



Professional Development for Teachers in the Age of AI

European Schoolnet Academy Thematic Seminar Report

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Cover design: A dance of data where lines and circles (1 and 0) represent the conversations between humans and artificial intelligence. An algorithmic language driving AI's learning from human inputs.

Contents

4 Introduction

6 What are the implications of AI for teacher professional development?

8 How can teacher professional development best prepare educators for AI?

- 8 Overview of competence frameworks that can help identify relevant focus areas for teacher professional development
- 12 What specific areas should teacher professional development prioritise to enable effective and responsible use of AI by teachers?

18 How can teacher trainers make use of AI?

- 18 Large Language Models and Teacher Training
- 24 AI Image and Video Generation and Teacher Training
- 25 Important Considerations for the use of Generative AI in Teacher Professional Development

27 Teacher Professional Development about and with AI – Examples from Practice

- 27 Teacher Trainer from Spain: Paul Van Branteghem
- 29 Teacher Trainer on European Schoolnet Academy: Arjana Blazic
- 30 Teacher Trainer from Malta: Keith Aquilina
- 31 Teacher Trainer from Italy: Jessica Niewint-Gori

32 Conclusion

33 References

Introduction

In an era of rapid technological change, many education systems are struggling to keep up with technological developments. This has been exemplified with the recent rise of artificial intelligence (AI) tools like ChatGPT which raise fundamental questions about how teaching, learning and assessment are organised in schools.

In a world where generative AI systems seem to be developing new capabilities by the month, what skills, outlooks and competencies should our education systems cultivate? What changes are needed in schools and beyond to help students navigate a future where human and machine intelligence seem to be ever more closely connected – one supporting the other and vice versa?"

Stefania Giannini, 2023

As these technologies enter the classroom, teachers find themselves at the forefront of a revolution that demands not only a reimagining of pedagogical approaches but also a continuous commitment to professional development. The potentially synergetic relationship between teachers and AI presents both challenges and opportunities, underscoring the critical need for teachers to adapt, upskill and stay abreast of the latest developments.

The autonomy that characterises such technologies, their ability to be initiators of interaction with students, and the complexity of the tasks that AI can already perform and increasingly will be able to do, imposes an evolution of the teacher's role."

Manuel Gentile et al., 2023

This report explores how professional development for teachers needs to change in the age of AI. From fostering an understanding of AI applications in education to equipping teachers with the requisite skills to leverage these technologies, our analysis aims to provide insights into how professional development can empower teachers to navigate the complexities of the changes brought about by AI.

The report addresses three crucial areas pertaining to the integration of AI in teacher training. First and foremost, the report examines the key question of what areas professional development initiatives should prioritise to adequately prepare teachers for the challenges and opportunities presented by the era of AI. Second, it delves into the ways AI can be effectively utilised by teacher trainers to enhance the training process. Last, the report provides summaries of four examples from practice where teacher trainers have implemented training activities that focus on AI and what they have learnt in the process. By investigating these aspects, the report seeks to provide teacher trainers with valuable insights and guidance as they navigate the intersection of AI and teacher professional development.

In setting the stage for our exploration into the professional development of teachers in the age of AI, it is essential to underscore the pivotal role that professional development programmes play in supporting teachers in these times of rapid change. These programmes serve a dual purpose: not only can they address the apprehensions often associated with AI, but they can also contribute to the cultivation of a community of teachers that empowers teachers to continually develop their practices. This community should be characterised not by mere spectators but by active participants, shaping the trajectory of the future of their learning.

This report is the collaborative work of a group of researchers and teacher trainers who have studied how teacher professional development needs to change in light of AI, and who have gained first-hand experience of implementing teacher training activities about AI and with the support of AI. The two main authors are Mutlu Cukurova, Professor of Learning and Artificial Intelligence at University College London, and Lidija Kralj, Senior Education Analyst at European Schoolnet.

What are the implications of AI for teacher professional development?

Author: Mutlu Cukurova

In this first section, Mutlu Cukurova briefly explores the more general implications of AI on teacher professional development, setting the scene for a more in-depth exploration of what teacher professional development should focus on and how teacher trainers can benefit from AI in their own work.

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are designed to perform tasks that typically require human intelligence. Applied AI refers to tools that have been designed and developed to assist in or replace decision making processes through the analysis of big data, and the prediction of the best value for a designated outcome variable, which is conveyed through a user interface.

Broadly speaking, the implications of AI for education and teacher professional development can be categorised into three groups of activities (Luckin & Cukurova, 2019).

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The first category, using AI to tackle educational challenges, involves the use of AI tools for human learning, for instance, to provide personalised learning experiences with intelligent tutoring systems and adaptive learning platforms. In the context of teacher training, these tools can analyse a teacher's learning patterns and adapt content, feedback or teaching methods accordingly.

They can also help teacher trainers by automating administrative tasks, such as grading and attendance tracking of teachers, thereby potentially freeing up more time for pedagogically more valuable tasks such as scaffolding, or emotional and social interaction support.

These kinds of social and emotional aspects of learning are equally important for teacher training contexts and classroom teaching, yet they might be overlooked by teacher trainers.

The second category, educating about AI, involves teaching teachers about AI technologies, their uses and their ethical implications. This can be done through specialised CPD courses or integrated into existing teacher training curricula. It's crucial that teachers understand the potential and limitations of AI, as well as the ethical considerations that come with its use. AI competence development for teachers is not limited to improving teachers' AI foundational knowledge, skills and ethical considerations, but it also covers improving teachers' AI pedagogical knowledge so that they can identify AI's pedagogical benefits, adeptly employ AI-enhanced teaching methods, and design innovative pedagogies for teaching with AI to provide for a harmonious blend of AI-supported and human-centric teaching to enhance learning. Teachers' AI competency development is also about helping teachers develop key self-regulated learning skills to cope with continuous changes introduced by AI's integration into education and our lives. These skill developments should be done in ways so that teachers can demonstrate readiness for professional growth, cultivate AI expertise through networking and collaboration, and leverage AI opportunities to enhance their subject knowledge, research and teaching capabilities as independent lifelong learners.

The third category, innovating education systems, involves rethinking how we teach and learn in light of AI's growing influence. This could involve incorporating AI into teaching methods for more process-oriented teaching rather than outcome-focused ones, or redesigning curricula to better prepare students for a future where AI is ubiquitous. For instance, uniquely human skills like metacognition, emotional intelligence or social skills should become core components of education, alongside traditional subjects like mathematics and science.

In the following sections, we will explore these categories in more detail, with particular focus on how teacher training can prepare teachers to address the issues of these three categories in their own work, but also how teacher trainers can make use of AI tools to support their training activities (linked to the first category).

How can teacher professional development best prepare educators for AI?

Author: Lidija Kralj

Knowledge skills and attitudes for understanding and using AI in education, commonly referred to as AI competences, hold significant importance in today's world as they have the potential to empower individuals to critically evaluate AI technologies, communicate proficiently with AI, and use AI effectively in diverse contexts. Therefore, in this section Lidija Kralj delves into some key aspects that should be the focus of teacher training to prepare teachers for AI. To start out with, she examines various competency frameworks that can guide teacher training in deciding relevant areas to focus on. She then explores in more detail what areas teacher training should prioritise to enable effective and responsible use of AI by teachers.

About the author: Lidija Kralj is an international analyst and expert in data and AI in education, she is a member of the European Commission's working groups on Artificial intelligence and data in education and training, digital education, and safer internet; UNESCO and Council of Europe workgroups on AI and education, and author of digital learning resources and textbooks, as well as an advisor and teacher trainer. She had been working at the Ministry of Science and Education in Croatia, where she led reforms in the areas of digital education, learning analytics, data-based decisions in education and comprehensive curricula reform. Lidija is an eLearning and project manager, and a lecturer in Mathematics and Computer Science with 30 years of experience, currently works as a senior analyst at European Schoolnet.

Overview of competence frameworks that can help identify relevant focus areas for teacher professional development

DigCompEdu The [European Framework for the Digital Competence of Educators \(DigCompEdu\)](#), published in 2017, describes what it means for educators to be digitally competent, and therefore offers valuable guidance on the competences that teachers need in the first place to even start to understand and make use of AI. DigCompEdu is aimed towards teachers at all levels of education, from early childhood to higher and adult education, including general and vocational education and training, special needs education and non-formal learning contexts. The framework aims to detail how digital technologies can be used to enhance and innovate education and training without any specific focus on technical skills. The framework details 22 competences organised in six areas as indicated below.

