European Commission

Teachers' competences

Briefing report No. 1

by the European Digital Education Hub's squad on artificial intelligence in education

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Teachers' competences

Demands on the teaching professions are continually evolving, necessitating the development of an increasingly sophisticated set of competences. In particular, the speed at which digital technologies are developing creates a strong impetus for educators to enhance their digital competence. The realisation of the potential educational benefits of artificial intelligence (AI), and digital data more generally, calls for the active and meaningful engagement of teachers and school leaders. This in turn requires the development of the necessary AI and data literacy to appreciate the full potential of such systems, while being aware of their drawbacks and limitations. **What teachers should be aware of, understand, and be able to do and what kind of attitudes could support them were questions to which the European Digital Education Hub's (EDEH) squad on artificial intelligence in education searched for answers**. We are starting with the presentation of several documents that cover teachers' competences in the area of digital technology, data and artificial intelligence. Competences are presented in three segments, although **there are overlaps** in competences for teaching ***for, with*** and ***about*** AI.

Teaching for AI entails competences for all citizens, including teachers and learners, to engage confidently, critically and safely with AI systems to provide them with the necessary knowledge, skills and attitudes to live in a world surrounded and shaped by AI.

Teaching with AI focuses on how AI systems can be used for educational goals, including using pedagogical judgement on when to use them, but also knowledge about the functioning of underlying algorithms, pedagogical models and data.

Teaching about AI is the more technical part, focused on training students in the fundamentals of AI. It is usually part of AI literacy which should comprise both the technological and the human dimensions of AI organised according to the student's age. Knowledge about AI basics is key for preparing students for the labour market, independently of their future careers.

Competences for teaching *for* AI

AI policies and systems should aim to protect children, provide equitably for their needs and rights, and empower them to participate in an AI world by contributing to the development and use of AI. This is what UNICEF states in Policy guidance on AI for Children (2021). Building on this foundation are nine requirements for child-centred AI: 1. Support children's development and well-being; 2. Ensure inclusion of and for children; 3. Prioritise fairness and non-discrimination for children; 4. Protect children's data and privacy; 5. Ensure safety for children; 6. Provide transparency, explainability and accountability for children; 7. Empower governments and businesses with knowledge of AI and children's rights; 8. Prepare children for present and future developments in AI; 9. Create an enabling environment for child-centred AI. These requirements are highly pertinent to the educational context and could be used to guide the deployment of future AI-driven applications in education, keeping in mind the empowerment of children as well as the establishment of safe environments for children to experiment with new technology.

In 2022, the European Commission published **DigComp 2.2:** The Digital Competence Framework for Citizens (DigComp 2.2) with new examples of knowledge, skills and attitudes for confident, critical and responsible use of digital technologies for learning, at work, and for participation in society. DigComp is an EU-wide tool to improve citizens' digital competence, help policy-makers formulate policies that support digital competence building, and plan education and training initiatives to improve the digital competence of specific target groups. Besides general digital skills already present in previous versions of DigComp the new version introduces more than 30 examples related to interacting with AI systems and also an appendix (page 77-82) describing 73 examples that can support citizens when interacting with AI systems. These include for example: What do AI systems do and what do they not do? How do AI systems work? What are the challenges and ethics of AI? Below are several examples cited from DigComp 2.2 that could be reflected in teachers' competences too (using the original numbering system of the DigComp 2.2 document).

1. Information and data literacy

4. Aware that search engines, social media and content platforms often use AI algorithms to generate responses that are adapted to the individual user (e.g. users continue to see similar results or content). This is often referred to as "*personalisation*".

5. Aware that AI algorithms work in ways that are usually not visible or easily understood by users. This is often referred to as "*black box*" decision-making as it may be impossible to trace back how and why an algorithm makes specific suggestions or predictions.

14. Weighs the benefits and disadvantages of using AI-driven search engines (e.g. while they might help users find the desired information, they may compromise privacy and personal data, or subject the user to commercial interests).

22. Aware that the data, on which AI depends, may include biases. If so, these biases can become automated and worsened using AI. For example, search results about occupation may include stereotypes about male or female jobs (e.g. male bus drivers, female salespersons).

27. Able to recognise that some AI algorithms may reinforce existing views in digital environments by creating "*echo chambers*" or "*filter bubbles*" (e.g. if a social media stream favours a particular political ideology, additional recommendations can reinforce that ideology without exposing it to opposing arguments).

Competence areas in DigComp

2. Communication and collaboration

50. Knows how to identify signs that indicate whether one is communicating with a human or an AI-based conversational agent (e.g. when using text- or voice-based chatbots).

56. Aware that everything that one shares publicly online (e.g., images, videos, sounds) can be used to train AI systems. For example, commercial software companies who develop AI facial recognition systems can use personal images shared online (e.g. family photographs) to train and improve the software's capability to automatically recognise those persons in other images, which might not be desirable (e.g., might be a breach of privacy).

70. Recognises that while the application of AI systems in many domains is usually uncontroversial (e.g., AI that helps avert climate change), AI that directly interacts with humans and takes decisions about their life can often be controversial (e.g. CV-sorting software for recruitment procedures, scoring of exams that may determine access to education).

105. Aware that AI systems collect and process multiple types of user data (e.g. personal data, behavioural data and contextual data) to create user profiles which are then used, for example, to predict what the user might want to see or do next (e.g. offer advertisements, recommendations, services).

113. Knows how to modify user configurations (e.g. in apps, software, digital platforms) to enable, prevent or moderate the AI system tracking, collecting or analysing data (e.g., not allowing the mobile phone to track the user's location).

117. Identifies both the positive and negative implications of the use of data (e.g. collection, encoding and processing), but especially personal data, by AI-driven digital technologies such as apps and online services.

3. Digital content creation

119. Knows that AI systems can be used to automatically create digital content (e.g. texts, news, essays, tweets, music, images) using existing digital content as its source. Such content may be difficult to distinguish from human creations.

134. Knows how to incorporate AI edited/manipulated digital content in one's own work (e.g. incorporate AI generated melodies in one's own musical composition). This use of AI can be controversial as it raises questions about the role of AI in artworks, and for example, who should be credited.

4. Safety

187. Weighs the benefits and risks before allowing third parties to process personal data (e.g. recognises that a voice assistant on a smartphone, that is used to give commands to a robot vacuum cleaner, could give third parties - companies, governments, cybercriminals - access to the data).

216. Considers the ethical consequences of AI systems throughout their life cycle: they 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.

5. Problem solving

221. 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

231. 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.

233. Knows how and when to use machine translation solutions (e.g. Google Translate, DeepL) and simultaneous interpretation apps (e.g. iTranslate) to get a rough understanding of a document or conversation. However, also knows that when the content requires an accurate translation (e.g., in healthcare, commerce or diplomacy), a more precise translation may be needed.

246. Open to engage in collaborative processes to co-design and co-create new products and services based on AI systems to support and enhance citizens' participation in society.

255. Has a disposition to keep learning, to educate oneself and stay informed about AI (e.g. to understand how AI algorithms work; to understand how automatic decision-making can be biased; to distinguish between realistic and unrealistic AI; and to understand the difference between Artificial Narrow Intelligence, i.e. today's AI capable of narrow tasks such as game playing, and Artificial General Intelligence, i.e. AI that surpasses human intelligence, which still remains science fiction).

Competences for teaching *with* AI

In deliberating these matters, the ***Emerging Competences for Ethical use of AI and data*** section of the European Commission's Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators (2022) provides a useful starting point. It suggests potential indicators of emerging teachers' and school leaders' competences for the ethical use of AI and data in teaching and learning. These indicators have been organised according to the six areas identified in the European framework for the Digital Competence of Educators (DigCompEdu), an existing framework that supports the development of educator-specific digital competences in Europe. We are quoting emerging competences for the ethical use of AI and data as they are written in the Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators.

Area 1: Professional Engagement

Is able to critically describe positive and negative impacts of AI and data use in education

- Takes an active part in continuous professional learning on AI and learning analytics and their ethical use.

Able to give examples of AI systems and describe their relevance.

- Knows how the ethical impact of AI systems is assessed in the school.
- Knows how to initiate and promote strategies across the school and its wider community that promote ethical and responsible use of AI and data.

Understand the basics of AI and learning analytics

- Aware that AI algorithms work in ways that are usually not visible or easily understood by users.
- Able to interact and give feedback to the AI system to influence what it next recommends.
- Aware that sensors used in many digital technologies and applications generate large amounts of data, including personal data, that can be used to train an AI system.
- Aware of EU AI ethics guidelines and self-assessment instruments.

Area 2: Digital resources

Data governance

- Aware of the various forms of personal data used in education and training.
- Aware of responsibilities in maintaining data security and privacy.
- Knows that the processing of personal data is subject to national and EU regulation including General Data Protection Regulation (GDPR).
- Knows that processing of personal data usually cannot be based on user consent in compulsory education.
- Knows who has access to student data, how access is monitored, and how long data are retained.
- Knows that all EU citizens have the right to not be subject to fully automated decision making.
- Able to give examples of sensitive data, including biometric data.
- Able to weigh the benefits and risks before allowing third parties to process personal data especially when using AI systems.

