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Friend or foe?

Evidence from the use of generative artificial intelligence in learning and teaching

European Education Policy Paper

European Education Policy Papers series

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They aim to support EU and national policymaking in education by providing accessible, policy-relevant evidence.

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Friend or foe? Evidence from the use of generative artificial intelligence in learning and teaching

Directorate-General for Education, Youth, Sport and Culture

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Glossary

Adaptive Learning Systems refer to artificial intelligence-driven systems that personalise education by adjusting to the specific needs of individual learners. These systems modify content, pace, or delivery methods to enhance each learner's experience (European Commission, 2026).

AI agents refers to the nascent ability of Large Language Models to independently plan, collect data, execute commands and utilise other systems to solve tasks. No formal definition of AI Agents exist within the EU context, but the AI Act Service Desk underlines that "(...)there is broad agreement that an AI agent must have the ability to receive and process input from their environment, and execute actions based on this processing that may interact with or affect their environment."

AI foundational model refers to a general-purpose AI model, which is "trained with a large amount of data using self-supervision at scale, that displays significant generality and is capable of competently performing a wide range of distinct tasks regardless of the way the model is placed on the market and that can be integrated into a variety of downstream systems or applications" (Article 3(63) AI Act).

AI literacy refers to "the technical knowledge, durable skills, and future-ready attitudes required to thrive in a world influenced by AI. It enables learners to engage, create with, manage, and design AI, while critically evaluating its benefits, risks, and ethical implications" (OECD/European Union, 2026b). At EU level, the definition of the EU AI Act in Article 3(56) states that 'AI literacy' means skills, knowledge and understanding that allow providers, deployers 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.

Artificial intelligence (AI) system refers to a machine-based system designed to operate with varying levels of autonomy, which may exhibit adaptiveness after deployment, and which, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments[1].

Custom prompting refers to the intentional design or adaptation of instructions provided to a generative AI system in order to influence the content, format, accuracy, tone, or pedagogical purpose of the generated output.

EdTech (short for educational technology) indicates the industry that combines education and technological advances as well as the scientific field which involves the interdisciplinary knowledge informing the use of technological tools and devices, processes and procedures, resources and strategies to improve learning experiences in a variety of learning settings (SWD/2020/209 final).

Generative Artificial Intelligence (genAI) refers to a specific category of AI tools and systems designed not only to analyse data but to adapt and generate content such as text, images, code, or music. These systems (e.g. large language models, diffusion models for image generation, and multimodal AI tools) are trained on vast datasets and can produce 'human-like' outputs based on prompts or instructions (European Commission, 2026).

Institutional guardrails are organisational, technical, ethical, and procedural safeguards established by institutions to ensure that AI systems are used safely, lawfully, ethically, and in accordance with institutional objectives and regulatory requirements.

[1] Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence

Intelligent Tutoring Systems (ITS) refer to advanced computer-based learning environments that aim to provide personalized, adaptive, and interactive instruction by emulating many of the key functions of a human tutor. They leverage techniques from Artificial Intelligence (AI), cognitive science, and educational psychology to tailor the learning experience to the individual needs, pace, and understanding of each learner. ITS are designed to support self-regulated learning, provide immediate and individualized feedback, adapt to the learner's evolving competence[2].

Machine learning refers to a branch of AI that enables computer systems to identify patterns, make predictions, and adapt over time using large sets of data without being explicitly programmed. The system statistically "learns" from experience and adjusts its outputs as new data are introduced (European Commission, 2026).

Large Language Models (LLMs) refer to an AI tool trained on vast amounts of text data—from books, articles, websites, and more—to understand and generate human-like text. It can perform a wide range of language-based tasks such as writing essays, answering questions, summarising texts, translating languages, coding, and generating ideas (European Commission, 2026).

Natural Language Processing (NLP) refers to a branch of AI that enables computers to understand, interpret, and respond to human language in spoken or written form. It powers many systems that allow users to interact with technology using everyday language rather than programming commands (European Commission, 2026).

Retrieval-augmented generation is an AI architecture that combines information retrieval with generative AI models, enabling systems to retrieve external knowledge sources before generating responses.

Scaffolding refers to the support provided to learners that enables them to accomplish tasks they could not complete independently, with support gradually withdrawn as competence increases.

[2] https://eu-jamrai.eu/intelligent-tutoring-systems/

Foreword

This report has a clear purpose – to look at how Generative AI is being used, especially in the classroom, and to identify the positives and negatives - from the perspective of the student, the teacher, the parent, the researcher and the institution.

As I sat down to write this foreword, an interesting thought experiment occurred to me. What would happen if I used a Generative AI prompt to help me? Would I simply ask the question: "Is Generative AI a Friend or Foe?" and use the response, or would I use a comparative approach in the prompt results themselves?

This reflex reminds us of one of the most important skills that need to be taught – one that can only be taught by humans – the capacity to apply *critical thinking*. It is this ability that will help us keep GenAI as a friend and guard us from the risk of it becoming a foe.

The wider impact of Artificial Intelligence, whether it is voice assistants, GPS navigation, social media feeds or autonomous vehicles, are all part of a societal discussion. Some of these will impact on the education sector and will be addressed in the European Commission's Education Package at the end of 2026.

This report, however, focusses on the extent to which GenAI is impacting on education now. From students learning how to access information and how to analyse it. To teachers gaining new possibilities for personalised instruction and support. Educational institutions, and systems, are adapting their policies and practices. And parents, as the report helpfully emphasises, have an even bigger role to play in each child's education journey, especially by showing the difference between helpful digital tools and digital *distraction*.

The European Commission is leading this conversation. Through our Union of Skills, we are addressing the need for systemic adaptation to fast-changing skill demands. We are placing people at the centre of Europe's competitiveness and preparedness agenda.

Delivering on the Digital Education Action Plan, in March 2026, we updated the Guidelines on the ethical use of AI and data in teaching and learning for educators. The Commission-OECD AI literacy framework for primary and secondary education of June 2026 sets out a common approach.

The findings of this paper present a growing evidence base from the use of generative AI in education. Used appropriately, generative AI can support more personalised learning, help educators design new pedagogical approaches and reduce their workload, and assist learners with different needs and backgrounds.

At the same time, there are risks related to bias, privacy, and overreliance of its users. The increased use of the technology underlines in particular the importance of being able to *think before you prompt*.

The latest PISA results shed a new light on these risks and show that some of the potential concerns raised in this report deserve immediate attention. We must ensure that students use AI in a critical manner that supports their cognitive development.

We also need to make sure that GenAI does not widen the digital gap we have been working so hard to narrow.

The forthcoming European Commission Education Package with its strong AI and digital dimension will continue our commitment to empowering human agency and strengthening digital sovereignty.

Reading, mathematics, and science literacy, digital skills and civic competences are still the bedrock. They are part and parcel of what defines our sense of society, in an increasingly AI-enabled world.

Preparing education systems for the upcoming changes is a challenging task. It requires not only more but a new kind of cooperation between many actors. I hope this paper will provide useful insights for policymakers and practitioners across the EU.

The predications on how Artificial Intelligence will influence society is on a grand scale. Many forecasts outline huge benefits; some are less optimistic.

What this report outlines is that Generative AI if used correctly, can be part of instilling that most precious skill – learning how to learn.

Roxana Mînzatu

Executive Vice-President

Social Rights and Skills, Quality Jobs and Preparedness

Executive summary

Generative artificial intelligence (genAI) is a new class of AI systems that can generate original content in response to user prompts. This includes text, images, audio, video, computer code, and data analyses. Unlike traditional AI systems, which are mainly designed to classify information, recognize patterns, or make predictions, genAI produces new material that resembles human-created content.

GenAI is taking the world by storm. Earlier waves of technological integration in different spheres of society and the economy (such as the arrival of the personal computer or the internet) have been surpassed by the current uptake of genAI, which can effectively create new content that is hardly distinguishable from human-created content.

The world of education has been particularly influenced by both promises and risks, which genAI presents for students, teachers, parents and school administrations. In addition, given its novel nature and fast pace of development, genAI might also bring unexpected effects on education, which are currently not foreseen by anyone. The technology's advantages include the possibility to enrich teaching and learning methods – for example through the possible use as a personalised tutor, individualised support to students with special needs, or a much-needed administrative-burden-relief to overworked teachers. Criticism focuses on the risks related to its use, like the challenges it brings to academic integrity, potential for cognitive overreliance of its users, or data privacy and ethical issues. In other words, generative AI can be both a friend and a foe to the educational landscape.

Whether genAI is beneficial for learning outcomes ultimately depends on how the technology is used. Experimental studies[3] demonstrate that when genAI is used to augment human knowledge and students engage constructively with it, this is associated with higher learning outcomes. Conversely, when students use genAI mechanically, taking information that is generated at face value and not augmenting with their own understanding, this can result in lower learning outcomes. This important result has been confirmed in the recent PISA 2025 survey.

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3 See for example part 2 on the implications for students.

The advent of powerful genAI models is transforming institutional policy. After initial conservative reactions in late 2022, including many outright bans, the technology is moving from a technological innovation to a mainstream tool in the EU, with 20 education systems reporting at least one top-level policy framework addressing the integration of AI or other emerging technologies in schools.

Institutional guidelines play a crucial role in shaping responsible genAI use. In their absence, educators and students may adopt inconsistent or potentially harmful practices. Institutional integration of AI literacy programmes can address academic integrity issues and AI literacy is in fact increasingly important for academic success and better job prospects later on in life. As a result, many European countries have already started integrating AI literacy in national school curricula and guidelines. Additional aspects that can support the responsible genAI use include initial and continuous teacher training, or the availability of infrastructure and appropriate genAI tools.

Increased uptake of genAI has implications for national school curricula. The impressive ability of generative AI to summarise and explain complex information might significantly change how students access knowledge and challenge traditional assumptions around knowledge acquisition, critical thinking, and assessment within national education systems. The ability of the technology to summarise text for example might put into question the adequacy of current writing curricula, as it is no longer certain whether education systems can continue to teach writing in the same way when genAI can help refine and translate ideas into well-crafted text. The evolution of genAI tools could also enable changes to curricula that result in better outcomes for students with learning disabilities, or an increased emphasis on students' capacity to plan, structure and rethink content. In response to such challenges and potential benefits, many of the European education systems have already started to adapt their national school curricula.

Students are at the forefront of the genAI transformation in education. In 2025, four in ten young people aged 16-24 across the EU reported using genAI tools for formal education. Strong national differences can be observed between Member States, with young people from Spain (59.4%), Czechia (58.8%) and Estonia (58%) reported the highest levels of genAI use for formal education, with Poland (28.6%), Romania (24.8%) and Germany (17.6%) on the other end of the spectrum[4]. Students experience both the technology's potential to enhance learning and the potential challenges related to cognitive and socio-emotional development. Evidence on the impact of genAI on learning outcomes remains piecemeal, as generative AI has only recently started being integrated into learning. Therefore, its overall impact on long-term skills performance remains unclear.

GenAI tools can support the successful performance of scholastic tasks but might not lead to genuine knowledge acquisition. While the use of off-the-shelf generative AI can lead to successful completion of scholastic tasks, it may not boost knowledge gain and transfer. A particular concern related to the use of generative AI in educational settings is to what extent students might cognitively (over)rely on the technology. The available evidence remains inconclusive, but also suggests that students might be prone to rely on, rather than learn from, genAI assistance. And where this is the case, the performance of students decrease, as demonstrated by the PISA 2025 survey results.

GenAI tools developed with pedagogy in mind are likely to produce better educational outcomes. While a clear and systemic picture of the genAI tools used in educational settings is not yet available, these can generally be distinguished between genAI models fine-tuned for educational purposes and genAI models used for education, alongside other purposes.The available evidence strongly points to the superior performance of learning-oriented genAI models over off-the-shelf tools in terms of their effect on educational outcomes. This brings important policy implications, but also distinct challenges related to the educational use of off-the-shelf genAI tools. While many of the shortcomings of off-the-shelf genAI models (such as revealing the answer outright rather than guiding the student to it) can be addressed during integration in educational settings, learning also takes place outside of the classroom. This stresses the necessity to also monitor for continued skills erosion due to extra-curricular use of off-the-shelf genAI tools.

[4] Eurostat (isoc_ai_iaiu)

Recent advances in genAI can support a more personalised approach to education. GenAI is increasingly used to automate learning activities, breaking complex lessons into manageable chunks and providing temporary support (i.e. scaffolding), which can include personalised reminders for the task completion, automated real-time feedback or recommendations on what and when to study. Students receiving one-on-one tutoring have been shown to outperform peers in traditional classroom settings by an average of two standard deviations, however, the roll-out of one-on-one tutoring to large student populations is challenging due to the high cost and resource demands. Generative AI holds the promise to solve the long-standing dilemma on the scalability of tutoring programmes.

Unequal access to genAI might reinforce existing equity and inclusion challenges in education. Socio-economic and demographic characteristics, such as gender, age, family income, family size, or (parental) educational level can influence who accesses genAI tools and can benefit from genAI technologies in learning environments. When universally accessible, genAI use might introduce new disparities due to divergences in how students with different socio-economic backgrounds use the technology.

It is still unclear how generative AI might affect child development in educational contexts. The potential impact on children's emotional development and well-being, and its connection to educational outcomes, remains underexplored. Socio-emotional competences are key to academic success, so better understanding whether and how the usage of genAI-powered tools in educational contexts might affect the development of certain socio-emotional skills in children remains paramount from a parental, scholastic and societal perspective.

Generative AI promises to be transformational for teachers but also bring additional complexities to teaching. GenAI tools could help decrease teachers' workload by supporting the creation of lesson plans and assignments, thereby freeing up time and extending the possibility to focus on content and pedagogical development. However, the increased complexity of initially integrating genAI in the classroom and possible need to subsequently monitor genAI-created content might also entail additional efforts for teachers, putting into question how much time the uptake of the technology can ultimately free for teachers.

Teachers need substantial initial and continuous professional development to make full use of the benefits offered by genAI. Only 29.7% of teachers in the EU engaged in continuous professional development activities on the use of AI for teaching and learning according to TALIS 2024. Across the EU, most teachers (53%) neither participated in professional learning nor reported a high need, while 22% participated without reporting high need[5]. Considerable support will be necessary to improve teachers' AI literacy and skills and allow them to keep track with the ever-increasing genAI capabilities. Important research gaps exist, related to whether teachers are also prone to cognitive offloading or might have to invest more time into integrating and monitoring genAI use than the technology can save for them. Addressing such gaps could ensure that the uptake of genAI does not ultimately come at the expense of the quality of the teacher's profession.

Parents play a key role in supporting their children's learning in digital environments. At the same time, guidance or mentoring on how to boost parents' digital competence in the age of genAI is still lacking to a great extent. Improving parents' digital literacy can support children's learning in genAI environments, but genAI cannot replace the importance of everyday parental support to their children's development. Potential long-term cognitive costs stemming from the use of off-the-shelf genAI tools at home deserve careful consideration, so they do not undermine educational outcomes in the classroom.

Traditional AI tools can support the involvement of disadvantaged parents in the school community by facilitating real-time direct contact between non-native speaking parents and teachers. Such AI tools can also support the effective and timelier parental engagement with their children's academic performance, which is essential for fostering student success. Traditional AI systems can support parents (and teachers) in detecting early signs of academic struggle and also foster possible proactive interventions. The potential of genAI tools in particular to support parents is not clear cut, with possible benefits to be balanced against many inherent drawbacks of the technology.

[5] TALIS 2024.

Further dedicated research in the EU educational context is necessary to better understand the impact and usage of genAI, in particular on students and teachers. Most of the current evidence comes from outside the EU, which raises questions as to the extent of applicability/transferability of such findings, given that genAI systems designed primarily for global audiences may not always respond effectively to the needs of particular cultural or educational contexts. In addition, limitations of the methodology behind the current evidence base underline the need for developing large-scale, representative and longitudinal data on the impact of genAI on teaching and learning to better understand the long-term impact of genAI on basic skills performance.

Introduction

The rise of generative AI and its effect on the educational landscape

Generative artificial intelligence (genAI) Is a new class of artificial intelligence systems capable of generating original content in response to user prompts. These systems can generate a wide range of outputs, including text. GenAI differs significantly from earlier forms of artificial intelligence, such as rules-based AI systems and traditional machine learning models.

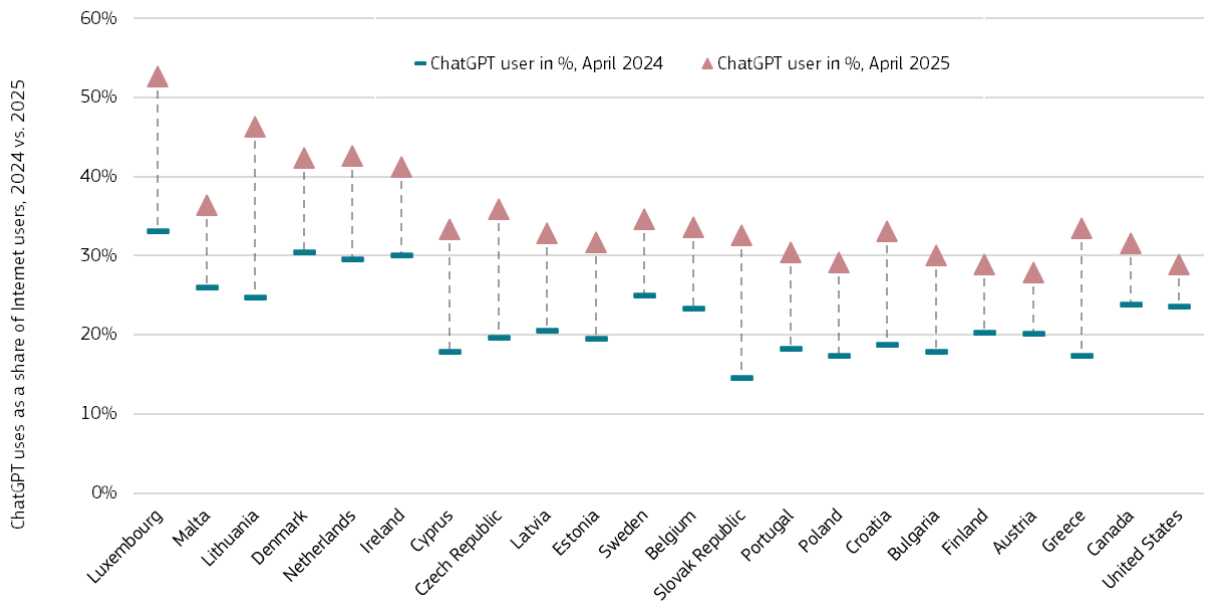
Rules-based AI tools rely on pre-programmed instructions and predefined decision trees (if-then instructions), which limit its capabilities to situations anticipated by human developers. Traditional machine learning systems are generally designed to perform predictive or classification tasks such as recognizing patterns, detecting anomalies, or forecasting outcomes from existing data. By contrast, generative AI generates new content that resembles human-created material, often synthesizing information in novel ways. So, while it is only one type of AI system among others, genAI's capacity for content generation has turned it into a transformative technology across multiple sectors, including education. The present paper is therefore focused on generative AI.

Since the launch of OpenAI's chat-based generative pre-trained transformer model (ChatGPT) in November 2022, generative Artificial Intelligence has taken the world by storm, and its uptake continues to grow yearly. Referring to ChatGPT visits as a share of Internet traffic as a proxy shows that the usage of genAI in the EU is on par with international peers, such as Canada and the USA, and even surpasses them in some of the EU Member States (e.g. Luxembourg, Lithuania, the Netherlands, Denmark, Ireland) - see Figure 1.

GenAI can be defined[6] as a "specific category of AI tools and systems designed not only to analyse data but to adapt and generate content such as text, images, code, or music. These systems (e.g. large language models, diffusion models for image generation, and multimodal AI tools) are trained on vast datasets and can produce 'human-like' outputs based on prompts or instructions" (European Commission, 2026). Put more simply, genAI can effectively create new content that is hardly indistinguishable from human-created content.

[6] For more on the definitions used throughout this paper, please also see the Glossary at the end.

Figure 1: Increase of ChatGPT total monthly visits in the EU as a share of Internet traffic, 2024-2025



Source: Liu et al. (2025).

Earlier waves of technological integration in different spheres of society and the economy (such as the arrival of the personal computer or the internet) have been surpassed[7] by the current uptake of genAI (Bick et al., 2025), underpinned by its unmatched capacity to generate new content.

The technology's ability to generate new high-quality, human-like text in response to simple prompts has shaken many aspects of society and the economy, including the world of education, to which it has brought potential benefits, but also pitfalls. Its advantages include the possible use as a personalised tutor, individualised support to students with special needs, or a much-needed administrative-burden-relief to overworked teachers. Criticism focuses on the risks related to its use in education settings, like the challenges it brings to academic integrity, potential for cognitive overreliance of its users, or data privacy and ethical issues. This mix of simultaneous promises and challenges has caused Weng et al. (2023) to label genAI as both "a friend and a foe" to the world of education.

The perceptions of Europeans on the use of AI (not limited to genAI) in education are mixed. According to the 2025 Flash Eurobarometer on Future needs in Digital Education[8], more than half (54%) believe that AI can both benefit and bring risks to teaching and learning, and underline the importance of the education community assessing and exploring both. Nearly one in four respondents (22%) think that AI does not belong in the classroom. In contrast, about one in six (17%) state that AI can improve teaching and learning, and that the education community could benefit from experimenting with it.

