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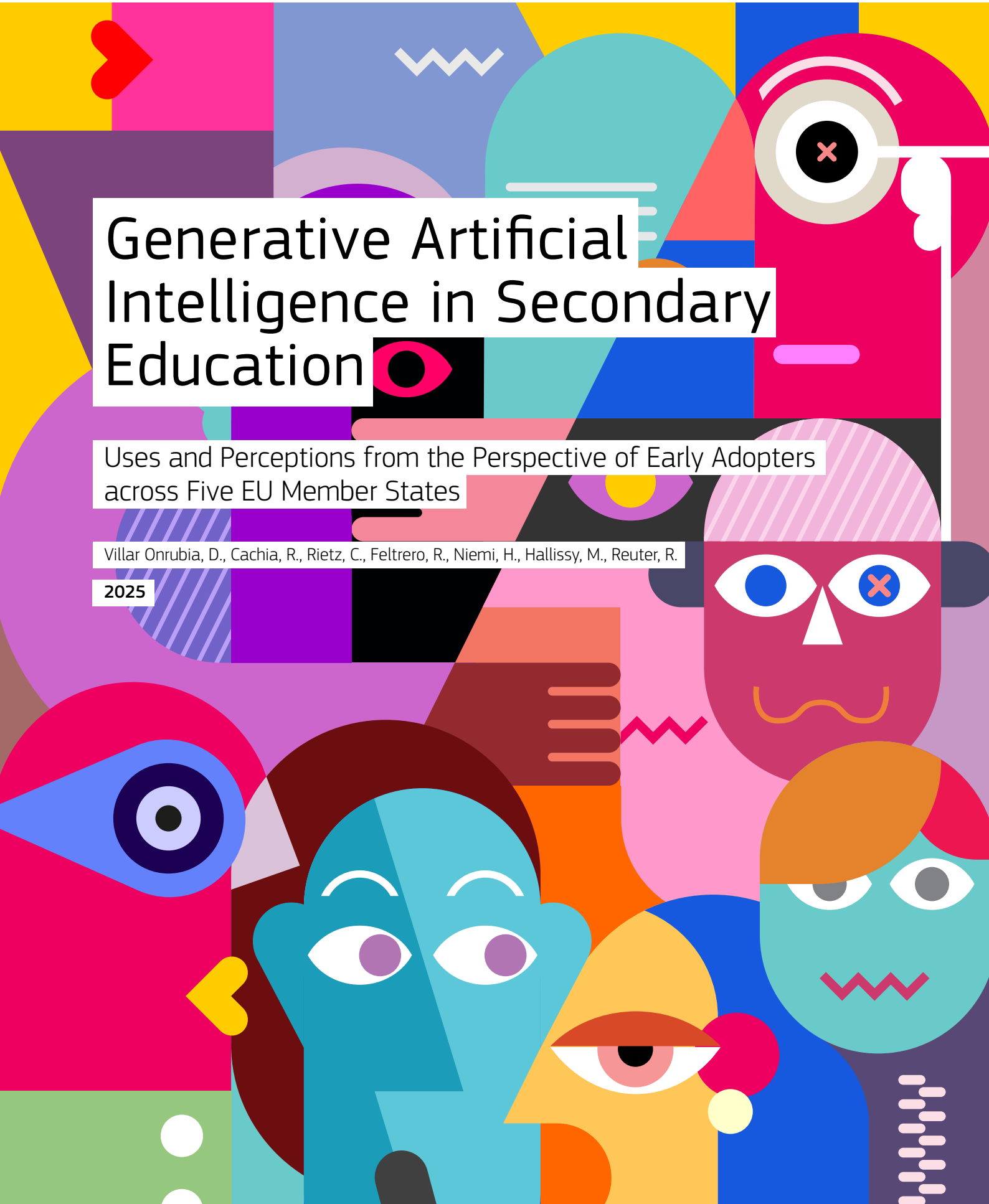

Generative Artificial Intelligence in Secondary Education

Uses and Perceptions from the Perspective of Early Adopters across Five EU Member States

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Contents

Abstract

This exploratory study examines the use and views of early adopters of generative AI (GenAI) in secondary education, exploring emerging practices and perceptions across five EU Member States. The study, based on the views of teacher educators, teachers, school leaders, students, and policymakers, highlights that GenAI offers new opportunities for teaching and learning while also posing important challenges. By understanding the experiences and views of these early adopters, the study provides insights into key aspects of how GenAI is being adopted in secondary education and how to promote an effective and responsible use by educators and students. Based on the findings, we provide a set of policy considerations emphasising the importance of ethical uses and the need to redefine and improve AI literacy and digital education competence in the light of emerging technologies.

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Executive summary

EU Policy context

The European Union is actively shaping the AI landscape by promoting responsible AI development and deployment through the AI Act. The Commission has launched the AI Continent Action Plan and the Apply AI Strategy recognising skills and talent as enablers for AI innovation in Europe. It is also promoting quality education and skills provision in relation to AI through the *Digital Education Action Plan* and the *Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators*. The *AI Literacy Framework for Primary and Secondary education* (AILit), developed in partnership with the OECD,[1] and the recently updated *European Digital Competence Framework* (DigComp 3.0)[2] are also key instruments supporting AI literacy development for all.

Key conclusions

The report highlights the need for comprehensive policies and guidelines on GenAI use in education. At policy level, there is a need to promote the inclusion of GenAI into AI literacy efforts, curricular updates, teacher education, and professional development for educators. New policy measures, such as investing in infrastructure and resources, could support effective and ethical GenAI integration. Significant knowledge gaps were identified, including the potential impact of GenAI on student learning, how it can enable teachers in their work and the need for clarification and more scientific evidence-based results and sharing of good practices on the effectiveness of different GenAI-based educational interventions.

Main findings

This study collected data during 2024, at a time when GenAI was attracting the attention of early adopters in the educational sector. Such users in secondary education started to experiment extensively with this technology soon after it was available in the consumer market. Educators and students saw GenAI as a tool to enhance learning, but also raised concerns about academic integrity, bias and the potential risks of over-reliance on this technology and its impact on their learning. The importance of human agency when using AI systems was also highlighted. Critical reactions primarily focused on data protection, algorithmic biases, the need for developing critical thinking and academic dishonesty, while broader concerns such as environmental impact, copyright issues in training large language models, effects of data centres on communities, and digital sovereignty were largely overlooked.

Policies and guidelines in education were largely regarded as insufficient at that time. Educators and teachers found themselves in need of specialised support and training to effectively maximise opportunities and address the challenges posed by this technology, which despite its disruptive potential in the educational sector, was not originally designed for educational purposes. GenAI was perceived as a resource that could help educators save time — for instance, by supporting them in the simplification of complex concepts or personalising feedback — but also require an extra effort from them to understand how it works, how they can use it effectively and also in an ethical manner.

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1 AILit Framework

2 DigComp 3.0 - The Joint Research Centre: EU Science Hub

While students were generally quite active in using GenAI, they also highlighted the value of presential teaching, human interaction and personal feedback from their teachers. They were also concerned that over-reliance on GenAI could lead to a loss of these essential aspects of the learning experience. To ensure that all students can benefit from the potential of GenAI, it is essential to address any further exacerbation of the digital divide and provide equitable access to GenAI tools and resources. The use of GenAI in education raises important ethical considerations, including the potential for these systems to reinforce biases and exacerbate existing inequalities, highlighting the need for a critical perspective on the development and deployment of these technologies in educational settings.

While the study's exploratory nature and sampling limit generalisability, insights from early adopters provide valuable guidance for integrating GenAI in secondary education. Such insights allow us to provide policy considerations relevant for the integration of GenAI in education.

1. Introduction

Artificial Intelligence in education (AIED) and, more broadly, the idea of utilising technology to automate core processes in teaching and learning are far from new, having shaped the history of educational technology (EdTech) to a considerable extent (Selwyn, 2019; Watters, 2021; Williamson et al., 2020). However, the introduction of generative AI (GenAI) to the consumer market in late 2022, when ChatGPT was publicly released, came with deep implications for the sector as it posed new challenges and opportunities to key stakeholders, including educators, students and policymakers.