AI governance

- Knows that AI systems are subject to national and EU regulation (notably AI Act to be adopted).
- Able to explain the risk-based approach of the AI Act (to be adopted).
- Knows the high-risk AI use cases in education and the associated requirements under the proposed AI Act.
- Knows how to incorporate AI edited/ manipulated digital content in one's own work and how that work should be credited.
- Able to explain key principles of data quality in AI systems.

Area 3: Teaching and Learning

Models of learning

- Knows that AI systems implement designer's understanding of what learning is and how learning can be measured; can explain key pedagogic assumptions that underpin a given digital learning system.

Objectives of education

- Knows how a given digital system addresses the different social objectives of education (qualification, socialisation, subjectification).

Human agency

- Able to consider the AI system impact on teacher autonomy, professional development, and educational innovation.
- Considers the sources of unacceptable bias in data-driven AI.

Fairness

- Considers risks related to emotional dependency and student self-image when using interactive AI systems and learning analytics.

Humanity

- Able to consider the impact of AI and data use on the student community.
- Confident in discussing the ethical and legal aspects of AI, and how they influence technology use.

Participates in the development of learning practices that use AI and data

- •Can explain how ethical principles and values are considered and negotiated in co-design and co-creation of learning practices that use AI and data (linked to learning design).

Area 4: Assessment

Personal differences

- Aware that students react in different ways to automated feedback.

Algorithmic bias

- Considers the sources of unacceptable bias in AI systems and how it can be mitigated.

Cognitive focus

- Aware that AI systems assess student progress based on pre-defined domain-specific models of knowledge.
- Aware that most AI systems do not assess collaboration, social competences, or creativity.

New ways to misuse technology

- Aware of common ways to manipulate AI-based assessment.

Area 5: Empowering Learners

AI addressing learners' diverse learning needs

- Knows the different ways personalised learning systems can adapt their behaviour (content, learning path, pedagogical approach).
- Able to explain how a given system can benefit all students, independent of their cognitive, cultural, economic, or physical differences.
- Aware that digital learning systems treat different student groups differently.
- Able to consider impact on the development of student self-efficiency, self-image, mindset, and cognitive and affective self-regulation skills.

Justified choice

- Knows that AI and data use may benefit some learners more than others.
- Able to explain what evidence has been used to justify the deployment of a given AI system in the classroom.
- Recognises the need for constant monitoring of the outcomes of AI use and to learn from unexpected outcomes.

Area 6: Facilitating learners' digital competence

AI and Learning Analytics ethics

- Able to use AI projects and deployments to help students learn about ethics of AI and data use in education and training.

Educator-specific digital competences are captured also in the DigCompEdu Framework (2017) which aims to describe digital competences to effectively and responsibly use, create and share digital resources for learning, focusing also on the potential of digital technologies for learner-centred teaching and learning strategies. Based on that framework the free self-reflection tool for primary and secondary school teachers **SELFIE FOR TEACHERS** was launched in October 2021 which includes competences relating to AI and some relevant questions for educators to reflect upon the use of AI tools in education.

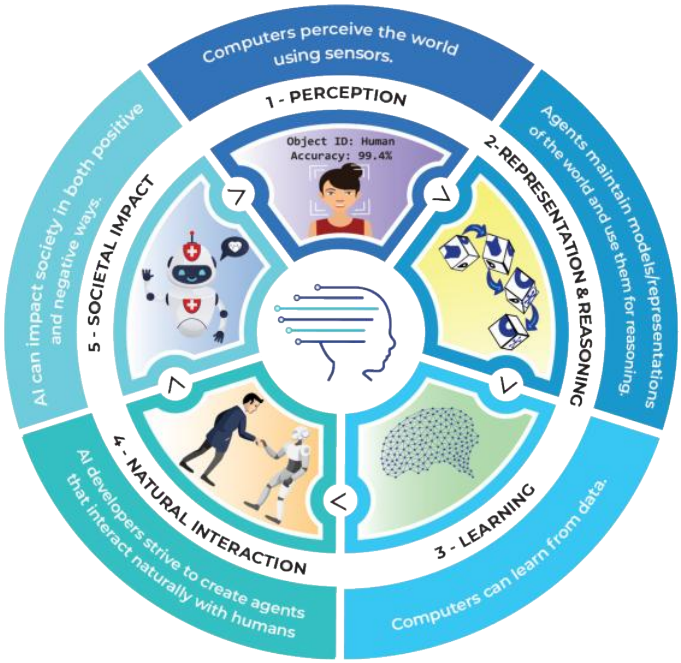
In 2020, UNESCO organised the first International Forum on AI – AI and the Futures of Education 'Developing Competencies for the AI Era. To support its member states in harnessing the benefits and mitigating the risks of using AI in education, UNESCO is implementing an initiative on Artificial Intelligence and the Futures of Learning. The project revolves around three strands of work: a report with recommendations on AI-enabled futures of learning; guidance on ethical principles on the use of AI in education; a guiding framework on AI competencies for school students. Through its projects, UNESCO affirms that the deployment of AI technologies in education should be purposed to enhance human capabilities and to protect human rights for effective human-machine collaboration in life, learning and work, and for sustainable development. An UNESCO series of **consultation on AI competency frameworks for teachers** is dedicated to the development of a framework on AI competencies for teachers to guide the planning of the national and institutional frameworks, standards or training programmes. Among the findings from that consultation are the following:

- The main areas of AI competency for teachers are AI literacy, AI and pedagogy, ethics of AI, the use of AI for continuous professional development, and the ability to foster AI competencies for students. It is important that AI literacy and competencies incorporate both the technological and human dimensions of AI.
- Competences need to address: what AI tools exist for teachers, the influence of AI on education, how AI changes the relationship between teachers and learners, ethical and human-centred issues, AI awareness and social responsibility (covering what AI is, what it can do and needs to do, typical applications of AI, the impact of AI, including the ethical impact on humans and society). It was also suggested to be careful that the AI competencies and curriculum for teachers avoid perpetuating AI myths and hyperbole and the need for experiential activities to promote AI understanding and application.

Competences for teaching *about* AI

The Council of Europe report "Artificial Intelligence and Education - A Critical View Through the Lens of Human Rights, Democracy, and the Rule of Law" recommends that all citizens should be supported and encouraged to achieve a certain level of AI literacy. They should have the knowledge, skills and values centred on the development, implementation and use of AI technologies. AI literacy should encompass both the technical and human dimensions of AI, including how it works and its impact on people's lives, such as their cognitive abilities, privacy, and agency. Without understanding the impact of AI on people, teaching about what AI does is incomplete.

Members of the EDEH squad also pointed out that **Teachers' competences need to be based upon students' competences and needs** and suggested a few examples of that approach. The proposal is to start with skills students need to achieve in primary, secondary or tertiary levels of education, bearing in mind that students could be both users and developers of artificial intelligence applications.



AI4K12 Grade Band Progression Charts

One of the projects that could be used as a resource for envisioning teachers' competences based on students' competences is **AI4K12 Five Big Ideas for AI education**. Core ideas mentioned in that initiative provide a comprehensive overview of the AI field, tailored to the understanding of school-aged children:

- Perception: Computers perceive the world through sensors that gather information from their surroundings.
- Representation and Reasoning: AI agents create and maintain internal models of the world, which they use to make decisions and solve problems.
- Learning: Machines can learn from data and improve their performance over time.
- Natural Interaction: Intelligent agents require a broad range of knowledge to interact naturally with humans, including language, social skills, and emotional intelligence.
- Societal Impact: AI has the potential to impact society in both positive and negative ways, and it is important to consider the ethical implications of its use.

Project AI4K12 Five Big Ideas for AI education also listed some competences for K-12 students (students from kindergarten till grade 12, aged 5 – 18):

Grades K–2 (age 5 to 8): Identify common AI applications encountered in their daily lives; Discuss whether common uses of AI technology are a good or bad thing.
Grades 3–5 (age 9 to 11): Explore how behaviour is influenced by bias and how it affects decision-making; Describe ways that AI systems can be designed for inclusivity.
Grades 6–8 (age 12 to 14): Explain potential sources of bias in AI decision-making; Understand trade-offs in the design of AI systems and how decisions can have unintended consequences in the function of a system.
Grades 9–12 (age 15 to 18): Critically explore the positive and negative impacts of an AI system; Design an AI system to address social issues (or explain how AI could be used to address a social issue).

To support K-12 students, the AI4K12 Five Big Ideas for AI education associated guidelines recommends to use transparent AI demonstrations that help students see what is happening inside the black box, so they can understand that it is nothing magical Teachers should help students build mental models of what is happening under the hood in AI applications. Additionally, students should be encouraged to develop AI applications using AI services. The use of these guidelines can help students better understand and engage with AI technology.

To equip students with AI-related competences, the EDEH squad proposed **multiple domains** that are pertinent to enhancing the skill set of educators. These areas aim to develop teachers' competences in AI and include the following suggestions:

Basic digital skills

- Content creation
- Cloud usage
- Data analysis and representation
- Collaboration and communication tools

Computational thinking

- Design thinking
- Problem-solving
- Block-based programming
- Text-based programming

Mathematics

- Fundamentals of statistics
- Fundamentals of probability

Existing applications of AI

- To provide a realistic view of AI
- To be updated on the real usage of AI
- Ethics behind real cases
- Legal issues and data privacy

Specific AI topics

- Perception and actuation
- Representation and reasoning
- Machine learning
- Collective intelligence

Recommendations by the Squad

Different competences are needed for teachers, school leaders, IT support personnel and other professionals in education. This can mean varying levels of knowledge, skills and attitudes related to teaching *for, with* and *about* AI.

