial intelligence in education. By supporting schools over a two-year period, the program not only focuses on the technical and pedagogical integration of AI and XR, but also on developing long-term policy to support these innovations. This initiative aligns with broader efforts across Belgium to empower teachers and school teams to use digital technologies in teaching and learning in a responsible and purposeful way. On the other hand, there are also smaller initiatives, such as research groups offering free online training on AI in education, based on recent literature and research (e.g., https://itec.kuleuven-kulak.be/online-

training-on-ai-in-education/). This initiative was very welcome, as it was accessed by over 1000 teachers in 3 months' time.

1.3.2 Netherlands

The Dutch AI agenda for education starts at national level with the AI Coalition for the Netherlands (AIC4NL). This coalition adopts a broad and integrated approach to stimulate and guide the development and application of AI in the Netherlands. Its aim is to position the country as a leader in human-centered and ethical AI by translating technological progress into societal and economic value. In this context, the coalition explicitly links and supports several key national initiatives contributing to the responsible and future-proof use of AI in education.

One of these initiatives is the National Education Lab AI (NOLAI). Following a 2022 report from the Dutch Education Council on the opportunities and risks of intelligent technology in education, the Dutch government allocated €80 million from the National Growth Fund for the period 2022–2032 to establish NOLAI (NOLAI, 2022). Hosted at RU, NOLAI facilitates collaboration among schools, academia, and industry, each playing an equal role in developing responsible intelligent educational technologies to meet educational needs. Guided by a co-creation program and a scientific program, NOLAI also features a reference framework on AI to foster shared language and enhance collaboration among schools, scientists, and businesses. Engaging secondary teachers in collaborative co-creation projects is challenging as their experience with and knowledge about AI educational innovations is still limited.

The National Approach to Teacher Professionalization (NAPL) complements these efforts by organizing and supporting continuous professional development for teachers in primary, secondary, and vocational education. Within this program, AI education is one of the focal points, ensuring that teachers acquire the competencies to engage responsibly and confidently with AI innovations.

Another key development is the NPuls pilot hub 'Data & AI', which also operates within the framework of the National Growth Fund. NPuls serves all public vocational education and training schools, universities of applied sciences, and research universities in the Netherlands. Its aim is to improve the quality, effectiveness, and efficiency of education through the responsible use of data and AI, including innovations that enable learners to progress through education with personalized guidance and education on demand.

Finally, there is the "Empowering Educators in the Digital Transition" project, a collaborative initiative between Flanders and the Netherlands. This project supports both governments in designing, developing, and implementing reforms in digital education, with a strong focus on equipping teachers with the digital competencies they need to effectively integrate technology into their teaching practice.

1.3.3 Austria

Austria has been active in promoting AI knowledge among educational professionals through various initiatives, including policy documents and professionalization efforts. One of those policy documents is the "Artificial Intelligence Mission Austria 2030" which was issued in 2018 by the Federal Ministry for Transport, Innovation and Technology and the Federal Ministry for Digital and Economic Affairs. This strategic document focuses on regulatory frameworks (ethics, legal), safety and security of AI, defining standards, AI infrastructure, data use and sharing, R&D, transfer, and uptake of AI, cooperation between education, research, and business, societal dialogue, and creating awareness.

Beyond this, the Federal Ministry of Education has issued a handbook "Engaging with artificial intelligence in the education system" in 2023 which aims to raise awareness for the topic among interested parties in the education system on the one hand, and on the other hand to provide basic information on how AI-based systems work and, above all, on their potential

and possible applications in education. These efforts are accompanied with various practice-related approaches that have the aim to explore the AI potential for the field of education. One of those methods is the piloting of AI tools in selected schools which lead toward collection of good practice examples and didactic concepts and ideas on how to best use the potential of AI for teaching and learning. This was accompanied by expansion of existing digital learning offers for teachers (e.g. MOOCs (Massive Open Online Course)) with sections referring to the use of AI-based tools and materials for teaching and learning. Furthermore, the Federal Ministry of Education has also issued in 2023 guidelines for upper secondary schools on the use of AI-based tools in the final exams – highlighting the potential, risks and aspects relevant for an assessment and providing basic orientation for dealing with AI-based applications in the context of final examinations in schools. Additional efforts in this context are connected to the Network eEducation Austria which has currently more than 4.000 schools as members. The goal of the Network eEducation Austria is to support and foster digital developments in schools through different measures and activities. The current activities of eEducation Austria were complemented with additional activities referring to encourage schools, and school administrators in particular, to address the AI in a sustainable manner in their school development process.