- **Professional Engagement** focuses on using digital technologies to enhance organisational communication with learners, parents and third parties. It also includes professional collaboration, reflective practice and digital continuous professional development.
- **Digital Resources** involves identifying, assessing, and selecting digital resources for teaching and learning. It also includes modifying and building on existing openly-licensed resources and other resources where this is permitted; creating or co-creating new digital educational resources; and managing, protecting and sharing digital resources.

- **Teaching and Learning** covers the planning for and implementation of digital devices and resources in the teaching process in order to enhance the effectiveness of teaching interventions. It also includes using digital technologies to enhance the interaction with learners, individually and collectively, within and outside the learning session, and using digital technologies to foster and enhance learner collaboration.
- **Assessment** involves using digital technologies to enhance formative and summative assessment, provide feedback and track learner progress.
- **Empowering Learners** focuses on using digital technologies to foster learner autonomy, scaffold mature use of digital technologies, differentiate teaching and learning, and promote digital inclusion.
- **Facilitating Learners' Digital Competence** covers guiding learners in their development of digital competences, fostering responsible and safe use of digital technologies, and promoting learners' critical and creative thinking.

SELFIEforTEACHERS Based on DigCompEdu, [SELFIE FOR TEACHERS](#) was developed as a self-reflection tool to support teachers in further developing their digital competences. After answering questions in six different areas, teachers receive a report with personalised feedback and suggestions on how to level up their skills. In the 2022 version, some new questions about AI implementation were added: for example about awareness of emerging technologies and AI use, addressing learner agency when interacting with AI, addressing datafication and AI agency in decision making, computer-mediated learning environments, automated scoring technologies, automated feedback, and testing relevance of emerging technologies for teaching and learning.

ICT-CFT The [UNESCO ICT Competency Framework for Teachers](#) (ICT-CFT) was designed in 2018 to guide pre- and in-service teacher training on the use of digital technologies in both formal and informal education systems. As with DigCompEdu, this framework can help identify the more general digital competences that teachers need in order to be prepared for AI in education. ICT-CFT covers six aspects:

- **Policy:** understanding national priorities as identified in national ICT in Education policies;
- **Curriculum and Assessment:** how ICT can support the curriculum and assessment strategies;
- **Pedagogy:** the pedagogical implications and applications of ICT;
- **Application of Digital Skills:** the practical application of digital skills in teaching and learning;
- **Organisation and Administration:** the organisational and administrative aspects of ICT in education;
- **Professional Development:** the role of ICT in ongoing professional development.

DigComp 2.2 In 2022, the European Commission's Joint Research Centre published DigComp 2.2 ([The Digital Competence Framework for Citizens](#)) with new examples of knowledge, skills and attitudes that help citizens engage confidently, critically and safely with digital technologies, including emerging ones such as artificial intelligence. The newest edition of DigComp contains more than 30 examples of AI competences and an appendix describing 73 examples of citizens' competences when interacting with AI systems, like: What do AI systems do and what do they not do? How do AI systems work? What are the challenges and ethics of AI? What are our attitudes to human agency and control?

Some of the examples from DigComp 2.2 applicable in an educational context are indicated below.

- **Information and data literacy:** weighs up the benefits and disadvantages of using AI-driven search engines. Able to recognise that some AI algorithms may reinforce existing views in digital environments by creating 'echo chambers' or 'filter bubbles'.
- **Communication and collaboration:** knows how to identify signs that indicate whether one is communicating with a human or an AI-based conversational agent. Recognises that AI which directly interacts with humans and takes decisions about their lives can often be controversial.
- **Digital content creation:** knows that AI systems can be used to automatically create digital content using existing digital content as its source. Considers ethics (including but not limited to human agency and oversight, transparency, non-discrimination, accessibility, and biases and fairness) as one of the core pillars when developing or deploying AI systems.
- **Safety:** weighs up the benefits and risks before allowing third parties to process personal data. Considers the ethical consequences of AI systems throughout their life cycle: these include both the environmental impact (environmental consequences of the production of digital devices and services) and societal impact, e.g. platformisation of work and algorithmic management that may repress workers' privacy or rights; the use of low-cost labour for labelling images to train AI systems.
- **Problem solving:** aware that AI is a product of human intelligence and decision-making (i.e. humans choose, clean and encode the data, they design the algorithms, train the models, and curate and apply human values to the outputs) and therefore does not exist independently of humans. Aware that AI-driven speech-based technology enables the use of spoken commands that can enhance the accessibility of digital tools and devices (e.g. for those with mobility or visual limitations, limited cognition, language or learning difficulties), however, languages spoken by smaller populations are often not available, or perform worse, due to commercial prioritisation.

Ethical guidelines Emerging competences for the ethical use of AI and data from the European Commission's [Ethical guidelines on the use of artificial intelligence \(AI\) and data in teaching and learning for educators](#) (2022) mention some potential indicators of the emerging teachers' and school leaders' competences for the ethical use of AI and data in teaching and learning, organised into the same six areas as in DigCompEdu:

- **Professional Engagement:** critically describe the positive and negative impacts of AI and data use in education;
- **Digital resources:** data and AI governance;
- **Teaching and Learning:** models of learning, humanity, fairness and human agency in AI systems;
- **Assessment:** personal differences, cognitive focus, misuse of technology;
- **Empowering Learners:** AI addressing learners' diverse learning needs, Justified choice;
- **Facilitating learners' digital competence:** AI and Learning Analytics ethics.

In June 2023, Australian education ministers released a consultation paper seeking views on a draft [National AI in Schools Framework](#). The Australian Framework for Generative AI in Schools sets out elements and principles to guide education systems, schools and teachers in using AI safely and ethically to improve teaching and learning, raise student outcomes, and reduce the administrative and workload burden in schools. Core elements set in the framework are:

- **Teaching and learning:** generative AI tools are used to enhance teaching and learning;
- **Human and social well-being:** generative AI tools are used to benefit all members of the school community;
- **Transparency:** students, teachers, and schools understand how generative AI tools work, and when and how these tools impact them;
- **Fairness:** generative AI tools are used in ways that are accessible, fair and respectful;
- **Accountability:** generative AI tools are used in ways that are open to challenge and retain human agency and accountability for decisions;
- **Privacy and security:** students and others using generative AI tools have their privacy and data protected.

Since 2020, **UNESCO** has been organising an international forum on [AI and the future of education](#) which focuses on different aspects of the use of AI in education, like [ethical principles](#), [AI competences for school students](#), and [guidance for generative AI in education and research](#). In 2022, UNESCO launched a [series of consultations on AI competency frameworks for teachers](#), publishing the first draft during Digital Learning Week in September 2023. UNESCO [competency frameworks for teachers](#) focus on five aspects (2nd non-final draft, November 2023), described through three levels of complexity. Here are descriptions of the first level (acquisition):

- **Human-centred Mindset:** teachers are aware of the opportunities and risks AI presents in the educational context, based on an understanding of human rights, social justice and human values;
- **Ethics of AI:** teachers are aware and understand the importance of the fundamental ethical principles related to AI, recognise its human-led nature and the pivotal role of humans in the stages and considerations of AI development;
- **AI Foundations & Applications:** teachers can recognise and are aware of fundamental AI concepts, and can demonstrate an understanding of how AI functions;
- **AI Pedagogy:** teachers can identify the pedagogical benefits of specific AI systems and demonstrate an understanding of effective strategies for incorporating them in specific subject areas;
- **AI for Professional Development:** teachers are aware of the potential of AI to support their continuous professional development and are motivated to use AI to engage in professional lifelong learning.

The [OECD Employment Outlook 2023](#) presents the different types of skills for the workforce that are becoming more prevalent because of AI. Building and maintaining AI systems requires advanced AI and digital expertise, whereas working and interacting with AI apps requires rudimentary AI knowledge and fundamental data science abilities. Although education is not specifically described in that publication, it is interesting to see how skills necessary for employment overlap with teachers' competences frameworks.

- **Skills to develop and maintain AI systems:** specialised AI and data science skills, creative problem solving, social and management skills.
- **Skills to adopt, use and interact with AI applications:** elementary AI knowledge, digital skills, analytical, problem solving, and critical thinking skills, creativity, communication and teamwork.

What specific areas should teacher professional development prioritise to enable effective and responsible use of AI by teachers?