The EU policy context[9]

The European Union has already done much to actively shape the AI landscape, take full benefit of the many promises the technology brings, and address the potential issues. With the EU AI Act, adopted in 2024[10], the EU has been promoting responsible AI development and deployment, including through its provision on AI literacy (Article 4). The European Commission has also launched the AI Continent Action Plan[11] to strengthen the EU's AI capabilities and the Apply AI Strategy[12] to foster AI adoption in key industries and the public sector, including

7 Relative to each technology's first mass-market product launch, Bick et al. find that work adoption of generative AI has been as fast as the personal computer (PC), and overall adoption has been faster than either PCs or the internet.

8 https://europa.eu/eurobarometer/surveys/detail/3352

9 For more information on the EU policy context, please see annex 1

10 https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai

11 https://digital-strategy.ec.europa.eu/en/library/ai-continent-action-plan

12 https://digital-strategy.ec.europa.eu/en/policies/apply-ai

education. Both communications also recognise AI literacy, skills and talent as enablers of AI innovation and responsible adoption, putting forward dedicated actions, such as the creation of the AI Skills Academy, which will train students and professionals on AI, and especially GenAI, across sectors. The General Data Protection Regulation (GDPR)[13], which governs how personal data must be collected, processed, stored, and protected, shapes the use of generative AI in education, as such systems often process student data. In the field of education, the European Commission has recently put forward several general initiatives, which frame how the EU could address the challenges and opportunities stemming from the unfolding digital transformations of education systems, such as the Union of Skills communication[14], the Basic Skills Action Plan[15], the STEM Strategic Action Plan, and the 2018 European Key Competences for Lifelong Learning Recommendation[16].

In addition, several other initiatives focus directly on the digital transitions in education and the recent rise of AI use in the classroom.

The Digital Education Action Plan (2021-2027)[17] sets out a common vision of high-quality, inclusive and accessible digital education in Europe and aims to help national education and training systems adapt to the digital age. Following the review of the Digital Education Action Plan, the digital dimension of the upcoming Education Package is being prepared, which aims to establish a robust and inclusive EU digital education ecosystem that addresses emerging needs, including in the context of the rapid AI transformation.

To address the importance of using AI in teaching in an ethical and responsible way, the Directorate-General for Education, Youth, Sport and Culture of the European Commission has recently released its updated Guidelines on the ethical use of artificial intelligence and data in teaching and learning for educators[18], which focus on supporting teachers and school leaders make informed choices, build confidence step by step, and develop the necessary skills to take advantage of AI while managing potential risks.

The European Commission, together with the OECD, has also developed the AI literacy framework for primary and secondary education.[19] This framework focuses on what are the set of competences young people need to understand and interact with AI systems in a confident and critical manner, based on essential knowledge, skills, and attitudes.

The European Digital Competence Framework[20] has recently been updated (DigComp 3.0) to embed AI competence across all areas of digital competence and everyday tasks. It incorporates recent and emerging digital technological trends and their implications for digital competence. In the revised framework, AI-related knowledge, skills and attitudes are featured in all 21 competences. The Commission services have begun work towards an update of the European Digital Competence Framework for Educators (DigCompEdu) to reflect the rapid technological changes impacting education today.

The Council Conclusions on teachers in the era of artificial intelligence[21] acknowledge that AI is rapidly reshaping education and has the potential to influence how teaching and learning are organised, how information is accessed, and how schools manage administrative tasks. The Conclusions call on EU Member States to strengthen teachers' AI and digital skills, promote the development and use of education-specific AI tools, address unequal access to digital resources, and ensure AI enhances rather than undermines autonomy and sustainable working conditions for teachers.

The upcoming EU Teachers Agenda will aim to boost the status, working conditions, and career prospects of educators, focus on navigating digital and green transitions, and support their professional development.

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13 https://eur-lex.europa.eu/eli/reg/2016/679/oj/eng

14 https://commission.europa.eu/topics/competitiveness/union-skills_en

15 https://education.ec.europa.eu/document/action-plan-on-basic-skills-legal-document

16 https://op.europa.eu/en/publication-detail/-/publication/297a33c8-a1f3-11e9-9d01-01aa75ed71a1/language-en

17 https://education.ec.europa.eu/focus-topics/digital-education/actions

18 https://op.europa.eu/en/publication-detail/-/publication/f692aa0b-17a7-11f1-8870-01aa75ed71a1/

19 https://ailiteracyframework.org/pdfs/framework_pdf/AILF_en.pdf

20 https://joint-research-centre.ec.europa.eu/projects-and-activities/education-and-training/digital-transformation-education/digital-competence-framework-digcomp/digcomp-30_en

21 https://data.consilium.europa.eu/doc/document/ST-8262-2026-INIT/en/pdf

The present paper

Generative AI is a nascent technology, so research on its impacts on education is in its infancy and as yet inconclusive. Most of the initial research done has been focused on a normative analysis of the genAI impact on education (i.e. what should happen, and vice versa what should be avoided). To support ongoing policy initiatives (and address the steep rise of genAI since the end of 2022), work has also been done to analyse and understand the impact of genAI on education. Nevertheless, due to the quick pace of technological development, the emerging evidence base largely remains piecemeal and leaves many areas for research and questions that still need to be answered, especially from the perspective of European educational contexts, as most of the examined evidence currently comes from outside the EU.

The present paper has therefore been prepared in order to better systematise the evidence on the impact of genAI on teaching and learning from a distinct EU policy perspective. Going beyond the general discussion on what genAI can bring to or take away from the educational landscape, the current paper aims to shed light on several seminal questions:

- *What is the observed, measurable impact of generative AI on the world of education?*
- *What are the system-level implications from the increased uptake of the technology?*
- *What is the initial evidence on its impact on learning outcomes, student's cognition, or the teacher's profession, among others?*
- *What is the role of parents in framing their children's use of genAI outside of the classroom?*
- *What data and research are currently missing and what might be needed to more systematically answer the above questions?*

Thematic focus of the paper

The paper provides a literature review of the evidence up to March 2026 on the impact of the use of generative artificial intelligence on students, teachers, parents and school and academic administrations. Although not a primary area of EU education competence, the implications for parents remain highly relevant to the policy debate as parental engagement can shape in important ways learners' experiences with genAI.

The structure of the paper is as follows: part 1 examines the system-level implications from the increased uptake of genAI in education; part 2 looks at the implications from generative AI for students and learning, focusing in particular on learning outcomes; cognition and critical thinking; self-regulated learning and the use of genAI tutors; implications for equity, inequality and inclusion; and socio-emotional implications from the use of genAI. Part 3 explores the implications for teachers and part 4 for parents.

The overview of the evidence base presented in this paper aims to be comprehensive but also focused on its appropriateness and applicability to the EU educational policy context. In addition, it should be noted that the evidence base evolves rapidly, with new studies and policy developments emerging continuously, making a comprehensive coverage challenging. Where possible, the paper focuses on counterfactual evidence on the causes of observed phenomena from the use of genAI in education, and the analysis is also complemented by an overview of existing qualitative research.

In addition, while the paper tries to differentiate between the impact of the technology on different education levels, this is not always possible given the existing data and research. In this regard, the applicability of individual findings concerning a particular education level to education more widely are to be considered with caution. As the paper underlines on many specific occasions throughout, further dedicated work is necessary to examine the specific impact of genAI on different issues at different educational levels.

An important distinction in the paper is that between the impact of genAI tools for general purpose (off-the-shelf genAI tools) and those tools more specialised (or fine-tuned) for educational purposes (learning-oriented genAI tools[22]). The paper then uses this schematic distinction to seek and draw parallels between used

[22] These are not necessarily to be understood as purpose-built AI tools but could also encompass generic AI foundational models with some custom prompting, retrieval-augmented generation, or institutional guardrails layered on top, all with a view of better aligning model performance to intended pedagogical outcomes.

genAI tools and observed learning outcomes. The paper therefore also contributes to the ongoing discussions on developing European EdTech solutions and supporting Europe's digital sovereignty.

While the focus is on the impact of generative AI, given its recent emergence and use in education, in a few very limited instances, the paper also draws insights from more established forms of artificial intelligence use cases in education, such as adaptive learning and intelligent tutoring systems. Unless otherwise specified (mentioning that the evidence is based on more traditional AI models), and for the sake of avoiding repetition, the paper therefore uses from now on interchangeably the terms "AI" and "genAI". While highly relevant to the policy debate, issues related to the impact of genAI on jobs and adult skills, research and innovation[23], or the usage of mobile phones at school or the impact of social media on well-being and learning aspects, are not examined in this paper.

Several limitations and caveats are particularly noteworthy when reading this paper. The examined evidence comes mostly from outside of the EU but is chosen to resonate with the EU policy context in view of the policy challenges raised by the findings in the literature. Experiments that underpin the evidence base are mostly done with small samples, and conducted in a lab setting, with trials in the classroom still the exception rather than the norm, which underlines the necessity for further research in educational settings of many of the aspects examined in this paper. The findings of the paper are therefore subject to the limitations of the methodology that might have an impact of the representativeness of the findings and their scalability – in particular the lack of large-scale and longitudinal data on the observed phenomena and in European education contexts.

Large-scale data on the impact of AI on learning is starting to emerge, with the publication of PISA 2025 in the beginning of September 2026. The PISA results have been released after the completion of this manuscript and so are yet to be analysed in-depth in further publications to come. A first glimpse of the results is however sobering and proves the relevance of many of the questions and risks outlined in this paper, as PISA shows that frequent use of AI for school work might reduce intellectual effort and be associated with negative academic performance in science (OECD, 2026c).

Recent work that looks at the impact of genAI on education from a more systematic perspective (and by doing so touches upon some of the above questions) includes the OECD's 2026 Digital Education Outlook, which explores the effective uses of genAI in education. While both documents examine a largely overlapping evidence base, the present paper also looks at the research and data gaps in the evidence from an EU policy perspective. The current paper also looks at the impact of the technology on parents, who can play a key role in supporting their children's learning in digital environments.

The elaboration of the paper is supported by several papers prepared by the ENESET academic network[24], set up and financed by the European Commission. In particular, these papers (published alongside the present paper) analyse in further depth emerging evidence from the use of Large Language Models in school education (Crêteur, 2026), the impact of genAI on higher education students (Pinto and Ferreira, 2026), and the impact of AI on children's socio-emotional and cognitive competences (Tilbury, 2026).

Disclaimer: GenAI was used to support some of the initial search for academic articles and suggest potential sources for further review. The actual review, interpretation and integration of evidence in the text of this paper, as well as drafting thereof, was done 100% by old-fashioned human efforts.

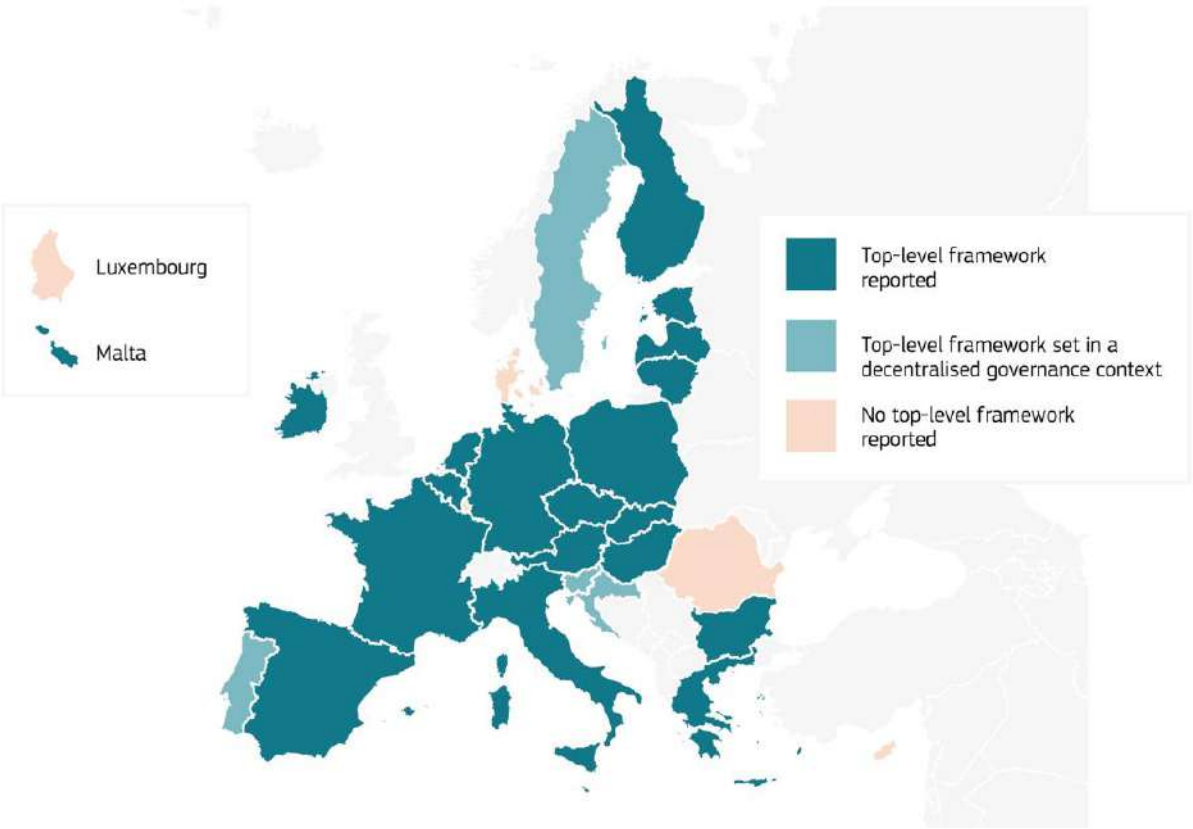
[23] The Commission has presented a European Strategy for AI in Science in October 2025 to make the most of this opportunity and support scientists to responsibly adopt AI technologies for carrying out their research. The strategy introduces RAISE - the Resource for AI Science in Europe, a virtual institute pooling talent and resources to drive excellence in AI research. Through the Horizon Europe and Digital Europe programmes, the Commission invests more than EUR 1 billion per year in AI, with measures to fund and scale innovative ideas and solutions. Recent relevant topics for research under the Horizon Europe work programme include calls on the impact of AI on cognitive development, among others.

[24] https://education-socioeconomic-experts.ec.europa.eu/index_en

Part 1 - System-level implications of generative AI uptake in education

Artificial intelligence in general is slowly moving from a technological innovation to a mainstream tool across education systems in the EU. In the EU, 20 education systems report at least one top-level policy framework addressing the integration of AI or other emerging technologies in schools in 2024-2025 – see Figure 2 (European Commission / EACEA / Eurydice, 2026)[25]. Across the OECD, the Policy Survey on School Education[26] in the Digital Age (primarily focused on primary to upper-secondary education) looked for evidence of systemic AI (including but not only genAI) adoption across 37 jurisdictions[27]. Its findings reveal that guidelines and regulations related to AI were rarely addressed in detail, and binding regulations regarding their use are even more rare[28] (Boeskens and Meyer, 2025).

Figure 2: Top-level frameworks on the integration of AI and other emerging technologies in schools, ISCED 24, 2024/2025



Source: Adapted from European Commission / EACEA / Eurydice (2026), Figure 1.13..

The advent of powerful genAI models is transforming institutional policy. In the world of higher education, initial reactions to the sudden rise of generative AI in late 2022 included many[29] outright bans from use or significant restrictions (Krause et al., 2025). Three years later, this initial reaction has given way to more cautious, yet steady embrace of the opportunities that genAI offers for the world of education. Given the impracticality (but

25 In most cases, these references appear within broader digital education strategies, national AI policy frameworks or guidance documents rather than in dedicated AI-in-education frameworks., as elaborated in the 2026 European Commission / EACEA / Eurydice report.

26 The survey results cover central-level policies across a range of domains: Central strategies and policy co-ordination for digital education; governance and regulation; the adaptation of pedagogical approaches, curricula and assessments to digital education; funding and procurement of digital resources; digital infrastructure and innovation; building educators and other stakeholders' digital capacity; aligning human resource policies with digital education; and frameworks to monitor and evaluate digital education and its impact on students.

27 The survey was completed by 37 jurisdictions (26 OECD member countries, seven sub-national entities and four non-member economies). 22 EU Member States completed the survey: Austria, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Belgium (Flemish Community of Belgium and French Community of Belgium), Bulgaria, Croatia, and Romania.

28 AI was mentioned in the strategies of 26 of the 32 responding jurisdictions (81 per cent), only 8 strategies (25 per cent) contained specific initiatives, and 6 strategies (19 per cent) include timebound goals on the topic.

29 Among the top 500 universities listed in the 2022 Quacquarelli Symonds World University Rankings, the foremost 43 universities implemented policies to ban ChatGPT, restricting the use of ChatGPT or any other AI tools during exams unless explicitly permitted.

also undesirability) of banning the technology, as well as the many potential benefits stemming from genAI, education systems have rather started to focus on integrating genAI tools effectively (Krause et al., 2025).

Institutional guidelines play a crucial role in shaping responsible GenAI use. In their absence, educators and students may adopt inconsistent or potentially harmful practices (Erhardt et al., 2025). The responsible integration of AI in education also demands the continuous evolution of policies, practices, and attitudes (Ghimire and Edwards, 2024), or the Intellectual Property legal framework and provisions and rules on awarding doctoral degrees. The absence of comprehensive policy frameworks governing AI ethical use in education can expose students and teachers to risks such as data misuse, algorithmic bias, and academic dishonesty (ibid.). Evidence from a survey of over 15,000 Estonian school students corroborates the importance of well-established institutional guidelines on AI use, but also raises a warning sign, as students' everyday AI use is observed to outpace formal pedagogical guidance and AI literacy training, leaving in particular younger students vulnerable to uncritical reliance on AI tools (Granström and Oppi, 2025). Evidence of people's perceptions on the use of AI in education also underlines the importance of schools and universities having clear guidance on how and when to use AI[30].

A possible disconnect between institutional policies (or their absence) and student practices might affect essential educational objectives. The increased uptake of genAI necessitates that institutional policies offer general guidance on how genAI can be used ethically, safely, responsibly and fairly to uphold academic integrity[31], the right to education, quality, learning outcomes, inclusion and accessibility. Some higher education students might use GenAI tools in a way that is not yet regulated by education institutions but could be seen as problematic (Pinto and Ferreira, 2026). Clearly communicated institutional policies and discipline-specific guidance can significantly influence student behaviour and reduce potential misuse (ibid.). In this context, AI literacy is increasingly important for both academic success and academic integrity compliance - understanding how genAI systems work, including limitations, biases, and appropriate uses, can make higher education students better positioned to engage with these tools critically and ethically.

Increased uptake of genAI might have implications for national school curricula in the future. The impressive ability of generative AI to summarise and explain complex information might significantly change how students access knowledge and challenge traditional assumptions around knowledge acquisition, critical thinking, and assessment within national education systems. The ability of the technology to summarise text for example might put into question the adequacy of current writing curricula, as it is no longer certain whether education systems can continue to teach writing in the same way when AI can help refine and translate ideas into well-crafted texts (Fuster Rabella, 2025). The author suggests that such changes need not necessarily be negative, as evidence on using speech-to-text software shows that students with learning disabilities that impair transcription skills, might produce better quality writing when dictating their work.

GenAI can be embedded in the curriculum in a way to contribute to positive education outcomes, for example by incorporating such tools to scaffold progressively students' learning from more basic knowledge construction and towards more complex tasks (Pallant et al., 2025). Some studies highlight the importance of developing higher-order skills in students to give them the ability to critically evaluate, contextualize, and build upon AI-generated content. This has important implications for national curricula, in which learning from basic knowledge construction towards more complex tasks can be encouraged through assessment and activity design.

National school curricula have already started to adapt. A survey of 23 European education systems[32] explored the extent of AI tools (not limited to genAI) integration within the national school curriculum (European Schoolnet, 2025). It found that eight EU education systems[33] include AI as a cross-curricular activity, six[34] as module within a relevant subject, two[35] as a standalone subject, four countries[36] are currently piloting its integration with a

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30 For more information, see the Flash Eurobarometer on Future needs in Digital Education.

31 The commitment to do one's work in an honest and responsible way.

32 Flemish Community of Belgium, French Community of Belgium, Croatia, Cyprus, Czechia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and Türkiye.