In addition to these above-described efforts, there are approaches focused on integration of the AI topic in the initial education, training, further education and continuing professional development for teachers, as teachers are the driving force behind developments in the education system and their continuing education and training is therefore of central importance. A currently (2025) ongoing teacher education reform includes a major revision and restructuring of the curricula for the study programs (Bachelor and Master level) for primary and secondary level teaching. The Quality Assurance Council (QSR) of Austria and the Federal Ministry of Education have defined new focal topics based on which the revision process should be done, and have given recommendations and set requirements for reforming the existing

curricula and integrating the relevant focal topics. One of those topics refers to “Artificial intelligence, media education, digitization, globalization”, meaning that learning about AI and learning with AI must be addressed in all new curricula. Based on these recommendations and requirements processes of curricula reforms have been initiated. The Austrian curricula for obtaining a teacher degree both for bachelor and master primary level have been consequently reformed, and integrate in an extensive way the AI topic. Valid from 1st of October 2025, these curricula should prepare pre-service teachers to use the AI potential for teaching, learning and assessment. Similarly, the existing bachelor and master curricula for obtaining teacher degree for secondary level are currently being reformed and a new curriculum for secondary level will be implemented from the winter semester 2026/2027 onwards. This curriculum should professionalize teachers on secondary level to use the AI potential in educational setting.

1.3.4 Turkey

In Turkey, there is an active push towards the utilization of AI in education. At the policy level, the National AI Strategy Plan (2021-2025) was implemented. Turkey launched a national strategy plan for AI containing guidelines and objectives for the implementation of AI across various sectors, including education. Additionally, in the 2024-2025 academic year, the Higher Education Council (YÖK) announced plans to equip students with AI competence through interdisciplinary research programs.

Recently, the Ministry of National Education (2025) published the “Artificial Intelligence in Education Policy Document and Action Plan (2025-2029). The document, which includes strategic approaches for the 2025-2029 period, sets out strategic goals for the effective, ethical and inclusive use of artificial intelligence technologies in education. At the same time, studies are being carried out to establish AI-based learning analytics platforms, aiming to improve the digital skills of students and teachers, increase personalized learning opportunities, and strengthen quality and inclusiveness in education. In line with these main objectives, a total of

15 policy steps and 40 action steps have been identified. Seventeen of these action steps are planned to be implemented within one year, 10 within one to three years, and 13 within three to five years.

Moreover, The National Artificial Intelligence Strategy 2024-2025 Action Plan has been launched. Prepared by the Ministry of Industry and Technology of the Republic of Turkey and the Presidential Digital Transformation Office, the action plan identified strategic priorities as follows:

- Training Artificial Intelligence Experts and Increasing Employment in the Field
- Supporting Research, Entrepreneurship, and Innovation
- Expanding Access to Quality Data and Technical Infrastructure
- Implementing Regulations to Accelerate Socioeconomic Harmonization
- Strengthening International Collaborations
- Accelerating Structural and Workforce Transformation

Regarding AI-related projects, reference can be made to the FATIH Project, a large-scale initiative by the Turkish government aimed at enhancing technological infrastructure and resources in schools. While initially not specifically focused on AI, the project now encompasses the integration of AI tools to enhance teaching methods and support personalized learning. Results indicate that the project primarily focused on hardware and found e-content to be unsatisfactory. Additionally, it highlighted issues such as unprepared teachers, sustainability problems, and disruptions in classroom practice. These issues were attributed to the abrupt top-down initiation of the project. Consequently, it is recommended to consult educational technology integration literature before launching such initiatives.