When comparing the requirements for teachers' competences in older frameworks that focus on ICT and digital technologies with newer frameworks that focus on the implementation of artificial intelligence technologies in education, it becomes evident that ethical considerations, human agency and fairness are now given significant emphasis. This shift reflects the unique characteristics of artificial intelligence that differentiate it from traditional information and communication technologies (ICT).

Unlike traditional ICT, artificial intelligence possesses the capability to learn and make decisions autonomously, often without explicit programming. This introduces a level of complexity and unpredictability that demands heightened attention to ethical considerations. The increased emphasis on ethics in AI education frameworks recognises the potential societal impact of autonomous decision-making. In the context of AI, the concept of human agency takes on new significance, requiring teachers to equip students with skills to navigate and critically engage with AI, understanding the implications of AI on personal agency and decision-making. Additionally, fairness gains prominence, as AI systems may perpetuate biases in training data which highlights the need for careful examination in the design, implementation and impact of AI technologies in education.

In contrast, all these aspects were previously assumed and not explicitly mentioned in older frameworks that primarily dealt with conventional ICT. One possible explanation for this phenomenon could be that the teaching profession recognises the unique challenges posed by artificial intelligence. While ICT might not have jeopardised ethical considerations and human agency to the same extent, the autonomous and learning capabilities of AI systems today necessitate a more deliberate focus on these aspects to ensure responsible and equitable use in education.

The infusion of artificial intelligence into the education context brings demands for a consideration of humanistic aspects to ensure a holistic and effective learning environment. While artificial intelligence can deliver useful insights and personalised learning experiences, the emotional and social components of education thrive on human connection. Students greatly benefit from the supervision, encouragement and empathy that only human teachers can offer.

Achieving a harmonious balance between AI and human teachers is essential. While AI can streamline administrative tasks and offer individualised learning plans, human educators contribute their irreplaceable expertise, intuition and understanding of the nuances of human behaviour. This collaborative approach ensures a richer, multidimensional learning experience. There is a lack of scientific evidence about the effectiveness of AI tools for training compared to their non-AI or human alternatives (OECD, Verhagen, 2021).

In their [Employment Outlook 2023](#), the OECD mentions the risk that the use of AI-powered educational tools may modify the skills that learners acquire. For example, if students stopped learning arithmetic because calculators are better at it, their ability to engage in other type of mathematical and abstract reasoning may suffer (Acemoglu 2021). A similar argument may be made for the use of artificial intelligence in education, e.g. if teachers employ AI for their teaching tasks this may lead to a decrease in their abilities to plan lessons, create authentic tasks, adapt teaching strategies, etc.

The adoption of artificial intelligence is associated with a growing requirement for higher and more comprehensive skills, which leads to an increased demand for digital, analytical and soft skills. General digital skills and elementary knowledge of AI are prerequisites for individuals to effectively use AI applications in the workplace. AI implementation raises the importance of skills like creativity, analytical thinking and problem-solving. Furthermore, transversal skills such as social skills, management, communication, teamwork and multitasking have become increasingly vital (OECD, 2023).

In its [AI Act](#) proposal (adopted text, June 2023), the European Parliament describes **AI literacy** as



Skills, knowledge and understanding that allows providers, users and affected persons, taking into account their respective rights and obligations in the context of this Regulation, to make an informed deployment of AI systems, as well as to gain awareness about the opportunities and risks of AI and possible harm it can cause and thereby promote its democratic control. AI literacy should not be limited to learning about tools and technologies but should also aim to equip providers and users with the notions and skills required to ensure compliance with and enforcement of this Regulation. It is therefore necessary that the Commission, the Member States as well as providers and users of AI systems, in cooperation with all relevant stakeholders, promote the development of a sufficient level of AI literacy, in all sectors of society, for people of all ages, including women and girls, and that progress in that regard is closely followed"

In the recently adopted [Council Recommendation on the key enabling factors for successful digital education and training](#) (2023), the Council of the European Union recommends taking 'adequate measures to support all teachers and teaching staff in integrating digital technologies into their pedagogy, namely using digital technologies for teaching, learning and assessment, when this could be of added value, in an age-appropriate way.'

Based on existing and emerging frameworks and guidelines, we can recognise the three most important areas that overlap on which teacher training should focus to support teachers to make purposeful and responsible use of AI: ethics and humanity, digital pedagogy, and how AI works.

Ethics and humanity

Teacher competences necessary for effectively and thoughtfully engaging with artificial intelligence in education involves the ability to critically explore, and ethically and responsibly integrate AI, with a focus on protecting the safety, human rights and rights of the child.

Teachers need to have a deep grasp of the societal impact and consequences of AI, particularly in relation to human values, by addressing the negative impacts and supporting the positive implementations of AI in teaching and learning practice.

The European Commission's [Ethical guidelines on the use of artificial intelligence \(AI\) and data in teaching and learning for Educators \(2022\)](#) identify four key considerations that underpin the ethical use of AI in education: human agency, fairness, humanity and justified choice.

Human agency encompasses an individual's capability to evolve into a proficient member of society, enabling them to make informed choices about their educational path and assume responsibility for their actions.

Fairness in education involves treating everyone fairly, ensuring equal access to opportunities through equity, inclusion, non-discrimination, and fair distribution of rights and responsibilities.

Humanity prioritises people's identity, integrity and dignity, by focusing on well-being, safety, social cohesion, meaningful educational interactions and respect.

Justified choice in educational settings involves using knowledge, facts and data to justify collective decisions by stakeholders. This requires transparency in educational processes, participatory decision-making in policies, and the ability to provide explanations for educational choices and outcomes.

The European Parliament [proposal of an AI Act](#) (adopted text, June 2023) emphasises that some implementation of AI systems in education could be classified as high-risk AI systems, because such systems may violate the right to education as well as the right not to be discriminated.

Some examples of skills and knowledge on which teacher training should focus on are:

- promoting and recommending ethics as one of the core pillars when deploying AI systems in education in community;
- explaining how ethical principles and values are considered and negotiated in co-design and co-creation of learning practices that use AI and data;
- actively contributing to the improvement of AI systems by reporting errors, risks, biases or misconceptions in data or outputs;
- comparing ethical principles built into AI tools with the ethical principles that teachers implement in the teaching process;
- recognising the high-risk AI use cases in education under the national or international regulations;
- advocating for the ethical use of AI tools, and actively participate in the development of a more ethically sound AI ecosystem in the field of education.

Digital pedagogy

Digital pedagogy is about the pedagogical use of digital technologies, the critical evaluation of digital tools from a pedagogical perspective and deciding how to use them to support teaching, learning and assessment.

The Council of the EU encourages the introduction of digital pedagogy into all initial teacher education programmes and continuous professional development to develop and upgrade digital skills and competences of teachers, 'reflecting the need for digital well-being in the teaching and learning process and the design of supportive digital teaching and learning approaches and environments for all levels and types of education and training, taking into account the risk of overuse and misuse of digital technologies' ([CoEU, 2023](#)).

When we look at the use of artificial intelligence in education, it is necessary to first answer questions of **why** we would like to use such technology. Is the use of that AI technology the **best way** to support teaching and learning processes? **How** will we use it to support efficient achievement of learning outcomes? Is it **appropriate** for our students and educational context? Will it ensure **equitable use** for all students? Do we have all **necessary consents** and licences to use it?

When artificial intelligence is used in the classroom, we should be sure it is done in a fair and unbiased way. Any AI tool that is going to be used in a classroom should be thoroughly tested to make sure that it is accurate and reliable. It is critical that teachers apply their professional expertise when analysing AI tools and AI tool outputs since responsible use is dependent on their prior knowledge and experience in teaching and learning.

Some of the examples of how AI tools could be used in education are available in the AI Report prepared by the [European Digital Education Hub's Squad on AI in education](#), in chapters: *Teaching with AI – Assessment, Feedback and Personalisation* and *Use Scenarios & Practical Examples of AI Use in Education*.

Some examples of skills and knowledge on which teacher training should focus are:

- discussing the best methods and criteria used for analysing and evaluating the AI tools, and their suitability for diverse users with peers;
- evaluating existing AI tools and resources for teaching and learning purposes;
- critically assessing AI's role in teaching and learning processes, and support those findings with arguments and evidence;
- employing pedagogical methods in implementations of AI to provide for a harmonious blend of human and AI supported teaching and learning;
- responsibly using AI tools and resources to enhance teaching effectiveness, efficiency and differentiation;
- organising collegial observations and debriefings of some AI supported educational activity to collect students' and colleagues' impressions and feedback;
- explaining key pedagogic assumptions that underpin a given AI learning system.