Initially, the educational implications of GenAI were largely viewed through the lens of its potential to facilitate academic misconduct, leading to widespread bans in some institutions and jurisdictions. However, attention quickly turned to how the technology could enhance learning by acting as a collaborator in the form of, for instance, a "Socratic opponent, co-designer, motivator, or study partner" (Tuomi et al., 2023, p. 40).

To get a snapshot of emerging uses and perceptions of GenAI in secondary education during the academic year 2023/24, the European Commission (EC) launched an exploratory study across five EU Member States: Ireland, Finland, Germany, Luxembourg and Spain. The study was conducted by the JRC, in partnership with researchers in all the selected countries, and co-funded by DG EAC. The goal was to gain insights of initial uptake of GenAI in secondary education, prioritising the perspectives of early adopters in this sector. Overall, participants were favourable to the integration of GenAI in education and there was more emphasis on the opportunities and potential benefits than on concerns. Critical reactions were mainly concerned with issues around data protection, algorithmic biases or academic dishonesty, while wider considerations regarding the appropriateness and some potential negative consequences of GenAI development and deployment were largely absent: e.g., environmental impact, copyright infringement in the training of large language models, effects of data centres on local communities, effects of data annotation work on Global South workers, digital sovereignty implications, etc.

We looked at how GenAI was perceived, used and adopted by different educational stakeholders, with particular attention to how such an emerging technology might redefine AI literacy needs, for both students and educators. The ability to engage effectively and responsibly with GenAI is part of a wider set of skills, attitudes and knowledge related on AI literacy in general and, more broadly, part of digital competence. AI literacy can be defined as "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, 2025, p. 6). Additionally, the study explored how GenAI might affect teaching practices, with attention to the potential implications for subject-specific pedagogies.

The study was conducted in partnership with research teams in each of the countries included in the study and adopted a qualitative research approach — based on interviews, focus groups and desk research — to explore the potential implications of GenAI for secondary education from the perspective of key stakeholders: policymakers, teacher educators, school leaders, teachers and students. The study covered lower and upper secondary education, as defined by levels 2 and 3 of the International Standard Classification of Education (ISCED) (UNESCO Institute for Statistics, 2012).

Research participants were selected to reflect a diverse range of backgrounds and perspectives on GenAI in education, while requiring at least a minimum level of familiarity with this technology at such an early stage. Educators (i.e., in-service secondary education teachers and teacher educators) and secondary education students were selected on the basis of their direct experience with GenAI in teaching and learning, in order to gain insights into how it was affecting their own practice.

Policymakers and school leaders were selected for their unique role in shaping the GenAI might be adopted in secondary education schools.

Given the exploratory nature and sampling strategy of the study, the findings cannot be generalised to either the countries or the overall sector. Nevertheless, despite these limitations, understanding the experiences and considerations of early adopters can provide valuable insights into key aspects of an effective and responsible approach to adopting GenAI in secondary education. The report draws on these insights to offer a set of policy recommendations.

2. Policy Context

The European Commission (EC) has undertaken various efforts to shape the AI landscape, through both legislation and strategic policies. The AI Act (Regulation (EU) 2024/1689 (Artificial Intelligence Act), 2024) entered into force in August 2024. As the first legal framework for AI, it aims to promote responsible AI development and deployment in the EU. Notably, the AI Act includes provisions on AI literacy, recognising the importance of equipping workers and citizens with a foundational understanding of AI technologies, including both their opportunities and risks, to ensure effective and responsible interaction with AI systems (EC: JRC, 2025).

To become a global leader in AI, the EC also launched the *AI Continent Action Plan*,[3] which identifies five key domains, including strengthening AI skills and talents. This domain focuses on a) educating and training the next generation of AI experts based in the EU; b) incentivising European AI talent to stay and to return to the EU; and c) attracting and retaining skilled AI talent from non-EU countries, including researchers (EC: DG CNECT, 2025a).

Furthermore, the *Apply AI Strategy*[4] serves as a blueprint for the full adoption of AI in EU strategic sectors, leading to the strengthening of the AI Continent. It will aim to boost new industrial uses of AI and improve the delivery of a variety of AI-supported public services, pursuing three main goals:

1. to foster the integration of AI technologies in the EU's leading strategic industrial sectors,
2. to unlock the potential of innovation and enable EU companies to be global AI front runners,
3. to foster the integration of AI solutions in the public sector to substantially improve the quality of services provided to the public.

The strategy will focus on specific sectors where EU expertise can enhance productivity and competitiveness, including the public sector and science, which have a significant impact on EU industries and societal benefits. The strategy outlines concrete policy actions, deliverables, and milestones for each sector, to be achieved within three to five years, with support from funding programs, AI factories, data spaces, testing facilities, digital innovation hubs, and skills academies (EC: DG CNECT, 2025b).

In line with the *Apply AI Strategy*, the EC is also working towards the *European Strategy for AI in Science*,[5] specifically aimed at:

1. accelerating the adoption of AI by scientists, by creating essential enablers such as improved access to data, computational power and talent
2. monitoring and steering the impact of AI on the scientific process, addressing science-specific AI challenges such as preserving scientific integrity and methodological rigour.

More specifically, in the context of education and training, the EC has been actively engaged in shaping the policy context for AIED as part of its broader efforts to promote quality education and skills provision for the digital transformation of education, as outlined in the *Digital Education Action Plan (DEAP) 2021-2027* (EC, 2020).[6] To support this effort, the Directorate-General for Education, Youth, Sport and Culture (DG EAC) published the *Guidelines on the Ethical Use of AI and Data in Teaching and Learning* (EC, 2022), aiming to help educators understand the potential of AI in education and training, as well as raise awareness of the potential risks. The goal was to enable

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3 The AI Continent Action Plan | Shaping Europe's digital future

4 Apply AI Strategy | Shaping Europe's digital future

5 Artificial Intelligence (AI) in Science - Research and innovation

6 Digital Education Action Plan 2021-2027 - European Education Area

educational stakeholders to engage with AI systems in a positive, critical, and ethical manner. The guidelines are currently under review and an updated version will be released in early 2026.

Additionally, resulting from the DEAP and following a proposal by the Commission, the Council adopted two recommendations that are relevant to AIED: one on improving the provision of digital skills in education and training (Council of the European Union, 2024a) and the other one on the key enabling factors for successful digital education and training (Council of the European Union, 2024b). Through these instruments, the EC is actively encouraging Member States to integrate AI and other emerging technologies into their education and training systems and to develop skills related to AI.

In May 2025, a first draft of the *AI Literacy Framework for Primary and Secondary education* (AILit),[7] a joint project between the EC and the OECD was published with the aim to provide a better understanding of what AI literacy entails and enable teachers, educational leaders, education policymakers and learning designers to support AI literacy development among students (OECD, 2025). The framework will contribute to the PISA 2029 Media and AI Literacy[8] assessment and will be finalised in 2026.

As part of the Union of Skills,[9] the EC updated the *European Digital Competence Framework* (DigComp 3.0)[10] to ensure that it covers relevant emerging technologies and practices, including the efficient and responsible use of GenAI. A new component of DigComp 3.0 is the inclusion of new competencies statements that address knowledge, skills and attitudes that are needed on a daily basis to be able to use AI effectively and ethically and the addition of AI labelling in all competence statements explicitly or implicitly referring to AI (JRC et al., 2025).

Lastly, as part of the Union of Skills, the EC will adopt a *2030 Roadmap on the future of digital education and skills*, offering a comprehensive and ambitious vision for the digital transformation of education, including in the context of the AI disruption.

7 AILit Framework

8 PISA 2029 Media and Artificial Intelligence Literacy | OECD

9 Union of skills - European Commission

10 DigComp Framework - The Joint Research Centre: EU Science Hub

3. Methodology

This exploratory study investigated the potential impact of GenAI on secondary education in diverse social, cultural, and institutional contexts in Europe. To achieve this, we examined the perceptions and adoption of GenAI among key stakeholders in five European Union (EU) Member States (MSs), deliberately selected to cover a range of characteristics, including size, geography, and education system structure. By prioritizing diversity in the country selection, our research design aimed to identify factors that are key to the integration of GenAI in various educational settings, offering insights that can help to inform uptake across different contexts.