Turkey has also invested in establishing universities and research centers specializing in technology and AI. These institutions are engaged in developing AI applications for educational

purposes and training teachers in the use of AI in their teaching. These projects and policy initiatives illustrate how Turkey views AI as a crucial tool for modernizing and enhancing the education system. There is a clear need for the preparation of both current and future teachers. Previous project experiences highlight the importance of a bottom-up approach; first understanding teachers' perceptions and needs and incorporating them into project implementation.

1.3.5 Poland

The “Polish Policy for the Development of Artificial Intelligence (2019 - 2027)” outlines a number of activities and objectives that Poland should achieve in the short term (until 2023), medium term (until 2027) and long term (after 2027). With the nation's growth in focus, endeavors have been divided into six areas, being (1) AI and society, (2) AI and innovative companies, (3) AI and science, (4) AI and education, (5) AI and international cooperation, and (6) AI and the public sector.

Examples of activities and objectives established by Poland across short, medium, and long-term horizons, aligning with the goals to be accomplished within the AI-teach project, include: Short-term (until 2023), introducing mechanisms encouraging teachers to collaborate with experts from the private sector in order to obtain expert support in the preparation of teaching materials and implementation of the teaching process, including through in-class support (after meeting the requirements provided for in the law); developing mechanisms to support teachers and educational staff in improving their qualifications and skills in the area of AI and modern technologies, along with tools for rewarding students and their teachers for outstanding achievements in these areas; supporting knowledge and experience exchange between educational institutions using modern technologies by promoting good practices using e-learning platforms designed for this purpose (e.g. in the MOOCs formula); providing educational content for schools and supporting them in teaching digital skills, including AI-

related competencies. Medium-term (until 2027), preparing teachers to introduce issues related to artificial intelligence in particular subjects or fields of education. Long-term, Poland is the European leader in education in AI and other digital technologies at secondary school level.

In addition to the policy document described above, the extensive research report titled "Polish Education in the shadow of AI" conducted by Collegium Da Vinci in collaboration with experts, presents based on data collected in 2023 from educational stakeholders, including students and secondary school teachers, challenges for the Polish education system in the context of the growing role of artificial intelligence. For example, the report shows that secondary school teachers have little faith in their own competences in using AI-based tools. This concern is further supported by Walkowiak and Kopciał (2023), who found that both pre-service and in-service teachers in Poland express a strong need for structured AI training and institutional support. The lack of systematic integration of AI-related pedagogy in teacher education programs significantly limits teacher readiness.

This finding raises the question to what extent the short-term objectives set in the policy document that runs from 2019 to 2027 have been achieved. Promoting AI literacy, in particular of secondary education teachers, seems to require special attention. Nowak and Kuś (2022) emphasize that most Polish universities lack dedicated AI literacy or ethics modules in pre-service teacher education, further challenging the realization of national policy objectives.

One recent initiative that reflects efforts to meet these short-term objectives is *CivicEduExpert*, an AI-driven digital assistant developed by Fobizz in 2025. Designed specifically to support teachers with lesson planning and didactic tasks, the tool is tailored to educators' needs and supports multiple languages, including Polish. It enables teachers to generate lesson ideas, create worksheets, suggest assignments, and adapt materials for different learning levels. While *CivicEduExpert* aligns with the national policy's emphasis on enhancing teacher competence in AI, its impact remains difficult to assess. As of now, there is no publicly available

documentation of pilot programs or formal integration into Polish schools or teacher-training curricula, suggesting that its adoption may still be in preliminary stages.

Meanwhile, programs are being established within secondary education in Poland to foster students' AI literacy. In the AI for Youth program, secondary school students gain knowledge and practical skills to create their own project using AI algorithms to solve social problems at the local or global level. However, program evaluations (Digital Poland Foundation, 2023) have shown that while students report high engagement, nearly half of participating teachers felt underprepared to support AI-based learning, highlighting a disconnect between student opportunities and teacher preparedness.

Early this decade, Poland introduced an ambitious policy on AI, consisting of short (until 2023), medium (until 2027) and long-term (after 2027) objectives. Regarding AI in education, one of the set short-term goals was to provide support to teachers in order to improve their AI skills. Despite this target, data collected in 2023 shows that secondary school teachers have little confidence in their own AI competences. This is consistent with broader research, suggesting that the implementation of teacher-focused AI education support mechanisms remains insufficient (Walkowiak & Kopciał, 2023).