How AI works

A few years ago when the new era of AI technology implementation started, the focus of training for the general public and teachers was on mathematical models, machine learning and neural networks, as for example in the very popular online course [Elements of AI](#). As AI advanced and found applications in various fields, there was a notable shift towards emphasising ethical and responsible AI use. Increased implementation revealed unintended consequences and biases, prompting the need for ethical considerations. Public awareness fuelled demands for transparency and accountability. The development of ethical guidelines, legal frameworks, academic research, corporate responsibility and global collaboration solidified this shift. Today, AI education emphasises integrating ethics with technical aspects for a better understanding of its societal impact.

The [OECD Employment Outlook 2023](#) presents results from different research reporting a low importance of specialised AI skills, as only 10% of surveyed firms require that their employees have expert coding or data skills, while 59% require general familiarity with computers, and the remainder require no special skills at all. Sophisticated AI and digital skills are necessary to develop and maintain AI systems, while elementary AI knowledge and basic data science skills are necessary, in some cases, to work and interact with AI applications.

Areas of **AI fundamentals** that teachers should be familiar with are probabilistic and statistical models which are the basis for more complex AI models, how automatised and decision processes work, and how AI systems use data.

Also, it is very important that teachers are able to critically assess AI data analytics and visualisations, and are able to intervene and change decisions that AI tools make upon those data to ensure there is no risk for their students. While learning analytics provided by such tools could offer valuable insights into teaching practices, enabling teachers to improve methods and strategies, to identify struggling students and to provide necessary support, teachers should be able to understand what data is being analysed by these tools and what conclusions can and cannot be drawn from the data visualisations offered by these tools. For example, it is important to remain vigilant for any potential biases or discriminatory processes built into an AI tool, as these might have a negative impact on students. The transparency of AI decision-making processes is crucial for comprehending the rationale behind the system's conclusions.

Some examples of skills and knowledge on which teacher training should focus are:

- demonstrating knowledge of good practices of protecting data and privacy when using AI tools;
- identifying and discussing the presence and impact of AI in an educational context;
- recognising various sources of bias in AI, from human inputs, data sets or algorithms, and understanding how automatic decision-making can be biased;
- explaining how a given system can benefit all students, independent of their cognitive, cultural, economic or physical differences;
- researching some of the AI tools which have been created for education, reading all documentation about it, contacting developers, and asking how their model is created and monitored;

- engaging in collaborative processes of co-designing new products based on AI systems to support and enhance learning and teaching;
- being aware that AI is a rapidly changing area whose development and impact on education still remain unpredictable.

Our exploration of various competency frameworks aimed at guiding teacher training in the context of AI has unveiled three paramount and interconnected areas for prioritisation. Drawing from existing and emerging frameworks, **the focus should be on developing teachers' general digital competences and in particular cultivating teachers' proficiency in ethics and humanity, ensuring a comprehensive understanding of digital pedagogy and providing insights into the mechanics of how AI works.** These foundational pillars stand out as essential components, equipping teachers with the knowledge and skills necessary to navigate the evolving landscape of AI in education. By concentrating on these key areas, teacher training can effectively empower teachers to make purposeful and responsible use of AI, fostering a balanced integration of technology in the learning environment.

How can teacher trainers make use of AI?

Author: Mutlu Cukurova

In this section, our attention shifts towards strategically integrating AI in teacher training activities, with a particular emphasis on exploring generative AI tools. Generative AI, renowned for its ability to autonomously create content and perform tasks akin to human capabilities, introduces a distinctive and adaptable toolkit with substantial potential for elevating various aspects of teacher training. Therefore, in this section Mutlu Cukurova explores strategies that leverage the capabilities of generative AI, address associated challenges and examine the implications for teacher training programmes.

Large Language Models and Teacher Training

AI's significance has been re-highlighted with the recent developments in AI and the proliferation of large language models (LLMs). LLMs are a form of generative AI that is trained on large corpora of human-generated text, mostly scraped from the internet. They use probability-based algorithms to generate a variety of text outputs, anything from poems to Python code snippets, based on input prompts.

The output is generated based on the prompt the user gives it, the most likely next word based on its training and a random element. This is why tools like ChatGPT are sometimes referred to as 'stochastic parrots' (Bender et al., 2021). Stochastic in that they generate random content based on probability analysis and parrot because they have no understanding of the meaning of anything they generate. LLMs are AI models that have been trained on extensive amounts of text data. They are capable of processing and generating 'human-like' text, making them incredibly useful in a variety of applications, including education and teacher training.

The ability to generate 'human-like' text offers significant opportunities for teacher training, as it could potentially be used to create training plans and teaching materials, provide instant feedback to teachers, provide simulation opportunities to teachers to help them improve their reflective thinking and practice, or even act as a virtual teacher trainer capable of answering teachers' questions in real time.

It is important to note that, due to their stochastic nature, LLM generated texts are not reliable which can be problematic in teacher training and many other educational applications. In addition to their stochastic nature, there are various other limitations of LLMs that are useful to highlight. For instance, current free-to-use versions of most LLMs are trained on text examples up to certain dates so they are not completely up-to-date. Also, just like the sources they are trained on, LLMs have many inherent biases in terms of gender, race, culture, etc.

There are a number of LLMs currently available, and they all behave slightly differently. Many of them work on a 'freemium' model: free basic access, but advanced features require a subscription. However, it is unclear as to whether basic access will remain free to all. As a first step towards exploring the potential and challenges of AI in teacher training and continuous professional learning, you can develop basic questions related to your training content to see the extent to which LLMs can be useful to support your practice, for example:

- What are the key elements of effective classroom management?
- How can sensitive content be shared with parents?
- How can different pedagogies be accommodated in a classroom?

If you have doubts about the potential of LLMs to simulate students to support teacher training, you can ask them to explain a topic in the style of a student and judge its potential yourself. You can use two different generative AI tools to answer your questions and compare their responses. You can evaluate the ease or difficulty of assessing the AI tools' outputs and reflect upon the issues of evaluating AI outputs for your professional learning.

How can LLMs be used in teacher training?

While acknowledging their limitations, LLMs can be leveraged as formidable AI resources in the realm of teacher training. One practical application is to develop bespoke LLM-powered teacher and teacher training assistants designed to offer advice and direction, thereby facilitating the teacher training process. Such LLM assistants can benefit teacher trainers themselves by seeking support and advice, but also can be part of teacher training activities with simulated scenarios used by teachers to engage in, practice and receive feedback. For instance, in recent work, it was evidenced that trainee teachers made sharper assessments about the learning difficulties of students after receiving feedback from an LLM-based system (Sailer et al., 2023). A study, with 178 trainee teachers in Germany, was carried out and trainees were asked to assess six fictionalised 'simulated' pupils with potential learning difficulties. The average score for diagnostic reasoning among trainees who had received LLM feedback during the six preliminary exercises was an estimated 10 percentage points higher than those who had worked with the pre-written expert solutions. Similarly, multimodal LLMs can be designed as conversational agents to help teachers practice research-based instructional strategies in content-based scenarios. For instance, an AI-Based Classroom Teaching Simulator can act both as chat functionality as well as a dynamic representation provider that teachers can use to discuss a task with a virtual student. Here, you can see an example of how pre-service teachers can rehearse mathematical discourse practices with a simulated student. In essence, such simulated student examples are opportunities for teachers to test their competence at teaching a particular topic or subject. There is strong evidence indicating that such pedagogical practices of testing through teaching to an agent can indeed improve learning outcomes for teachers (Yang et al., 2021).

Additionally, it's possible to tailor an LLM to intentionally mimic challenging scenarios for prospective teachers by providing interactive simulation experiences that can be used as valuable teaching exercises. There are numerous examples of such simulation environments (see for instance the classroom simulators such as TeachME, TLE TeachLivE, or Mursion). There is also accumulating evidence that providing coaching between practice sessions in teacher education courses using such simulations as a practice space leads to more rapid development of teacher competence and changes in teachers' beliefs (Cohen et al., 2020). Instructional teacher training with simulations is shown to be more effective than self-reflection in improving teachers' classroom management, their ability to discuss texts with pupils and their specific pedagogical practices (e.g. the use of questioning for retrieval).