There are significant differences in competences for those who will teach *about* AI (the techniques and the technologies) and those who will just use AI as support for teaching and learning processes, but all teachers need to know what impact AI has on people and have competences to teach *for* and *with* AI.

All competences need to be described contextually and with existing subject-specific examples.

Members of the EDEH squad on artificial intelligence in education who dedicated time for this briefing report: Yann-Aël Le Borgne, Francisco Bellas, Dara Cassidy, Riina Vuorikari and Lidija Kralj.

EDEH squad work around preparation of education for, about and with AI continues in briefing reports that follow.

European Commission

How to Support Teachers to Use AI in Teaching

Briefing report No. 2

by the European Digital Education Hub's squad on artificial intelligence in education

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How to Support Teachers to Use AI in Teaching

Artificial intelligence (AI) technology has already moved from an emergent to a more advanced stage where people are trying to explore its affordances and discover new innovative usages. It became extremely clear that AI technology is here to stay, and teachers cannot ignore it anymore. How should offerings to educators be positioned, and which problems are we going to solve through AI usage? We will try to model the 5 Whys technique on how AI is making an impact on education, teaching and learning. The below sets of questions refer first to education in general and then to the teaching/learning process:

1) Why is AI making an impact on education, teaching and learning?
AI is making an impact on education, both for teachers and for students as it enables new forms of personalisation and learning through individual feedback and coaching. While there are concerns over academic integrity, there is also hope that AI will enable teachers to provide more personalised learning experiences for their students.

2) Why is personalisation important in education?
Every student is different in their abilities, interests and circumstances of learning. It is important to tailor learning experiences for each individual student. This task is incredibly difficult in large classes, when a teacher cannot provide real-time feedback for every student.

3) Why is real-time feedback valuable in education?
Real-time feedback helps students identify their strengths and weaknesses, adjust their learning strategies, and improve their performance. It allows them to focus on achieving educational outcomes most effectively.

4) Why is enhancing educational outcomes important?
Education provides students with the knowledge and skills they need to succeed in their personal and professional lives. Educational outcomes are designed in a way that improves students' future prospects and contributes to societal well-being.

5) Why is societal well-being important?
Providing students with high-quality education can help create a more just and equitable society, where everyone has the opportunity to reach their full potential regardless of their background or circumstances.

1) Why should teachers use AI in the classroom?
AI allows to provide real-time feedback and personalise learning experiences for students and can also support teachers in improving their learning designs for classes.

2) Why is it important to personalise learning experiences for students?
Personalisation allows to create individual learning paths and achieve educational outcomes most effectively. But for this, teachers need big amounts of data, as well as time to support multiple students.

3) Why is it beneficial for teachers to have access to real-time data and insights?
When teachers have real-time data and insights, they can adapt their teaching strategies to be most effective for a given student or a group of students.

4) Why can AI help teachers save time and reduce workload?

AI can assist with tasks such as grading, data analysis, and providing feedback, allowing teachers to focus on teaching and providing personalised support to their students.

5) Why is it beneficial for teachers to stay up-to-date with technological advancements in education?

Teachers can improve their skills and knowledge, making them more competitive and effective in their roles. It can also increase job satisfaction and motivation by providing opportunities for professional growth and development.

In the article "AI in education: added value or not?" Digisprong mentions some practical ideas and dilemmas about AI use in education. For example, educational applications driven by artificial intelligence can divide students into level groups, automatically correct exercises, and help beginner students with reading difficulties. But that also means teachers need to keep an eye on the results from AI to make sure the quality of the teaching process remains high. More examples can be found in the Briefing report No. 3 "*Use Scenarios and practical examples of AI use in Education*".

Although AI is evolving rapidly, its abilities are still limited. Teachers' pedagogical and educational role remains important. Digisprong mentions several tasks which AI cannot perform well yet, like monitoring and giving feedback on higher thinking skills or collaboration, and it does not consider students' thought processes or intermediate steps. Today, most AI tools for education can only provide feedback on skill sets for which there are clearly defined "right or wrong" answers such as reading, writing, coding, and mathematics.

How Could Teachers be Supported?

How could AI support teachers?

AI can support teachers in their everyday practice, for example in:

- **Enabling personalised learning.** Using AI, teachers can create personalised learning materials for students regarding their strengths and weaknesses, students' pace and ability (e.g. gifted students or twice exceptional).
- **Offering feedback.** AI can help teachers provide immediate feedback to students. This can be useful or not as research shows (Sumeracki, 2022) but this is up to the teachers to decide.
- **Focusing on certain tasks.** AI can allow teachers to focus more on tasks like student engagement, student observation, formative assessment, etc.
- **Monitoring the class.** AI can be used to monitor the class and through frequent testing give a data-driven overview to the teacher about the students' content learning.
- **Having an overview of the learning process.** If AI is used for frequent testing, it could provide a great overview of the learning process of students or classes.
- **Teacher training.** In teacher training or preparation of substitute teachers for students of different age groups AI can, for instance, provide quick examples of pieces of text and adapt them to a given age level so the teacher can practice grading or correcting assessments for that target group of students. AI-based text tools could be used as instruments to train writing and creativity skills and critical thinking.
- **Planning learning.** AI-based apps can support teachers in the process of creating courses, course modules, units, or lessons.

How could AI support educational institutions?

AI, used at an institutional level, can support teachers in their everyday practice, for example in:

- **Interpreting testing data.** If hypothetically, the whole school does frequent testing with adaptive learning applications, maybe AI can be useful to create learning groups that are based on students' abilities and not anymore based on the biological age/class grade.
- **Personalised training models for groups of students and teachers.**
- **Predictive analysis of student achievement.** Providing early warning of students at risk

of failing to reach the required learning standards of their grade level and providing suggestions for support.

- **Support in academic writing of institutions official documents.**
- Recommending learning materials to support the teacher in their own professional development.

How could teachers be supported to teach with AI?

Teacher level

Teachers who want to teach with AI could be supported by:

- European School Education Platform & eTwinning communities
- European Digital Education Hub
- EU Teacher Academies
- Peer-to-peer connections
- possibility of virtual exchanges
- blended intensive programmes
- Projects such as AI for teachers
- Requirement (e.g., in procurement processes) to include teacher support materials and training opportunities in AI tools for schools

Institutional level

In order to support teachers in using AI in their daily professional life, institutions could:

- Allocate more time for professional development and planning.
- Give teachers access to applications dedicated to class management using AI.
- Implement AI at the organisational level. If, for example, educational institutions use AI for assessment and monitoring then they could consider leveraging the use of student achievement data in new ways, for example by supporting the creation of learning groups based on abilities or students' interest rather than age groups with the help of AI-driven organisational tools. It is important that educators would be part of planning such activities.
- Offering managerial-level support for integrating AI in a reflective and critical way to improve performance on certain tasks. Educational leaders and managers should reflect on: What is the support needed from the managerial level? What should principals do? How should they set goals? How should they organise shared learning of teachers in single schools? How can this be integrated

into pedagogical programs? What are the pitfalls, risks as well as ethical and law-related considerations?

- Provide incentives to teachers to upskill themselves, e.g., credits, certification and promotion.
- Organise open discussions and reflections with all educational stakeholders on legal/ ethical questions regarding technology usage in education.

National level

- Guidance on teacher competences to teach with, for and about AI. This could be included in the national recommendations for each curriculum (You may find more in *Briefing report No. 1 Teachers' competences*).
- Integrated learning scenarios: AI could be used as a tool to create more transdisciplinary approaches or to promote moments of vertical teaching or mixed classes. If given access to data and trained properly, it could be a tool to generate an overview of which content is taught in which class, which would make AI a useful tool to help teachers create integrated learning scenarios (like for integrated STEM teaching).
- Provide incentives to teachers to upskill themselves, e.g., credits, certification, promotion.
- AI, coding and statistics should be part of initial teacher education. At university level, educational leaders and program coordinators should start building teachers' training curricula by answering questions such as what the challenges for teachers of the future are, how AI will affect their jobs, and how they can use AI. This kind of training based on a future oriented perspective would be highly recommendable for initial teachers training.
- Offer professional development on AI in national catalogues for teachers trainings, e.g. the ones developed in North Macedonia, Serbia or Croatia

European level

- European programmes to support AI use in education, like Erasmus+
- Recommendations and guidelines to encourage AI use in education, like the Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators

How Could Teachers Start with AI in Education?

The TPACK framework highlights that the effective incorporation of technology to enhance student learning relies on three fundamental elements: content, pedagogy, and technology. To achieve a valuable teaching and learning experience, educators must possess thorough knowledge of the subject they teach, a strong grasp of effective teaching methodologies, and a good understanding of the technology they can use or abstain from using. In 2018, Punya Mishra's website upgraded the TPACK diagram, and included the context domain to emphasise the limitations and different circumstances teachers face while teaching. Besides these elements, it is important to note that integrating technology in classroom activities also requires some understanding of the cognitive process of learning.

Knowledge about the content

Educators can begin by utilising AI to expand their understanding of subject-related content. There are various AI applications that can offer descriptions of particular concepts, clarify them, and provide teachers with tailored explanations appropriate for their students' age level. Furthermore, AI-powered search engines can enhance the search experience by assisting teachers in finding information more quickly and efficiently.