Five research teams from five MSs were selected by the Joint Research Centre (JRC) to collect and examine data in their respective countries. The JRC was responsible for the concept, design, management and cross-country analysis of the study.

A qualitative research approach, based on semi-structured interviews and focus groups, was chosen to explore GenAI-mediated educational practices in depth. The interviews and focus groups, which drew on participants' lived experiences and opinions, provided insights from a range of stakeholders in the secondary education sub-sector. The format of the research instruments offered a balance of structured and open-ended questions, ensuring thematic focus while allowing for flexibility in responses (Bryman, 2016).

The research instruments were based on a meta-theoretical framework, known as the Activity-Centred Analysis and Design framework (ACAD), which was created to support educators and learners as co-designers of learning situation (Goodyear et al., 2021). ACAD has been adopted before as a theoretical lens to re-conceptualise educational design in an AI world, "by exploring a problem space of educational design, with a practical illustration of how educators and learners can work together to re-imagine education futures in an AI world" (Carvalho et al., 2022, p. 2).

Fieldwork was preceded by desk research and various team meetings devoted to charting the AIED policy landscape for each of the MS included in the study and ensuring a consolidated and common approach and data collection protocol across all settings.

As an explorative study, it aims to offer a rich and nuanced perspective on this topic, rather than broad generalisations. The final section of the study synthesises the main findings, situating them within the context of existing research on GenAI and education, and presents a set of concrete recommendations for policymakers at both the EU and Member State levels, with the goal of informing actionable decisions and strategies for addressing the opportunities and challenges posed by GenAI in education.

3.1. Participants

Participants in this study were selected to reflect a diverse range of backgrounds and perspectives on GenAI in education, in line with best practice for qualitative research. The selection approach was designed to capture the multifaceted impact of GenAI at different levels of the education system.

Research teams recruited one policymaker and four teacher educators in their respective countries, to be interviewed individually. Policymakers could be working at either national or regional level, but the essential criterium was that they should specialise in the education sector. Teacher educators were academic staff at higher education institutions involved in the delivery of teaching qualifications specific to pre-service secondary education teachers or, in some cases, teachers responsible for the delivery of continuous professional development (CPD) opportunities aimed at in-service secondary education teachers.

A series of focus groups were conducted in each of the selected countries, with educators in leadership roles at their schools (i.e., principals), as well as students and teachers. The latter were divided into two different groups according to their areas of specialisation, namely a) arts-humanities subjects and b) science, technology, engineering and mathematics (STEM) subjects. This division allowed for more targeted discussions relevant to each group's unique experiences and needs.

Table 1. Research participants per Member State and stakeholder group (n=121)

Member State	Policymakers (n=)	Teacher educator (n=)	School leaders (n=)	Teachers (n=)	Students (n=)
Finland	1	4	4	5	4
Germany	1	4	5	7	13
Ireland	1	4	4	8	3
Luxembourg	1	4	5	10	5
Spain	1	4	4	14	5
	5	20	22	44	30
Total					121

Source: the authors

The recruitment of research participants followed a convenience sampling strategy (Bryman, 2016) and was conducted through various channels, including educational institutions (i.e., universities and schools), ministries, professional networks, student associations, and relevant initiatives (e.g. Erasmus+ projects, professional development courses). Participants were selected based on their background and experience in relation to GenAI in education.

The participants recruited in all Member States, except in Germany, were not restricted to any specific regional or local education system, allowing for a diverse range of perspectives and experiences to be covered. However, in the case of Germany, the research participants were recruited exclusively from the federal state of Baden-Württemberg, due to the country's complex federal structure and the significant differences in education systems across its 16 federal states. This decision was made to ensure a more manageable and focused sampling approach, given the constraints of the study, and to allow for a deeper exploration of the issues and challenges related to GenAI in education within a specific regional context.

3.1.1. Policymakers

Direct involvement in the design or supervision of digital education policies was key to the selection criteria for policymakers. Policymakers in each Member State were selected based on their responsibilities in relation to AI in secondary education (Table 2).

Table 2. Interviewed policy makers

Member State	Role
Finland	Responsible for digitalisation and AI in education at national authority. Duties included supervising the development and implementation of strategies to integrate technologies into education.

Luxembourg	Responsible for providing strategic advice at national authority, overseeing the development of a national AI strategy in education.
Germany	Responsible for educational policies and school enrolment processes at regional level (Baden-Württemberg)
Ireland	Based at the national authority responsible for policymaking in the field of education and in charge of overseeing the implementation of the digital strategy for schools.
Spain	Based at national authority responsible for the digital transformation of education, which included fostering the integration of AI into education.

Source: own elaboration.

3.1.2. Teacher educators

Teacher educators selected for participation in the study were specialists in subject-specific pedagogies across STEM and arts-humanities disciplines. In particular, the following areas were prioritised: Language Education, Arts Education, Mathematics Education and Informatics Education.

Most of the teacher educators were teaching in recognised and established initial teacher education (ITE) programmes giving access to the qualifications required to enter the teaching profession at secondary education level, while others were involved in providing continuous professional development (CPD) programmes for in-service teachers. Depending on how the delivery of teacher education is organised in each MS, they were based at universities or other types of educational institutions. Some teacher educators were affiliated with educational research centres.

3.1.3. School directors

The educators in leadership roles recruited for the focus groups had a strong background in teaching and education, and had gained experience in the management of educational institutions through their work in secondary education schools. They were typically from state-funded schools and many of them had started their careers as teachers and had moved into leadership roles, such as principals or head teachers, after gaining experience and developing their skills. Overall, they had a deep understanding of the educational system and the challenges faced by schools, and were well-placed to provide insights into the impact of GenAI on education.

3.1.4. Teachers

Two focus groups per MS were organised with secondary education teachers as participants. One bringing together Humanities teachers and the other one STEM teachers. Languages and arts teachers were recruited to discuss the implications of GenAI for teaching in the Humanities, whereas mainly maths and informatics teachers were selected to participated in STEM focus groups.

Participants were typically experienced teachers, with some having many years of teaching experience, and came from different types of secondary schools, including state-funded and private schools. Overall, the teachers participating in the study brought diverse perspectives and experiences, offering valuable insights into the impact of GenAI on teaching practices and the potential implications for the broader education system by drawing on their unique position as early adopters.

3.1.5. Students

The secondary education students who participated in the focus groups were typically in their final year of secondary school and were all over 18. They were from different types of secondary schools, including state-funded and private schools. The students were invited to participate in the focus groups after calling for expressions of interest in discussing the impact of GenAI on their learning. The focus groups consisted of small groups of students, often with a mix of male and female participants, and were facilitated by experienced moderators.

3.2. Data collection

Data collection was specifically devised to be conducted by means of online video interactions. Internet-based interviews and focus groups are far from new (Fielding et al., 2008), and their effectiveness has been documented in the literature, which informed the design and use of such research techniques in this study (Bolin et al., 2023; De Villiers et al., 2022). Not having to rely on the co-location of researchers and participants made the recruitment of relevant participants easier, less expensive and enabled the involvement of people from different parts of each country.

The focus groups lasted around 90 minutes each, providing ample time for in-depth discussion and interaction among participants on specific aspects of GenAI integration into secondary education. The interviews lasted around 60 minutes each and allowed for a more detailed exploration of individual perspectives. Informed consent was obtained from all participants before the interviews and focus groups, addressing ethical concerns and responsible data use.

All interviews and focus groups followed a strict protocol to ensure comparability and scientific rigour. Sessions began with an introduction and brief introduction of the facilitators, followed by an overview of the purpose of the study. Participants were then informed of the data collection methods and data handling procedures. A brief definition of GenAI, as understood in the context of this study, was provided to establish a common understanding. A short video was specifically produced to introduce the concept and key aspects for discussion at the beginning of focus groups.[11]

The interactions began with a warm-up discussion leading into the main questions, which followed different tracks depending on whether the session was an interview or a focus group.