33 BE(fl), BE(fr), HR, CZ, FI, LU, PT, ES, CH

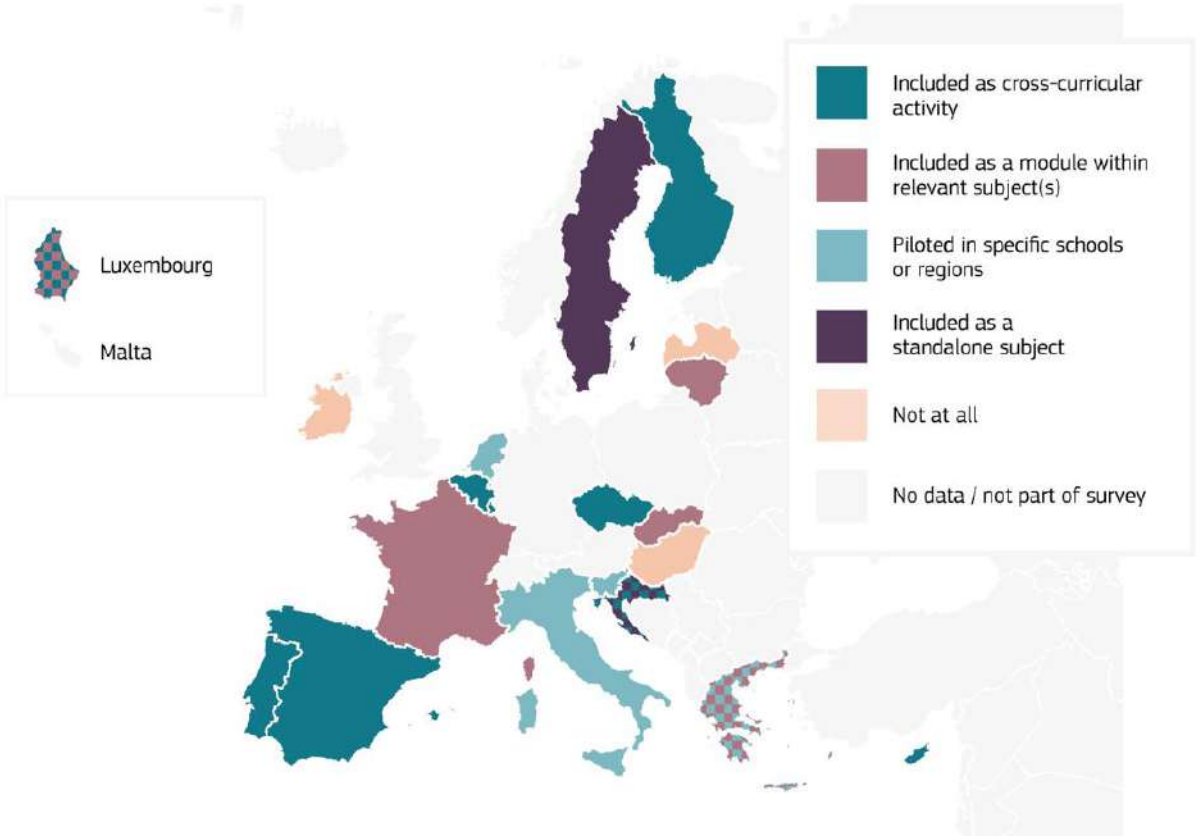
34 CY, FR, EL, LT, LU, SK

35 HR and SE

36 EL, IT, NL, SI

limited number of schools, with three countries[37] not reporting explicitly including AI in the curriculum – see Figure 3. All 23 education systems also report including AI literacy in (some) parts of their education systems – see Figure 4. Future adaptations of the curricula can benefit from taking into account the need for addressing AI literacy and skills demands for civic participation but also for the labour market.

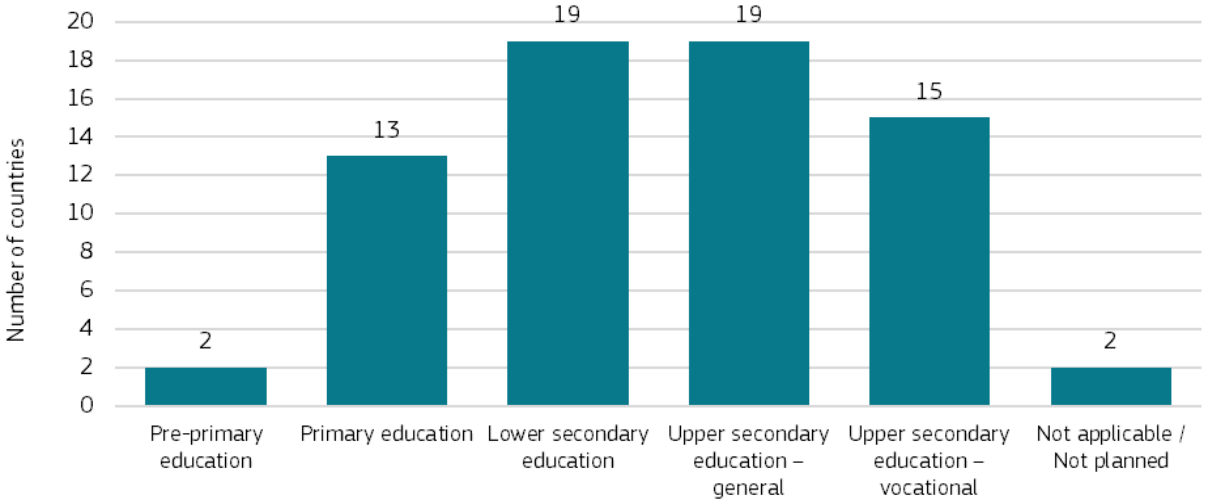
Figure 3: Extent to which AI is explicitly included in the national school curriculum, primary and secondary education



Source: European Schoolnet (2025)

[37] HU, IE, LV

Figure 4: Number of European countries and educational level(s) at which AI literacy is currently included or planned to be included



Source: European Schoolnet

Note: The survey sought to investigate the extent to which AI literacy is included - or planned to be included - in the curriculum, and if at all, at which levels. AI literacy is considered "the technical knowledge, durable skills, and future-ready attitudes required to thrive in a world influenced by AI. It enables learners to engage, create with, manage, and design AI, while critically evaluating its benefits, risks, and ethical implications" (OECD/European Union, 2026b).

GenAI brings opportunities but also challenges to assessment practices. An international survey of educators and students in three higher education institutions in Australia, Cyprus and the USA explored their perspectives on the impact of generative AI on assessments (Kizilcec et al., 2024). The survey found that the types of assessment expected to be most impacted were the ones that require written inputs and have a clear correct solution, whereas assignments requiring in-person presence were expected to be impacted the least.

There might be a need to reimagine assessment in the age of generative AI. The rise of the technology calls for a rethink of assessment strategies to avoid relying on formats amenable to AI-enabled cheating (Villar et al., 2025). This can include new types of exercises that challenge students to think critically and engage deeply with the material. It can also include oral assessments, which might present challenges in terms of organisation, staff resourcing, scaling and standardisation, but they also offer a specific approach to upholding academic integrity in the age of AI. The study also notes that while protecting the authenticity of assessment and examination processes, in-person oral assessments can support the development of fundamental competencies, such as the capacity for persuasion and critical reasoning. Furthermore, genAI integrated together with learning analytics could facilitate the students' progress monitoring, serve as learning companions that provides personalised and timely feedback, and allow a shift toward continuous formative assessment (Herrero et al, 2025).

GenAI can support teachers in assessments but needs to be tailored to the task. One study examined the use of a learning-oriented version of ChatGPT-4 for the evaluation of university students' open-ended written examination responses and found that it can be an effective tool to assess written texts, essays and exams (Jauhiainen and Guerra, 2025). It found both similarities and differences in the evaluations provided by ChatGPT and a human evaluator, with slightly less than three out of four (72.2%) of final grades were same or within one grade difference, almost a fourth (24.1%) was different with two grades, and very few (3.7%) were more than three grades different.

The human evaluator was found to give slightly higher grades that the genAI tool, with AI being stricter in terms of evaluating the completeness of student responses (Jauhiainen and Guerra, 2025). The study concluded that before genAI tools are deployed for evaluating written responses, it is crucial to tailor such models for educational assessments, as well as provide appropriate teacher training. Importantly, it also underlined the significant initial amount of time necessary to train the model in performing in alignment with pedagogical practices, thereby raising concerns of hidden labour for teachers utilising the technology (see part 3).

Assessing genAI support for task completion is best measured against technology-free interventions. As Crêteur (2026) points out, the tendency of AI tools usage to sometimes lead to substantial student engagement without producing corresponding learning gains (a so-called engagement paradox) might result in the successful completion of a task by secondary education students without accompanying increase in knowledge or skills. To account for this engagement paradox and capture also depth of learning associated with genAI tools usage, the author notes that assessment practices need to compare performance during AI-assisted exercises against AI-free interventions.

AI in general brings challenges for the handling of student data. In order to be used to analyse vast amounts of student data across all education levels and identify learning patterns, assess performance or provide insights to teachers, AI needs to follow ethical data mining principles (Jauhiainen and Guerra, 2025). In practice, this means ensuring that student data is handled in ways, which are fair, transparent, respectful of privacy, and beneficial, and without causing harm. In addition, AI tools in general could also present potential student data security risks, especially when they store or share data without explicit user consent (Sutedjo et al., 2025) or store such data outside of the EU. Data privacy is in fact among the most common reported concerns related to the integration of AI (including but not only genAI) in school education (European Schoolnet, 2025).

Summary of findings and implications

The counterfactual evidence base on the impact of generative AI in education is mostly focused on learners, and to a much smaller extent teachers, while in contrast, the impact on institutional aspects and structures remains underexplored. The evidence examined throughout this section suggests that genAI tools usage in educational settings require deliberate policies to be beneficial for learning (Crêteur, 2026). To make most of the potential benefits that genAI offers to the world of education, educational policy-makers, leaders and teachers across all educational levels might need to reimagine the process of assessment. In particular, the remarkable ability of genAI tools to produce high-quality written texts calls into question the continued use of written assignments for formative and take-home summative assessment purposes. In contrast, other forms of exams, such as in-person and/or oral examinations, might gain more relevance in the age of generative AI. In addition, educational policy-makers, school leaders and educators could consider incorporating in the school curricula assessments without AI access, functioning as diagnostic tools that make the gap between AI-assisted performance and independent capability visible to both students and teachers (Crêteur, 2026). Beyond the specific issue of assessment, there are also more systemic implications from genAI's uptake in education – which cannot be separated from the learning objectives set out in the curricula, the teaching methods and resources suggested in the supporting documents for the curricula, and the training of educators to achieve these objectives.

To address potential issues related to academic integrity, institutional responses could consider structured AI literacy programmes covering not only technical skills but also critical evaluation of AI-generated content and awareness of academic integrity norms (Pinto and Ferreira, 2026). The authors note that training instructors and academic staff in AI literacy is equally important, as their confidence and competence in guiding students is a key enabler of responsible genAI use. The revised guidelines on the ethical use of artificial intelligence and data in teaching and learning for educators (European Commission, 2026) underline the importance of responsible use, transparency, and human agency within AI-mediated learning environments. In addition, the entry into force of the provisions of the AI Act addressing educational use cases identified as high-risk would also imply institutional responsibilities that educational leaders would need to take into account. In this regard, the European Commission has recently shared for stakeholder consultation its draft guidelines on the classification of high-risk AI systems[38].

While progressing with the increased uptake of generative AI tools across all educational levels, it is crucial to pay attention to their implications for administrative capacities, the potential teacher hidden labour examined in a subsequent part of the paper, as well as issues related to data privacy, in particular access to and storage of student data. The costs associated with the increased uptake of learning-oriented genAI tools are not to be underestimated, including the possibility that some schools in poorer regions might not be able to afford them and be forced to turn to off-the-shelf AI tools. This might in turn increase the digital divide between better- and worse-off schools. The increased uptake of genAI might also increase the rural-urban school divide due to continued uneven access to high-speed internet, devices, and AI literacy in rural communities.

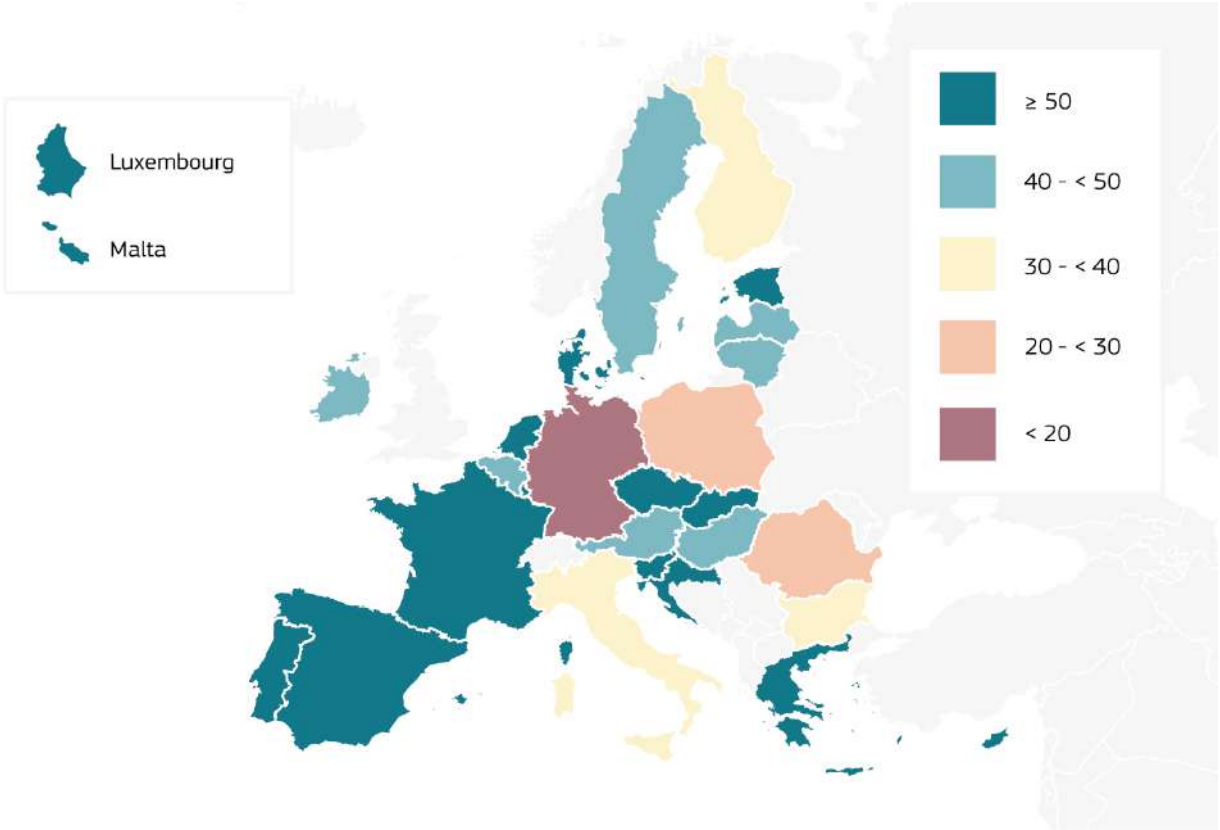
[38] https://digital-strategy.ec.europa.eu/en/library/draft-commission-guidelines-classification-high-risk-ai-systems

Part 2 - Implications for students

2.1. How much and for what do students use genAI?

According to EUROSTAT, in 2025, four in ten young people aged 16-24 across the EU reported using genAI tools for formal education in the last 3 months (see Figure 5). Among EU countries - young people from Spain (59.4%), Czechia (58.8%) and Estonia (58%) reported the highest levels of genAI use for formal education, with Poland (28.6%), Romania (24.8%) and Germany (17.6%) on the other end of the spectrum.[39] The percentage of young people, who have reported using genAI for any purpose in 2025 is almost twice the share of people in the general population[40] (63.8% vs. 32.7%).

Figure 5: Percentage of young people aged 16-24 using genAI for formal education in 2025



Source: Eurostat (isoc_ai_iaiu)

Comparative data from 20 European countries[41] on children who engage[42] in any type of genAI activity confirm the widespread use of the technology by children aged 9-16 (see Figure 7). While the survey results do not suggest any big differences between children who use genAI in terms of their socio-economic status, girls are slightly more likely than boys to report using GenAI, and engagement with the technology increases steadily as children grow older (Staksrud et al., 2026) – see figure 8. The same patterns largely hold true when the usage of genAI for educational purposes (i.e. to get a better school grade[43]) is considered (see Figure 9). More than a third of children report using genAI for schoolwork (to write essays or stories) or for summarising longer texts, whereas about 15% of children report using the technology for personal companionship and advice (to talk about and get advice on physical health and fitness, or to talk about their worries and get advice) – see Figure 10.

39 EUROSTAT, Source dataset: isoc_ai_iaiu

40 People aged 25-64.

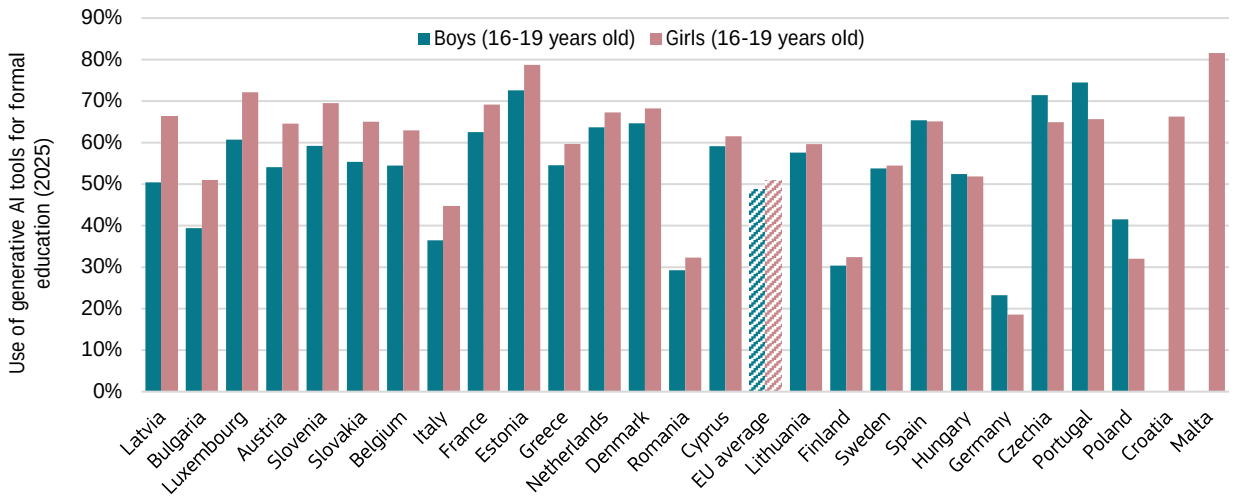
41 Austria, Belgium, Croatia, Czechia, Estonia, Finland, Germany, Ireland, Italy, Latvia, Luxembourg, Malta, Norway, Poland, Portugal, Serbia, Slovakia, Spain, Switzerland, and the United Kingdom. This includes data from the EU Kids Online survey with 25,592 children aged 9 to 16 in 17 countries and additional qualitative interviews with 244 children aged 13 to 17 years in 15 countries (Staksrud et al., 2026).

42 During the last month prior to the survey.

43 See Figure 9. The data from the survey is only available for Switzerland, Estonia, Finland, Croatia, Italy, and Norway. Also, it should be noted that using genAI to get a better grade also raises issues of academic integrity, which are further examined in part 1 on system-level responses.

Data from EUROSTAT offers a more detailed (and slightly nuanced) overview of the usage of AI tools along gender lines than is visible in the Staksrud et al. (2026) survey. While in most EU Member States girls aged 16-19 report using genAI tools for formal educations more than boys, in a few countries (such as Czechia, Germany, Poland and Portugal), the use of genAI for educational purposes is more prevalent among boys (see figure 6). Further dedicated research on the different gender patterns in genAI use and the possible impact on educational outcomes would be beneficial to inform future policy-making efforts.