Knowledge about underlying pedagogical models of educational applications

From the educational science point of view, caution regarding the underlying pedagogical models of educational applications and services is needed. For teachers, before using any AI-driven educational applications with students, it is essential to reflect on which theoretical constructs the pedagogical decisions are based on and how traceable these decisions are. Practical questions such as "Do I agree with the grades this system is automatically giving?" or "Is this AI-driven system shaping or producing the kind of learning practices I want my students to perform and pursue later?" can be useful (SURF 2022).

Secondly, the intended learning outcomes and educational goals of AI-driven educational applications and services require scrutiny. Before integrating any new technology in education teachers should ask themselves why they shall use it, what the intended learning outcomes and educational goals of AI-driven educational applications are. For example, if the goal is to develop learner agency and reflection skills, AI-driven educational technologies, which support critical thinking and independent working, could be integrated. Some AI tools rely

on specific schema or curriculum alignment, and teachers and schools should ensure that those are appropriate for the educational context in which they are situated (e.g., some may be aligned to US curriculum standards).

Eventually, it will be important for teachers to consider "which parts of the teaching tasks or learning processes could be substituted, enhanced and transformed through automatisation, algorithms and machines" (Vuorikari et al, 2020).

Understanding of the technology

When educators opt for a new technology to incorporate into their classroom, they must be conscious of its potential benefits and drawbacks to determine if it will hinder or augment the learning experience. By employing frameworks such as the SECTIONS model proposed by Bates for evaluating digital media, teachers can become more critical and adapt the tech tool to their specific context.

Understanding of the teaching context

Creating a conducive environment is crucial for a successful learning experience. Teachers need to recognise the strengths and limitations of the learning environment and evaluate whether AI technology is suitable for their context before designing their course. For instance, having a group of tech-savvy students but no internet and appropriate device access in the learning space would make the use of AI technology in the learning process impossible. Therefore, having an accurate and practical assessment of the available physical and human resources is indispensable for integrating technology into any educational process.

Knowledge about the cognitive processes

Learning with different tools activates different cognitive processes and thus teachers need to be aware of the ones that are related to AI integration.

As with all teaching activities, having an understanding of the cognitive learning process is crucial to select the appropriate pedagogical approach and technology to effectively support and enhance the learning activity.

With AI "[o]ur whole relationship with knowledge and skills has changed. The nature of work will also change so how we learn will changed." ('Donald Clark Plan B', 2023) "We have moved from Human Teachers and Human Learners, as a dyad to AI Teachers and AI Learners as a tetrad." ('Donald Clark Plan B', 2023)

With AI, teachers can engage their students in a more interactive and personalised manner, while simultaneously enhancing their own teaching methods. One of the key cognitive processes that AI can aid in is attention. As previously discussed, AI-powered tools can help teachers maintain students'

engagement level high by delivering personalised content, offering instant feedback, and providing adaptive learning experiences that are customised to each student's unique needs. Additionally, AI-supported learning can be beneficial in enhancing students' learning strategies.

Dual coding (Dual Coding) is an important strategy in learning. It refers to the concept of utilising multiple forms of stimuli to assist learners in encoding information more efficiently, thus making it easier to recall later. Visual and verbal stimuli are the two primary types of stimuli used in the classroom for this purpose. As AI apps can generate, for example, visual stimuli from verbal ones, they can be concurrently used to support students in better perceiving and processing information.

Retrieval practice (Retrieval Practice) is another cognitive process that can be strengthened using AI. Intelligent tutoring systems and other AI-powered tools can help students practice retrieving information, which improves memory consolidation and long-term retention. They can be useful tools for spaced repetition techniques (Spaced Practice) by integrating moments of reviewing material at gradually increasing intervals.

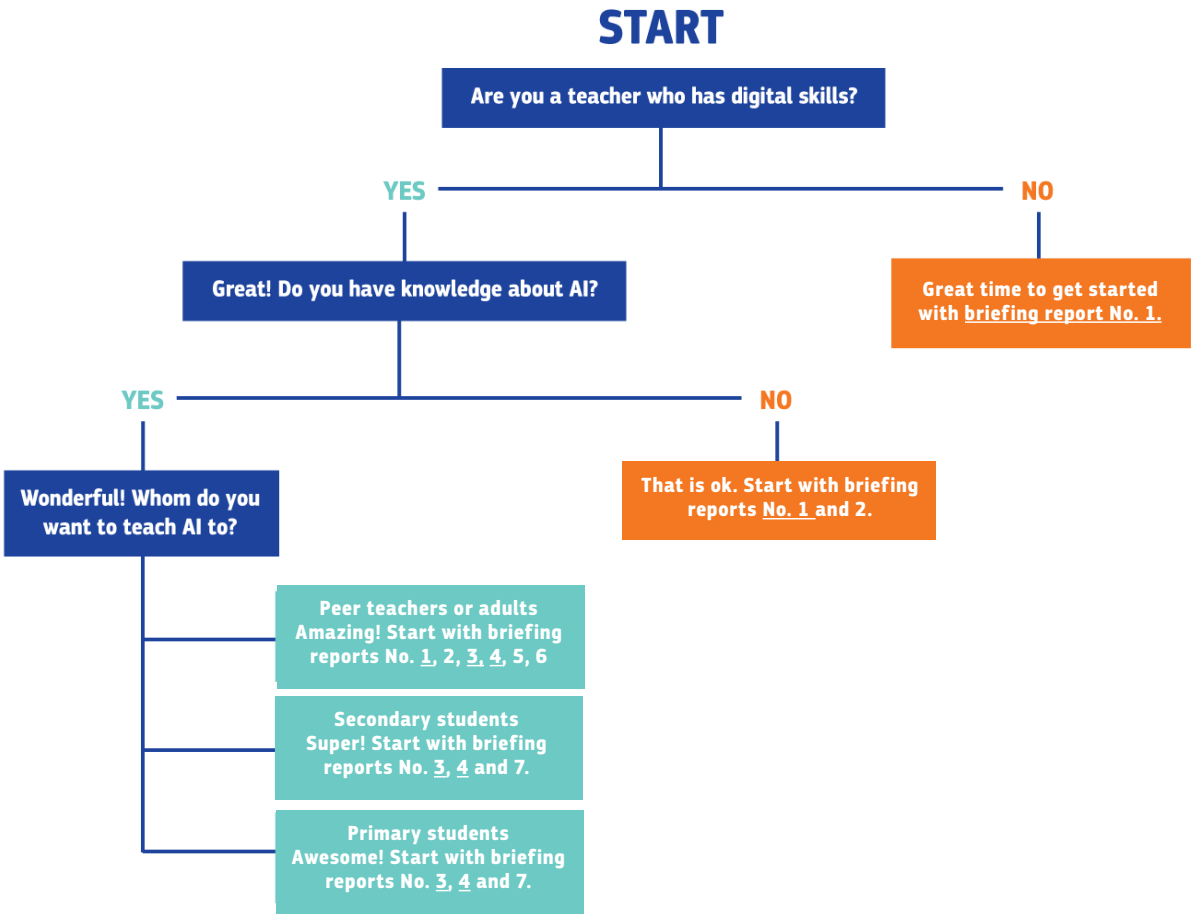
AI has several other ways to support students in learning, including exploring examples and linking them to the study topics. This will help them understand how the example is relevant to the concepts taught. Additionally, AI can generate different examples on the same topic that students can use to establish connections between them and enhance their problem-solving skills.

AI can help increase student motivation by providing personalised learning experiences, immediate feedback, and a sense of autonomy in their learning journey. By leveraging these cognitive processes, AI can play a vital role in supporting and enhancing learning outcomes in the classroom.

Finally, keeping in mind that metacognition is a critical cognitive process that can promote self-awareness and improve learning outcomes, AI-powered tools can help students become more aware of their learning strategies, strengths, and weaknesses, providing guidance on how to improve their learning outcomes.

Recommendations by the Squad

- Create an online course for school management on integrating AI at the school level to support education.
- Define “human-AI interface interaction skill”.
- Make recommendations for including “teaching with AI” in initial teacher education.
- Propose several professional development pathways for teachers to get acquainted with AI.
- Teachers who are wondering how to get started with AI could access this flowchart and find guidance depending on the choices they make.



Briefing reports No. 5, 6 and 7 will be linked here as soon as they are published.

Members of the EDEH squad on artificial intelligence in education who dedicated time for this briefing report: Cristina Obae, Yann-Aël Le Borgne, Francisco Bellas, Riina Vuorikari, Oksana Pasichnyk, Petra Bevek, Bertine van Deyzen, Ari Laitala, Madhumalti Sharma, Robbe Wulgaert, Jessica Niewint-Gori, Johanna Gröpler, Alexa Joyce and Lidija Kralj.

EDEH squad work around preparation of education for, about and with AI continues in briefing reports that follow.

European Commission

Use Scenarios & Practical Examples of AI Use in Education

Briefing report No. 3

by the European Digital Education Hub's squad on artificial intelligence in education

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Introduction and Report Organisation

This report presents a set of use scenarios based on existing resources that teachers can use as inspiration to create their own, with the aim of introducing artificial intelligence (AI) at different **pre-university levels,** and with different goals. The Artificial Intelligence Education field (AIEd) is very active, with new resources and tools arising continuously. Those included in this document have already been tested with students and selected by experts in the field, but they must be taken just as practical examples to guide and inspire teachers' creativity.