The main part of the interview focused on three key areas:

1. Impacts and responses: Discussed the impact of generative AI on teaching practices, student learning and institutional responses in schools.
2. Opportunities and challenges: Explored the benefits and challenges of AI in education, including its impact on critical thinking, creativity and teacher preparation.
3. Future perspectives: Addressed the long-term implications of AI for the roles of teachers and students, and the potential for supportive educational policies.

The main discussion in the focus groups was structured around several key themes, namely:

— **Teaching and educators**: How GenAI could redefine the teaching profession, including the opportunities, challenges and skills required for teachers.

— **Learning and students**: Impact of GenAI on student learning, particularly on cognitive development, social interaction and collaboration.

[11] Video available at https://vimeo.com/921602138/ecc97fdae9

— **Assessment**: Potential changes GenAI could bring to traditional assessment methods and the implications for both teachers and students.

— **Ethics:** Key ethical issues related to the use of GenAI in secondary education.

— **Policy**: Support and guidance available to school leaders on GenAI, existing policies and who should develop these policies. The sessions ended with a closing question that not only summarised the key points of the discussion, but also invited participants to share any additional thoughts on aspects that had not been covered.

All interviews and focus groups were conducted in official languages of the selected Member States to ensure that participants could express their thoughts comfortably and effectively.

3.3. Data analysis

Each research team was responsible for the transcription of the data collected in their respective countries, as well as for the anonymisation and translation into English. Machine automated transcriptions from the video recordings were manually reviewed to ensure a consistent corpus of data, adhering to established transcription rules and ensuring both anonymity and accuracy. The data were then examined through a thematic analysis process that combined both inductive and deductive coding (Naeem et al., 2023).

This approach enabled an in-depth analysis of the data, allowing for the identification of nuanced themes and patterns across the interviews. Following initial discussions and analysis, a coding scheme was developed deductively between teams, based on the theoretical framework and existing literature. The scheme was complemented by a process of inductive coding, allowing for greater flexibility in capturing emerging themes and insights from the data.

An in-house tool launched by the JRC in 2023 to enable experimentation with GenAI across EU bodies was employed to support the comparative analysis and for text enhancement purposes during the drafting of this report (Fernandez Machado et al., 2025). Our use of this tool followed the *Living guidelines on the responsible use of generative AI in research* (EC: DG RTD, 2025) and the authors remain ultimately responsible for the scientific output.

4. National policy actions for GenAI in education

At the time when fieldwork for our study took place in **Finland**,[12] the Finnish National Agency for Education (FNAE) [Opetushallitus] and the Ministry of Education and Culture (FMEC) were working in partnership with key stakeholders (e.g., experts in the fields of education, researchers) to develop a set of recommendations for the use of AI in early childhood education, basic education, liberal education, and upper secondary education.[13] The premise was that AI-related skills are necessary for society and the goal to promote the understanding, responsibility, and safe use of AI. In 2023, the FMEC published the *Policies for the Digitalization of Education and Training until 2027* (FMEC, 2023). These policies outline Finland's vision of becoming a leading user of sustainable digitalization in education by 2027. They serve as a strategic basis for promoting the digitalization of education, including the integration of AI technologies. Previously, in 2022, FNAE and the National Audiovisual Institute published the *Framework for Digital Competence*,[14] which promotes equal opportunities for children and young people to achieve the digital competence needed in studies, working life, and social participation.

In **Germany**,[15] responsibility for the education system is divided between the State [Bund] and the Federal States [Bundesländer], with administration of the education system being almost exclusively a matter for the Federal States. At the time when the study was conducted, seven out of the sixteen federal states in Germany had developed guidelines for the use of GenAI in schools or education. Other Federal States had only compiled a list of links for teachers and schools. In general, these documents contained mostly recommendations and orientation, explaining what GenAI is, provide examples of usage scenarios for learning and teaching and discuss some risks and challenges. In October 2024, the Conference of the Ministers of Education [Kultusministerkonferenz] (KMK) of the Länder adopted a *Recommendation for action for the education administration on the use of artificial intelligence in school education processes* (KMK, 2025).

In July 2021 the Government of **Ireland**[16] published their first national AI strategy, which was updated in 2024.[17] It included strategic actions specifically devoted to the role of AI in education and preparing the Irish workforce for the impact of AI. Subsequently, the Department of Education's (IDoE) digital strategy for schools incorporated references to AI under Pillar 3: 'Looking to the future: policy, research and digital leadership'.[18] At the time when data for this study were collected, the IDoE, with the support of Oide TiE (Technology in Education),[19] was developing guidance on the use of AI in education for teachers and school leaders. This guidance aims to provide an overarching

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12 For an overview of the national education system of Finland, including a description of secondary education, see the page of its Eurydice Network national unit: https://eurydice.eacea.ec.europa.eu/eurypedia/finland/overview

13 Artificial intelligence in education – legislation and recommendations | Finnish National Agency for Education

14 The Framework for Digital Competence

15 For an overview of the national education system of Germany, including a description of secondary education, see: https://eurydice.eacea.ec.europa.eu/eurypedia/germany/overview

16 For an overview of the national education system of Ireland, including a description of secondary education, see the page of its Eurydice Network national unit: https://eurydice.eacea.ec.europa.eu/national-education-systems/ireland/overview

17 National AI Strategy Refresh 2024 - DETE

18 Digital Strategy for Schools to 2027

19 Oide is the professional development support service for teachers and school leaders, funded by the Department of Education and Youth. They have a dedicated Technology in Education Team and professional learning materials and resources on AI are available at Resources and Projects - Oide.

awareness of the opportunities and risks and what should be taken into consideration in using AI in a safe, responsible and ethical manner in schools.

Luxembourg's[20] digital transformation in education is guided by national strategies like the *Digital Decade Strategic Roadmap* (Government of Luxembourg, 2024), aligning with the EU's digital goals. This roadmap emphasises AI and data literacy, aiming to integrate AI into teaching methods and curricula to enhance digital literacy and workforce readiness. It proposes AI-related courses in secondary, higher education, and vocational training, and highlights lifelong learning through customised experiences with AI companies to align skills with market needs. The *Einfach Digital* program,[21] developed by the Ministry of Education, Children and Youth, aims to further integrate AI and digital tools into pedagogy, focusing on prioritising educational needs over technology. The most recent update of Luxembourg's *AI Strategy* (Government of Luxembourg, 2025) pays attention to GenAI specifically within the wider AI landscape.

The education system in **Spain** is highly decentralised, with responsibilities shared between the national government and autonomous communities.[22] The national government sets general education policies and basic regulations, while regional authorities develop and implement these within their territories, managing their education systems with executive and administrative powers. At a national level, the Ministry for Education, Vocational Training and Sport (SMEVTS) [Ministerio de Educación, Formación Profesional y Deporte] has addressed the integration of GenAI in education through several initiatives delivered by the National Institute of Educational Technologies and Teacher Training [Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado – INTEF]. In this regard, the *Guide on the Use of Artificial Intelligence in Education* (INTEF, 2024) deals with the challenges and opportunities associated with the use of GenAI in education. Likewise, the School of Computational Thinking and AI [Escuela de Pensamiento Computacional e Inteligencia Artificial – EPCIA][23] has offered a range of CPD activities aimed at supporting educators in the use of GenAI.

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20 For an overview of the national education system of Luxembourg, including a description of secondary education, see the page of its Eurydice Network national unit: https://eurydice.eacea.ec.europa.eu/eurypedia/luxembourg/overview

21 einfach digital | Innovative Initiatives

22 For an overview of the national education system of Spain, including a description of secondary education, see the page of its Eurydice Network national unit: https://eurydice.eacea.ec.europa.eu/eurypedia/spain/overview

23 EPCIA - Code INTEF

5. Findings

This section provides an overview of the findings of this study. First, we provide a short summary of the main findings, followed by a more in-depth analysis per each thematic areas identified in our analysis.