Also, recent Polish research highlights both the opportunities and challenges of integrating artificial intelligence into education. Zalewska-Bochenko (2024) offers a comprehensive analysis of AI’s potential to transform the teaching process by increasing accessibility, enhancing flexibility, and personalising learning experiences. Her work also stresses ethical considerations, particularly around the equitable distribution of AI benefits, the risk of over-reliance on technology, and the need to balance innovation with human-centered pedagogical values.

Complementing this systemic perspective, Patkowski and Zieliński (2024) investigate the attitudes of key educational stakeholders — including pupils, teachers, students, and business representatives — toward AI in education. Their findings reveal a cautious optimism: while respondents acknowledge AI's capacity to support learning and efficiency, they also emphasize the necessity for regulatory frameworks and ethical guidelines to mitigate risks such as bias, misuse, and erosion of traditional teaching practices.

Together, these studies suggest that successful AI adoption in Polish education requires not only technological readiness but also a sound ethical and regulatory foundation, ensuring that innovation serves educational integrity and human development.

1.3.6 Norway

Since 2018, NORA, which stands for Norwegian Artificial Intelligence Research Consortium - strives to strengthen Norwegian research, education and innovation in the field of AI by supporting the development of joint research projects between partners, the establishment of AI-related start-up companies, etc. In January 2020, the Norwegian Government presented its National AI strategy. The aim of the strategy is to delineate policy actions for the upcoming years, aiming to optimize the opportunities that AI can offer to Norwegian individuals, businesses, industries, and the public sector. To equip the future workforce with technological literacy and the appropriate digital skills, the Norwegian Government is initiating reforms across all levels of education. Specifically, at the primary and secondary education level, the government envisions revising the curricula to incorporate greater emphasis on programming and computational thinking. To support teachers in these reform processes, professional development opportunities related to AI are offered through the Centre for Computing in Science Education (CSSE) and Centre for Teaching and Learning in Science and Technology (KURT). An example of such a course is ProFag programming.

In addition to national initiatives, Norway is involved in international collaborations that aim to further develop digital or more specifically AI competences of different stakeholders. A first example is Norway's participation in The Digital Europe Program (DIGITAL), an EU funding program (2021-2027) that supports projects in five areas, including AI, with the aim to bring digital technology to businesses, citizens, and public administrations within the European Union. A second example is the involvement of Norway in the “Learn to Machine Learn” (LearnML) project. In light of this project, ArtBot has been developed, which is a game introducing primary and secondary education students to the core principles of AI and ML. Also, it should be mentioned that Norway recently funded six new research centers about AI, which are expected to produce research and applications of AI in various field, education included.

In summary, Norway recognizes the importance of AI literacy for teachers, and efforts are being made to integrate it into teacher education and classroom practices. However, ongoing professional development and support are crucial to ensure that teachers stay abreast of technological advancements, including AI.

Apart from the focus on AI within the governments of the aforementioned countries, it remains unclear to what extent AI is specifically addressed in the curricula of (pre-service) teachers. To address this, a thorough curriculum analysis of the participating countries in the AI-teach project is presented later in this report (see section 3 – AI in EU curricula).

1.4 Teachers’ needs related to training according to literature and research

Although several governments are promoting the integration of AI in education, teachers do indicate several needs related to training initiatives or professional development. In reality, teacher training programs often lack sufficient focus on AI, particularly in fostering a holistic understanding of both its technical and pedagogical dimensions (Guan et al., 2025). For

example, it can be observed that pre-service teachers tend to use AI tools typically only when necessary. They often do not view AI as a collaborative partner and express limited knowledge of fundamental AI concepts and technologies (Guan et al., 2025).