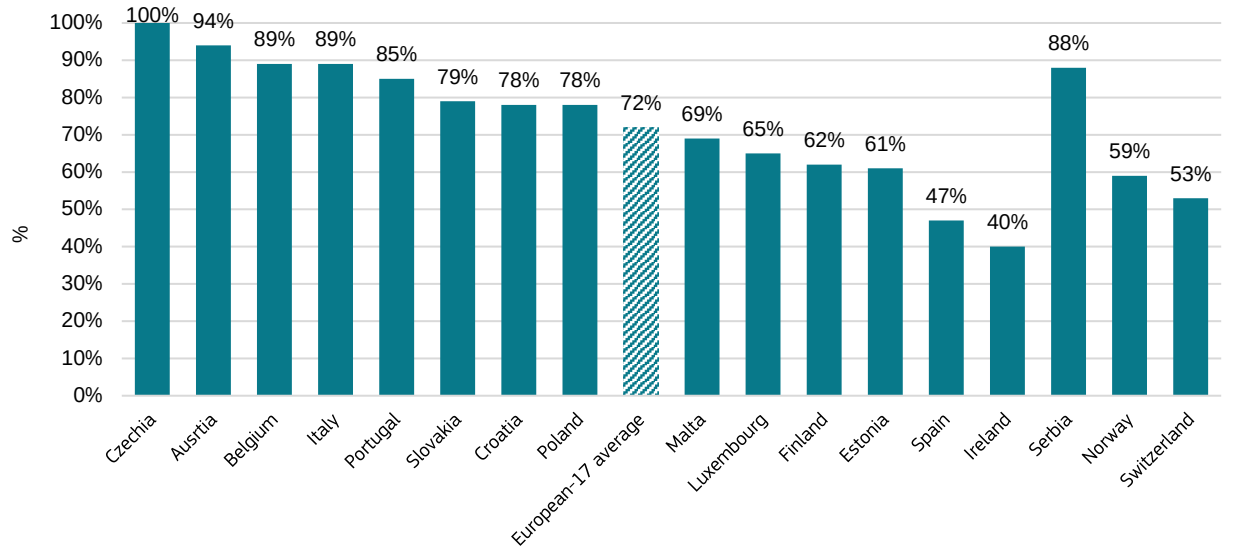
Figure 6. Use of GenAI tools for formal education by country and gender, 2025



Source: Eurostat (isoc_ai_iaiu)

Note: no data available for both genders for Ireland, no data available for boys in Malta and Croatia. Data for Greece, Croatia, Cyprus (boys), Luxembourg (girls), Malta, Austria (boys), Slovakia, and Finland (boys) has low reliability. Formal education refers to a structured and organised educational system that follows a specific curriculum and is typically provided by institutions such as schools or universities, often leading to recognised degrees or certificates (https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/w/ks-01-25-066)

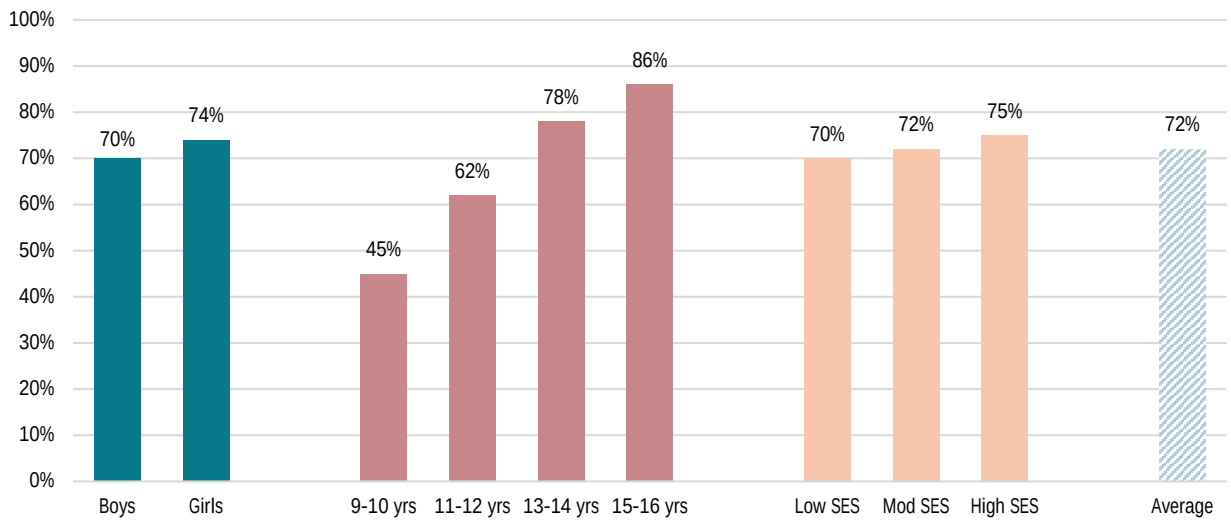
Figure 7. Children (aged 9-16) who engage in any type of GenAI activity by country across 17 European countries, 2025



Source: Staksrud et al. (2026).

Note: QC11 Which of the following purposes, if any, have you used Gen AI for During the PAST MONTH. Looking at those who have engaged in at least one of eight activities. Base: All children aged 9-16 (N= 25,592 but see table2 for the number of respondents by country).

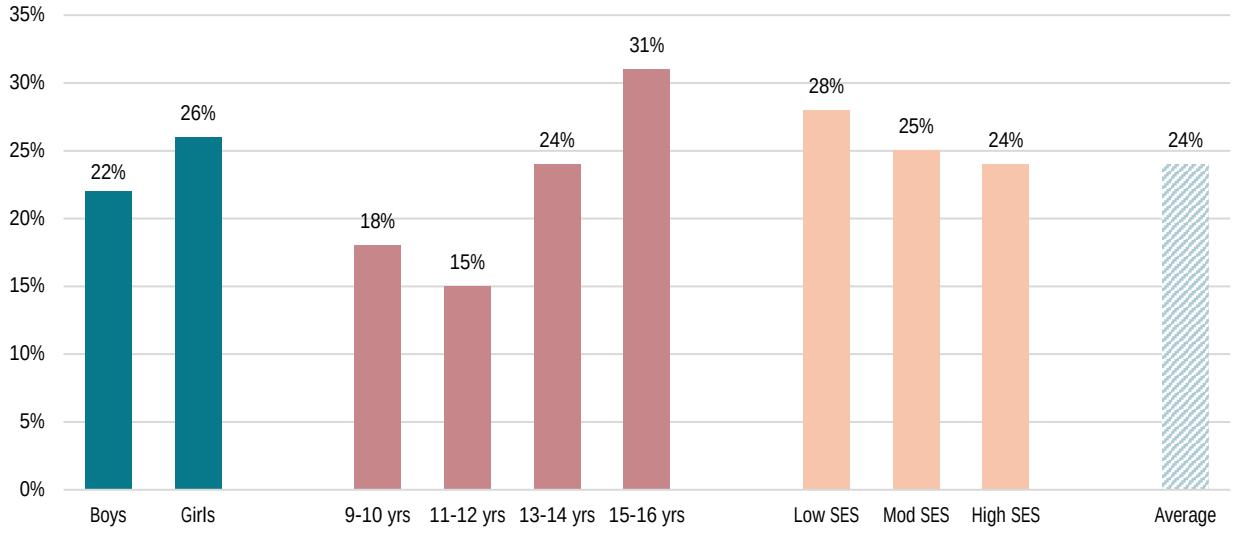
Figure 8. European children (EU and selected non-EU, aged 9-16) who engage in any type of AI activity by gender, age and socio-economic status (SES) across 17 European countries, 2025



Source: Staksrud et al. (2026).

Note: QC11 Which of the following purposes, if any, have you used Gen AI for during the PAST MONTH? Looking at those who have engaged in at least one of the eight activities. Base: All children aged 9-16 (N= 25,592 but see table2 in the source publication for the number of respondents by gender, age and SES) in CZ, AT, BE, IT, RS, PT, SK, HR, PL, MT, LU, FI, EE, NO, CH, ES and IE. SES is operationalised in line with the EU Kids Online survey methodology as a composite index based on parental education and occupational status.

Figure 9. Using GenAI to get a better school grade by gender, age and socio-economic status (SES) across 6 European countries, 2025



Source: Staksrud et al. (2026).

Note: Base: children who have used GenAI in the past month in Switzerland, Estonia, Finland, Croatia, Italy, and Norway (N= 3510 by gender, N = 3603 by age and N=3300 by SES)

Figure 10. What children (aged 9-16) have used GenAI for during the past month by country across 17 European countries, 2025

Source: Staksrud et al. (2026).

Note: QC11 Which of the following purposes, if any, have you used Gen AI for during the PAST MONTH? Base: All children aged 9-16 (N= 25,592 but see detailed table 2 in Staksrud et al. (2026) for the number of respondents by country).

Data from five EU Member States[44] on the use and views of early adopters of generative AI in secondary education (Villar et al., 2025), offers more granular details on the use of genAI by students. The qualitative study found that high-school students incorporate genAI into their daily school activities and use it as a supportive tool to put skills into practice (such as to help them converse in a foreign language), receive feedback, simplify complex topics, or generate summaries and exam simulation. Students reported the use of GenAI tools for brainstorming and content generation in the context of creative tasks (e.g., writing, arts), language skills development (e.g., by practising with chatbots or using language apps), as well as for the creation of learning resources such as concept maps or flashcards. Beyond getting support for specific learning activities, some students already perceived GenAI as a personal assistant that was there to be used to support them as they performed academic and everyday personal tasks. The study therefore highlights that genAI could be used as a valuable tool for fostering creativity, critical thinking, and problem-solving skills.

While the available information contextualises the education use of genAI in the EU, important data gaps on the use of genAI remain. Most available data is centred around incidence of use (e.g. providing a binary distinction of whether one has used genAI in the last period or not). There is currently limited data on frequency and intensity of genAI use, while data on typology of genAI use is very scarce. In the future, addressing this data gap might be useful to determine how genAI usage engagement might influence educational, socio-emotional, and well-being outcomes for students. Such data has been useful in the past to better understand the impact of other digital technologies (see e.g. Bozzola et al., 2022).

[44] Ireland, Finland, Germany, Luxembourg, and Spain.

2.2. Implications for learning outcomes

Evidence on the impact of genAI on learning outcomes remains piecemeal. As generative AI has only recently started being integrated into learning, its overall impact on the development of basic skills and key competences is still unclear. In its absence, judgement as to the overall impact of AI is currently supported by evidence centred largely on limited use-cases of AI (i.e. mostly for language learning assessment or writing). In addition, experiments that underpin the evidence base are mostly based on small samples, conducted in a lab setting, with trials in the classroom still the exception rather than the norm. The current section of the paper aims to summarise the information available within the framework of the five pillars of basic skills defined by the Union of Skills, while also looking at additional evidence on other educational outcomes, as available.

Students tend to rely on, rather than learn from, genAI assistance. A randomised control experiment found that while university students can effectively self-regulate learning with the support of AI, removing this aid substantially affects performance (Darvishi et al., 2024). The study observed that in the context of providing assistance with writing feedback using a tailored AI system, students tended to rely on AI assistance rather than actively learn from it, as they struggled to provide feedback of the same quality when the AI assistance was removed. The study also noted that the human-AI collaboration led to the highest performance though the difference was not statistically significant compared to the AI-only approach to composing peer reviews. Evidence from the US context examining real tutoring conversations between secondary education students and Khanmigo (Khan Academy's AI tutor) found that only 1% of interactions reached the level of deep cognitive engagement that predicts learning, while 68% were passive[45] (Weatherholtz et al. 2025).

Whether genAI is beneficial for learning outcomes might ultimately be up to how the technology is used. The impact of AI on learning depends on the modalities of its use (Pallant et al., 2025). When genAI is used to augment human knowledge and higher education students engage constructively[46] with it, this is associated with higher learning outcomes for university students (Pallant et al., 2025; Weatherholtz et al. 2025). Conversely, when university students use AI mechanically, taking information that is generated at face value and not augmenting with their own understanding, this results in lower learning outcomes (Pallant et al., 2025).

The impact of genAI on reading competence remains underexplored. A large, randomised control trial in the USA (based on more traditional AI models) looked into how the adoption of reading software reflects on the literacy scores of primary and pre-primary school children[47] across an entire school year (Wright et al., 2023). The programme showed large positive effects among pre-primary school children[48] and small-to-moderate effects among primary school children[49] on their reading scores, due to more consistent program use for the former (and therefore stronger program effects). In addition, the study found that students with disadvantaged socio-economic backgrounds (with English as a second language or from low-income households) or with special education needs appeared to benefit the most from the programme. An impact assessment of the interactive, AI-powered literacy platform Lalilo found that using it was associated with stronger rates of growth in early reading skills of primary education pupils[50].

A useful proxy could be the genAI impact on writing competence. In the absence of evidence from the use of generative AI on reading performance (in particular at secondary education level), parallels can be drawn with its impact on writing skills. While genAI demonstrates remarkable command of language and already has the ability to generate quality text hardly distinguishable from that of the average human, it has the potential to generate biases and (sometimes) nonsensical content. GenAI has made outsourcing writing tasks feasible, and this raises concerns about the impact on related skills, such as on reading development (Fuster Rabella, 2025). The author notes that writing and reading draw on similar knowledge and cognitive systems and serve similar purposes, while

45 Students giving perfunctory responses or mining for answers.

46 For example, take ownership, explain thinking, or make inferences when using a genAI tutor (Khanmigo) – see Weatherholtz et al. (2025) or usage of GenAI to clarify concepts students do not understand, rather than just copy answer – see Pallant et al. (2025).

47 The study evaluated the impact on children in K-3, which covers children aged 5-9.

48 Children in kindergarten, normally aged 5-6.

49 Children in first to third grade of primary school, normally aged 7-9.

50 https://renaissance.widen.net/s/p5npjkl7c8/r63694. Children aged 7-8 (in grade K-2).

early writing skills have been shown to contribute to early reading development. Some authors also suggest that the emergence of genAI could lead to learning writing in different ways (Tuomi et al, 2023).

Most of the current evidence of the genAI impact on writing skills is positive. For example, Apriani et al. (2025) aimed to measure the effect of using ChatGPT on tertiary education students' academic writing abilities and to investigate students' perceived experiences regarding the use of ChatGPT in their writing process. The study found that after the intervention, the post-test scores revealed significant improvement in the experimental ChatGPT group. The authors concluded that ChatGPT significantly improves students' academic writing abilities, as evidenced by both quantitative and qualitative data. Other studies also confirm the positive impact of genAI on academic writing skills (see e.g. Zhang, 2025; Ding et al., 2025).

GenAI can boost math skills but is also prone to errors. Pardos and Bandari (2024) compared the learning gains of an off-the-shelf genAI model to human tutor-produced support across four mathematics problem subject areas for adult participants recruited from Amazon's Mechanical Turk. ChatGPT produced statistically significant learning gains[51] comparable to human-authored help in a fraction of the time, but necessitated a hallucination mitigation technique[52], which might call into question the suitability of current off-the-shelf genAI tools for educational use.

Another study conducted a set of large, pre-registered experiments to investigate how genAI based explanations affect learning (Kumar et al., 2023). In the two experiments, participants[53] first practiced high school-level math problems with varied levels of assistance, then all participants had to answer new but similar test questions without any support. The first experiment found that LLM-based explanations positively impacted learning compared to seeing only correct answers, with benefits being greatest for participants trying problems on their own first before consulting genAI explanations. The second experiment looked at the impact of genAI explanations that contained arithmetic errors[54] and found that such explanations still led to learning gains in between those from correct LLM explanations and participants seeing correct answers without any explanations.

Impact on science outcomes might depend on pedagogical alignment of the genAI tools. While there seem to be no studies yet to measure the impact of genAI on scientific literacy and performance, most evidence comes from the higher education context and is focused either on physics courses and/or the application of STEM tutoring agents. A study from the US context[55] used a randomised control trial to look at the impact of a learning-oriented AI tutor on university students' learning as compared to an active learning class with no AI support (Kestin et al., 2025). The study found that university students learned significantly more in less time when using the AI tutor at home on their own, compared with the in-class active learning, and they also felt more engaged and more motivated. The study also underlined that to realize the potential for improving STEM outcomes, student-AI interactions must be carefully designed to follow research-based best practices.

Recent large-scale international survey data suggests that uncritical use of AI can negatively affect science performance. According to the PISA 2025 results, which were released after the completion of this manuscript, one in three (31.2%) 15-year-olds across the EU report using genAI tools for their school work to help them summarise a text they have to read on a frequent basis ("every day or almost every day" or "about once or twice a week"). Use is highest in Spain (39.9%), while Finland (16.5%) and Ireland (16.6%) are the only two countries with a share below 20%. In science, on average across the EU, those students score 18 PISA points below students who do not frequently use AI for that purpose. The upcoming Education and Training Monitor will explore in further detail the use of artificial intelligence as a driver of the EU PISA results.

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51 Measuring the difference between pre- and post-tests.

52 Notably, ChatGPT-generated help failed quality checks on 32% of problems. This was, however, reducible to nearly 0% for algebra problems and 13% for statistics problems after applying self-consistency, a "hallucination" mitigation technique for Large Language Models. For more information on genAI models hallucinating, please see footnote 50

53 The participants were recruited from Amazon Mechanical Turk.

54 In the context of Generative AI (GenAI), hallucinations are confident responses generated by an AI model that are factually incorrect, nonsensical, or ungrounded in reality (See https://www.cloudflare.com/en-gb/learning/ai/what-are-ai-hallucinations/ Accessed on 22 April 2026).

55 Harvard University

Evidence on the impact of genAI on digital and citizenship skills is still very limited. One of the first studies to perform a randomised control trial[56] on the impact of generative AI on digital (or rather AI-specific) skills found that genAI support significantly improved prompting skills of university students if used as a learning tool with the promotion of cognitive engagement in mind, rather than a shortcut (Xiao et al., 2026). Another randomised control trial[57] examining the impact on programming skills found that upper-secondary education students from the experimental group showed lower self-efficacy and learning achievement outcomes after using an off-the-shelf genAI model (Yang et al., 2025). A study focusing on the US context examined lesson plans generated by several different off-the-shelf genAI models[58] for their impact on lower-secondary education civic skills and found that they rarely cultivated higher order thinking or introduced diverse perspectives in each lesson (Trust et al., 2025). It should be noted that citizenship skills are highly context- and culture-specific and evidence on the impact in one jurisdiction might not be easily transferable or generalisable across other (in particular EU) jurisdictions. At the time of writing this paper, no empirical evidence was yet available on the impact of genAI on citizenship skills as elaborated in the European Commission's Basic Skills Action Plan.[59]

Generative AI can effectively support language learning. A randomized controlled trial to evaluate the impact of a genAI tool for virtual tutoring in secondary education in Nigeria deployed Microsoft Copilot to support secondary education students in English language learning over six weeks (De Simone et al., 2025). The results suggested that students selected to participate in the trial scored better[60] in the final assessment delivered as part of the intervention, as well as at the subsequent regular English curricular exam. Two parallel studies examined the effect of genAI-supported conversation practice and on-demand explanations in a mobile app (Duolingo) on foreign language learners' reported self-efficacy (Kittredge et al., 2025). The results of the first study suggested that learners, who had already used the genAI-supported features, felt significantly more prepared to use French/Spanish in real-life situations after one month. The second study found similar results for learners, who used the features for the first time.

But the technology is yet to catch up with traditional tutoring methods. Vanzo et al. (2024) performed a randomized controlled trial in four Italian high-school classes, in which they replaced traditional English-language homework with genAI homework sessions for the treatment group in order to understand if such an intervention would be beneficial to students, in terms of the students' self-assessments and also externally measured learning gains. The study recorded some improvements in learning outcomes and student engagement, though not to the extent of expected improvements from traditional one-on-one tutoring[61].

The educational use of off-the-shelf genAI tools brings distinct challenges. Varsik and Vosberg (2024) note that that while AI can enhance educational outcomes across educational levels, there is also a risk that the motives behind off-the-shelf AI tools might lead to a prioritisation of financial gains over educational and equitable outcomes. This could for example be the result of generative AI systems optimising for user engagement (which might be commercially valuable) rather than effective knowledge transfer, because the off-the-shelf AI models' incentives and training signals often reward responses that keep users interacting. In contrast, learning-oriented genAI tools have been shown to bring much more positive educational outcomes (OECD, 2026; Polanco-Jimenez and De Witte, 2026) but might also come with a hefty price (see section 2.5).

2.3. Implications for cognition and critical thinking

The ability to think critically is a cornerstone of academic achievement and democratic participation more broadly. Critical thinking is a fundamental cognitive skill, which is essential for academic success across all

56 The study conducted a semester-long RCT (N=979) with four framework-based instructional conditions varying in engagement intensity with a pre-test, immediate and delayed post test and surveys.

57 153 high school students were randomly assigned to a control group where they were taught programming in a traditional lecture-based instruction modality or to an experimental group where they could use ChatGPT for programming support.

58 The study investigates 310 AI-generated lesson plans, featuring 2,230 learning activities, created by ChatGPT, Gemini, and Copilot for the 53 content standards mandated in the Massachusetts eighth-grade United States and Massachusetts Government and Civic Life curriculum.

59 https://education.ec.europa.eu/sites/default/files/2025-03/Action_Plan_on_Basic_Skills_COM_2025_88_1_EN_0.pdf

60 0.31 standard deviations higher

61 For more on the impact of AI tutors, see also section 2.4

education levels, professional competence, and informed citizenship (Gerlich, 2025). Critical thinking is also an essential aspect of the key competences for lifelong learning, as described in the EU framework (European Commission, 2019). The European framework for the personal, social and learning to learn key competence (LifeComp) defines critical thinking as "assessment of information and arguments to support reasoned conclusions and develop innovative solutions" (Sala et al., 2020). Strong critical thinking skills help understand complex concepts, analyse texts, and construct well-reasoned arguments, and students with such skills tend to perform better academically (Gerlich, 2025).

A particular concern related to the use of generative AI in learning (which might also extend to teaching – see part 3) is to what extent **students might (over)rely on technology and permanently "outsource" certain** cognitive processes (and in a worst-case scenario also cognitive abilities). Cognitive offloading is not an AI-specific phenomenon, and in fact it has been accompanying technological innovations throughout history since the controlled use of fire (Van Damme, 2026). Such cognitive offloading is underpinned by the externalisation of cognitive processes, which could involve tools or external agents (notes, calculators, or digital tools like artificial intelligence) to reduce cognitive load (Gerlich, 2025) and free space for other cognitive or creative tasks (Van Damme, 2026). Cognitive offloading takes on a renewed importance in the context of genAI use, as unlike earlier examples of technological development, genAI can also perform higher-order cognitive tasks such as generating ideas, synthesizing knowledge, and producing written work.

Cognitive offloading is not necessarily a negative process. As elaborated in Fuster Rabella (2025), using tools to decrease the internal cognitive demands of a task can support humans to overcome limitations and perform tasks more efficiently, and even do tasks that are otherwise unfeasible. The author notes this enhancement of individual performance might also bridge cognitive gaps between individuals with differing abilities or expertise. The use of AI might theoretically therefore, *ceteris paribus*, improve equity outcomes in education. Still, the currently available evidence on the interplay between generative AI use and cognitive offloading paints a rather less positive picture.