Research participants across the five Member States saw GenAI as a technological innovation with high potential to shape, or even disrupt, education. The data suggest that educators in the included countries were already using GenAI in various ways shortly after this type of technology entered the consumer market; for example, experimenting with it to generate educational resources such as lesson plans and presentations, to design personalised learning experiences, to analyse student performance data (e.g., learning analytics), to support learning by means of AI assistants (e.g., chatbots) or to design assessment instruments (e.g., AI-generated questions for exams). There were also indications that students might be using GenAI more intensively than teachers.

The educators participating in the study tended to think that GenAI may operate as a tool for teaching and learning enhancement; for example, by supporting personalised learning, increasing student engagement and helping students to achieve intended learning outcomes. At the same time, there were also concerns about its potential to hinder learning; for instance, by enabling plagiarism and exposing students to biases and inaccurate or even factually wrong content.

In comparison with teachers, students in the study reported that they and their peers were already using GenAI frequently as part of their daily work. While students were also aware of major risks of GenAI, overall, they seemed to be more focused on potential benefits and opportunities than educators; for example, as a means to personalise their learning or to make teaching more effective. Moreover, the students believed that they were incorporating GenAI more frequently than their teachers into their daily routines, using it as a supportive tool to practice skills, receive feedback, simplify complex topics, generate summaries or simulate exams. 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.

Overall, there was concern among educators, teachers and school leaders about a generalised lack of guidelines, policies, and infrastructure to support an effective early adoption of GenAI in secondary schools and, more generally, education at large. Teachers, school leaders and policymakers across these countries highlighted the need for clear policies, professional development, and support to ensure that teachers are equipped to adequately incorporate GenAI into their practice and know when and how to use it effectively and appropriately. It is worth noting that data collection for this study took place before the entry into force of the AI Act, which is the first comprehensive legislation in the world aimed at regulating AI across sectors; including the designation of prohibited and high-risk uses of AI in education and training, as well as provisions specifically concerned with AI literacy.

The need to address ethical considerations that may result from the integration of GenAI into secondary education, with particular attention to data privacy, security, the potential for bias in AI-generated content and academic integrity, was highlighted across all countries. Additionally, educators and policymakers in these countries recognise the need for ongoing relevant professional development and support to ensure that teachers are well-equipped to address these ethical concerns and use GenAI in a responsible and effective manner. Participants reported that training

opportunities on GenAI in education were starting to emerge, but they were still far from meeting the needs of the sector.

This chapter presents key findings from the study in relation to AI literacy — addressing the implications for both students and educators —, how GenAI might reconfigure teaching practices and potential consequences for discipline-specific pedagogies.

5.1. AI literacy

Research participants from all stakeholder groups emphasised the importance of ensuring that secondary education teachers and school leaders possess the capacity to harness the potential of GenAI to enhance education while mitigating associated risks and challenges, such as bias, academic dishonesty, and data privacy concerns. Moreover, participants considered it essential to ensure that students are able to engage with this technology in a responsible and effective way but noted that this goal is contingent upon first establishing the necessary capabilities and competencies needed by teachers. It is important to highlight that the knowledge, skills and attitudes required for this are part of the broader notions of AI literacy and digital competence.

5.1.1. Implications for students

The data collected for the study suggests that, shortly after the mainstreaming of GenAI tools, students in post-primary schools were already actively using GenAI systems for different purposes, often more intensively than their teachers. They were incorporating GenAI into their daily school activities, using it as a supportive tool to put skills into practice (e.g., conversing in a foreign language), receive feedback, simplify complex topics, generate summaries and exam simulation. Despite some concerns about the potential for GenAI to diminish independent thinking, students generally acknowledged the role it can play in facilitating a deeper understanding of challenging subjects. As noted by a student in Spain:

> *"…I am a person who is not good at drawing, but for example, if I put in the AI, I put certain phrases or certain keywords to have a nice image so that it helps me analyse, to synthesise, so to speak, a text better. I remember the text better because, for example, for a microbiology cover, I used to draw it, because the truth is that I was not very good at it because I am not very good at it, but now I put Chrome in the AI, and then it helps me to remember all that and the truth is that above all, the help of summaries, diagrams and everything helps me to digest everything much more easily, all the information."* (Secondary education student in Spain, translation)[24]

Respondents also highlighted that GenAI could serve as a valuable tool for fostering creativity, critical thinking, and problem-solving skills. It can support students in creative fields by offering perspectives and helping to overcome mental blocks. Additionally, GenAI may facilitate dynamic learning environments where students engage in real-world problem tasks.

At the same time, students were equally aware of potential downsides. A major concern was that over-reliance on GenAI could lead to a decline in independent thinking and creativity, with students defaulting to AI for quick solutions, task completion and production of outputs, rather than engaging

[24] Original quote: "…por ejemplo, para una portada de microbiología, yo antes para dibujarla, pues la verdad es que se me daba bastante mal porque no soy muy agraciado en ese ámbito, pero ahora le pongo el Chrome en la IA, y después me ayuda a acordarme todo eso y la verdad es que ante todo, todo lo que son, la ayuda de los resúmenes, de esquemas y todo para mí me ayuda a digerir todo mucho más fácil, toda la información."

in an active process of inquiry as the basis for learning and competence development. Where using GenAI as a mere shortcut, students claimed that they could not only be at risk of hindering their learning but also of underperforming in high-stakes examinations where they have to operate without any AI assistance. As noted by students in one of the focus groups:

> *"Like, I mean, we do learn by doing. You can read 1000 English essays, but still, we have to be able to write one. If you don't practise writing it, you're not going to learn anything. And if the AI's doing it for you, you're not learning. And on the day of the Leaving Cert [exam] you don't have the ChatGPT in your pocket to pump out, whatever, that Platt, or that Yeats poetry. So, you have to write."* (Student in Ireland, original quote)

In a similar vein, a school director in Luxembourg argued that:

> *"And you notice that the students use it [ChatGPT] regularly and no longer understand what they actually end up giving as a solution. And that of course poses certain challenges for the teacher, because the students go so far as to argue that, yes, we have provided a solution here, here is your solution. They now have to come to terms with this, but of course they are not ready to realize that what they are doing... is not actually helping them at all in terms of their skills and abilities."* (School director in Luxembourg, translation)[25]

Research participants highlighted the urgent need for the development of AI literacy among students. Key competences mentioned include a foundational understanding of GenAI's underlying mechanics, enabling students to critically assess the quality and reliability of AI-generated content. Participants mentioned that AI literacy should include examples of effective and constructive use of GenAI, promoting self-regulation and autonomy. In this regard, the overall goal would be to empower students to become lifelong learners who are mindful of when and how to use these tools effectively and responsibly.

Examples of digital competences that students should develop in relation to GenAI, as identified by participants in the study, include:

- GenAI fundamentals, how it works and its limitations.
- The ability to critically evaluate the outputs of GenAI systems.
- Ethical implications of GenAI, such as the potential role of deepfakes in cyber-bullying and its impact on mental health and wellbeing.
- Knowing how to use GenAI as a complement to, rather than a substitute for, their own creativity.
- Learning to learn with the support of GenAI systems.
- GenAI and digital citizenship.

5.1.1.1. GenAI and the integration of AI literacy into the formal curriculum

The growing pervasiveness of GenAI is redefining what it means to be digitally competent, as it carries profound implications for study, work and everyday life. Moreover, like other previous information and communication technologies (e.g., pen, paper, books, archives, typewriter), GenAI is

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[25] Original quote: "Und da merkt man halt, dass die Schüler das regelmäßig nutzen und überhaupt nicht mehr verstehen, was sie eigentlich da am Ende als Lösung abgeben. Und das stellt natürlich dem Lehrer für gewisse Herausforderungen, weil die Schüler so weit gehen, dass sie argumentieren, ja, wir haben ja aber nämlich eine Lösung hier abgeliefert, hier ist ja Ihre Lösung. Da müssen sie halt jetzt damit klarkommen, aber sie sind natürlich nicht so weit einzusehen, dass das, was sie machen...sie ja eigentlich in Ihren Kompetenzen, ihren Fähigkeiten überhaupt nicht weiterbringt."

likely to eventually become integrated into human cognitive processes by transforming the act of writing and the way we think and use writing as part of learning (Tuomi et al., 2023).