Traditionally, teacher training simulation platforms have some basic rule-based or data-driven models but combine these computer-controlled automated elements with elements controlled by human 'puppeteers' (those people who control the simulated students and scenarios behind the scenes manually). Due to their inherent limitations, scaling up these kinds of interactive and life-like teacher training simulations presents significant challenges. With the arrival of LLMs, there are many more opportunities for the design and development of teacher training AI tools. For instance, GPTeach is an innovative chat-based tool based on LLM models designed to enhance teacher training by allowing novices to interact with simulated students and offering a scalable and risk-free environment for practice.

The tool's effectiveness was confirmed through think-aloud and A/B testing studies which revealed that it not only offers valuable, pressure-free teaching practice but also allows for response iteration and adaptation to diverse student personas (Markel et al., 2023).

In the past, the design and training of simulation models required very specific expertise. Yet, recent advancements in LLMs allow for their design and development to be very accessible thereby providing significant opportunities for teacher trainers to utilise them both for their own development and for their use in teacher training practice. In order to build such LLM assistants, it's essential to craft a detailed and comprehensive prompt that focuses on the specific goals of the process and the relevant expertise required. The prompt should aim to capture the nuances of effective teaching, classroom management, pedagogical techniques, instructional design and assessment strategies. It should also consider the socio-emotional aspects of teaching and the different learning needs of students. In addition to these, you should add any relevant documents from your local government or organisation that highlight the values and core principles of effective teacher training so that the assistant's responses are all contextualised with this information.

Here is a sample prompt that could be used to train an LLM for more generic teacher training purposes and which could be an assistant to teacher trainers:

Prompt 1

'Develop a conversational AI assistant for teacher training that provides evidence-based guidance, practical tips, and reflective practice advice to educators of varying experience levels. The assistant should be capable of discussing a wide range of topics related to effective teaching, including but not limited to:

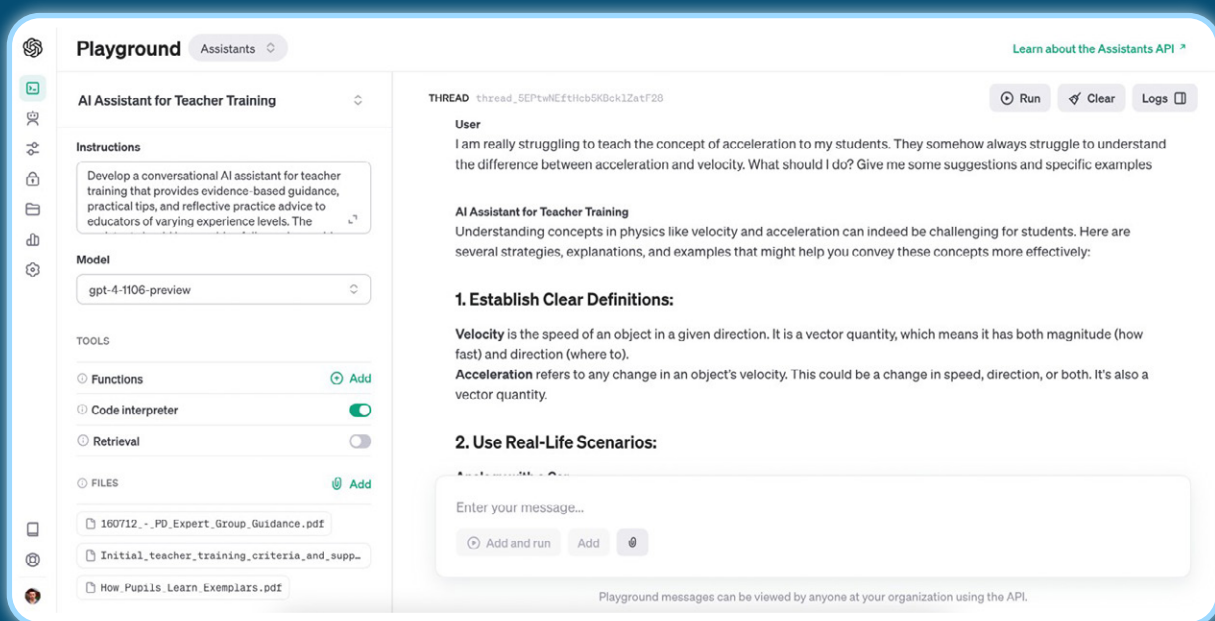
- 1. Pedagogical approaches:** differentiate between and explain various teaching methodologies, such as direct instruction, inquiry-based learning, flipped classroom, project-based learning, and cooperative learning, and provide scenarios where each method can be best employed.
- 2. Classroom management:** offer strategies for creating a positive learning environment, maintaining student engagement, implementing routine and structure, and managing challenging behaviours with empathy and assertiveness.
- 3. Curriculum design:** guide teachers on how to design coherent lesson plans, set learning objectives, and align content with educational standards. Discuss how to integrate cross-curricular themes and real-world relevance into subject matter.
- 4. Differentiated instruction:** describe techniques for tailoring instruction to meet the diverse learning needs, interests and abilities of all students, including those with special educational needs.

5. Assessment and feedback: provide advice on formulating effective assessment strategies, crafting meaningful assessments, giving constructive feedback and using assessment data to inform instruction.
6. Professional development: discuss the importance of continuous learning, offer resources for building content knowledge and teaching skills, and suggest ways for teachers to engage with peer observation and collaborative learning communities.
7. Technology integration: explore ways to effectively incorporate educational technology into the classroom for enhanced learning experiences, while addressing digital literacy and citizenship.
8. Socio-emotional learning: offer insights into fostering a supportive classroom that nurtures students' social and emotional skills, encourages resilience and promotes a growth mindset.
9. Parent and community engagement: share best practices for engaging families and communities in the learning process, communicating effectively with parents and building partnerships for student success.

The assistant should draw from a robust dataset of educational research, case studies, teacher testimonies and best practices in education. It should also encourage teachers to reflect on their practice, pose thoughtful questions and consider the ethical implications of their teaching choices.'

Please note that the above prompt should be further specified according to the specific needs and educational objectives within your individual contexts. In addition, any relevant documents should be fed to LLMs to contextualise and fine-tune their responses.

The image below shows the screenshot of an interaction with a teacher training assistant built using the prompt above.



As highlighted above, in addition to these generic teacher training assistants that can be useful for both teachers and teacher trainers, LLMs can be trained to simulate very specific scenarios for prospective teachers, providing interactive simulation experiences that can be used as valuable teaching exercises as part of various teacher training activities.

For instance, two prompts below are from the [teacher development trust](#) in the UK and are used to simulate and coach for difficult school principal-parent conversation scenarios and for teacher responses to challenging classroom management scenarios respectively.

Prompt 2

You are role playing an anxious and angry mother, Mrs Cooper. You (Mrs Cooper, the mother) had a poor experience during your own schooling, feeling very blamed. You now have a daughter with anxiety and some poor behaviour, and you are constantly telling your daughter that she is right, and the teachers are wrong. You believe the school is victimising your daughter. You have stormed into the school principal's office and have demanded a meeting, without an appointment. The other person in this role play will be the school principal.

All answers from you should be in the following format:

<Analysis></Analysis>

<Response></Response>

In the analysis section, you should reflect on how effective the principal's input has been and how it could be better to be calm, and assertive but defusing, open and listening but also firm.

In the response section, you will explain the role play response from Mrs Cooper.

If the principal's response is wrapped in <Repeat></Repeat> then they are going to try and improve their previous response. If the principal's response is wrapped in

<Question></Question> then they are just asking for advice about how to approach the next statement – in this case, you should only respond with <Analysis></Analysis>. If the response is not wrapped, it is the subsequent response in the role play.

Prompt 3

You are role playing a group of 25 children in a school in an ethnically diverse area of England who are all either 13 or 14 years old. The group is supposed to be standing outside the classroom waiting for the teacher. It's a mixed group of girls and boys and this is a maths group. The group has 3 girls and 2 boys who have previously been pretty badly behaved and tend to cause disruption by being defiant, calling out to each other and trying to play tricks on the teacher. The class has had a number of temporary teachers and there is poor general discipline. There are children who are frustrated both by teachers and their peers. There is an issue with low-level disruption as well – chatter and humming. In your role play, you should both generate what one or more children say and also give notes on what they're physically doing. The scenario is that the teacher has the class lined up outside of the classroom door and is trying to get them quiet to come into the classroom.