Reservations to use AI may be driven by teachers' internal factors (Filiz et al., 2025; Guan et al., 2025). Psychologically, attitudes toward AI are crucial. Models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) highlight perceived ease of use and perceived usefulness as key predictors of behavioral intention or willingness to use tools in the classroom (Zhang et al., 2024). Other attitudinal aspects also play a role in AI adoption, including self-efficacy (Guan et al., 2025), trust in AI systems (Zhang et al., 2024), confidence (Hur, 2025), teachers' sense of agency (Brod et al., 2023) and so on. To address all these aspects, it is essential that AI training places sufficient emphasis on broader AI literacy so that teachers feel experienced to align AI tools with curriculum goals and teaching methods while being able to assess benefits and risks (Filiz et al., 2025). Understanding which teacher tasks can or cannot be delegated to AI is also crucial (Guan et al., 2025).

When it comes to (pre-service) teacher training initiatives programs, research consistently emphasizes the need for both formal and informal support across multiple areas (e.g., Guan et al., 2025; Hur, 2025; Pratiwi et al., 2025). For example, Filiz et al. (2025) report that teachers seek support for technical and operational guidance, curriculum alignment, ethical considerations, flexible professional development, and so on. Specifically, teachers value support that combines theoretical insights with hands-on, practical strategies. To guide teacher development, several frameworks have been proposed such as the DigCompEdu framework (European Commission, 2017), which focuses on 22 digital competencies across six areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners, facilitating students' digital competence. A recent extension includes AI-specific

competencies such as data literacy, computational thinking, ethical use of AI, and preparing students for an AI-driven world (Bekiardis & Attwell, 2024). Finally, the UNESCO AI Competency Framework for Teachers is presented, defining five domains—human-centered mindset, AI ethics, AI foundations, AI pedagogy, and AI for professional growth—each with progression levels from acquisition to creation.

Regarding (pre-service) teacher training programs, Guan et al. (2025) emphasize that a strong sense of professional community enhances teachers' confidence and readiness to adopt AI. This community can exist at the school level—for example, through knowledge sharing among colleagues—but also at broader levels, such as partnerships between teachers and EdTech providers or training designers. Co-creation processes, as suggested by Pritawi et al. (2025), can foster a sense of ownership and lead to more tailored, context-sensitive support.

1.5 Conclusion

From the above description of international projects, initiatives, and studies, several conclusions can be drawn: There is a clear need for teacher AI literacy and various initiatives in diverse forms to address this need. Teachers generally hold positive perceptions towards the potential of AI technology, but this contrasts with their knowledge and competencies regarding AI adoption in education. Additionally, they experience various feelings of uncertainty, distrust or lack of self-efficacy due to AI challenges (e.g., ethical, technical). This is not only observed in the described partner countries but is also confirmed by others.

Regarding support initiatives, it is evident across all partner countries and also recognized internationally that this is a timely and intriguing issue. For instance, findings from Ferede and colleagues (2022) and corresponding work by Schildkamp and colleagues (2021) suggest that both, sufficient opportunities for professional development and adequate technical support, are crucial conditions to meet as a means to face the implementation

challenges of new technology. The research found that not one specific type, but various support initiatives are desired by teachers. This is also acknowledged by each partner country of the AI-teach project, revealing preferences ranging from on-campus courses to hybrid initiatives to e-learning, aiming to reach a diverse audience with varying levels of prior knowledge. Furthermore, it is recommended to invest in tailored training. In this regard, it is important for these professionalization initiatives to prioritize connection and co-creation with teachers.

All previously described insights are foundational building blocks of the AI-teach project. As we strongly believe that it is not the technology that makes the difference, but the pedagogical way in which it is being used (Clark, 1994), we do not approach the project from a technological perspective, but from a human perspective; thus, we focus not only on the potential of intelligent technology but also on the collaboration between teachers and intelligent technology.

(Pre-service) teachers are key stakeholders within the AI-teach project. The starting point are their needs and perceptions from a broad perspective, also exploring agency, trust, and so forth. We emphasize co-creation with (pre-service) teachers as well as teacher educators, thereby employing a bottom-up approach. In this manner, we aim to develop various tailor-made professionalization initiatives according to the principles of DBR (McKenney & Reeves, 2018).

We will do so by gathering more insights through an analysis of focus group interviews with teachers, a best practices analysis and a curriculum analysis to further investigate the gaps within the field of AI implementation in education.

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