The effective and responsible engagement of students with this technology, whether as producers or consumers of content, requires the development of critical thinking skills as well as so-called information, media, data and algorithmic literacies. Considering the status of education as a public service and a fundamental right, education and training systems and institutions play a central role in building such capabilities across EU societies and ensuring that AI skills gaps are gradually closed (Bertoletti et al., 2025). Doing so would require efforts cutting across the realms of formal, non-formal and informal education, adjusting the curriculum across all levels of education and training, as well as lifelong and life wide learning opportunities.

The level of readiness to cover the knowledge, attitudes and skills relevant to GenAI within the curriculum varies substantially across the examined Member States, mainly depending on the extent to which digital competence, and other competences, such as critical thinking or creativity, are already covered. Other contextual factors at school level can play an important role. As noted by a research participant in Germany:

> *"I think you also have to look at it in the context of which student clientele you have. If I'm talking about us from a community school perspective, then it will certainly be a different process than at a grammar school, because you first have to learn how to give the input so that the AI spits out something sensible, so to speak. That may be completely different in sixth form, in adult education. But down here, I would simply say from year five onwards, especially in primary school, I also think that we first need to lay the foundations for generating a sensible approach to these AIs".* (School leader in Germany, translation)[26]

The data suggested that, despite varying levels of readiness for digital education adoption, there was still a long way ahead for digital competences relevant to GenAI, and more generally AI literacy, to be embedded into the formal curriculum at a scale (i.e., for all students).

When looking at the five MSs studied, we found that **Finland**'s national curriculum had been developed more than a decade ago and, therefore, research participants stressed the need for an urgent update to include AI literacy in order to prepare students for a future increasingly influenced by AI. Likewise, as a requirement for competence development, they also highlighted the importance of ensuring equitable access to AI tools and resources across various regions and schools to avoid widening the digital divide.

Participants in Baden-Württemberg, **Germany**, considered that GenAI integration into the secondary education curriculum was still in its infancy and unlikely to change significantly in the near future, citing an already overcrowded curriculum and insufficient time for developing new courses and teaching formats. The vast majority of teachers in the study expressed concerns, anticipating that it would take many years for GenAI to be incorporated into curricula and syllabuses, which would, in turn, delay its inclusion in teacher further education and training. Of particular concern was the lack of official guidelines at the time of fieldwork at federal state level.

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[26] Original quote: "Ich denke, man muss es auch im Zusammenhang sehen, welche welches Schülerklientel man hat. Wenn ich jetzt von uns aus Gemeinschaftsschulesicht gehe, dann wird es ein anderer Prozess werden wie mit Sicherheit an einem Gymnasium, weil da muss ja erst mal gelernt werden, wie gebe ich den Input, damit die KI was Vernünftiges auch ausspuckt, quasi. Das mag in der Oberstufe, in der Erwachsenenbildung ganz anders sein. Aber hier unten sage ich jetzt einfach mal ab Klasse fünf, speziell auch in der Grundschule denke ich auch, wir müssen ja erstmal die Grundlagen dafür bilden, um dann einen vernünftigen Umgang mit diesen KIs zu generieren."

In **Ireland** research participants saw potential for GenAI technologies to change practices in schools in time, provided the curriculum is adapted to enable such technologies to be utilised by students. Teachers and school leaders recognised that the curriculum dictates what is taught in Irish post-primary schools and they called for the curriculum to be updated to include AI literacy as a core competence, so that students are prepared for a future in which AI will play a significant role. Such a curriculum update should not only encompass technical skills, but also critical thinking and ethical considerations related to AI. They also highlighted the need for guidelines or guidance from the Department. These insights should be considered in the context of the newly released *Literacy, Numeracy and Digital Literacy Strategy* for all schools. [27]

In **Luxembourg**, the Ministry of Education, Children and Youth had implemented several targeted measures to integrate AI into the education system and promote digital literacy among students. The introduction of the 'Digital Sciences' subject in lower secondary education, in 2020, was an important step toward integrating AI literacy into secondary education (7th-9th grade, 12 to 15-year-olds). Building on the coding skills acquired in primary education, it extends to cover various aspects in six digital thematic fields, from the WWW to gaming, robotics, and AI, using a three-step approach: real-life relevance (problem- and case-based learning), technological understanding, and reflection on societal, individual, and ethical impacts. The curriculum already included AI topics such as machine learning, computer vision, and ethical considerations and, while it did not specifically focus on GenAI, it was perceived as a suitable context for its development.

In **Spain**, national legislation establishes that the education system must ensure a full integration of students into the digital society and the learning of responsible consumption and critical, safe, and respectful use of digital media, with respect for human dignity, social justice, and environmental sustainability, constitutional values, fundamental rights, and particularly, with respect for and guarantee of personal and family intimacy and the protection of personal data.[28] Digital competence is recognised as a key competence in the secondary education curriculum, in both compulsory education[29] and baccalaureate[30] levels. Instead of being confined to specific areas, domains or subjects, students are expected to develop the key competences transversally across the entire curriculum. It includes information and data literacy, communication and collaboration, media education, the creation of digital content (including programming), security (including digital well-being and competences related to cybersecurity), issues related to digital citizenship, privacy, intellectual property, problem-solving, and computational and critical thinking. However, at the time when fieldwork took place, the educators and school leaders participating in the study did not report any changes to the formal curriculum specifically aimed at ensuring the development of AI literacy, specifically concerned with GenAI, among secondary education students.

5.1.2. Implications for educators

Overall, the integration of GenAI in education was seen as an opportunity to enhance teaching and learning, but it is fully dependant on careful implementation underpinned by skills development among both in-service and pre-service teachers. Furthermore, only by ensuring the development of certain standard levels of AI literacy among educators it would be possible to ensure that all

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27 Literacy, Numeracy and Digital literacy Strategy

28 Competencia Digital del Alumnado - INTEF

29 Competencia digital en Educación Secundaria Obligatoria | Ministerio de Educación, Formación Profesional y Deportes

30 Competencia digital en Bachillerato | Ministerio de Educación, Formación Profesional y Deportes

students can engage effectively and responsibly with GenAI tools. As noted by a humanities teacher in Germany:

> *"The role of teachers must be responsible when it comes to new technology. I need to know what to teach the students and how to teach it to the students. Because AI can be useful. But AI can also be dangerous. And I have to show the students both sides. And I can only show them if I know how to use AI."* (Secondary education teacher in Germany, translation)[31]

At the time when data collection for the study took place, the presence of GenAI within Initial Teacher Education (ITE) programmes was minimal and generic, if any, across all countries. Curricular adaptation in this regard was only envisioned by research participants as a long-term endeavour, because of the typical pace of institutional change in education. As for Continuing Professional Development (CPD) opportunities for in-service secondary education teachers to develop digital competence specifically focused on GenAI were still scarce.

The mainstreaming of GenAI came with profound implications for the redefinition of educators' digital competence needs, meaning that both pre-service and in-service teachers must develop new skills, knowledge and attitudes that are essential to the teaching profession in a rapidly changing socio-technical landscape.

The perspectives and experiences of participants in this study helped us identify the following competences as essential for the future of the teaching profession at the secondary education level:

- Understanding the specificities of GenAI and what makes it different from other forms of AI and digital technologies in general.
- Understanding how GenAI works from a technical point of view and being able to critically evaluate outputs of GenAI tools.
- Identifying opportunities for teaching and learning enhancement (e.g., personalised timely feedback, realistic simulations).
- Developing a critical perspective on how the use of GenAI may have unintended consequences on cognitive processes (e.g., down-skilling resulting from overreliance), social relations (e.g., replacing humans with machines inappropriately), the environment (e.g., energy and water consumption).
- Understanding the capabilities and limitations of GenAI tools for the enhancement of teaching and learning in relation to subject-specific pedagogies.
- The ability to use GenAI effectively and responsibly in the design and delivery of learning experiences for secondary education students, drawing on relevant pedagogical strategies.
- Knowing how to design assessments that minimise the risk of AI misuse.
- Knowing how to critically engage with GenAI tools and ensure that they are used effectively and ethically beyond education.
- Being able to harness GenAI to provide feedback on students' work.
- Knowing how to build and modify GenAI tools to be adapted to specific teaching needs.