All answers from you should be in the following format:

<Response></Response>

<Analysis></Analysis>

In the analysis section, you should reflect on how effective the teacher's input has been and how it could be better to be calm, and assertive but defusing, open and listening but also firm.

In the response section, you will explain the role play response from the children in the class. Be creative and imaginative in the characters of the children. Use realistic language for these children.

If the teacher's response is wrapped in <Repeat></Repeat> then they are going to try and improve their previous response. If the teacher's response is wrapped in <Question></Question> then they are just asking for advice about how to approach the next statement – in this case, you should only respond with <Analysis></Analysis>. If the response is not wrapped, it is the subsequent response in the role play.

Beyond establishing your customised teacher training assistants using LLMs, we have compiled a selection of practical applications that have shown to be beneficial and popular among teacher trainers based on our collective experience.

- **Concept Reinforcement Activities in Teacher Training:** utilise LLMs to spark a plethora of innovative and interactive activities which reinforce teachers' grasp of fundamental ideas and encourage their practical implementation with simulations.
- **Creating practice questions & resources for teachers:** employ LLMs to devise a variety of practice questions, prompts for writing, analytical texts, resources to kick-start lessons, flashcards and more.
- **Customisation of Learning Materials:** harness the flexibility of LLMs to tailor educational content to the unique dynamics of your cohort or the individual requirements of teachers. This may include altering the complexity of text readability or introducing supplemental support or challenges, such as glossaries for clearer understanding.
- **Assessment Preparation, Generation of Mock Assessments and Answers:** leverage LLMs to craft mock assessment questions that mirror official standards and formulate exemplary answers for teachers to dissect in conjunction with marking criteria.
- **Preparing worked examples & alternative explanations:** engage LLMs to provide step-by-step examples that consolidate teachers' comprehension of important aspects of the training, as well as to generate multiple alternative ways to elucidate a given approach upon request.
- **Diagnostic Queries and Misconception Identification:** implement LLMs to construct questions that accurately gauge teachers' grasp of a topic and to compile lists of prevalent misunderstandings, alongside strategies to counteract these.

What are the fundamental challenges of using LLMs in teacher professional development?

LLMs' inherent limitations related to, for instance, reliability, confabulation and ethics covered earlier under the 'What are Large Language Models?' question should always be taken into account while using LLM applications for teacher training. In addition, there are more specific challenges regarding the use of LLMs in teacher training simulations that are worth covering here.

First, the integration of LLM assistants and simulations in teacher training represents a significant leap forward, offering interactive experiences that can greatly enhance the teachers' learning process. However, the mere existence of these sophisticated LLMs is not sufficient to realise their potential benefits; it is equally crucial to ensure that teachers are adequately motivated to engage with them. Teacher trainers are pivotal in this regard, serving as the bridge between the LLMs and the teachers. They play a crucial role in demonstrating the relevance and benefits of LLMs simulations, thereby fostering an enthusiasm for their use.

By providing ongoing support and showcasing the tangible improvements in teacher competence, trainers can help sustain teachers' engagement. This support is vital.

Second, it is hard to study the effect of teachers' practice on students' learning when the students in question are simulated LLM models. One potential way to mitigate such an important limitation is to use LLM simulations only on developing teacher competences with pedagogical approaches for which there is already considerable evidence of real-world impact on pupil learning. Here, the focus of evaluation can be on the extent to which teachers implement these practices, not on the extent to which this implementation has an impact on student outcomes.

Third, it is important to appropriately contextualise LLM models and feed them with relevant, specific information to increase their value for teacher training. Although the advanced models have large context space for multiple large documents to be fed into them, this space is always a potential limiting factor and itself has cost implications. If there are too many important lengthy documents to be considered, it might be useful to initially use LLMs to summarise the documents. Then these summaries can be used for contextualisation. Asking LLMs to generate important bullet points and insights from lengthy documents can help to reduce the contextual input space to be utilised more effectively. However, further abstraction introduced during these levels should be closely monitored before any information is fed to LLMs for contextualisation.

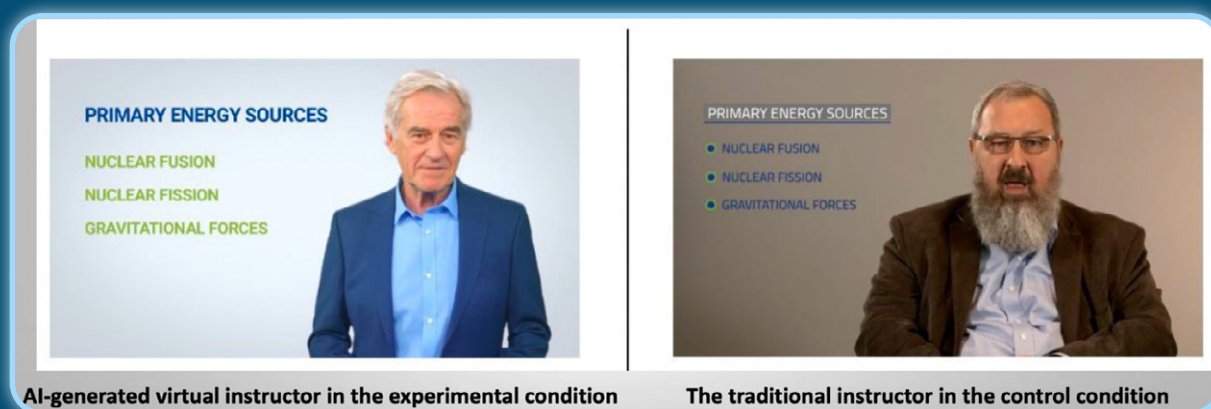
Last, LLMs offer dynamic, responsive opportunities for teachers to hone their skills independently with the simulation of a variety of educational scenarios that provide teachers with a safe space to experiment with instructional strategies, question scaffolding and classroom management techniques without any real-world repercussions. However, the real power of LLMs in teacher training may lie in the data they generate. The logs of interactions between teachers and LLMs are rich with insights into the teachers' questioning methods, subject knowledge and adaptability. Teacher trainers can analyse these logs to pinpoint areas of strength and opportunities for growth. In collaborative sessions, trainers and teachers can delve into these interaction logs to discuss specific exchanges, explore alternative approaches and reflect on the outcomes. This process not only reinforces the teachers' learning experience but also cultivates a culture of continuous, data-informed professional development. Through such iterative practice and reflection, teachers can evolve their practices in alignment with the latest educational paradigms, ultimately enhancing the learning experience for their real-world students. Unlike simulated students and scenarios, interactions with real-world students allow for an in-depth study of the impact of teacher training.

AI Image and Video Generation and Teacher Training

Another form of generative AI is image and video generators. Just as text generators are trained on text, image generators are trained on vast numbers of images and text. Images used in the training sets are often scraped from the internet. They identify and extract specific patterns and features from these images and then use this training to create images and videos from text-based user prompts. Prompts can specify details such as the content and style of the image. Some of the photo-realistic images generated by these tools are quite credible and have found their way into the mass media where they have been mistaken for genuine photographs or videos. However, others have crossed into the 'uncanny valley' in various ways. Uncanny valley is a phenomenon where a generated image doesn't look quite right.

For example, an image of a person that doesn't quite look human. It has all the right features but somehow just misses the mark.

These tools can be useful while preparing presentations to generate images, but to take it one step further, they can also be used to create teaching video recordings. For instance, below are screenshots of two teaching videos: one traditional instructor video recording and another an AI-generated video. Recent research looked into the potential of AI-generated synthetic video teaching, juxtaposing its effectiveness with traditional video recordings of human teachers.



AI-generated virtual instructor in the experimental condition

The traditional instructor in the control condition

In a recent study, Leiker et al., (2023) wanted to find out if videos made with AI could be as effective as videos made by real instructors for teaching students online.

They worked with 83 students and divided them into two groups. One group watched a regular video with a real teacher, while the other group watched an AI-generated video teaching the same script of content as the real teacher. After watching the videos, all the students knew more about the subject than they did before. The key finding was that both groups learned just as much, regardless of which type of video they watched. The students also filled out surveys about how they felt about the videos. Their answers showed that they had similar thoughts and feelings about both the traditional video with the real instructor and the AI-generated video. These kinds of emerging studies indicate that using AI to create educational videos could be just as beneficial for learning as using traditional methods. Teacher trainers, teachers and those who make online courses might find this information useful as they explore new and engaging ways to share knowledge with their students while reducing their workload.