The use scenarios have been organised in three main categories, according to the three main approaches followed in AIEd:

Teaching ***for*** AI entails competences for all citizens, including teachers and learners, to engage confidently, critically, and safely with AI systems to provide them with the necessary knowledge, skills and attitudes to live in a world surrounded and shaped by AI.

Teaching ***about*** AI is the more technical part, focused on training students in the fundamentals of AI. It is usually part of AI literacy which should comprise both the technological and the human dimensions of AI organised according to the student's age. Knowledge about AI basics is key for preparing students for the labour market, independently of their future careers.

Teaching ***with*** AI focuses on the application of AI-based tools for educational goals. These types of tools provide autonomous support to students in different aspects of learning, facilitating teachers' work. Moreover, they can also support teachers and institutions in management and supervisory tasks. The main goal in this category is not to understand the technology behind these tools , but to take advantage of the potential of AI to enhance teaching and learning.

While the third category is quite clear, the difference between the first and second could be confusing for teachers. Teaching *for* AI implies training students in all the AI topics from an AI **user perspective**, rather than an AI **developer perspective**, which will be covered in the Teaching about AI section. We could differentiate these two perspectives with the following key ideas:

- In terms of **curriculum**, teaching *about* AI should be included as specific subjects or courses (or part of them) with a detailed program covering the main AI topics (perception, actuation, reasoning, representation, learning, impact, etc.). **The learning outcomes are more technical and specific,** so before learning about AI, students should receive background training in maths, programming, and other technical knowledge required to properly understand the AI topics from a developer perspective. Teaching *for* AI could be organised in a more transversal manner through embedding it in different courses and areas (e.g., language, history, natural sciences, mathematics, arts). The learning material could be organised as small activities within different subjects (not only technical), or as specific subjects where the AI topics are delivered without relying on deep technical aspects (like programming). Learning for AI does not require a specific background in maths or programming.
- In terms of **methodology**, in teaching *about* AI, students develop simple AI-based solutions by programming them, while in teaching *for* AI, they can focus on analysing existing AI-based applications or tools by using them, understanding the way they work and their impact.
- In terms of **specialisation**, teaching *for* AI is necessary for all students, independently of their area (humanities, science, engineering, arts). Teaching *about* AI could be targeted to technical paths, thinking about those students interested in working as "AI engineers". Hence, **teaching *for* AI is a pre-requisite for educators and learners before moving to teaching about AI.**

The following 3 sections contain selected use scenarios in these categories that exemplify their differences and opportunities at classes.

Teaching *for* AI

In this section we describe projects and learning scenarios that provide activities for teachers to engage students in activities that improve knowledge, skills, and attitudes towards how AI systems are used in today's society, and focus on everyday applications that are driven by AI. To teach for AI use in everyday life, the focus is two-fold:

- to introduce some basic principles to keep in mind when interacting with **common AI applications,** such as virtual assistants and recommendation systems, to mitigate risks related to safety, personal data, privacy and well-being;
- to become aware of **how AI is used in various parts of our society**, e.g., autonomous vehicles, medicine, industry, agriculture, and creating realistic expectations about what AI systems do and do not do.

This is a key topic, and students should be aware of the limits of AI from a formal perspective, mainly understanding the differences with human intelligence.

When creating lesson plans to teach *for* AI, areas that are part of the DigComp framework can become helpful. Especially **understanding AI's impact** on information, data and media literacy is crucial due to disinformation on social media platforms and other new forms of automated AI -generated content that exists on the internet.

AI literacy and digital citizenship are essential topics to cover and should include examples for responsible use of AI and data-driven technologies, with a critical mindset to be aware about the potential biases and limitations of such systems. Here, an important goal is to help people navigate ethical questions related to digital practices – like the question of human autonomy which underpins many of the EU values.

At a certain student age, the inclusion of **legal topics** such as personal data protection (GDPR) and privacy, ethical considerations in data collection, storage, and usage, and bias and fairness in AI algorithms will be important.

It could also be useful to include examples about **AI applications in tools and services,** including using AI-powered tools for productivity, communication, and entertainment, integrating AI services into custom applications using application programming interfaces (APIs), and evaluating AI services for data privacy and security concerns. Similarly, introducing students to methods of exploratory data analysis through descriptive statistics and data distributions, data visualisation techniques and tools such as bar charts, pie charts, and scatter plots, and making data-driven decisions based on analysis and visualisations could be useful as well.

Teaching ***for*** AI can also include aspects such as understanding the nature of different types of data (structured, unstructured, and semi-structured), data formats (text, images, audio, and video), and data sources (public datasets, APIs, and web scraping), and more technical concepts of AI such as machine learning and deep learning.

Use Scenario 1: Bias on AI Algorithms

Idea:

- Explaining to students the bias that can be introduced in machine learning if data are not properly selected and analysed, and how it can have a relevant impact on automatic decision systems.
- *Why:* to introduce them to the impact of AI.
- *How:* by means of a developing and analysing simple decision systems.

Target level: upper primary school and secondary school (ages 8 to 18).

Topic: machine learning

Possible resources:

Name: **A Fresh Squeeze on Data**

- **Target level:** ages 8-10
- **Link:** https://freshsqueezekids.com
- **Description:** This lesson is intended to provide student awareness of bias and their relationship with data. As a demonstration, this lesson allows the teacher and the students to explore and experiment with data bias. The teacher will explain why data is important, how to collect data, what is bias and its relationship with data. The lesson will conclude by asking students to imagine practical, real-life implications of data bias.

Name: **AI + Ethics Curriculum for Middle School**

- **Target level:** ages 10-14
- **Link:** https://docs.google.com/document/d/1e9wx9oBg7CR0s5O7YnYHVmX7H7pnITfoDxNdrSGkp60/
- **Description:** On page 29 of this pdf file, there is a detailed activity with the required materials. Students will have to use an online programming tool (teachable machine), which does not require any previous experience on programming.

Name: **Our AI Code of Ethics**

- **Target level:** ages 10-14
- **Link:** https://studio.code.org/s/ai-ethics-2021/lessons/1
- **Description:** This lesson belongs to the code.org initiative, and it builds on prior activities involving research and finding sources to justify an argument. In small groups, students conduct research using articles and videos that expose ethical pitfalls in an AI area of their choice. Afterward, each group develops at least one solution-oriented principle that addresses their chosen area. These principles are then assembled into a class-wide "Our AI Code of Ethics" resource (e.g., a slide presentation, document, or webpage) for AI creators and legislators everywhere.

Name: **Build a Bot**

- **Target level:** ages 14-18
- **Link:** https://dschool.stanford.edu/resources/build-your-own-bot
- **Description:** This facilitation guide includes a set of activities for children, families, and parents to experiment with the potential and peril of AI assistants. In this document there are three workshops with facilitator guides, slide decks, worksheets, and other materials. These have all been designed as unplugged activities and do not require a computer.

Use Scenario 2: Computational Thinking and Algorithms

Idea:

- What is an algorithm? How does it work? How is it related to AI?
- *Why:* to introduce students in the fundamentals of problem solving by means of computer programs.
- *How:* by creating simple algorithms with and without AI.

Target level: lower secondary school (ages 10 to 14)

Topic: design thinking, problem solving, algorithms

Possible resources:

Name: **Algorithmic Literacy**

- **Link:** https://algorithmliteracy.org
- **Description:** Digital2030 (an experience by Digital Moment), the Canadian Commission for UNESCO (CCUNESCO) and UNESCO have partnered up to launch the Algorithm Literacy & Data Project to raise awareness and educate children about the presence of algorithms and how they influence our digital experiences — in other words, get algorithm literate. The goal is to empower children to exercise critical thinking in how they engage online, and to become proactive, creative users and makers rather than passive consumers.

Name: **AI + Ethics Curriculum for Middle School**

- **Link:** https://docs.google.com/document/d/1e9wx9oBg7CR0s5O7YnYHVmX7H7pnITfoDxNdrSGkp60/
- **Description:** On page 16 of this pdf file, there is a detailed activity with the required materials. Students will have to create an algorithm to make the “best” peanut butter and jelly sandwich. Students then explore what it means to be ”best” and see how their opinions are reflected in their algorithms.

Use Scenario 3: Data Privacy and AI

Idea:

- What data are AI systems collecting about us? How can we keep our online data private?
- *Why:* because AI changes the way some of our most basic human rights need to be protected and adapted.
- *How:* getting students to experiment with AI systems that collect personal data and reflect on what privacy means in the context of AI.

Target level: lower secondary school (ages 10 to 14)

Topic: privacy, digital rights, algorithms, bias

Possible resources:

Name: **Artificial Intelligence and Human Rights – Lesson 4 – Technology and Privacy**

- **Link:** https://www.dayofai.org/curriculum
- **Description:** AI Blueprint Bill of Rights (please register to use lessons for free). Students learn about the increasing use of AI in our everyday lives, and how that use is forcing us to consider how some of our most basic human rights need to be protected and adapted. Students focus on four specific rights: non-discrimination, privacy, transparency and safety, with a targeted lesson on each.