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31 Original quote: "Die Rolle von Lehrkräften muss in Sachen neue Technologie Verantwortungsbewusstsein sein. Ich muss wissen, was ich den Schülern beibringen und wie ich es den Schülern beibringe. Denn KI kann nützlich sein. KI kann aber auch eine Gefahr sein. Und beide Seiten muss ich den Schülern zeigen. Und ich kann es nur dann zeigen, wenn ich weiß, wie ich KI benutze"

— Knowing how to create or adapt learning methodologies to include educational uses of GenAI.

5.1.2.1. AI literacy for in-service teachers

Even though continuous professional development (CPD) activities for in-service secondary education teachers addressing GenAI were already starting to be available in some countries at the time of data collection for this study, they were largely regarded as insufficient.

In the case of **Finland**, all teacher educators interviewed for the study spoke about the need for comprehensive training and guidance on the responsible use of GenAI, pointing that the complexity and rapid pace of technological advancements can be overwhelming for educators. Likewise, many teachers felt unprepared to incorporate GenAI tools effectively, which implies a critical need for comprehensive professional development. For that, a holistic approach to professional development emerged as essential; one that includes hands-on experience, collaborative learning, and continuous support. After fieldwork for this study took place, the Finnish initiative Faktabaari released its *AI guide for teachers* (Avoin yhteiskunta ry et al., 2025).

The data collected in **Germany** indicated a strong call for professional development activities for teachers specifically focused on the integration of GenAI into their teaching, as the limited offerings and formats available at the time when fieldwork took place did not seem to satisfy the real needs of teachers. The official recognition of upskilling efforts as part of the lifelong learning portfolio of teachers emerged as key priority. At the operational level, there was a need for a curricular and formal framework and appropriate further training programmes. In order to do justice to the disruptive nature of GenAI, teachers should be given more time to acquire the knowledge and also to deepen and reflect on it in collegial collaboration.

In **Ireland**, Oide have recently developed a dedicated webpage for AI in schools, the AI Hub,[32] which provides information and resources on AI and how it can benefit and support users, as well the current limitations and concerns about its use. They have also developed an online introductory course for teachers, 'AI for Schools'.[33] The Teacher Educators interviewed for the study noted the importance of providing professional learning opportunities for practising teachers, in order to enable them to experience and critically consider the use of GenAI technologies in their professional practice. There is a recognition that teaching staff, at all levels, require professional learning activities in this area and that these need to be more engaging and varied in nature.

The research conducted in **Luxembourg** concluded that one of the main challenges was the need for ongoing professional development to ensure that teachers are adequately prepared to use AI tools effectively. Many teachers in Luxembourg are keen to use AI but feel that they lack the necessary skills and confidence to do so. Meanwhile, some teachers expressed concerns about the potential for GenAI to marginalise traditional teaching practices. These concerns highlight the need for ongoing dialogue and adaptation within teacher training frameworks to ensure that the benefits of GenAI are realised without undermining the fundamental aspects of teaching. This gap highlights the importance of providing targeted training and support specific to the needs of teachers to help them navigate the complexities of AI integration. By creating opportunities for teachers to share their experiences and insights, schools and training institutions could also help build a community of practice and a network that supports the effective use of GenAI in education.

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32 Webwise.ie - AI and Online Safety

33 AI for Schools - Oide Technology in Education

In **Spain**, the levels of digital competence required from teachers in pre-university education are defined by the *Spanish Framework for the Digital Competence of Teachers* (SMEVTS et al., 2022), which was based on the *EU Digital Competence Framework for Educators (DigCompEdu)* (JRC et al., 2017). However, teacher training and capacity building is a responsibility of regional governments. There was high consensus among research participants in the study around the need for teacher training specifically focusing on GenAI in education. In this regard, school leaders called for more autonomy in the provision of teacher training adapted to their needs, with some indications that public schools are more restricted than private, especially when it comes to introducing new techniques of educational data analysis with the support of GenAI, due to data protection laws in public institutions.

5.1.2.2. AI literacy for pre-service teachers

Initial Teacher Education (ITE) refers to the teacher education programmes that, upon completion, give access to the educational qualifications required to be able to enter the teaching profession, in this case at secondary education level. While the structure and delivery of ITE varies considerably across the countries included in the study, it was regarded by research participants as a key enabling factor for the effective and responsible integration of GenAI into secondary education.

In the case of **Finland**, the use of digital tools in teaching and learning have been part of teacher education programs since the 1990s. However, and even though GenAI was perceived as an integral component of digital learning and a novel method of knowledge production by research participants, no concrete changes had been made to teacher education curricula or programs at the time of data collection.

For the first phase of teacher education in **Germany**, educational technology and media education is still not mandatory and pre-service teachers can get their degree without having been in contact to educational technology for teaching and learning. Almost without exception, the teachers participating in the study in Germany assumed that it will be many years before GenAI finds its way into curricula and syllabuses - and thus also into the initial training and continuous development of teachers.

The data collected in **Ireland** suggest that GenAI was still in the early stage of entering the pre-service training of teachers. Even though the teacher educators interviewed in the study were already using it themselves to varying levels, there was no indication of programmatic approaches to the use of GenAI and most were still experimenting with the technology and trying to understand the implications of it for their programmes.

The integration of GenAI into pre-service training in **Luxembourg** is progressing, albeit unevenly. Teacher educators in the study had begun to explore ways to incorporate it into their training programs, with a particular focus on equipping future educators with the skills necessary to navigate an AI-enhanced educational landscape. For example, some training programs now include modules on AI literacy, encouraging pre-service teachers to engage with AI tools and consider their implications for classroom practice. Despite this progress, the integration of AI into teacher education is still at an early stage. While some programs have made significant progress, others are only beginning to explore the potential of AI.

Likewise, participants in **Spain** highlighted the insufficiency of current teacher education in the use of GenAI, noting that although digital competence is part of the pre-service training, GenAI has not yet been significantly integrated into these programs. Research participants were not aware of any changes to the formal curriculum relevant to the development of AI literacy, with a focus on GenAI, for teaching in secondary education. This issue is particularly significant, as the vast majority of teachers continue to overlook the impact that students' use of GenAI has on their own pedagogical

practices. Teachers who lack training to adapt to these new student practices are the ones most likely to reject this technology uncritically."

5.2. Implications of GenAI for teaching practices

The sudden rise of GenAI has affected the work of secondary education teachers in various ways across the EU Member States in the study, most notably by providing new tools that can be used as part of teaching and learning activities, by raising concerns about academic integrity and data protection, and by somehow questioning the traditional role of educators in the teaching and learning process. Key aspects include workload management, pedagogical shifts, ethical concerns, and the need for professional development and infrastructure.

5.2.1. Country overviews

In **Finland**, GenAI's integration into educational settings was recognised for its potential, but with cautious optimism. Finnish teachers, educators, and students acknowledged AI's opportunities, focusing on its capacity to assist in creative and routine tasks like lesson planning and content creation. Despite these benefits, GenAI had not yet led to significant changes in schools. Teachers emphasised the importance of AI literacy, ethical considerations, and human agency. GenAI was mainly used for specific tasks, often related to producing visual or digital products, while teachers maintained a focus on fostering students' higher-order thinking skills essential for national final examinations. Concerns about academic integrity and the need for reliable detection tools were prevalent, highlighting the necessity for ongoing professional development and infrastructure to support AI-based learning. While AI tools assist in routine tasks and enhance teaching efficiency, ethical concerns about academic integrity and overreliance on technology persist. The need for continuous professional development was emphasised to ensure teachers can integrate AI effectively while maintaining ethical standards.