Heavy reliance on genAI tools may lead to superficial fluency and failure to internalize knowledge. A study by Kosmyna et al. (2025) focused on exploring the cognitive cost of using a Large Language Model (LLM) in the educational context of writing an essay. Participants, who were university students[62], were assigned to three groups (LLM group, Search Engine group, Brain-only group), where each participant used a designated tool (or no tool) as a source of information to support them with the essay writing task. The study used electroencephalography (EEG) to record participants' brain activity and assess their cognitive engagement and cognitive load, in particular looking to gain a deeper understanding of neural activations during the performance of the task at hand.

The results of the study suggested that while benefits from off-the-shelf LLM use were initially ostensible, its drawbacks became apparent over the course of four months, as the LLM group's participants performed worse than their counterparts in the Brain-only group in terms of neural and linguistic characteristics, and scoring of the essays. A most striking revelation was the inability of any of the participants in the AI-supported group to correctly quote one's own essay, which had been written shortly before. This suggested that memory encoding while writing an essay with the support of genAI was shallow, and that semantic content may not have been fully internalized by the LLM users (ibid.).

The study also found that the unsupported (brain-only) group demonstrated strong variability in its approach to essay writing across most topics, whereas the LLM group produced statistically homogeneous essays within each topic, which showed considerably less deviation compared to the other groups (ibid.). The use of AI may thus contribute to the homogenization of thought processes (Jukiewicz, 2025). Taken together, the results of the Kosmyna et al. study strongly imply that genAI tools, while beneficial for helping performance, may inadvertently suppress deep cognitive processing in university students, as well as their retention of and authentic engagement with written material. These findings are also very relevant from younger learners' perspective. Effortful thinking is very important from a developmental perspective because learning activates brain processes that reshape neural connections - when young learners generate responses, evaluate outcomes, and adapt strategies, these brain circuits are reinforced over time (Tilbury, 2026). In turn, the author notes that when AI

[62] There were 54 participants, who were aged between 18 and 39 years. 35 participants reported pursuing undergraduate studies and 14 postgraduate studies.

systems consistently reduce the need for this effortful engagement, the implications might extend beyond behaviour to underlying neural development of children.

The immense capabilities of genAI systems could eventually transmute cognitive "offloading" into "outsourcing." While people have used external structures and technology to reduce cognitive load since time immemorial, (generative) AI might potentially represent a qualitative leap beyond cognitive offloading and towards cognitive outsourcing (Van Damme, 2026). This potentiality raises serious concerns as to the impact of genAI on cognition, as while cognitive offloading might support thinking, cognitive outsourcing effectively replaces it.[63] While a systematic evidence-based analysis of such a development is yet to materialise, the (piecemeal) evidence described in this section lends credence to such a possibility.

The impact of generative AI on critical thinking skills is not clear-cut. One study, which was focused on out-of-school AI use, explored the potential cognitive costs of AI tool reliance across different age groups[64] and found a significant negative correlation between the frequency of AI usage and critical thinking abilities of adults (Gerlich, 2025). The study also found a strong positive correlation between frequency of adult AI usage and the extent of cognitive offloading and correlational evidence that when cognitive offloading increases, critical thinking decreases. The impact was especially pronounced on young adults[65], who showed higher dependence on AI tools and lower critical thinking scores. Higher educational attainment was also associated with better critical thinking skills, irrespective of the use of AI. The author went on to suggest that the long-term reliance on artificial intelligence for cognitive offloading could erode essential cognitive skills such as memory retention, analytical thinking, and problem-solving.

The findings of another study[66] suggested that leveraging generative AI for students' in-class activities supported the development of critical thinking skills (Essel et al., 2024). The study utilized a mixed-method research approach[67] as it sought to answer whether the scores related to critical thinking skills of university students using an off-the-shelf genAI model differed significantly those of students using traditional lecture-based methods. The study's experimental group utilising ChatGPT exhibited a noteworthy increase in critical thinking, reflective scepticism, and critical openness compared to the control group. The lack of clarity regarding the impact of AI on critical thinking competence of university students and adults (as exemplified by the previous two studies' results) calls for further research of the topic across all education levels.

Appropriate genAI use necessitates human understanding of its capabilities and risks. The potential negative impact of the technology on the cognitive abilities of humans raises concerns about how feasible it might be in the long-term to ensure effective human control of AI tools in all scenarios and use cases. In response, the AI literacy framework[68] aims to equip people with the skills to critically understand, question, and appropriately use AI—thereby counteracting potential cognitive decline by promoting active, reflective, and responsible human oversight of AI systems.

Overreliance on genAI could make students cognitively lazy depending on how the technology is used. A randomised experimental study looked into the impact of AI usage on university students' motivations, self-regulated learning processes and learning performances on a writing task and found evidence of potential dependence on an off-the-shelf genAI model, which could lead to "metacognitive laziness", and might hinder the ability to self-regulate and engage deeply in learning (Yizhou et al., 2024). In addition, the use of AI tools might also restructure not only task performance but also the underlying cognitive architecture of university students (Kosmyna et al., 2025). GenAI use might also systematically distort high school students' ability to evaluate their own understanding, creating a metacognitive blind spot (Crêteur, 2026). At the same time, when technologies are used

63 In the words of the Dutch educational psychologist Paul Kirschner, "(w)hat people are doing with AI is something fundamentally different [than offloading]. They aren't storing intermediate results so they can continue thinking. They're handing over the thinking itself. That's cognitive outsourcing." Source (last accessed on 22 April 2026).

64 Participants were categorised into three age groups: 17–25 years (young), 26–45 years (middle-aged), and 46 years and older (older).

65 17-25 years old.

66 The study cohort consisted of 125 undergraduate students enrolled in a "Quantitative Research Design" course during the second semester of the academic year.

67 incorporating quantitative and qualitative data collection instruments, and an experimental procedure with a pretest-posttest control group. The study ultimately enlisted a sample of 125 students randomly allocated to either the experiment group (60 students) or the control group (65 students).

68 Reference to be added.

to prompt reflection, scaffold reasoning, or encourage learners to evaluate and refine their thinking, they may strengthen metacognitive awareness and self-regulated learning (Tilbury, 2026). Data on students' perceptions suggests that they might be aware of the possibility for cognitive overreliance and therefore also take actions to avoid it. In this context, students report that genAI could serve as a valuable tool for fostering creativity, critical thinking, and problem-solving skills and help to overcome mental blocks (Villar et al., 2025).

GenAI might shape cognitive development by amplifying confirmation bias. Confirmation bias refers to the tendency of individuals to seek, interpret, and recall information in ways that align with their pre-existing beliefs (Du, 2025). This phenomenon takes on particular significance in the context of generative AI, as such systems are designed to produce responses that are contextually relevant and aligned with user prompts. Du (2025) points out that (adult) usage of genAI-powered chatbots may therefore inadvertently reinforce assumptions held by individuals rather than challenge them. From a general perspective, the author notes that the systematic confirmation of user expectations could influence decision-making, public discourse, and the broader information ecosystem. Mitigating such propensity towards confirmation bias could depend on the education of adult AI users, as much as on broader technical interventions. From this perspective, broader media literacy efforts that stress the importance of critical thinking are particularly important.

Positive impacts on task performance are not necessarily conducive to genuine knowledge acquisition. One study explored the cognitive load and learning outcomes for university students associated with using off-the-shelf large language models (LLMs) versus traditional search engines for information gathering during learning (Stadler et al., 2024). The findings suggested that university students using generative AI experienced much lower cognitive load compared to students using traditional search engines, but the former also demonstrated lower-quality reasoning and argumentation in their final recommendations compared to the latter. This indicates that while generative AI might lead to better task performance (i.e. gathering of information), its usage does not necessarily promote deeper engagement with content necessary for high-quality learning.

Likewise, engagement of high school students with genAI tools by itself does not guarantee learning (Crêteur, 2026). The author notes that a critical metric is rather whether high school students develop knowledge and skills that persist beyond the AI-supported session. The accompanying ENESET paper by Crêteur (2026) on secondary education students looks at this in more depth – it employs an engagement-centred analytical framework, which examines the relationship between LLM-mediated engagement across three dimensions (behavioural, cognitive, and emotional) and learning outcomes.

Other studies (Yizhou et al., 2024; Bastani et al., 2025) have also found that while the use of off-the-shelf generative AI can lead to a noteworthy improvement of short-term task performance, it may not boost knowledge gain and transfer for both secondary education and university students. This is corroborated for example by another out-of-school study concerning adults, which finds robust evidence that when information is synthesized by off-the-shelf genAI models, people apply less effort in learning about the topic compared to gathering and synthesizing the information themselves through web search, which leads them to develop shallower knowledge about the topic (Melumad and Yun, 2025).

The growing body of evidence on the important distinction between task performance and depth of learning has led the OECD to underline that the introduction of genAI might lead to a **"mirage of false mastery,"** where high-quality AI-supported output (often using off-the-shelf AI models) conceals underlying weaknesses in secondary education students' skills (OECD, 2026). Such a dissociation between actual and perceived competence might also apply at higher education levels - with university students using AI sometimes not accurately monitoring their own learning – and therefore potentially failing to identify gaps in understanding (Pinto and Ferreira, 2026) that would prompt further cognitive efforts on their part.

The effectiveness of genAI in fostering long-term skill development, in particular for secondary education students, remains uncertain (OECD, 2026) and this is in fact a significant gap in the evidence base that would need to be addressed as a matter of urgency - most studies measure how secondary education students perform while using the AI tool, but not whether students have developed skills or knowledge they can use independently of the tool (Crêteur, 2026). Given that most of the current evidence also comes from outside the EU, there appears a distinct need for further research in the specific EU educational context. As Tilbury (2026) points out, AI systems designed primarily for global audiences may not always respond effectively to the needs of particular cultural or educational contexts. More generally, further research is needed to better understand the

dynamics between genAI use, cognitive offloading and the impact on critical thinking, including also how genAI can be used to enhance rather than replace cognition and critical thinking skills.

2.4. Self-regulated learning and the implications from genAI tutors

Self-regulated learning is essential to positive academic performance. The European framework for the personal, social and learning to learn key competence (LifeComp) defines self-regulation as "awareness and management of emotions, thoughts, and behaviour" and positions it as one of the three core competences within the "Personal" area (Sala et al., 2020). Effectively regulating one's own learning is a key characteristic of successful learners (Schunk, 2023). It involves actively setting one's learning goals and consciously using and adapting different learning approaches to accomplish those goals (Winne, 1996).

Effective self-regulation is not a given for every student. Students can encounter different challenges during the process of regulation, related to factors like inadequate metacognitive strategies, low achievement motivation, or task complexity (Yizhou et al., 2024). The provision of appropriate external support (through teachers, or digital technologies) can therefore be pivotal in assisting the regulation process for students (ibid.). The potential of AI-powered technologies to offer personalised support and scaffolding could (in theory) be a game changer across education levels, as immediate feedback is one of the cornerstones of self-regulated learning (Jukiewicz, 2025).

Recent advances in genAI hold promise for more powerful and effective personalised scaffolding. AI is increasingly used to automate and scaffold learning activities for university students (Darvishi et al., 2024). This includes personalised reminders for the task completion, automated real-time feedback or recommendations on what and when to study. Still, inherent issues in such AI models, like the potential to hallucinate, might require additional efforts (e.g. for teachers to check genAI-generated content) to realise this potential. In the context of this persisting issue, one qualitative study offered an innovative approach and sought to provide insights into how genAI can be effectively used to evaluate personalised scaffolds for self-regulated learnings for secondary education students (Qian K. et al., 2025). To address the challenge of AI hallucinations, the study proposed how to use tailored genAI tools to evaluate reliability and quality of AI-generated scaffolds.

Short-term gains from genAI-powered learning aids could be easily reversible. A randomised control trial tested whether the initial use of AI assistance and nudges by university students can be replaced with self-regulation strategies after some time without any impact on learners' performance (Darvishi et al., 2024). The study found that while university students can effectively self-regulate their learning with the aid of AI, when such support is removed, students' performance deteriorates. Somewhat surprisingly, the study also found that accompanying initial AI assistance with self-regulated strategies did not bring significant benefits over relying solely on AI assistance. The study concluded by underlining the need to strike a balance between AI assistance and fostering student agency, which would be essential to ensure the active participation of students in their own learning journey. Empirical research on whether genAI improves metacognitive knowledge is still limited, but converging evidence exploring other aspects of genAI use emphasises the importance of better understanding the underlying dynamics. For example, Polanco-Jimenez and De Witte (2026) find statistically significant evidence of long-term knowledge retention from the use of a learning-oriented genAI tool, as opposed to no such evidence for an off-the-shelf model.

AI in general can solve the long-standing dilemma on the scalability of tutoring programmes. Students receiving one-on-one tutoring have been shown to outperform peers in traditional classroom settings by an average of two standard deviations (Bloom, 1984). However, the roll-out of one-on-one tutoring to large student populations is challenging due to the high cost and resource demands (Vanzo et al., 2024; Bhatt et al., 2024). In recent years, adaptive learning software has emerged as a potential solution by using technology to mimic one-on-one tutoring (De Simone et al., 2025). This evidence from secondary education suggests that such systems can improve learning outcomes).

Still, limitations **related to "traditional" AI systems remain**. Vanzo et al. (2024) point out that while Intelligent Tutoring Systems can help improve learning outcomes for secondary education students, they face challenges in terms of scalability, content preparation, and flexibility. The authors note that the arrival of Large Language Models could represent a potential breakthrough in addressing such issues. LLMs can generate interactive and dynamic educational content with minimal human intervention, yet persistent issues, such as the propensity of genAI to hallucinate content remain a cause of concern.

Traditional AI tools could support high-dosage tutoring at large scale. A randomised control trial (based on more traditional AI models), which included approximately 4,000 high school students in two large school districts in 2018-19 and 2019-20 in the US[69], tested the effectiveness of an in-school math tutoring programme (Bhatt M.P. et al.,2024). The set-up included students working in groups of four, with two students having a human tutor while the other two worked with computer-assisted learning technology. The groups then alternated every other day. The study found gains in students' math standardized test scores similar in size[70] to traditional 2-to-1 tutoring models. While this example shows that the strategic use of more traditional AI tools can help increase the scalability of high-dosage tutoring, further research specifically on genAI tools is needed to evaluate their full potential for supporting high-dosage tutoring at large scale.

Evidence on the impact of genAI tutoring dosage has started to emerge. One World Bank study uses a randomized controlled trial to estimate the causal impact of an AI tutor on learning outcomes of secondary education students in Nigeria (De Simone et al., 2025). The study not only found that such learning-oriented systems can improve learning outcomes of secondary education students[71] but also estimates a dose-response relationship and finds a strong linear association between length of programme usage and improved learning outcomes[72]. The study also extends these findings to predict substantial gains with extended program duration[73]. The extent of applicability/transferability of such findings to the EU educational context remains unclear in the absence of further dedicated EU-focused research on the topic.

Gains from genAI-based tutoring might be short-lived and lead to underperformance when support is subsequently removed. AI tools might give primary and secondary education pupils a false sense of ability, as solving problems with assistance might lead them to overestimate proficiency (Borgonovi et al., 2025). A large-scale field experiment in a Turkish high school showed that being able to access an off-the-shelf genAI model while solving problems significantly improved performance, but when access was then removed students did worse[74] than those who never had access in the first place (Bastani et al., 2025). The study not only suggests that access to genAI "without any guardrails" can harm educational outcomes by reducing skill acquisition, but its results also provide strong evidence as to the superior performance of learning-oriented genAI tools as compared to their off-the-shelf counterparts[75].

69 In three public high schools in Chicago and another four high schools in New York City.

70 0.23 standard deviations for participating students

71 as compared to a control group which did not receive any intervention but continued their regular learning in the classroom

72 with an effect size of approximately 0.031 standard deviation per additional day of attendance

73 It estimates an increase of between 1.2 and 2.2 standard deviations for a full academic year of participation, depending on attendance rates

74 17% reduction in grades for GPT Base

75 The study result showed 48% improvement in grades for GPT Base (generally available tool) and 127% for GPT Tutor (an AI tool with prompts designed to safeguard learning).

Figure 11. Selected examples and evidence on the effectiveness of genAI tutors and Teaching Assistants in supporting student learning

Country	Initiative	Description	Evaluation outcome
Chinese Taipei	ChatGPT as programming TA	Used ChatGPT to support high school students learning programming by assisting with syntax, debugging, and explanations.	In an RCT,153 high school students were randomly assigned to a control group where they were taught programming in a traditional lecture-based instruction modality or to an experimental group where they could use ChatGPT for programming support. Students from the experimental group showed lower self-efficacy and learning achievement outcomes after using ChatGPT, with small-to-moderate effect size scores, suggesting how the impact of ChatGPT in programming courses may have negative effects on student outcomes (Yang, Hsu and Wu, 2025).
Italy	GPT-4 as English homework tutor	AI-assisted homework in English as a secondary language class across two grades using interactive ChatGPT sessions.	This small RCT was carried out in four high school classes for a total of 76 students involved. Overall, although students responded positively to AI as a learning companion and reported short term positive feedback on their experience, learning gains did not vary significantly between study groups. However, weaker students in terms of initial skills benefited more from the tutoring compared to stronger ones (Vanzo, Chowdhury and Sachan, 2025).
Nigeria	GPT-4 via Microsoft Copilot	Used ChatGPT to deliver after-school English tutoring sessions to high school students in Benin City.	For this RCT, 759 senior secondary school students were recruited on a voluntary basis among senior from nine schools in Benin City. After a six-week intervention three main outcomes were measured: English language proficiency, AI knowledge/skills, and digital skills. Significant improvements in the study group were observed for English and AI skills. The intervention appeared to have had a larger positive effect on girls compared to boys. Also, students with higher SES background benefited more than their peers from poorer households (De Simone et al., 2025).
Türkiye	GPT-4 in maths tutoring (RCT)	Tested standard ChatGPT versus a structured ChatGPT Tutor across high school maths classes.	This RCT involved 839 secondary school students and focused on normalized Maths grades as main outcome. Results indicated that access to standard ChatGPT improved students' performance by 48% on average relative to students in the control group. Moreover, access to a specialized version of ChatGPT instructed by best practices and teacher inputs (such as providing suggestions instead of giving the complete solution to questions), improved performance by 127%. However, while post-test performance (without any assistance) between students in the structured ChatGPT Tutor group and control students did not vary significantly, standard ChatGPT **decreased average students' performance by** 17%. These results indicate that AI tools such as ChatGPT can degrade student learning outcomes in absence of appropriate safeguards (Bastani et al., 2024).
United States	Peer feedback with AI guidance (RiPPLE adaptive education system)	RCT with 1625 undergraduate students across 10 courses testing AI-assisted feedback prompts vs. human-led selfregulation	This RCT assessed different outcomes evaluating the quality of student-submitted feedback to learning resources created by other students. Feedback was evaluated according to its relevance, originality and constructiveness (qualities that reduce the likelihood of submitting repetitive comments). AI support was more effective than self-regulation alone but led to over-reliance. In addition, hybrid human-AI

		strategies in writing tasks.	approaches did not yield significantly better results than AI alone (Darvishi et al., 2024).
United States	Utah's Early Interactive Reading Software	Five different adaptive AI reading software implemented in 692 schools (kindergarten and primary schools) serving over 166 000 students, including English language learners and low-income learners.	This large RCT investigated how the adoption of reading software in primary and pre-primary school children – across an entire school year – improved their literacy scores. The study divided students from the treatment arm in two distinct groups: those who met the usage criteria for the adopted software as provided by the vendors, those who met at least 80% of such criteria (in terms of minutes per week and total number of weeks for students to use the software). The programme showed large positive effects among pre-primary school children on their reading scores, especially for those who met the vendors recommendations for use. Small-to moderate effects were observed among primary school children. This was especially true when software was used as recommended. Across grades, students in disadvantaged subgroups (i.e., English language learners, low-income, and special education designation status), appeared to benefit the most from the programme (Wright et al., 2023)

Source: Adapted from Borgonovi, F. et al. (2025)

The selected examples presented in Figure 11 above, while coming mostly from outside the EU educational context and so necessitating further dedicated research in this regard, also suggest AI's potential to support more equal educational outcomes. For example, AI-supported interventions might have a larger positive effect on girls and benefit more the students from disadvantaged groups. At the same time, other evidence suggests that students with higher SES background might benefit more than their peers from poorer households. The next section examines these implications in further detail.

2.5. Implications for equity, inequality and inclusion

Addressing educational inequalities is important from an EU policy perspective, as disparities in access to educational resources, learning environments, or outcomes linked to students' social backgrounds can limit students' opportunities to reach their full potential (European Commission, 2025). Given the increased uptake of AI-powered tools in the classroom, understanding their impact on equity, (in)equality and inclusion gains in importance.