Name: **How Normal am I?**

- **Link:** https://www.hownormalami.eu/
- **Description:** Interactive documentary about how websites and cameras can collect personal and behavioural data and infer pieces of information such as your age, life expectancy, beauty score, body mass index, concentration level, and others. (Sherpa Horizon 2020 Project).

Teaching *about* AI

In this section we describe projects and learning scenarios for primary and secondary schools (K-12) that provide examples for teaching about AI, to train students in the fundamentals of AI from an AI developer perspective. In most cases, these resources imply that students program a simple AI-based solution, with the aim of gaining the AI basics from the background. It is a more technical approach to AI education. Teaching about AI should cover an introduction to AI, which includes the definition and history as well as the importance and applications of AI in various fields. Four key areas of AI should be covered: perception and actuation, representation and reasoning, learning and the impact of AI. Students should get a clear idea of an AI system as an agent (computational system) that is situated in an environment (real or virtual) which interacts with it in an autonomous fashion (no human supervision required) to reach some design goals. Consequently, the teacher should differentiate AI from machine learning, which is a specific area of AI.

However, it is essential to have an introduction to machine learning, covering supervised, unsupervised, and reinforcement learning, as common machine learning algorithms such as linear regression, decision trees, clustering, and neural networks. It is important to explain different ways of data collection and organisation, including identifying relevant data sources for AI projects, data cleaning and pre-processing techniques. It is also important to introduce students in AI applications like computer vision: object detection, recognition, and segmentation, face recognition, and facial landmarks. Additionally, an overview of robotics and control systems should be provided. The topics should also include generative models, natural language processing (NLP) and its applications. The teacher should cover the social implications and biases of AI, privacy, and data security, AI in decision-making and policy, responsible AI development. Within this scope, it is necessary that educators and learners have a proper background in mathematics, programming, statistics and informatics. Education in this realm requires background knowledge about mathematics, statistics, informatics and programming.

Use Scenario 1: Representation & Reasoning in AI

Idea:

- Providing students with the fundamentals of representation and reasoning on AI by means of the development of a smartphone application using App Inventor.
- *Why:* to train them about these 2 key topics of AI.
- *How*: by means of developing a smartphone app

Target level: high school (ages 15 to 18)

Topic: representation and reasoning

Possible resources:

Name: **AI + Project**

- **Link:** https://drive.google.com/drive/u/1/folders/190-rLvuWvKsNtX7Mb2FOB0SLuZTx404w
- **Description:** The linked folder contains a guide file for teachers so they can implement this activity, as well as the code with the solution. Students will develop an app called “School Path Guide”, using a graph representation and a simple probabilistic reasoning algorithm.

Name: **Elements of AI – Building AI – Dealing with Uncertainty**

- **Link:** https://buildingai.elementsofai.com/Dealing-with-Uncertainty
- **Description:** One of the reasons why modern AI methods actually work in the real world - as opposed to most of the earlier old-fashioned methods in the 1960-1980s - is the ability to deal with uncertainty. This activity shows students how Bayes probability works and how relevant it is for reasoning and problem solving in real AI.

Use Scenario 2: Recommendation Systems

Idea:

- Learning about “clustering” and using a clustering application to create their own recommendation system.
- *Why:* to understand how the use of clustering and filtering in recommendation systems in social media platforms can speed the spread of misinformation.
- *How:* by developing a basic understanding of what AI is and how it works in recommendation systems - what data it looks at, and how it chooses to filter content for us.

Target level: high school (ages 16 to 18)

Topic: recommendation, clustering, filter bubbles

Possible resources:

Name: **Day of AI – AI and Social Media**

- **Link:** https://www.dayofai.org/curriculum
- **Description:** AI in social media (please register to use lessons for free). Recommendation systems, the foundation of feeds and suggestions across social media platforms, define what we are and are not exposed to online. In this activity, students look at different forms of misinformation, how the use of clustering and filtering in recommendation systems in social media platforms can accelerate the spread of misinformation, and explore the social implications of these filter decisions for us as individuals, and as a society.

Use Scenario 3: Teaching Machines to Classify

Idea:

- What is a classification task in the context of supervised machine learning context and what are the basic building blocks of a classification pipeline?
- *Why:* to recognise the importance of the quality and the quantity of training data and their impact on the accuracy and fairness of classifiers.
- *How:* by the implementation of a three-step procedure to build a classifier, test it, assess its performance in terms of accuracy and fairness and streamline it when possible.

Target level: lower secondary school and high school (ages 12 to 18)

Topic: classification, machine learning, datasets

Possible resources:

Name: **EU CodeWeek – Supervised Machine Learning**

- **Link:** https://codeweek.eu/training/introduction-to-artificial-intelligence-in-the-classroom and Teaching Machines to Classify: Intro to Supervised Machine Learning, for Lower Secondary School
- **Description:** This activity covers essential concepts of machine learning at an introductory level, focusing specifically on the task of classification. It aims to inspire the future generation of innovators to harness the potential of machine learning and AI and understand related advantages and limitations, through simple yet powerful case studies.

Name: **AI + Project – Image Classification with Machine Learning**

- **Link:** https://drive.google.com/drive/u/1/folders/1lohSLWg8yRsZQEiM2X2oW6Ne_hDYqI6M
- **Description:** Develop a smartphone app using App Inventor that allows to play a scavenger hunt searching game in school based on machine learning.

Scenarios have been developed with pre-university levels in mind, to be used by teachers in formal or informal education. If we move to higher levels, each speciality would require a different focus of teaching about AI. In general, specific training in AI is recommended. For general citizenship education (adult education, informal education), teaching about and for AI is encouraged, and some remarkable initiatives are already available like ciutadanIA or Elements of AI.

Teaching *with* AI

In this section we describe use scenarios for learning/teaching with the use of AI-based tools. To appropriately apply AI-based tools in the classroom, it is important for the teacher to possess a basic knowledge of AI's capabilities, constraints and ethical considerations. As with any digital tool, it is essential to know how to select tools that align with the curriculum, pedagogical goals, and students' requirements, while considering the efficacy, ease of use, and privacy issues associated with these tools. To support and enrich the learning experience, educators should incorporate AI tools into their lesson plans while considering how AI can be used for teaching and for supporting students' learning and assessment, e.g., to personalise learning, provide feedback, or improve collaboration between peers. It is important for teachers to be aware of ethical implications such as bias, fairness, accountability, explicability and transparency of AI, also to assess regularly the effectiveness of AI tools used in the classroom and to ensure that learning objectives are being met and educational experiences are being enhanced. Collaboration between teachers, promoting the sharing of experiences, ideas, and best practices for using AI in the classroom can lead to more effective implementation of AI and other digital tools, as well as a better understanding of its potential benefits and limitations.

Use Scenario 1: Automatic Content Generation

Idea:

- Taking advantage of generative AI tools
- *Why:* to create initial versions of documents, images or art that can be later improved by students.
- *How:* by means of generative AI tools

Target level: all

Topic: text creation, language, arts, maths

Possible resources:

Name: **Genial.ly Generative AI in Education**

- **Link:** https://view.genial.ly/63ec8abdc804dc0018561bbe?fbclid=IwAR3FfHFK_hWIsiVoW8GFjYaLeL8XZfkKfILVB94oiKumKpUohLL0AG_lxgk
- **Description:** Collection of content creation tools.

Name: **Language Styles**

- **Link:** https://chat.openai.com and https://you.com
- **Description:** Write a first draft using you.com or ChatGPT. Use the chosen AI to improve content. Then compare with the other groups, what must be changed to switch between different writing styles. Similar approach for foreign languages: to enrich vocabulary, find synonyms, etc, use Google/ Microsoft Speech-to-Text for pronouncing exercises of new vocabulary.

Name: **Text to Images**

- **Link:** https://labs.openai.com and https://you.com/imagine
- **Description:** For science: classification of animals or fruits. Exploring characteristics of animals or fruits more in depth and use that knowledge to train teachable machine to classify them.
  For language: create a scene from a story. Be aware of the descriptions given.
  For art: Use https://digitalcurator.art/ to create a gallery of a certain style or period. Explore the characteristics of the paintings. Use DALL-E to create your own in the chosen style, confront in group, use a teachable machine to train.

Name: **Teachable Machine**

- **Link:** https://teachablemachine.withgoogle.com
- **Description:** Simple visual tool to create machine learning models
  Biology, categorisation, of birds, insects, etc. and text to image
  Introduction of dynamism (e.g., Giacomo Balla - "Dynamism of a Dog on a Leash", 1912) as well as physical education and anatomy.

Name: **Learning with Quizlet**

- **Link:** https://quizlet.com
- **Description:** Doing flashcards, quizzed with Quizlet or other apps. Creation of flashcards and using them for learning is important.

Use Scenario 2: Intelligent Tutoring Systems

Idea:

- Support teachers on equalising the advance level of students in different subjects.
- *Why:* to simplify the management of heterogeneous groups.
- *How:* by using a learning platform that provides individualised monitoring

Target level: secondary school

Topic: mathematics, programming

Possible resources:

Name: **GOORU NAVIGATOR**

- **Link:** https://gooru.org/about/navigator/
- **Description:** Navigator is an intelligent tutoring system, which monitors students' training in different subjects to reach desired learning outcomes. It provides personalised materials to students.
- **Demo video:** https://www.youtube.com/watch?v=c1IXDN952GM
- **Demo video for K12 maths:** https://youtu.be/IkaAjce1l28
- **NOTE:** It is not free (https://gooru.org/about/pricing/).