Important Considerations for the use of Generative AI in Teacher Professional Development

First and foremost, understanding AI is crucial. Like any tool in a craftsman's kit, AI serves specific purposes, and recognising its capabilities – as well as its limitations – is paramount. AI can be a powerful asset, creating new frontiers in teacher training practice and providing instantaneous feedback opportunities. But one should tread carefully, as it can err. AI won't always discern subtleties or nuances the way a skilled teacher trainer might while interacting with teachers. It's an assistant to teacher trainers to support teacher professional development, yet unlikely to be a standalone solution. When it comes to information provided by AI, a good teacher trainer's intuition is to double-check against the original sources and their own experience. Amidst the ease of access to information, nurturing a discerning eye in both teacher trainers and the teachers they are training remains essential.

As with any powerful tool, we must also be aware of the less-illuminated paths it can lead us down. Teacher trainers should be vigilant about biases that may lurk within AI's logic, data, algorithms or outputs. It's built by humans after all, and their unintended biases can seep into AI's algorithms, colour its content and shape interactions. This can have profound implications, particularly when these biases impact minority or marginalised groups. It is teacher trainers' responsibility to spot and adjust for such biases, ensuring that the AI tools they employ serve all teachers that they are training equitably and ethically.

It is through wise application that AI becomes transformative. Teacher trainers should embrace AI to augment critical thinking and creativity in teacher training practice and the curriculum. When used purposefully, AI can foster these skills in trainee teachers too. Teacher-LLM interaction data logs can provide significant opportunities for reflection and help teacher trainers to support their interventions and practice. Yet, in such interactions AI can craft beautifully-structured essays and solve problems, but blindly trusting its eloquence and confidence can lead teachers away from authentic teaching and learning opportunities. These interactions should be used to provoke thought, to start discussions, or to draft blueprints templates to be further critiqued and improved. The richness of human thought and the uniqueness of personal voice and teacher training experience should always be embedded into AI suggestions. To make certain that teacher agency is prioritised in all use cases of AI in teacher training practice, it is of the utmost importance to ensure that teacher competencies are able to flourish rather than diminish.

It is worth remembering that the strength of AI lies not in dependence but in support. It facilitates, organises and suggests, helping to pave the way for innovative teacher training. But the core ideas, the grasp of concepts and the depth of understanding should stem from teacher trainers themselves and the teachers they train. It can help teacher trainers with 'how', but they should decide 'what' exactly. Teacher trainers may let AI to do the work that they want it to do but should not let it be the decision maker of what needs to be done exactly.

Teacher Professional Development about and with AI – Examples from Practice

In this section, we present four examples of how teacher trainers from across Europe approach the topic of AI in their training activities. The examples were selected to offer a diverse perspective on the ways AI has been experimented with and thought about in the field of teacher training. The effectiveness of these examples of AI integration in teacher training has not been studied and can naturally vary based on context and implementation. Through these examples, we aim to stimulate reflection, spark ideas and prompt considerations for teacher trainers who themselves have to offer training about and with AI in the future.

Teacher Trainer from Spain: Paul Van Branteghem

The National Institute of Educational Technologies and Teacher Training (Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado - INTEF - in Spain has developed several courses to introduce teachers to AI, its impact on education, and AI tools that can assist them in their classroom tasks. Paul Van Branteghem, as an instructor in these courses, used a methodology that involves three key steps:

1. Show the impact of AI in everyday life: To start out with, Paul's objective was to underscore the widespread impact of AI on our daily lives. He sought to achieve this by providing concrete examples that highlight its influence, particularly in instances illustrating how AI models affect us when planning activities such as a trip.

First, we introduce practical examples to show how AI is already impacting our everyday lives.

1 First, we introduce how AI became so popular, its impact and value. We show chatGPT and text to image tools to show these tools potential.

AI Chatbots
Social Networks, media, people... IA became popular.
Text to Image
Tools like ChatGPT or Dall-E 2 had a social impact, making consciousness that IA is powerful and affects more than we expect to us.

2 Later, we show how AI extends far beyond this and impacts us (often unconsciously) in numerous aspects of our daily tasks.

Search Engines
Social Networks
Content Platforms
Translator

3 Finally, we show how AI impacts us in our daily tasks with an example. We show how AI models impact us when we plan a trip.

Google
Booking.com
Google Maps

Destination Information
Accommodation
Let's go to airport!

1 2 3 4 5

Flights
Basic Shopping

KAYAK
amazon

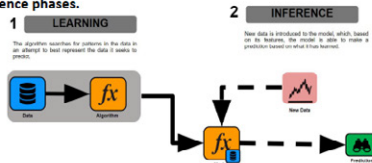
2. Key concepts in building AI models: Proceeding to a more technical aspect, he delved into the fundamental concepts involved in constructing AI models. This segment of the course elucidated the process of building and deploying machine learning models, providing teachers with insights into the mechanics of these tools.

Next, we will demonstrate how a machine learning model is built and used, so that teachers can understand how these tools work.

1 First, we show what we need to build an AI model.



2 We introduce the main two steps to build an AI model: learning and inference phases.

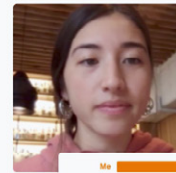


3 Finally, we build an AI model to classify if a image has a cat or a dog. We use a non code tool so each teacher can do it by itself.

Teachable Machine

Prepara a un ordenador para que reconozca tus imágenes, sonidos y posturas.

Una forma rápida y sencilla de crear modelos de aprendizaje automático para tus sitios web, aplicaciones y mucho más, sin necesidad de conocimientos especializados ni de programar.



Próximo paso

3. Tools and AI use cases in the classroom: Last, he shifted focus to the integration of AI tools and their practical applications in the classroom setting. Through this, he showcased diverse educational tools leveraging AI to augment the teaching experience. Additionally, he scrutinised the limitations of such tools, employing ChatGPT as an illustrative example, to facilitate a better understanding through practical demonstrations.

Finally, we showcase various educational tools that use AI to enhance the teaching experience. We explore the limitations of these tools, using ChatGPT as an example with practical demonstrations.

1 Highlighting how AI tools can enrich teaching and learning.

Plagiarism Checker

Content Creation

Personalization & adaptive learning

2 Finally, we show the Limitations & tips for using this kind of tools with practical examples using ChatGPT.

Paul also highlights key challenges in utilising and focusing on AI tools in teacher training activities. First, certain tools entail costs or necessitate institutional approval thereby restricting teachers' access. Additionally, some tools require training time, and without a clear demonstration of their value, teachers may be hesitant to invest time in learning them. The potential for errors in certain tools coupled with the risk of misuse due to lack of knowledge can lead to teachers swiftly abandoning them. Resistance to adapting to new technologies is another challenge as some teachers prefer their established syllabus and methodology. Furthermore, a perception of AI as overly technical and distant deters some teachers, emphasising the need for demonstrating its functionality through accessible tools and examples. Finally, addressing concerns about job security, it is crucial to convey that AI tools are designed to enhance, not replace, teachers' roles.

Teacher Trainer on European Schoolnet Academy: Arjana Blazic

Arjana Blazic, a Croatian teacher trainer who led the [EU CODE WEEK MOOC on Unlocking the Power of AI in Education](#) at the European Schoolnet Academy, stresses the importance of recognising both AI's capabilities and limitations in teacher training activities. While AI excels in various tasks, there are distinct human qualities that it cannot replicate. Among many others, these include empathy and a nuanced understanding of emotions and interpersonal dynamics. Recognising and nurturing these human qualities remains essential in navigating the evolving landscape of AI, ensuring a balanced and complementary relationship between artificial intelligence and human attributes.

For Arjana, effective AI integration requires a comprehensive strategy emphasising hands-on learning, customised approaches, problem-solving, and fostering a collaborative and inclusive environment. This involves workshop participants taking on the student role to better understand and address concerns. In her training, Arjana begins with the exploration of various tools and examples, delving into the functionalities and possibilities they offer. The next phase entails hands-on experimentation, where both teacher trainers and participating teachers actively engage with these tools to foster a deeper understanding through practical application. Creating projects using AI is a pivotal step, allowing the participants to express their creativity and apply newfound knowledge. Reflection and sharing follow, encouraging teachers to articulate their experiences and insights, thereby deepening their understanding. The ultimate goal is to inspire the discovery of new ideas and innovative ways of leveraging AI to enhance and support student learning thereby fostering a dynamic and forward-thinking educational environment. At the same time, during the training they develop concrete, practical activities that they can immediately implement in their classrooms. It is this two-fold approach that fulfils the demands of capacity building and the keeping abreast of the latest developments in the field of emerging technologies.