Unequal access to genAI might reinforce existing equity and inclusion challenges in education. Socio-economic and demographic characteristics, such as gender, age, family income, family size, or (parental) educational level, are very pertinent to addressing inequities in education, as they can influence who accesses AI tools and can benefit from AI technologies in learning environments (Carter et al., 2020). Data from the ICILS 2023 international survey suggests that socio-economic background of secondary education students has a strong and consistent relationship with the level of digital skills, with results from the survey pointing to a significantly higher underachievement rate of secondary education students with parents with lower qualifications (European Commission, 2025). The unequal level of digital skills in the EU continues to be a major bottleneck in Europe's ongoing digital transformation, at a time when the EU is facing a new age shaped by generative AI[76].

The impact of genAI might reinforce this already observed digital divide, which is also influenced by other factors with a technical and social dimension (Carter et al., 2020). For instance, the author notes that cloud-based AI services very much rely on internet connectivity to offer adaptive, real-time educational experiences. This can be

[76] Report on the State of the Digital Decade 2024. Available here.

problematic from the perspective of schools with high shares of socio-economically disadvantaged students, which report a significant lack of (access to) digital resources. Such limited availability of the necessary digital infrastructure for underprivileged communities can reinforce existing educational inequalities, allowing only more affluent primary and secondary education students to gain advantages from personalized AI support (Ho et al., 2024).

GenAI can support students from migrant backgrounds. The technology excels in languages with available data at scale, such as English, and can offer an important contribution for learners whose educational instruction is in a language different from their mother tongue. AI can also promote access to content in other languages thanks to its ability to offer real-time translation of superior quality.

Still, genAI tools might also continue to face challenges with less represented languages (Krause et al., 2025). This has potential implications for students across all education levels from underprivileged backgrounds, such as migrant students. Indeed, Crêteur (2026) points out that the same tool might produce different outcomes depending on who is using it and how.

Even when universally accessible, genAI use might still lead to new disparities. One study from the USA used a large-scale longitudinal dataset of university admissions essays submitted to a highly-selective U.S. engineering college to explore the socio-economic differences behind the adoption of LLM models for wiring support (Lee et al., 2026). The study found disproportionately larger increases in adoption by students with lower socio-economic status but also strong association with declines in their predicted admissions probability as compared to students with a higher socio-economic status.

This could be explained by divergences in how students with different socio-economic backgrounds use the technology – with one study finding that higher SES adults tend to employ more abstract and sophisticated prompting strategies, as compared to lower SES adults, who use more concrete prompts (Bassignana et al., 2025). While both groups can access genAI tools relatively easy, gains in writing (such as improved grammar) appear more concentrated among adults with higher socio-economic status. This has led Lee et al. (2026) to conclude that "LLMs may reduce disparities in access to support while simultaneously introducing new disparities in how that support translates into success."

Equitable access to genAI tutors is important for mitigating socio-economic inequalities. Many parents are not able to afford one-on-one tutoring, or after-school services for their children, and struggling students might often lag behind (Vanzo et al., 2024). It has been shown that university students, who also benefit from a learning-oriented AI-powered tutor at home might perform better than those exposed only to active learning classes (Kestin et al., 2025). Learning-oriented AI tools have also been shown to outperform off-the-shelf genAI tools in terms of desirable educational outcomes (Bastani et al., 2025).

GenAI can raise the quality of educational experiences for socio-economically disadvantaged students. A randomised control trial[77] from the USA examines the impact of a Human-AI collaborative approach that uses a genAI tutoring tool (Tutor CoPilot) to provide expert-like guidance to human tutors as they tutor high school students (Wang et al., 2025). The study finds that students working on mathematics with tutors having access to the genAI tool are more likely to master topics, and that secondary education students of lower-rated human tutors stand to gain the greatest benefit relative to the control group. The study therefore also underlines the potential of genAI tools to raise the quality of educational experiences for secondary education students from under-privileged communities. Further dedicated research in the EU educational context is necessary to better understand the potential for genAI tools to support effective tutoring for underserved communities.

EdTech can be costly. Access to AI tutors developed with pedagogical best practices in mind might come with a hefty price[78]. This might in turn have an impact on access to AI tools and exacerbate socio-economic inequalities in the future, in view of the possible negative implications of off-the-shelf AI tutors on educational outcomes as opposed to learning-oriented AI models (see section 2.4).

The impact of generative AI tools on students with special education needs remains underexplored. As highlighted by Linsenmayer (2025) in their review of how to leverage AI to support students with special education needs (SEN), there exists a significant gap in robust research on the effects of AI tools. The author notes that most

[77] involving 900 human tutors and 1,800 K-12 students from under-served communities (majority Hispanic) based in a Southern school district in the United States.

[78] Sevilla et al. (2025) put the annual per-student cost of a hybrid human-AI tutor integration at USD 700.

of the reviewed research does not properly assess the impact on improvement of learning and well-being outcomes of students with SEN, underrepresents such students in the sampling size, or is not underpinned by a robust methodology, such as a randomised controlled trial or a longitudinal study.

GenAI-powered learning platforms can help meet the specific needs of each student in a diverse classroom by tailoring activities in real-time (Linsenmayer, 2025). Integrating AI tools in the classroom can support students with SEN to participate alongside their peers on a more equal basis, therefore potentially leading to a more diverse and inclusive learning community (Varsik and Vosberg, 2024). Such tools can support students with special education needs access educational content and receive support, but despite this potential, there are also important challenges to be kept in mind (Linsenmayer, 2025). Among others, potential issues concerning special education needs students include algorithmic bias, data privacy issues, and the persisting digital divide. In particular, the reliability of genAI tools depends on the quality of the underlying datasets, which raises concerns about appropriateness and accuracy of AI outputs for students with special education needs, given the prevalence of inaccurate and non-evidence-based material online (ibid.).

The evidence presented in this section of the potential of AI to reinforce the existing digital divide underlines the importance for adequate measures to be put in place to diminish unequal access and make full use of the opportunities stemming from the increased uptake of genAI in the classroom. This resonates with the approach of the current Digital Education Action Plan, important actions in which concern strengthening digital skills for all learners and promoting inclusion in digital education ecosystems.

Case study – addressing the gender gap in math top performance using genAI

Individualised support through tutoring can have consistent and substantial positive effects on student achievement and learning, especially if provided during upper primary and secondary school education in math and during the school day, as opposed to after school (Thomas et al., 2024). With its potential to provide personalised learning opportunities and tutoring (see section 2.4), generative AI can therefore potentially boost math performance. But is this the case? What does the available evidence show?

When framed appropriately[79], the use of **AI-powered conversational agents can boost girls' perceived sense of belonging in mathematics**, as evidenced by early classroom pilots in the USA (Walkington, 2025). In addition, AI tools can boost female participation in STEM, for example by enhancing mentorship opportunities for women in STEM and matching mentees with suitable mentors (Borgonovi et al., 2025). This can then promote aspirations and career intentions.

Technology needs to be tailored to desired educational outcomes. Off-the-shelf AI tools might not necessarily be aligned with the logic of education systems to not only pursue task performance, but also a permanent transfer of knowledge and skills. For example, one study found no positive influence from the use of ChatGPT on students' math performance (Asare et al., 2023). In this instance, while genAI helped learners come up with solutions for the problems, neither analysis for the problems nor explanations for the solutions were provided by the AI tool, meaning its use did not improve learners' understanding of what they studied.

In contrast, properly designed or fine-tuned AI tools can help improve math educational outcomes – for example, **genAI can potentially support bridging the gender gap in math top performance in school education**. This would be essential for providing equitable learning opportunities (Wangda et al., 2025) and could support EU policy goals, such as the strategic target on enrolment in STEM, proposed in the Union of Skills[80]. To exemplify how generative AI can address gender considerations in math, one study proposes an innovative pedagogical approach powered by genAI, which enabled students to create math stories and enhance their conceptual grasp of important mathematical ideas (Wangda et al, 2025). The study found that female students were significantly more engaged in creating stories on the platform and improved much more when their math learning outcomes were subsequently measured, compared to male students.

79 As companions, rather than evaluators.

80 COM(2025) 90 final. Available here

2.6. Socio-emotional implications

Evidence on the impact of genAI use on socio-emotional development is in its infancy. At the same time, the technology is evolving so quickly that evidence ages rapidly and interacting with newer genAI models may offer a very different experience and have different cognitive and socio-emotional impacts than earlier versions. Much of the current evidence stems from outside of educational contexts and/or applies to adult participants. The outlined findings in this section should therefore be considered with caution, as the impact of AI on socio-emotional competences can greatly vary by age and further dedicated research is necessary to examine the socio-emotional implications of genAI use.

Socio-emotional competences are key to academic success. They are associated with well-being and positive life and academic outcomes in school-aged students and can predict students' academic achievement in reading, mathematics, and science outcomes (Martinez-Yarza et al., 2023). Socio-emotional competences are deeply integrated into the EU Framework for Key Competences for Lifelong Learning (European Commission, 2019) and the EU Framework for the personal, social and learning to learn key competence (Sala et al., 2020). Socio-emotional skills can influence cognitive skills[81] but are also dependent on them (Chernyshenko et al., 2018). Cognitive and socio-emotional skills "are thus tightly interconnected in a dynamic interaction that allows individuals with higher skills in one domain to be able to better influence the development of their skills in other domains" (ibid.).

Emotional self-regulation is a key developmental milestone for preschool children and forms the foundation for success – academic and social, later on in life (Pahigiannis and Glos, 2020). It helps children manage emotions, respond to social cues, and address challenges effectively. It also fosters children's ability to focus, engage, and adapt in classroom settings. In turn, children facing issues with emotional regulation often struggle to maintain attention and participate in classroom activities, negatively impacting their learning outcomes (Berrezueta-Guzman et al., 2025). Traditional methods for teaching older children emotional self-regulation[82] are effective but often require consistent teacher supervision, which can be particularly challenging in larger or under-resourced classrooms (ibid.). The family context is also very important for smaller children, who learn self-regulation through co-regulation (McClelland and Cameron, 2012).

Evidence from the impact of genAI tools on early childhood development is beginning to emerge. In one study, a ten-week experimental design involving two groups of four-year-old children assessed a robot's effectiveness on socio-emotional development of children through progress assessments, parental surveys, and teacher feedback (Berrezueta-Guzman et al., 2025). In particular, the study assessed the impact of AI-powered robots[83] on emotional self-regulation and engagement in preschool children. The results showed the robot's capacity to enhance emotional awareness and social interactions through adaptive and engaging methodologies. However, emerging qualitative evidence also suggests that genAI toys might struggle with social and pretend play, misunderstand children aged five and under, or react inappropriately to emotions (Goodacre and Gibson, 2026).

GenAI-powered tools might harm the development of certain socio-emotional skills. In particular, they might negatively affect secondary education students' sociability, sense of trust and empathy for others by reducing the need for human interaction (Varsik and Vosberg, 2024). The authors note that the potential socio-emotional gap can therefore also negatively affect the inclusive aspects of education, which are fundamental for fostering a sense of belonging and community within educational settings. Potential socio-emotional development issues are particularly worrying from the perspective of younger children (Tilbury, 2026). Studies suggest that AI-mediated environments may reduce opportunities for real-world social interaction, make it harder for young children to develop empathy and emotional regulation (ibid.). Early years practitioners express concern that such interactions could foster parasocial relationships with systems that simulate responsiveness but cannot reciprocate emotionally (ibid.). Conversely, generative AI used for collaborative purposes in teacher-led teaching approaches in the classroom might have a positive effect on socio-emotional development.

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81 For example, good social competence can help children adapt better to the school environment, gain higher status among their peers and consequently achieve more in school.

82 Such as role-playing, storytelling, and structured routines.

83 The robots in the study utilize generative AI, specifically GPT-4V(ision) as their core for processing real-time behavioural data and generating adaptive interactions.

Spending more time with genAI chatbots can be associated with negative psychosocial outcomes. A four-week randomized controlled experiment[84] in a laboratory setting including close to a thousand adult participants investigated the connection between different interaction modes and conversation types and their influence on four psychosocial outcomes: loneliness, social interaction with real people, emotional dependence on AI, and problematic AI usage (Cathy et al., 2025). The study found that, irrespective of experimental condition, participants voluntarily spending more time with the chatbot were associated with worse outcomes, such as higher loneliness, less socialization with real people, or more emotional dependence. While the previous study looked at the impact on adults, findings might be relevant from a wider scholastic perspective, as evidence suggests that socially responsive AI systems, such as chatbots or robot tutors, can feel surprisingly "real" to children (Tilbury, 2026). As a result, children may treat these technologies as interactive partners rather than purely mechanical devices. However further dedicated research in educational settings is needed to better understand the implications from genAI chatbots on children's psychosocial development.

Human interaction is key to success in school and later on in life. From an educational perspective, the potential reduction in human interaction is a cause for concern, as it might have an impact on social skills and mental health (Varsik and Vosberg, 2024). Lessons from the Covid-19 pandemic underline that the future of school education cannot forgo face-to-face interaction (Cachia et al., 2021). The experience showed the iimportant role of onsite schooling for socialisation and well-being – with children regretting missed face-to-face interaction with their friends, and the majority reiterating their desire to go back to school to see their friends.

Potential negative social outcomes stemming from a reduction in human interaction, while not inherent in the AI tools themselves, but rather how they are used, might shape cognitive and social development of children in unintended ways during critical developmental periods and weaken the relational foundations of learning (Tilbury, 2026). The (over)use of AI-powered chatbots might also lead users to experience mental health harms through the development of emotional dependence upon the AI agent (Laestadius et al., 2022). Indeed, some authors have already pointed out that the rise of genAI represents a qualitative next step in the impact on social interaction and necessitates that "we prepare for addictive intelligence."[85]

The potential impact of generative AI use on children emotional development and well-being, and its connection to educational outcomes, remains underexplored. AI might amplify mechanisms seen in digital environments (such as personalisation and feedback) while introducing new forms of autonomy and adaptivity that can intensify both opportunities and risks (Tilbury, 2026). The current lack of dedicated research leaves an important gap at the nexus between genAI use, social media use and impact on children development. The existing literature looking at this intersection is very scarce and does not offer any correlational or causal conclusions. For example, a study from the US examined associations between the extent and type of generative AI use among US adults with negative affective symptoms in a large, nationally representative sample[86] (Perlis et al., 2026). The study found that generative AI use was associated with modestly but statistically significantly greater depressive and other negative affective symptoms. The study also underlined that the pattern of concerns with genAI has paralleled those arising from social media use, but the study results did not establish an association between frequency of AI use and social media use.

2.7. Summary of findings and implications

The sum of evidence presented in the previous sections of part 2, while in several aspects remaining inconclusive or in need of further research, points to possible areas for future action to address the impact of generative AI on learning.

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84 n=981, >300k messages

85 See Robert Mahari and Pat Pataranutaporn blogpost (2024) (Source – accessed on 22 April 2026), who stress that "as addictive as platforms powered by recommender systems may seem today, TikTok and its rivals are still bottlenecked by human content. While alarms have been raised in the past about "addiction" to novels, television, internet, smartphones, and social media, all these forms of media are similarly limited by human capacity. Generative AI is different. It can endlessly generate realistic content on the fly, optimized to suit the precise preferences of whoever it's interacting with."

86 The survey study used data from a 50-state US internet nonprobability survey conducted between April and May 2025. Survey respondents were aged 18 years and older. There were 20 847 unique participants, with mean (SD) age 47.3 (17.1) years and 10 327 (49.5%) female, 10 386 (49.8%) male, and 134 (0.6%) nonbinary participants.

In the context of declining basic skills,[87] the findings presented in this part of the paper underline the need for improved, more systematic monitoring of the long-term impacts of genAI on learning outcomes, in particular as regards basic skills performance of secondary education students. The examined evidence also raises questions as to what the long-term impact of generative AI might be across all education levels on knowledge acquisition, literacy competence, or on skills, such as critical thinking, problem solving, and teamwork. The evidence on the impact of genAI on education, which this paper examines, is overwhelmingly based on experimental studies, which might be good at capturing short-term causal mechanisms, but the examined short-term impacts (e.g. cognitive costs) might also build up into academic performance gaps over time.

The presented evidence is quite clear on the superior performance of learning-oriented genAI tools as compared to their off-the-shelf counterparts. While this is in no way surprising, it underlines the need to not only promote the uptake of EdTech but also take concrete actions to avoid increasing the digital divide stemming from unequal access to educational AI tools, which might be much more costly. While embedding certain guardrails into off-the-shelf genAI tools can make them more suitable for educational use, the detrimental effects of such genAI models on learning continue to cause serious concerns due to widespread use outside of the classroom (Bastani et al., 2025). This therefore also stresses the necessity to monitor for continued skills erosion due to the extra-curricular use of off-the-shelf genAI tools.

GenAI delivers better results for some languages than others. The performance of genAI models is conditioned on their training data. While such systems might excel in languages with available data at scale (like English), they continue to face challenges with less represented languages (Krause et al., 2025). This has potential implications for students from underprivileged backgrounds (such as migrant students) but also more widely about **the EU's multilingualism policy**, which promotes language diversity and encourages language learning.

From the perspective of possible future consideration to tackle some of the challenges described in this paper, the following pointers are noteworthy:

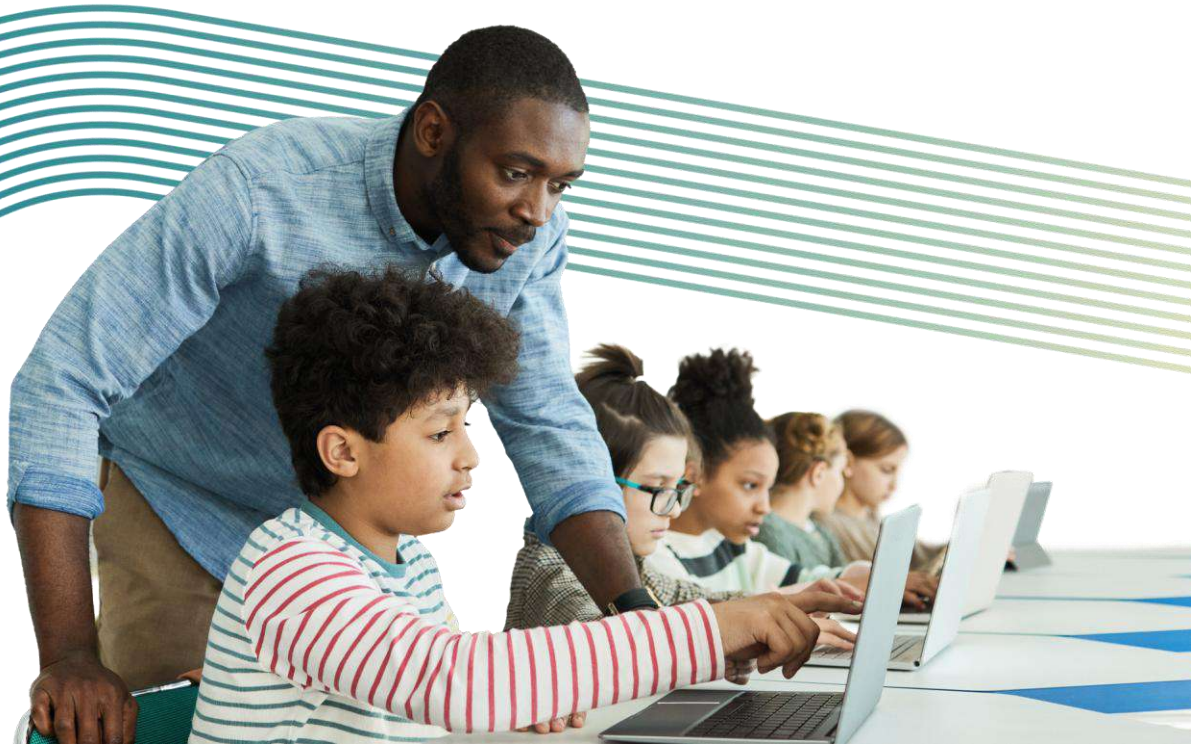
- Kosmyna et al. (2025) in particular underline the importance of educational interventions considering combining genAI assistance with technology-free learning phases to improve both immediate skill transfer and long-term neural development.
- The examined evidence also highlights the necessity for educational strategies that provide information efficiently but also challenge students to engage actively with complex material (Stadler et al, 2024) and therefore strike a balance between AI assistance and fostering student agency in order to ensure the active participation of students in their own learning journey (Darvishi et al., 2024).
- The lack of understanding regarding the systemic impact of genAI on basic skills performances highlights the necessity for a comprehensive assessment framework based on international systematically-available and comparable data.
- In addition, evaluating AI for educational use could go beyond relying solely on technical indicators such as accuracy or task performance (Tilbury, 2026). Instead, assessments could also consider developmental appropriateness for young learners and alignment with sound pedagogical practices.
- There is a need to prioritise longitudinal research that tracks the long-term effects of AI interaction on students' knowledge and skills, over time (OECD, 2026) and across all education levels.
- There is also a need for further evidence developed specifically in the EU educational context in order to better understand how the increase uptake of genAI is influencing EU educational systems. Such research could also help shed light on the implications of generative AI on essential EU policy frameworks, such as the Key competences for lifelong learning for example.
- Fostering AI literacy among young people already at primary and secondary education and mainstreaming it across educational provision is fundamental. Critical and responsible understanding and approach to AI tools is crucial for fostering informed usage of the technology and overcoming challenges related to

[87] For more information, see European Commission (2026c).

overreliance, socio-emotional and cognitive impact and self-regulated learning. The EU-OECD AI literacy framework in primary and secondary education offers an important tool in this regard.