Name: **DOMOSCIO SPARK**

- **Link:** https://domoscio.com/en/domoscio-spark-2/
- **Description:** An intelligent tutoring system, which monitors students' training in different subjects to reach desired learning outcomes. It provides personalised materials to students.
- **Demo video:** https://www.youtube.com/watch?v=3LygEeV-NhQ
- **NOTE:** It is not free.

Name: **COBIE AI**

- **Link:** https://cobie.io/smart-classroom/
- **Description:** Intelligent tutoring system that helps students learn to code. The teacher monitors what students are doing and provides help if needed to multiple students at the same time with the help of Cobie AI assistant. The system also includes a lecture synthesis system so that teachers can easily and quickly create personalised lectures.

Use Scenario 3: Automatic Translation of Conversations

Idea:

- Showing students how to maintain a conversation in real time in two languages, to communicate with other persons quickly using the smartphone.
- *Why*: to show them that language knowledge should not be an obstacle for socialising.
- *How*: by means of AI-based technology and their own smartphone.

Target level: all

Topic: conversation, language

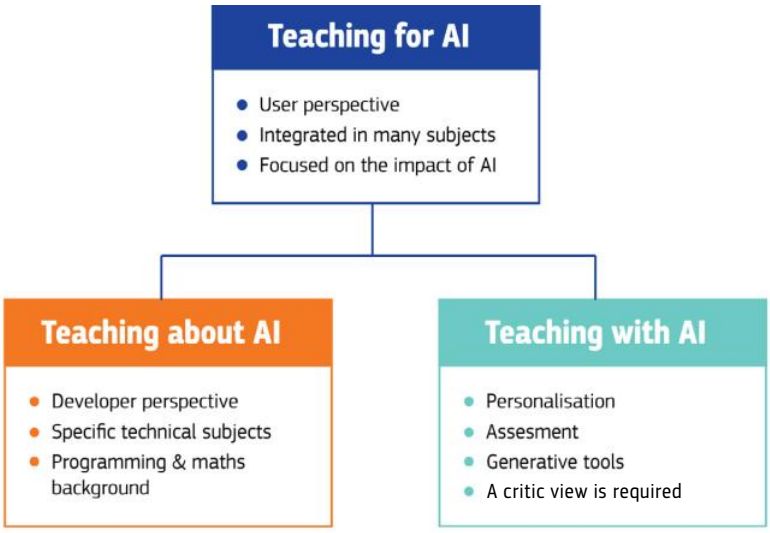
Possible resources:

Name: **SAYHI**

- **Link:** https://www.sayhi.com/en/translate
- **Description:** It is a smartphone app that detects your speech in any language and translates it to any other language in real time.

Recommendations by the Squad

The following diagram summarises the conceptual organisation of AIEd teaching categories presented in this report:



It can be observed that our main recommendation places Teaching *for* AI is on the top, representing the idea that it should be a pre-requisite for the other two.

Focus first on teaching *for* AI by means of practical projects and learning scenarios that provide activities for teachers to engage students in activities that improve knowledge, skills, and attitudes towards how AI systems are used in today's society and focus on everyday application that are driven by AI.

Take advantage of existing resources for teaching *with* AI to enhance teaching and learning. It is essential to know how to select tools that align with the curriculum, pedagogical goals, and students' requirements, while considering the efficacy, ease of use, and privacy issues associated with these tools.

Apply a developer approach when teaching *about* AI to train more specialised students in the fundamental areas of real-world AI, like perception, reasoning, representation or learning. They must face different AI challenges through hands-on and programming projects, so they attain the AI basics from a more technical perspective.

Members of the EDEH squad on artificial intelligence in education who dedicated time for this briefing report: Dara Cassidy, Yann-Aël Le Borgne, Francisco Bellas, Riina Vuorikari, Elise Rondin, Madhumalti Sharma, Jessica Niewint-Gori, Johanna Gröpler, Anne Gilleran and Lidija Kralj.

European Commission

Education about AI

Briefing report No. 4

by the European Digital Education Hub's squad on artificial intelligence in education

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Introduction

Artificial intelligence education is a highly active field, with new resources and tools arising continuously. In previous briefing reports, you may have read about teaching for, with, and about AI, supporting teachers, and identifying the necessary competences for them to become fluent in emerging technologies. With all these dynamic changes, this briefing report aims to highlight the importance of integrating AI literacy into both existing and new curricula. Our focus will be on providing valuable ideas and concrete examples for effectively incorporating AI education.

In the Eurydice report "Informatics education at school in Europe", artificial intelligence is mentioned in the "Awareness and Empowerment" area (one of ten areas analysed) in the context of awareness of the impact of emerging technologies. The report points out that while the "Awareness and Empowerment" area is an integral part of informatics, it is often covered in other subjects such as social sciences. As it is linked to transversal competencies like critical thinking and responsibility, it can be taught in all subjects. In addition, AI is mentioned in the context of continuous professional development for teachers and curriculum reforms, with the intention of including artificial intelligence literacy and data literacy (European Commission / EACEA / Eurydice, 2022).

The report AI Watch National Strategies on Artificial Intelligence: A European Perspective mentions that some Member States have national AI strategies with dedicated sections on AI skills, mostly focused on higher education, but some also address secondary, primary or pre-school levels.

According to the comprehensive 2022 UNESCO report "K-12 AI curricula: a mapping of government-endorsed AI curricula" only a limited number of government-endorsed AI curricula had been developed and implemented by 2021 when mapping was conducted. The UNESCO report emphasises that further research is needed to determine the extent to which K–12 curriculum reform will include the development and implementation of AI curricula.

This is why the current document proposes some examples of different countries' approaches on education about AI. As you will see below, some countries have chosen to develop new curricula, while others integrated AI into their existing ones.

Country Use-Cases

Belgium

Education in Belgium is managed, controlled and financed by one of the 3 linguistic communities: Flemish, French and German-speaking. Each community's education system operates as a distinct federal region based on the language of that community. The Federation Wallonia & Brussels focuses on French, the Flemish Community on Dutch, and the German-Speaking Community on German. One notable aspect of this organisation is the high degree of independence of each community, which leads to different approaches regarding the integration of AI into curricula.

Regarding digital education, the most recent report from the EU Education and Training Monitor highlights the following:

- The Flemish Community is actively involved in curricular reform, digital equipment, strengthening media literacy, and creating innovative learning environments (Vlaamse Regering 2019, Strategisch Plan Geletterdheid 2017-2024). Each school is encouraged to have a digital strategy. Digital competences, based on the DigComp framework, are gradually being integrated into the new primary and secondary curricula as cross-curricular attainment goals.
- The French Community is in the process of drafting curricula for pupils up to 15 years old and teacher training programs, based on an adaptation of the DigComp framework (Digital education at school in Europe Eurydice, 2019). However, planned reforms of initial teacher training and curricula are facing delays and will be rolled out gradually. Measures to improve students' digital competences are not yet in place.

Although AI competences are briefly mentioned in the new curricula, there is little detail provided regarding what should be taught to students. A few Belgian organisations, mostly from the non-formal education sector, are starting to implement drafts of AI curricula aimed at the primary and secondary schools. The most notable initiatives are:

- At the federal level: The AI4InclusiveEducation consortium, funded by the Digital Belgium Skills Fund
- In the Flemish Community: Dwengo, Amai!, and the Sint-Lievescollege (Prof. Robbe Wulgaert)
- In the French Community: Namur University Scholl-IT, Edu-Lab

Ireland

The Department of Education in Ireland published the Digital Strategy for Schools in 2022. It serves as a roadmap for schools to develop an overall direction for school management and in utilising digital technology in educational settings at both primary and post-primary levels. It aligns with the aims and objectives of the European Digital Education Plan and is built on three main pillars or axes.

Pillar 1: Supporting the embedding of digital technologies in teaching, learning and assessment

Pillar 2: Digital Technology Infrastructure

Pillar 3: Looking to the future: policy, research and digital leadership

It is within Pillar 3 that specific mention is made of artificial intelligence. Building on an earlier document, the National Strategy on Artificial Intelligence (AI) titled 'AI-Here for Good', there is a specific mention of the need to ensure that the strategy aims to build an understanding of how data and AI may be applied in an educational context.

Using the Digital Strategy document as a basis, some curriculum work has been done in the past year to develop pupils' understanding of AI. A specific module called 'AI in my Life' has been developed by Dublin City University (DCU) and offered to all upper secondary schools in 2023. This module follows a pilot program involving approximately 8,000 secondary school pupils from 100 schools in 2022. The module, which covers about 20 hours, focuses on topics such as learning about AI and how it works, exploring ethical and privacy implications, and evaluating the role of AI in their lives and society. It also explores future career paths in AI.

Italy

Since the pandemic and the lockdown, which necessitated distance learning, Italy has introduced several reforms and funding to promote digital skills and literacy among teachers and learners. The latest action plan is 4.0 Schools (2022). While the Next Generation Classrooms initiative generally focuses on teaching/learning spaces and methods to improve metacognitive (critical thinking, creative thinking, learning to learn and self-regulation) and non-cognitive skills (empathy, self-efficacy, responsibility and collaboration), the Next Generation Labs specifically addresses the training of specialised digital skills from secondary school onwards. These labs cover topics such as robotics and automation, cybersecurity or data processing. The labs are designed to be fluid learning environments where different experiences can be lived, personal skills can be developed in collaboration with peers, teamwork can be learned, and specific job-oriented digital skills can be acquired across different economic sectors, allowing the management of flexible curricula oriented towards new jobs that require more advanced digital skills.