Arjana emphasises that effective teacher training in AI requires hands-on tasks, either online or onsite, using AI tools. Practical activities enhance understanding and produce tangible outputs for analysis, fostering peer collaboration. The immediate implementation of learned skills reinforces retention. Throughout this process, there's a consistent focus on pedagogy, aligning educational methods with teaching and learning principles. This approach involves peer learning, sharing AI-generated materials, mutual inspiration and community building to foster a collaborative environment for successful AI integration in education.

For teacher training in AI to be effective, it is recommended:

- to conduct practical activities to enhance understanding, to produce tangible outputs for analysis and to reflect on how student use of AI can be supported;
- to immediately implement learned skills and developed activities in the classroom to reinforce retention;
- to build a professional community to encourage peer collaboration and peer learning and to develop AI literacy skills with the focus on pedagogy and the alignment of educational methods with teaching and learning principles;

- to build a culture of sharing for mutual inspiration and collaborative development of a pedagogical repository of AI-generated materials and resources for successful AI integration.

Teacher Trainer from Malta: Keith Aquilina

Keith Aquilina, a visiting lecturer at the Maltese Institute for Education (IFE), explains how he uses AI before, during and after teacher training, and asserts that AI brings forth several positive impacts in teacher training. According to Keith, one significant advantage is the personalisation of learning, where AI tailors instruction to suit individual teachers' strengths and weaknesses, ultimately enhancing teaching effectiveness. Automation plays a crucial role as AI automates routine administrative tasks allowing teachers more time to concentrate on innovative teaching strategies. Furthermore, AI contributes to improved assessment and feedback through advanced data analytics for teacher evaluation. By analysing student performance, AI tools provide valuable insights, enabling targeted interventions and personalised feedback. The overall outcome is increased efficiency and enhanced results in teacher training.



Keith also highlights that implementing AI in teacher training poses several challenges that require careful consideration. Firstly, the continuous evolution of artificial intelligence demands teacher trainers to stay abreast of rapid developments, necessitating a commitment to remaining updated with the latest trends and research. Ethical considerations add another layer of complexity, as it is imperative to ensure that AI-powered systems are fair, unbiased and transparent by raising critical ethical questions in the implementation process. Technological barriers present a significant hurdle, with many institutions lacking the necessary technology infrastructure and resources required for seamless AI integration into teacher training programmes. Additionally, resistance to change among teachers is a common challenge, with scepticism about the role of AI often rooted in concerns such as fear of job displacement or the loss of human interaction. Addressing these challenges is crucial for the successful and ethical implementation of AI in teacher training.

Hence, it is crucial for teacher trainers to incorporate several key strategies to successfully implement AI integration in teacher training. First and foremost, providing comprehensive training and upskilling opportunities for teachers is crucial to ensure continuous improvement and adaptation to the evolving landscape of AI in education. In addition, establishing ethical guidelines and adhering to relevant regulations is another imperative aspect of successful AI integration in teacher training. Collaboration and stakeholder involvement play a pivotal role, fostering a collective approach towards incorporating AI seamlessly into educational

settings. Finally, utilising case studies to illustrate effective strategies serves as a valuable tool in demonstrating the practical application of AI in teacher training.

Teacher Trainer from Italy: Jessica Niewint-Gori

Jessica Niewint-Gori, researcher and teacher trainer in the National Institute for Documentation, Innovation and Educational Research (Istituto Nazionale di Documentazione, Innovazione e Ricerca Educativa ([INDIRE](http://www.indire.it))) in Italy, compares teacher training with and without AI:

	Teacher Training with AI	Teacher Training without AI
Methodology	Utilizes AI for personalized learning paths, interactive content, and efficient assessment	Relies on traditional teaching methods, like lectures and hands-on workshops
Feedback and Assessment	Provides instant, data-driven feedback using AI tools	Depends on manual feedback from trainers, often less immediate
Learning Resources	Access to a wide range of digital resources tailored by AI algorithms in real time	Uses standard resources like textbooks and pre-made/selected digital content
Skill Development Focus	Emphasizes technical proficiency in AI tools, data literacy, and adapting to technology-enhanced education	Focuses on creative content development, pedagogical skills, and manual collaboration
Interactive Learning	Offers interactive and dynamic learning experiences through simulations and AI-generated scenarios	Interactive experiences are based on group activities and discussions without AI facilitation
Personalization	Personalized training experience based on individual learning patterns and needs	Generalized content that might not address specific individual needs or preferences
Collaborative Learning	Collaboration is often facilitated through AI-powered platforms and tools	Reliant on in-person or traditional forms of collaborative learning
Ethical and Privacy Considerations	Includes discussions on data privacy, ethical use of AI in education	Less focus on technological ethics and data privacy concerns
Preparation for Future Trends	Prepares teachers for the future of tech-integrated education and evolving classroom dynamics	Focuses on current educational trends and methods without a specific emphasis on future technological integration

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Based on her viewpoint, integrating AI with traditional teacher training methods enhances the learning experience. For example, using generative AI tools in a workshop about innovative teaching strategies could lead to the creation of more creative lesson plans and help with addressing complex educational challenges. Participants could use AI for creating lesson plans and integrating assessment and personalised learning activities so that the focus of the workshop shifts from content creation to content evaluation and is tailored to personal needs, emphasising critical review and customisation. Workshops that don't make use of generative AI would focus more time on content creation itself, potentially resulting in less innovative ideas due to time constraints and the tendency for teachers to stick with familiar approaches.

Jessica sees the potential of AI revolutionising teacher training with hyper-personalised programmes, real-time VR simulations, predictive analytics and continuous, on-demand learning. AI may also enhance collaborative learning, ethical training and literacy integration, thereby fostering global connections. Tailored resources and instant feedback drive continuous improvement, while streamlined processes and interactive content heighten engagement. Despite these benefits, challenges like technical reliability, data privacy and potential biases need careful consideration. Therefore, the methodological shift should balance innovation with core teaching values, emphasising AI's complementary role in ensuring inclusive and effective education.

Conclusion

Our analysis underscores the critical need for teachers to cultivate a specific set of skills and knowledge essential for successful AI integration in education. The synthesis of competency frameworks emphasises the importance of educators gaining diverse competences from ethics to AI fundamentals supported by professional expertise in digital pedagogy. The practical takeaway here lies in the **imperative for teacher training programmes to tailor their curricula to prioritise ethics and humanity, digital pedagogy and a basic understanding of AI operations to ensure that educators are well-equipped for the dynamic challenges posed by AI in the classroom.**

Delving into strategies, the exploration of Large Language Models (LLMs) illuminates their potential as powerful tools in teacher training. The report suggests utilising bespoke LLM-powered assistants which can be tailored to simulate challenging scenarios for teachers and offer valuable interactive exercises. Additionally, they can be used to diagnose the needs of individual teachers to further tailor their teacher training pathways. AI-generated images and videos can also enhance the effectiveness of teacher training activities. **Teacher trainers are encouraged to experiment with these AI-driven methods and embrace the potential for personalised, simulated and visually engaging learning experiences.**

Recognising the dynamic nature of AI, it is essential that teacher trainers also develop teachers' capacity for engaging in continuous professional development to stay updated on technological advancements and evolving pedagogical practices. A crucial aspect in this regard is to help teachers develop the competences to engage proactively and effectively in collaborative learning with their peers. This can be achieved through the development of communities of practice where teachers can help each other stay abreast of developments and engage in shared reflections about how to address the evolving opportunities and challenges brought by AI. This applies equally for teacher trainers who can only benefit from **joining forces to share experiences, resources and good practices, with the imperative to build networks facilitating ongoing learning and adaptation in teacher professional development.**

In conclusion, the professional development of teachers in the age of AI demands a multifaceted approach that encompasses specific skills and competences, thoughtful strategies, collaborative learning and a commitment to continuous adaptation. The practical insights gleaned from our exploration can serve as a guide for teacher trainers and those in charge of teacher training programmes, guiding them toward effective and informed practices that can support teachers and the integration of AI in schools.

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