- There is a need to promote effortful learning where genAI is used as a supportive partner rather than a replacement for thinking in the process of acquiring knowledge.

Part 3 - Implications for teachers

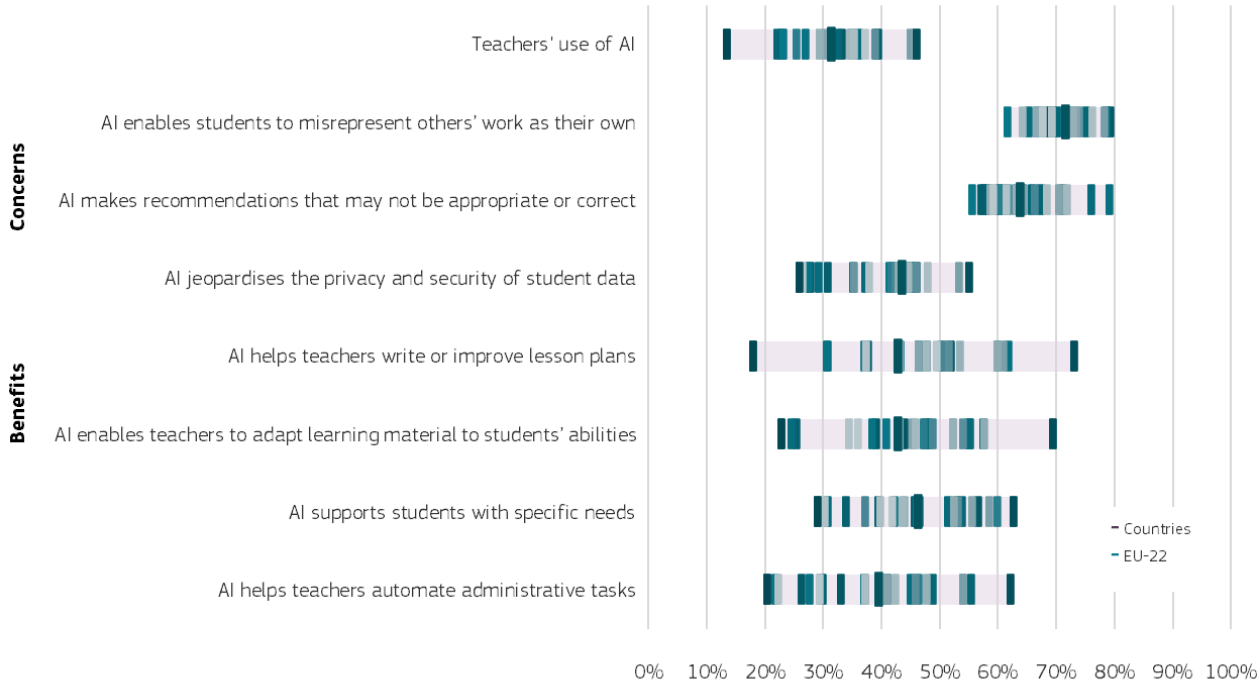


3.1. Implications for teachers

The increased uptake of generative AI in education, and in particular strong student engagement with such tools, raises a pressing need to support educators with specialised training and increase their AI literacy with the skills necessary to effectively integrate AI in the classroom (Matos et al., 2025; Sallai et al., 2024). Teachers remain significantly more concerned than students about the negative impact of generative AI on essential skills, such as communication, problem-solving, and critical thinking (Haroud and Saqri, 2025). Teachers are also concerned about their pupils using AI tools that are not developed for education purposes, especially such tools developed to mimic genuine human interaction[88]. The perceptions of Europeans on the use of AI for teaching also underline the importance of teacher training for the age of genAI, as about four in five respondents 'strongly agree' (35%) or 'somewhat agree' (46%) that all teachers need to be equipped with the skills to use and understand artificial intelligence (AI), including generative AI[89].

Survey data suggest that both teachers and principals in the EU tend to perceive more concerns than benefits associated with the use of AI in education. According to TALIS 2024, which focuses more widely on AI use (and not only on generative AI and large-language models), the most widely shared concerns relate to risks such as students misrepresenting others' work as their own, exposure to inaccurate or inappropriate AI-generated content, and threats to data privacy (Figure 12). Although teachers recognise several benefits – including support for lesson planning, adapting materials to students' needs, assisting students with specific needs, and automating administrative tasks – the share of teachers expressing concerns tends to be higher – and more consistent across countries – than the share highlighting benefits. While there is some cross-country variation, most countries are clustered around the EU-22 average, suggesting that these perceptions are broadly shared across European education systems.

Figure 12. Teachers' use of and opinions about AI, based on TALIS 2024



Source: Based on Tables 1.59, 1.61 and 1.62 (OECD, 2025f)

Note: Percentage of lower secondary teachers who report having used AI, and of teachers who "agree" or "strongly agree" with the statements included in the figure. Caution is required when interpreting data for the Netherlands due to higher risk of non-response bias. Consequently, the Netherlands are excluded from the EU-22 aggregate. (OECD, 2025f).

88 https://istp2026.ee/wp-content/uploads/2026/03/2026_ISTP_EIBriefing_Online-version.pdf

89 For more information, see the 2025 Flash Eurobarometer on Future needs in Digital Education.

Findings from the European Commission's survey on AI in teaching and learning (European School Education Platform, 2026) point to a similar pattern, suggesting that concerns may be more strongly expressed than perceived benefits: while respondents clearly recognise the benefits of AI (especially in terms of time savings, efficiency and personalisation) concerns tend to be more widespread. In particular, large shares of respondents report being "very concerned" about issues such as students' inappropriate use of AI (72%), over-reliance (71%), and academic integrity (55%), as well as data privacy (60%) and bias in AI systems (55%). By contrast, the perceived benefits include saving time on pedagogical tasks (52%) or creating customised resources (49%).

A similar pattern emerges among school leaders. Evidence from ICILS (2023)[90], collected shortly after the release of ChatGPT, shows that most students were in schools where principals expressed concerns that generative AI could encourage academic dishonesty, expose students to misleading information, or foster over-reliance on such tools. At the same time, principals also recognised its potential: more than half of students attended schools where principals believed AI could improve learning, nearly two-thirds where it could increase students' interest, and most where it could support teachers in lesson planning and resource development.

T**eachers' use of AI remains relatively limited,** though with cross-country variation. According to TALIS 2024, on average across the EU-22, around one-third of teachers (31.6%) using AI tools. Usage rates range from below one-quarter in France (13.5%), Bulgaria (22.1%) and Hungary (23.1%) to around 45% or more in Czechia (45.8%), Romania (45.8%), Poland (45.1%) and Malta (46.0%). The coexistence of moderate uptake and relatively high levels of concern suggests a cautious approach, with teachers gradually adopting AI while remaining mindful of its potential risks. Among teachers who have not used AI for teaching, the main barrier is a lack of knowledge and skills (74.3%), while more than half of teachers in the EU (55.9%) report that they do not believe AI should be used in teaching. Given that the TALIS questionnaire was administered in the spring of 2024, teachers' use of AI might have increased since the latest TALIS data became available.

Generative AI promises to be transformational for teachers but also bring additional complexities to teaching. AI tools could help decrease teachers' workload by supporting the creation of lesson plans and assignments, thereby freeing up time and extending the possibility to focus on content, pedagogical development, and delivery (Pallant et al., 2025). However, the possible complexity of integrating genAI in the classroom might entail additional efforts for teachers to check genAI-generated content (Selwyn et al., 2025) putting into question how much time the uptake of the technology can ultimately free for them. This might decrease the perceived usefulness of AI tools among teachers, which in turn is an important predictor of their attitudes and behavioural intention to use generative AI tools (Simsek et al., 2025). In addition, using genAI to automate teaching tasks also raises concerns about reduced teacher agency and potential cognitive atrophy (Cukurova et al., 2025), which resonates with the observed propensity of genAI systems to encourage cognitive offloading in learners (see section 2.3 of this paper).

GenAI cannot and should not replace teachers. Despite all the purported ways in which genAI can act as support to teachers, their role in education to offer guidance, mentorship, and critical thinking opportunities remains pivotal and irreplaceable (Krause et al., 2025). Linsenmayer points out that such a need can be addressed through the integration of critical AI literacy skills into the curriculum of higher education programmes for pre-service teachers and also offering continuing professional learning opportunities for in-service teachers (2025). Data on teachers' perceptions on the use of genAI emphasises the importance of balancing AI-assisted teaching with traditional educational methods (Villar et al., 2025). Educators acknowledge that, while AI can be a valuable supplement to existing practices, it cannot replace the human element in education.

The existing research on the impact of genAI tools on teacher training is predominantly focused on initial teacher training. A scoping review of the literature on generative AI and teacher development found that three-fifths of papers were focused on pre-service teachers and less than a third on in-service teachers (Tan, 2025). This presents an important research gap, as in-service teachers' experiences, needs, and challenges may differ from those of pre-service teachers. The focus on the impact of genAI on initial teacher training therefore affects the generalisability of findings as regards the impact on teacher development, suggesting that caution is necessary when applying such findings to broader contexts.

[90] An optional principal questionnaire on the topic of the use of generative AI tools in schools was administered in 12 countries taking ICILS 2023, of which 12 European education systems (Cyprus, Denmark, Greece, Romania, Slovak Republic, Slovenia, Sweden).

Initial teacher education is key for effective genAI take-up in the classroom. An exploratory study by the JRC on the use and views of early adopters of generative AI in secondary education, looked at emerging practices and perceptions across five EU Member States[91] and found that initial teacher education is a key enabling factor for the effective and responsible integration of GenAI into secondary education (Villar et al., 2025). The most notable ways, in which the rise of genAI has affected the work of teachers included providing new tools that can be used as part of teaching and learning activities, raising concerns about academic integrity and data protection, and questioning the traditional role of educators in the teaching and learning process. The study concluded that key considerations include workload management, ethical concerns, pedagogical shifts, and the need for professional development and infrastructure.

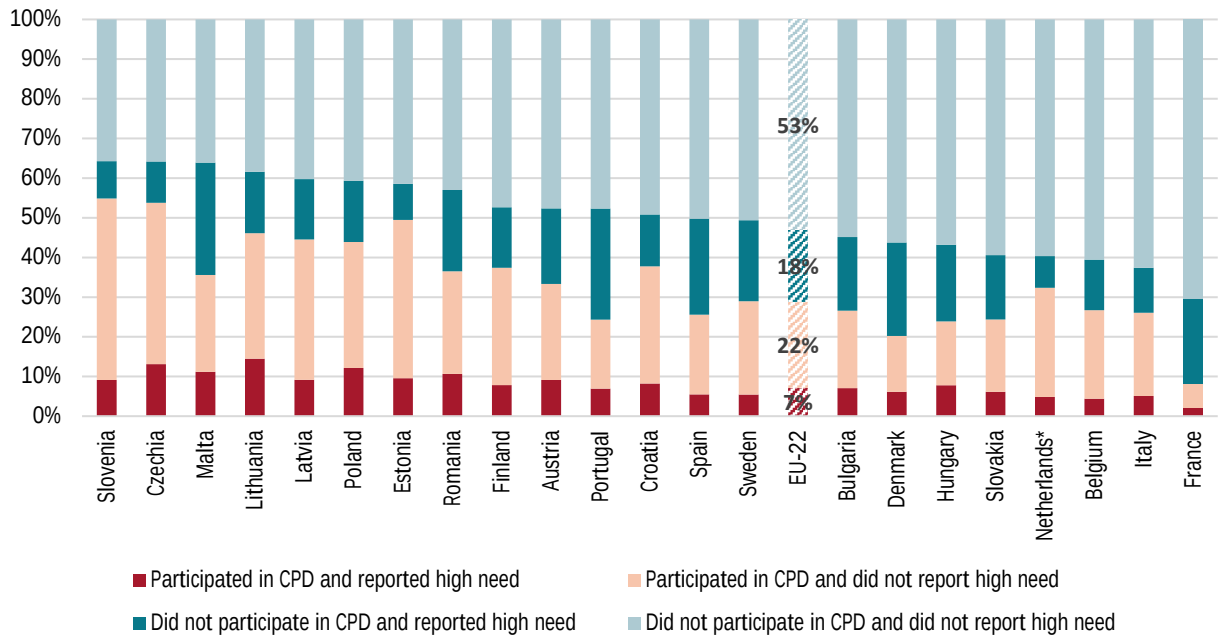
Generative AI can support initial teacher education. A small-scale, exploratory study by Lim J. et al. (2025) examined the potential of GenAI-enhanced virtual simulations to boost the problem-solving skills of pre-service teachers. The authors created a virtual environment, which integrates problem-based learning with GenAI technology and aimed to assess its effectiveness by comparing three groups of pre-service teachers: 1) a non-AI support group; 2) a traditional (rules-based) AI-support group; and 3) a genAI supported group.

But so can more established forms of AI. While the study found statistically significant improvements in problem-solving skills for the traditional and GenAI-supported groups as compared to the non-AI (text-based scenario) group, there was no significant difference between the generative- and traditional AI-supported groups. We currently lack more comprehensive evidence on why genAI models might be preferable to more established AI tools when it comes to initial teacher training. In view of this gap, and given that genAI sometimes hallucinates and produces wrong information, a cautious approach to AI integration for initial teacher training might consider the benefits of more established forms of AI technology until further evidence is available of genAI's potential for boosting teacher training.

In the context of teachers' use of genAI described above, professional learning is particularly relevant for helping teachers address both the opportunities and risks associated with genAI. However, only 29.7% of teachers in the EU-22 engaged in continuous professional development activities on the use of AI for teaching and learning in the 12 months prior to the survey. Across the EU-22, most teachers (53%) neither participated in professional learning nor reported a high need, while 22% participated without reporting high need (Figure 13). However, almost one in five teachers (18%) did not participate despite reporting high need, pointing to unmet professional learning needs. Only 7% both participated and reported high need. This pattern varies across countries: unmet need among non-participants is particularly high in Malta, Portugal and Cyprus, while it is relatively low in the Netherlands, Estonia and Slovenia. By experience, unmet need is slightly higher among more experienced teachers in the EU-22: 19% of teachers with more than 10 years of experience did not participate and reported high need, compared with 15% of teachers with five years or less.

[91] Ireland, Finland, Germany, Luxembourg, and Spain.

Figure 13. Professional learning needs in the use of AI and participation in continuous professional development on this area



Source: Based on table 4.30 TALIS 2024 (OECD, 2025f)

Note: Caution is required when interpreting data for the Netherlands due to higher risk of non-response bias. Consequently, the Netherlands are excluded from the EU-22 aggregate. (OECD, 2025f).

Continuous professional development can support improved teacher knowledge of AI, but not necessarily its increased uptake in the classroom. One of the few studies in the EU context (based on more traditional AI models) providing counterfactual evidence on how continuous professional training for teachers affects their perceptions and use of artificial intelligence comes from the Artificial Intelligence for and by Teachers (AI4T) project.[92] Funded by the European Commission through ERASMUS+, the project was a three-year experiment (2021-2024) designed to explore and support the use of AI in education, in particular through the lens of its impact on teachers (Paris et al., 2023). The project produced, implemented and evaluated professional learning activities to familiarise teachers with AI and was conducted in five EU countries: France, Slovenia, Italy, Ireland and Luxembourg. A randomised control trial evaluated the project[93] and the findings revealed that the professional learning pathway was particularly effective to improve teachers' knowledge of AI, but not necessarily their actual use of AI (Paris et al., 2023). This suggests that apart from knowledge of AI, other factors (such as perceived usefulness, perceived pedagogical value or concerns related to hidden labour) might also be at play when affecting the actual uptake of the technology in the classroom by teachers. In addition, the results also underline the importance of guidance and support offered at institutional level and by public (national and/or regional) authorities as key factors in equipping teachers to use AI in education (see e.g. European Commission, 2026).

Generative Artificial intelligence can reduce lesson preparation time without compromising on the quality of teaching resources. A randomised control trial[94] in the UK found that an off-the-shelf genAI-supported teacher group took nearly a third less time for lesson and resource preparation compared to a non-GenAI supported teacher group without any evidence suggesting a difference between the quality of the lesson resources used by the two groups (Palak Roy P. et al., 2024). In addition, the significant amount of time saved by the genAI-supported group occurred even when teachers automated only a relatively small amount of their overall planning[95]. The findings on the quality of AI-supported lesson plans are further corroborated by an experimental study, which

92 https://www.ai4t.eu/

93 An impact analysis was conducted on the three countries with large enough sample sizes, namely France, Italy and Slovenia.

94 Thirty-four schools (129 teachers) were randomly allocated to a ChatGPT group and 34 schools (130 teachers) to a non-GenAI group. Year 7 and 8 Science teachers were eligible to participate in this study.

95 Teachers tended to use ChatGPT for one or two activities rather than across the lesson.

examined whether lesson plans prepared using the off-the-shelf genAI model affected academic achievement in math courses at the primary school level (Karaman and Goksu, 2024). The study found that the effect of the implemented teachers and off-the-shelf genAI plans on mathematics achievement did not differ statistically.

GenAI can usefully support the production of lesson materials. One such study uses a mixed-methods approach[96] to evaluate the potential of LLMs to generate German reading comprehension texts for educational large-scale assessments[97] (Ripoll et al., 2025). The study aimed to determine if ChatGPT was capable of assisting text creation while maintaining high-quality standards. It found that all texts were of similarly high quality, with human reviewers being unable to consistently identify whether they were generated by AI or a human (ibid). The findings highlighted the potential of using genAI as a flexible assistant in the creation of reading comprehension but also underlined the necessity for human oversight of AI-generated content.

Integrating genAI in the classroom has the potential to reduce the strain on overworked teachers but might also entail additional responsibilities. This is particularly important considering the burdens typically reported by teachers (European Commission, 2026b) and might suggest the possibility (to a certain extent) to help mitigate the workload of strained teachers. Still, the propensity of genAI systems to sometimes provide inaccurate responses or simply make information up (by hallucinating) raises additional requirements on educators for verification (Villar et al., 2025). The authors note that the increased uptake of AI might therefore create new workload demands, such as monitoring technology use, implementing new assessment methods, an additional need to invest time in developing teachers' own AI literacy and dealing with unintended consequences, thereby possibly offsetting any possible time savings.

The use of genAI to support daily teaching and administrative tasks might result in 'hidden labour' for teachers. The OECD points out that evidence measuring time spent with technology shows increases in efficiency for some tasks like lesson planning, but qualitative studies highlight potential "blind spots" that necessitate further research (OECD, 2026). In particular, this includes the hidden labour educators must invest in reviewing and verifying the accuracy of AI-generated content. This leads the OECD to emphasise the need for further research into how the GenAI tools can be designed to enhance, rather than complicate, teaching practices.

The impact of generative AI on teacher cognitive abilities remains largely unexplored. The literature review for this paper did not manage to find any counterfactual evidence on the impact of genAI use on teachers' cognition. Evidence is rather focused on learners (as section 2.3 of this paper summarises). This represents an important research gap, given that the OECD has pointed out teachers might face the same risk of cognitive offloading and lack of learning as students as a result of genAI tools use (OECD, 2026). Reflections from theoretically grounded studies support this possibility, suggesting that genAI may displace teacher judgment in ways that undermine germane learning and reflective practice (Rind, 2026). However, further (qualitative and quantitative) research is needed to fully understand the actual impact of genAI on teachers' cognitive abilities.

3.2. Summary of findings and implications

The evidence suggests that genAI is already at a stage that could meaningfully support the elaboration of lesson plans and the reduction of administrative burden for teachers. To make full use of such benefits but also mitigate any potential shortcomings inherent in the technology, teachers will need substantial initial and continuous professional development support in order to improve their AI literacy and skills and allow them to keep track with the ever-increasing AI capabilities. Engaging with teachers about their continuous professional development needs related to genAI can help meet teachers' interests, therefore also potentially supporting the uptake of the technology for teaching. In addition, it would be important to ensure a coherent, accessible, evaluated and continuous up-to-date provision of such training and development for teachers. The importance of enhancing digital

[96] In a qualitative focus group discussion, experts identified the strengths, weaknesses, opportunities and threats (SWOT) of using GPT-4 for text generation. These insights informed the construction of a Text Analysis Cognitive Model (TACM), which served as theoretical foundation. Narrative and informative reading comprehension texts were then generated using two distinct prompt engineering techniques, derived from original passages and TACM specifications. In a blinded online review, N = 89 participants evaluated human-written and AI-generated texts with regard to their readability, correctness, coherence, engagement and adequacy for reading assessment.

[97] within the multilingual context of Luxembourg

skills and competences for education and training staff, including teachers, in order to prepare them for the ongoing digital transitions is also recognised in the current Digital Education Action Plan.

Important research gaps need to be addressed in order to make sure that the uptake of genAI does not ultimately come at the expense of the quality of the teacher's profession. In particular, further research is needed into the **potential impacts of genAI on teachers' cognitive abilities**, as well as potential for the integration of genAI to require more efforts from teachers than it saves them (i.e. hidden AI-related labour) that might reduce the net benefit for teachers' workloads. In addition, the current evidence base on the impact of genAI on teacher development is heavily skewed towards initial teacher training, therefore underlining the need to look as well into the impact on continuous teacher development.