In the Italian education system, the curriculum is based on guidelines that provide schools with a framework they must comply with when defining their own curriculum. To this end the guidelines describe the general and specific learning objectives, compulsory subjects, and timetables. Freedom of teaching is a principle outlined in the Italian Constitution (Article 33). The choice and use of teaching methods and materials must be consistent with the school curriculum included in the Three-year Educational Offer Plan (Piano triennale dell'offerta formativa – PTOF), which, in turn, must be consistent with the general and educational objectives of the national guidelines for the curriculum (Indicazioni nazionali per il curriculum). The document "National Indications and New Scenarios," referenced in Ministerial Note No. 3645 of March 1, 2018, provides schools with new guidelines for updating school curricula to computational thinking and the development of digital skills. While safeguarding the freedom in teaching, the National Guidelines for the curriculum suggest some basic methodological approaches, such as, taking advantage of pupils' experiences and knowledge, promoting exploration and discovery activities, encouraging cooperative learning, developing awareness of one's own learning method, carrying out in-lab learning, etc. The most common teaching methods used are frontal teaching,

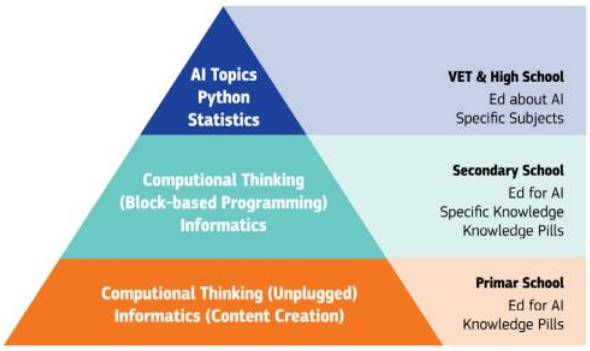
exercises, and individual/group work. Schools generally have facilities such as a gymnasium, a library and ICT, science, and multimedia laboratories. Almost all classrooms (99%) are equipped with interactive whiteboards (IWB). Teachers at all grades can choose the textbooks and other teaching materials for their classes. Textbooks can be in digital or mixed versions (either paper or paper and digital versions), all including integrative digital content, and must align with the curriculum and the school's Three-year Educational Offer Plan (PTOF). In addition, for specific subjects, schools can create their own digital teaching tools which students can use as textbooks (law 128/2013).

Civic education was introduced **for all school grades** in 2020/2021 and the lesson time could be used to teach transdisciplinary topics like in this case AI skills, focusing on ethical, societal and political aspects of AI. Students can learn AI ethics, discussion topics like privacy, data security, and bias. They can understand the influence of AI on politics and democracy, such as its potential role in misinformation campaigns. The social impact of AI, such as employment and inequality, and the intersection of AI and law could be discussion points to foster students' understanding of how AI impacts daily life.

Spain

The new education law in Spain (LOMLOE) includes contents of AI in different levels, from primary school to high school, mainly related with technology subjects.

But the strategy is open, and other fields and subjects from humanities also include AI topics.
The following graphic provides an overview of the roadmap for integrating AI into curricula across different education levels.



As can be observed, at the lower levels (upper primary school, 10-12 years old), the focus is on developing computational thinking and basic digital skills, such as computer usage. AI concepts are not specifically taught at this level, but teachers can incorporate activities related to technical thinking in general. Moving on to secondary school, at the lower levels (12-14 years old), the aim is to build upon the primary school strategy by introducing block-based programming alongside basic training in mathematics, logic, and informatics. At the upper secondary school level (14-16 years old), teachers can use specific AI resources within their subjects or even create dedicated AI courses. However, the approach should be geared towards "teaching for AI", where students do not require advanced programming skills or background knowledge. Lastly, in high school and vocational education, the emphasis shifts to a "teaching about AI" approach, which is more technical in nature. Students are expected to program AI-based solutions and learn about science of data and machine learning.

Below, you will find a specific example of an AI curriculum implemented in the Galician region, following national guidelines. The curriculum highlights the AI skills and knowledge incorporated into the mentioned subjects:

Digitisation (4th level – 15 years old)

Block 3. Computational thinking:

- CA3.1. Understand the foundation of artificial intelligence algorithms, valuing the importance of making ethical use of information processing in the development of applications.
- Introduction to artificial intelligence. Creating practical applications of AI.

Block 5. Critical digital citizenship:

- Ethics in the use of data and digital tools: artificial intelligence, algorithmic and ideological biases, technological sovereignty and sustainable digitisation.

Education in civic and ethical Values (3rd level – 14 years old)

Block 2. Society, justice, and democracy

- The challenge of artificial intelligence.

Technology (4th level – 15 years old)

Block 4. Programming, automation, and robotics

- CA4.2. Use, with a critical and ethical sense, computer applications and digital control and simulation technologies, such as the Internet of Things, big data and/or artificial intelligence.
- Introduction to artificial intelligence and big data: practical applications. Shared spaces and virtual disks.

Technology and Digitiation (2nd level – 13 years old)

Block 4. Programming, control, and robotics

- CA4.2 Program simple applications for different devices (computers, mobile devices, and others) using programming elements appropriately and applying editing tools and artificial intelligence modules that add functionality.
- Introduction to artificial intelligence.

Philosophy (1st high school – 16 years old)

Block 2. Knowledge and reality

- The mind-body problem from the modern age to artificial intelligence.

Technology and Engineering II (2nd high school – 17 years old)

Block 5. Programming, automation, and control

- Artificial intelligence, big data, distributed databases and cyber security.

The following are the specific AI subjects that will start in year 2023/24. The first one follows the "Education for AI" approach, while the second one follows the "Education about AI" one:

AI for society (4º ESO – 15 years old)

B1. What is artificial intelligence?

B2. Impact of AI

B3. Areas of AI

B4. AI technologies

AI technologies (1º bach – 16 years old)

B1. Fundamentals of Python programming for AI

B2. The intelligent agent

B3. Computer vision projects and impact

B4. Natural language projects and impact

B5. Supervised learning projects and impact

Ukraine

To include modern topics such as AI in education, it is not always necessary to rewrite the entire curriculum or study program, which can be a lengthy process. By having a broadly defined curriculum, it becomes possible to update the content to include AI while keeping the learning outcomes of the current program intact. For instance, in a standard high-school informatics course, the module originally named "Informational Technologies in Society" covered information technologies and systems in modern society, future professions, aspects of cybersecurity, e-government systems, and more. The learning outcomes were formulated quite broadly and flexibly:

- Explain the role of modern information and communication technologies in society and human life.
- Understand the general principles of work and areas of application of artificial intelligence systems, the Internet of Things, and smart technologies.
- Independently learn and adapt to new technologies.
- Recognise the communicative role of IT and the evolving trends of the digital society, as well as the impact of information technologies on people's lives.
- Make informed decisions about future careers by consciously applying IT knowledge.
- Respect rights and freedoms, including freedom of speech, online privacy, copyright and intellectual property, personal data, etc.

A working group comprising school and university teachers, along with IT professionals, was able to suggest AI-oriented content that could be covered in approximately 10 hours of class time. The content is designed to provide a general introduction to the topic of AI, rather than focusing on specific technologies or in-depth understanding.

The lessons in the "Artificial Intelligence" cycle are based on the educational series "Artificial intelligence for schoolchildren" developed by the Ministry of Digital Transformation. Most of the suggested lessons are practice-based and introduce various AI tools.

1. Information technologies and systems in modern society
2. Artificial intelligence
3. Technologies and tools of data analysis
4. Social aspects of large-scale data analysis
5. Digital citizenship and electronic governance
6. Information security
7. Practical problems and career opportunities

Conclusion and Recommendations

Examples presented in this briefing report show us that there is no right or wrong path towards education about AI; it is simply a matter of analysing the cultural, technical, social, and educational context of the country and deciding which approach is optimal. By taking a more critical approach to AI integration into curricula, different countries might even develop new and creative ways of implementing it into education.

Different countries have made different decisions regarding AI integration into curricula. Some decided to create new curricula to teach about AI, others to integrate it into existent curricula. It is thus important to have a critical approach when thinking about integrating AI into curriculum, take into consideration the local context but also look at the solutions found by other countries.

While approaches may vary, there is a growing consensus on the importance of introducing AI concepts to students at different educational levels, ensuring that they are equipped with the necessary skills and knowledge to thrive in a world increasingly influenced by AI and related technologies.

Recommendations by the Squad

- To ensure a comprehensive and unbiased approach to learning, it is essential that AI curricula are not tied to specific technologies or brands.
- With the aim of facilitating the development of the European Education Area, it would be beneficial if Member States shared good practice examples, thereby ensuring that students entering tertiary education possess comparable levels of competence about AI.
- Integrating AI into curricula requires both resource development and teacher training.
- The evidence-based approach would enhance the content and effectiveness of AI curriculum.
- Education about AI is needed, but freely embracing education with AI needs to be done with some caution.

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