While important unanswered questions as to the impact of genAI on teaching remain, more established types of AI tools seems to have the potential to bring benefits to the classroom. For example, the evidence examined in the paper suggested that traditional types of AI might be able to support the development of initial teachers' problem-solving skills on par with genAI.

Last but not least, genAI can be used to support students with special needs and allow them to participate on a more equal basis in the classroom, thereby improving equity outcomes in education. This potentiality is particularly important in view of the critical shortages of specialised teachers in the EU (Di Pietro, 2023) and therefore the potential of genAI tools to support the specialised teachers in their work. To make full use of the potential benefits, however, genAI tools need to be specifically developed with SEN students in mind, therefore minimising the risk of AI bias.

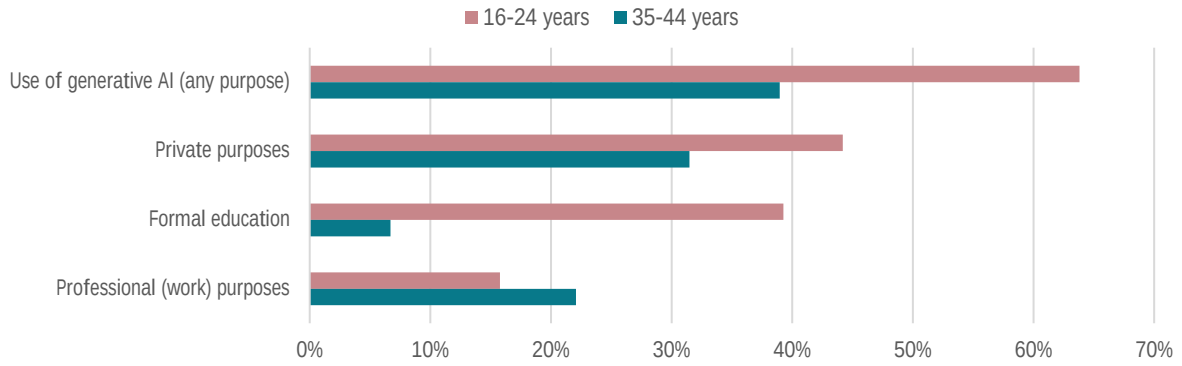
Part 4 - Implications for parents

4.1. Implications for parents

Parents have a pivotal influence shaping their children's learning environments and making key decisions concerning the educational tools and technologies their children use (McFayden et al., 2024). However, causal evidence on the role of parents in shaping children's learning through AI remains very scarce. While the integration of AI tools in classroom settings is often analysed through the prism of educators, parents influence how (and if) AI tools are incorporated in home-based learning (Tang et al., 2026). The absence of robust counterfactual evidence related to the role of parents therefore leaves a critical gap in the overall analysis of the impact of genAI on learning.

Parents (likely) lag significantly behind their children in using genAI tools. While a common data source comparing parental and children usage of AI has not been identified in the research for this paper, a useful proxy is the use of AI by age group. According to EUROSTAT, in 2025, almost two-thirds (63.8%) of young people aged 16-24 in the EU used generative artificial intelligence (AI) tools - as opposed to 39% of the share of people, whose children are now in school education (i.e. those people aged 35-44) – see Figure 14.

Figure 14: Use of generative AI tools in the EU, 2025 (% of people, by purpose and age group)



Source: Eurostat (isoc_ai_iaiu)

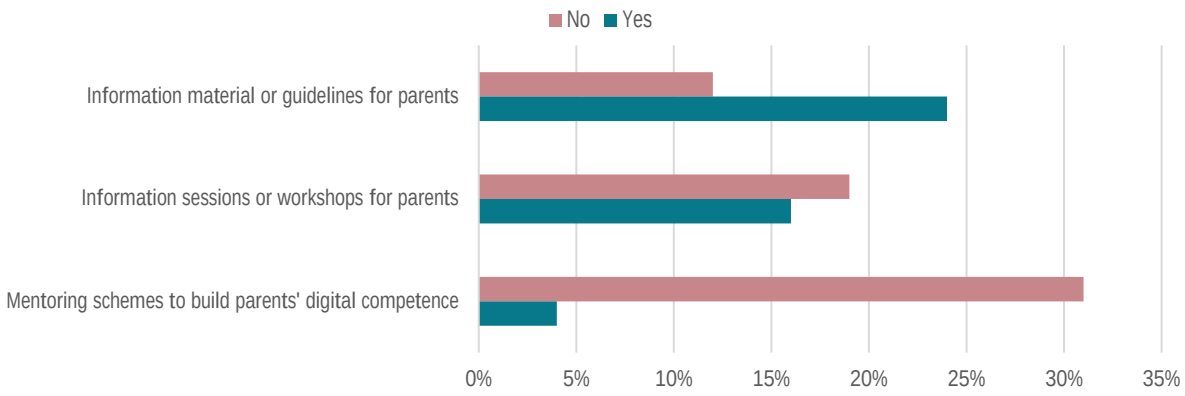
Parents play a key role in supporting their children's learning in digital environments. At the same time, guidance or mentoring on how to boost parents' digital competence in the age of genAI is still lacking to a great extent (see Figure 15). A qualitative study collected data from 160 parents of primary school students in Hong Kong and found that parents with better educational backgrounds are likely to be equipped with better AI knowledge and have more positive attitudes towards AI tools, therefore potentially also positively influencing their children's use of AI (Guo et al., 2025). Data from EUROSTAT[98] shows that highly-educated people[99] in the EU are three times more enthusiastic about AI usage than their low-educated peers (56% vs 19%). Parents' attitudes and abilities to deal with digital technologies-related issues are vital in providing better guidance for primary school children in today's digital environments (Guo et al., 2025). In particular, parents with higher levels of AI literacy skills might be more confident in helping their children navigate AI environments. Such higher parental self-efficacy[100] has in fact been associated with positive children learning outcomes.

98 See Individuals - use of generative AI tools [isoc_ai_iaiu__custom_21022098]

99 Aged 25-54.

100 Parental self-efficacy reflects parents' beliefs about their ability to effectively manage parenting tasks and challenges.

Figure 15. Central initiatives to strengthen parents' digital capacity, share of total jurisdictions reporting



Source: Boesken and Meyer (2025)

Note: 'Number of jurisdictions with the following central initiatives aimed at strengthening parents' digital skills and their ability to support their children's effective and safe use of digital resources. Note: Number of jurisdictions with available data = 35/36. See Annex Table 6.4 in original report for further details and individual jurisdictions' responses corresponding to this figure.

Traditional AI models can support effective and timelier parental **engagement with their children's** performance in school. A study by Kumar et al. (2024) shows how traditional AI tools can facilitate stronger collaboration between all stakeholders in the educational process. This is essential for fostering student success. Despite recent technological advancements, the authors note that many schools continue to rely on periodic report cards and occasional parent-teacher meetings, which might not often convey a complete and timely picture of a student's academic performance. To address such challenges, AI can be used to analyse and interpret academic data and combine it with insights into student behaviour and learning progress over time, but making use of this potential is preconditional on the necessary data being available. The authors also point out that such systems can support parents (and teachers) in detecting early signs of academic struggle and also foster possible proactive interventions.

Traditional AI tools can support the involvement of disadvantaged parents in the school community. They can help with the integration in primary and secondary education systems of parents from disadvantaged backgrounds, such as non-native-speakers (Borgonovi et al., 2025), for example by enabling real-time interpretation that facilitates a direct connection between teachers and non-native speaking parents. Such tools can also support such parents with more easily navigating the administrative side of school systems. Stronger parental involvement in the school community might help with better academic and well-being outcomes for students.

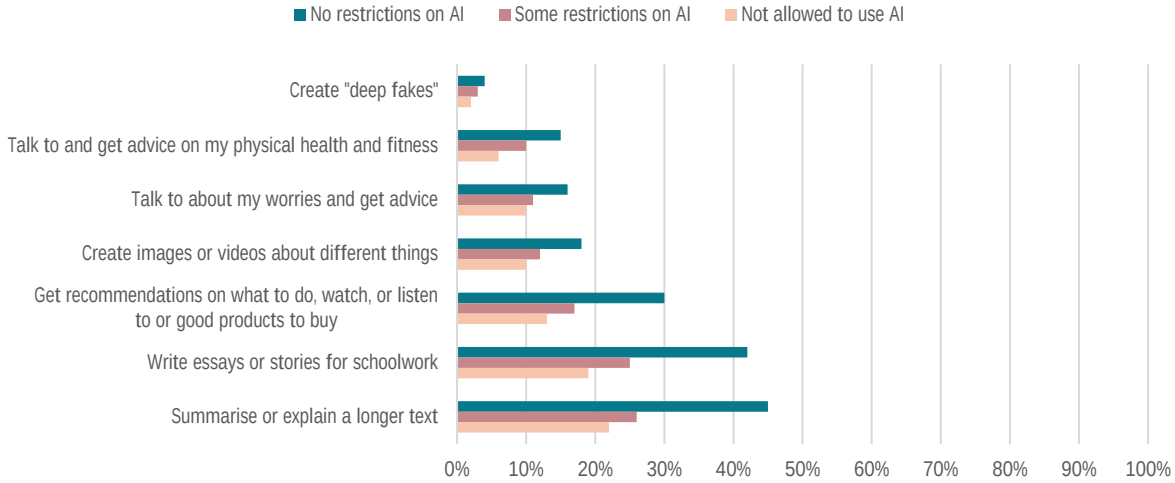
The potential of genAI to support parents is not clear cut. On the one hand, the technology can support parents' effective involvement in pre-primary children's education, which in turn fosters the development of children's cognitive and social skills (Ho et al., 2025). GenAI can support parents by boosting their ability to educate and engage with their children[101] by providing evidence-based advice through applications and chatbots, offering advice to parents how to teach complex concepts (ibid.). On the other hand, given the many inherent drawbacks of the technology, including privacy and data protection issues and the propensity to hallucinate among others, many parents remain sceptical about the role of AI in their young children's academic life, express concerns about the accuracy of AI-generated content, and worry that over-reliance on AI could stifle independent thinking (Mei et al., 2025).

Evidence suggests that genAI cannot replace parental support for their children. An LLM-powered conversational agent tested in home environments over six weeks with 10 families and their children aged 3–7 showed that the system can deliver structured literacy instruction as effectively as parents, though children achieved higher learning outcomes when learning with parents (Quan et al., 2026). The study found that this might be connected to personal preference - children perceived the LLM agent as smart and interesting but still preferred learning with parents due to emotional bonding.

[101] The in-home field study involved 20 families with children aged 3–5.

GenAI adoption by parents might be driven by short-term considerations. One study[102] examined the social dynamics of AI adoption and looked at the motivating factors that drive parents to adopt advanced AI tools for their high school children's education (Bursztyn et al., 2025). The study's results suggested that AI adoption resembled "rat race dynamics" - peer adoption creating short-run externalities – in particular anxiety about falling behind – that accelerate adoption despite possible drawbacks. Despite the mounting evidence of the sometime detrimental impact of genAI on learning, parental restriction on its use remains the exception rather than the norm (see Figure 16 for data on parental restrictions in Estonia, Poland and Norway).

Figure 16: Parental restrictions as perceived by children on different AI-related activities



Source: Staksrud et al. (2026).
Note: Base children (aged 9-16) who have used GenAI in the past month in Estonia, Poland, and Norway (N= 1,259)

4.2. Summary of findings and implications

Boosting parents' digital competence can support children's learning in genAI environments, but genAI cannot replace the importance of everyday parental support to their children's development. Traditional AI tools can help support effective and timelier parental engagement with their children's academic performance and also support the involvement of disadvantaged parents (such as non-native speakers) in the school community by facilitating real-time direct communication with teachers. The potential of genAI tools in particular to support parents is not clear cut, with possible benefits to be balanced against many inherent drawbacks of genAI. In view of the propensity of some parents to encourage genAI use at home and focus on its support for task performance despite possible long-term drawbacks, educational stakeholders need to monitor and make sure the increased uptake of learning-oriented genAI tools in the classroom is not undermined by long-term cognitive costs stemming from the use of off-the-shelf genAI tools at home. This is an issue that goes beyond educational policy but also has direct consequences for the long-term scholastic development of children across all educational levels.

[102] The study conducted experiments with parents of teenagers aged 13 to 18.

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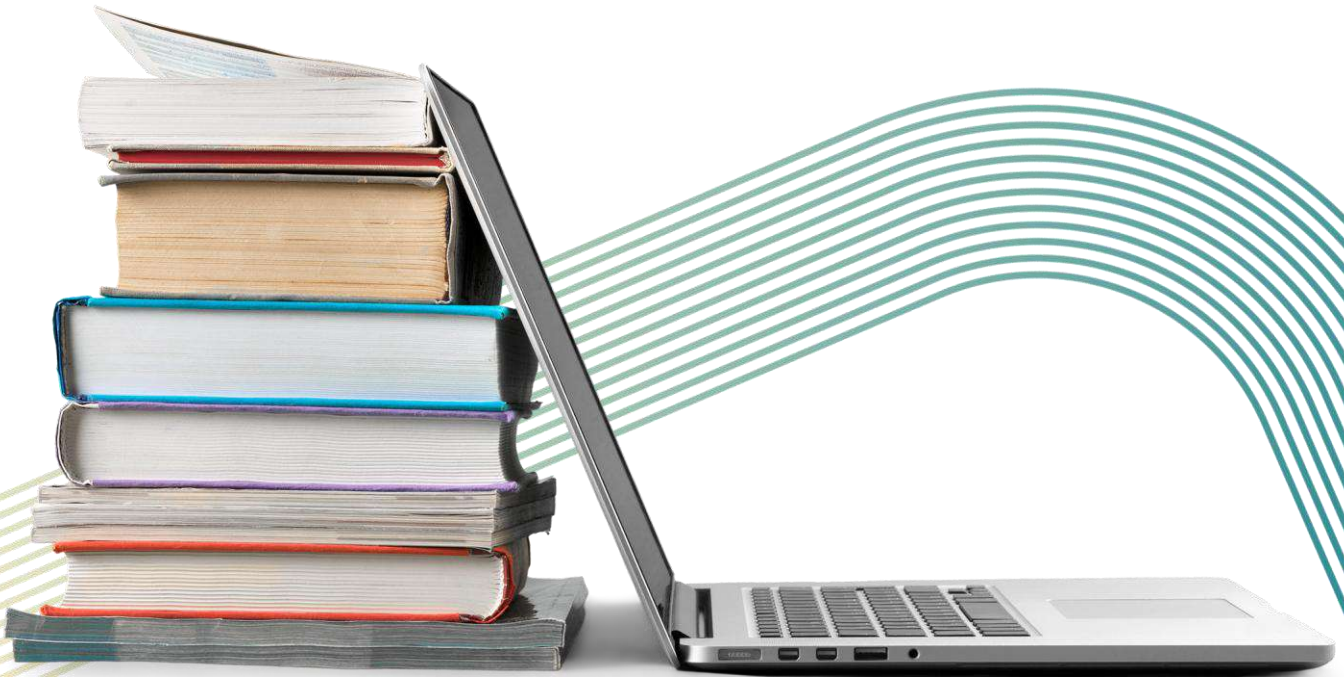

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Annex – EU policy framework

The European Union has already done much to actively shape the AI landscape, take full benefit of the many promises the technology brings, and address the potential issues. In particular, the EU has been promoting responsible AI development and deployment through the EU AI Act, adopted in 2024.[103] The European Commission has also launched the AI Continent Action Plan[104] and the Apply AI Strategy[105] recognising skills and talent as enablers for AI innovation in Europe. The General Data Protection Regulation (GDPR)[106], which governs how personal data must be collected, processed, stored, and protected, shapes the use of generative AI in education, as such systems often process student data.

In the field of education, the European Commission has recently put forward several general initiatives, which frame how the EU could address the challenges and opportunities stemming from the unfolding digital transformations of education systems. The Union of Skills communication[107] addresses the need for systemic adaptation to fast-changing skill demands and the necessary policy infrastructure to address large-scale disruptions in education systems, such as the technological changes underpinning the digital transformation. The accompanying Basic Skills Action Plan[108] prioritises the building of foundational capacities that enable adaptation to ongoing transformations. It underlines the importance of digital skills for "confident, critical and responsible engagement with digital technologies for learning, working and participating in society." The Action Plan also stressed the importance of media literacy to counter information manipulation (on the rise due in part to genAI) as part of a strengthened focus on citizenship and digital skills. Very importantly, the Basic Skills Action Plan positions digital and citizenship skills as part of the foundational skills, alongside literacy, mathematics, and science. Work on the implementation of the Basic Skills Action Plan continues, with a Basic Skills Support Scheme being prepared, which aims to help underachieving children and young people by ensuring they acquire basic skills before the end of compulsory schooling.

To address the critical challenges to STEM education stemming from technological change and therefore also the talent pipeline behind genAI development and governance, the STEM Strategic Action Plan, as part of the Union of Skills communication, identifies the shortage of STEM talent, mismatch between education output and labour market demand, declining performance in math and science, and gender gaps in STEM as factors preventing the increased uptake of STEM education and puts forward concrete actions and targets to boost STEM participation.

The 2018 European Key Competences for Lifelong Learning Recommendation[109] defines eight key competences needed for personal development, employability, and active citizenship. In many Member States, it supported the shift from content- and knowledge-based to competence-based education, serving as a reference tool to align education and training policies across all life stages, spanning formal, non-formal, and informal learning. Many of the learning outcomes and capabilities which are touched by AI and studied in this paper are part of the key competences framework: literacy; multilingual, digital, citizenship, mathematical competence and competence in science, technology and engineering, as well as personal, social and learning to learn competence or transversal skills including critical thinking and problem solving.

Without being designed as direct, explicit responses to the observed impact of genAI uptake in education, the abovementioned initiatives frame the way the use and impact of AI today is considered. In addition, several other initiatives focus directly on the digital transitions in education and the recent rise of AI use in the classroom.

The Digital Education Action Plan (2021-2027)[110] sets out a common vision of high-quality, inclusive and accessible digital education in Europe and aims to help national education and training systems adapt to the digital age. As part of the ongoing review of the current Digital Education Action Plan, the digital dimension of the upcoming

103 https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai
104 https://digital-strategy.ec.europa.eu/en/library/ai-continent-action-plan
105 https://digital-strategy.ec.europa.eu/en/policies/apply-ai
106 https://eur-lex.europa.eu/eli/reg/2016/679/oj/eng
107 https://commission.europa.eu/topics/competitiveness/union-skills_en
108 https://education.ec.europa.eu/document/action-plan-on-basic-skills-legal-document
109 https://op.europa.eu/en/publication-detail/-/publication/297a33c8-a1f3-11e9-9d01-01aa75ed71a1/language-en
110 https://education.ec.europa.eu/focus-topics/digital-education/actions

Education Package will aim to establish a robust and inclusive EU digital education ecosystem that addresses emerging needs, including in the context of the rapid AI transformation.

The European Commission, together with the OECD, has also developed the AI literacy framework.[111] This framework focuses on what are the set of competences young people need to understand and interact with AI systems in a confident and critical manner, based on essential knowledge, skills, and attitudes.

The European Digital Competence Framework[112] has recently been updated (DigComp 3.0) to embed AI competence across all areas of digital competence and everyday tasks. It incorporates recent and emerging digital technological trends and their implications for digital competence. In the revised framework, AI-related knowledge, skills and attitudes are featured in all 21 competences.

The Commission services have begun work towards an update of the European Digital Competence Framework for Educators (DigCompEdu) to reflect the rapid changes impacting education today. Since the publication of the framework in 2017, the digital landscape has evolved, bringing new opportunities, challenges and also risks for educators across all sectors. Emerging technologies - particularly artificial intelligence - are impacting how teaching and learning take place. At the same time, pedagogical approaches such as blended and hybrid learning, which became widespread during the COVID-19 pandemic, have become a more established feature of education systems.

The Council Conclusions on teachers in the era of artificial intelligence[113] acknowledge that AI is rapidly reshaping education and has the potential to influence how teaching and learning are organised, how information is accessed, and how schools manage administrative tasks. The Conclusions call on EU Member States to strengthen teachers' AI and digital skills, promote the development and use of education-specific AI tools, address unequal access to digital resources, and ensure AI enhances rather than undermines autonomy and sustainable working conditions for teachers.

To address the importance of using AI in teaching in an ethical and responsible way, the Directorate-General for Education, Youth, Sport and Culture of the European Commission has recently released its updated Guidelines on the ethical use of artificial intelligence and data in teaching and learning for educators[114], which focus on supporting teachers and school leaders make informed choices, build confidence step by step, and develop the necessary skills to take advantage of AI while managing potential risks.

The upcoming EU Teachers Agenda will aim to boost the status, working conditions, and career prospects of educators, focus on navigating digital and green transitions, and support their professional development.

111 https://ailiteracyframework.org/pdfs/framework_pdf/AILF_en.pdf

112 https://joint-research-centre.ec.europa.eu/projects-and-activities/education-and-training/digital-transformation-education/digital-competence-framework-digcomp/digcomp-30_en

113 https://data.consilium.europa.eu/doc/document/ST-8262-2026-INIT/en/pdf

114 https://op.europa.eu/en/publication-detail/-/publication/f692aa0b-17a7-11f1-8870-01aa75ed71a1/

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