Educators in **Germany** showed a proactive stance towards GenAI, displaying a high level of knowledge and systematic integration of AI tools in classrooms. Despite an absence of comprehensive policies and infrastructure, teachers adapted assessment practices to accommodate AI's influence. Teachers' thoughts on how examination formats need to change in the age of GenAI and how some of these formats had already been changed on their own initiative (a discussion in which schools were ahead of universities) were also particularly interesting. This means that the consideration of GenAI in school teaching and learning could already be observed at a very elaborate level in some cases, but it was not — or only to a very limited extent — 'covered' by framework specifications. Schools and teachers were therefore engaging with this technology in a 'lawless' space, without any protections against the risks associated with such emerging digital practices.

In **Ireland**, GenAI was gradually impacting the educational environment, with early adopters leading the way. Teachers utilizing GenAI reported increased efficiency, enabling them to craft more engaging learning experiences. While initial attitudes towards GenAI were sceptical, the perception was shifting as educators recognised the benefits of time-saving strategies. GenAI assisted with workload management by automating administrative tasks and offering innovative pedagogical approaches. However, systemic and general adoption by many teachers require professional learning supports (e.g., mentoring and peer support networks) to bolster teachers' confidence and competence in using GenAI effectively. The focus remained on developing students' digital literacy and ethical use of AI to foster critical thinking.

Luxembourg's teachers reported substantial workload relief through GenAI, for instance by supporting lesson planning and administrative management. This efficiency freed up time for direct student engagement and interactive teaching activities. AI empowered personalised learning experiences, allowed teachers to adjust methods based on real-time student performance data. Despite these advantages, concerns about the accuracy and reliability of AI-generated content persisted, necessitating careful verification. Teachers expressed a need for comprehensive training to confidently integrate AI tools into their classrooms, highlighting the challenges of teacher preparedness and the emotional impact of AI adoption on traditional teaching roles.

In **Spain**, research participants pointed that, as students increasingly rely on GenAI, teachers must rethink their approaches by designing assignments that are less amenable to AI-generated responses. Teachers recognised GenAI's potential to create personalised educational resources and streamline administrative tasks. However, there were widespread concerns about data protection, biases in AI-generated information, and the potential for plagiarism among students. The need for institutional guidelines to ensure responsible and ethical AI use was emphasised. Teachers called for adaptive teaching strategies and assessment methods that emphasised project-based and real-time evaluations.

5.2.2. Key dimensions of the teaching profession affected by GenAI

The mainstreaming of GenAI tools may affect some of the core elements of teaching and learning. As such, it has the potential to impact a wide range of tasks that teachers are required to undertake as part of their daily routines.

Design for learning is a key element of the teaching profession, understood as the planning of experiences and situations aimed at helping students achieve the intended learning outcomes of subjects and whole programmes, ultimately supporting the development of competences and attributes as defined by the curriculum. The early adopters of GenAI in secondary education involved in this study started to experiment with this technology for lesson planning and the creation of educational resources shortly after it became widely available to users. As an illustration, one of the teacher educators interviewed in Ireland recognised to be impressed by how one of her teacher students (i.e., a pre-service teacher) was making use of GenAI:

> *"I was out on placement visit there, and she had designed a lesson about Easter in German, and she had created her slides using AI and they were excellent. Now obviously she had edited them and added some things, but she had also created a series of related activities using AI as well, and they were fantastic"* (Teacher educator in Ireland, original quote)

Despite such advantages, educators participating in the study have emphasised the importance of balancing AI-assisted teaching with traditional educational methods. They acknowledge that, while AI can be a valuable supplement to existing practices, it should not replace the human element in education. As noted by research participants in Finland:

> *"Artificial intelligence can be an aid, but it cannot replace the teacher's role in the interaction."* (Teacher educator in Finland, translation)[34]

> *"And yes, I also hope that it doesn't change the work of the teacher, that yes, in my opinion, there should be a proper interaction between the teacher and the student, that learning can happen, then of course, some small parts can be done, maybe even some*

[34] Original quote: "Tekoäly voi olla apuväline, mutta se ei voi korvata opettajan roolia vuorovaikutuksessa."

kind of distance learning like this, that I could take one course led by artificial intelligence,." (Secondary education student in Finland, translation)[35]

Research participants highlighted the importance of developing AI literacy among both in-service and pre-service teachers, in order for them to be able to harness the potential of GenAI in their teaching and minimise potential risks. However, when discussing the negative impact of GenAI on education their attention primarily focused on aspects related to students' misuse and overreliance. Overall, they perceived the implications of GenAI for teaching to be particularly relevant in terms of enhancing student engagement, transforming assessment practices, and redefining teachers' workloads, presenting both opportunities and challenges for educators.

5.2.2.1. Enhancing student engagement

GenAI can be harnessed to improve student engagement in various ways, including personalizing learning experiences, providing interactive and immersive learning environments, and facilitating real-time feedback and assessment.

In **Ireland**, teachers noted that they are using GenAI to reignite curiosity for learning and create more active and personalised learning opportunities for students in their classes. For example, one of the participants explained how they managed to attract the attention of hard-to-engage student by customising an AI tool.

"And the other thing I'm able to do is I'm able to engage the kids more. So, for example, I made a paragraph writing buddy so some of our students would find it hard to get started writing. Yes, they might need sentence starters, and I want them to do it in a topic sentence, supporting details, conclusion. So, I've made a tool to help them do that. And it wasn't working with one kid. He was still disinterested. So, I made a smart Alec version that gave him a bit of sassy answers [laughter] and that engaged him. So, I was able to individualise the support. So doing the same job, getting the same result, but different types of support." (Secondary education teacher in Ireland, original quote)

Another teacher in Ireland highlighted the potential of GenAI to reduce stress and optimise opportunities for students to practice their foreign language oral skills in preparation for their Leaving Certificate examinations. Typically, the students are given a scenario, such as interacting with a waiter in a coffee shop, and they must engage in a conversation. Using GenAI allowed students to feel less under pressure to engage in such activities, as they are interacting with the computer, as "it gives them thinking time".

In **Luxembourg**, the introduction of GenAI supports a shift towards more student-centred approaches to learning. Teachers have increasingly used AI-powered tools to personalise the learning experience, tailoring teaching strategies to meet the diverse needs of their students. This shift has empowered teachers to adopt more innovative teaching methods, enabling them to provide more individualised feedback and support, which is particularly beneficial in fostering student engagement and motivation. For example, teachers reported using GenAI to analyse student performance data, allowing them to adjust their teaching methods in real time to better meet students' learning needs. This adaptability not only enhanced the learning process but also

[35] Original quote: "Ja kyllä mäkin toivon että se ei ei että tai toivon että se ei tulisi muuttaa sitä opettajan työtä, että kyllä mun mielestä siinä opettajan oppilaan välillä pitää olla ihan oikea vuorovaikutussuhde, että se oppiminen voi tapahtua sitten tietenkin jotain pieniä osia pystyy pystyy vaikka joku tämmöinen etäopiskelu että voisin käydä vaikka tekoälyn johdattamana yksi kurssin jaksossa jos kursseja on yhteensä 7 menossa, että mielellään kyllä olisin ihan oikean opettajan kanssa tekemisissä."

encouraged students to take more ownership of their education, fostering a sense of autonomy and self-regulation.

In **Finland**, GenAI was used to help create learning materials and tasks tailored to individual student needs, allowing for more effective differentiation and support. Likewise, it also helped in providing personalised feedback to students, helping identify individual learning needs and tailored educational experiences accordingly. This personalised approach enhanced student engagement and support differentiated instruction. As noted by a teacher educator:

> *"Artificial intelligence can help differentiate teaching and provide the right level of tasks for students."* (Teacher educator in Finland, translation)[36]

And in the words of a school director:

> *"At its best, artificial intelligence can provide personal learning and act as a study coach."* (School director in Finland, translation)[37]

At the same time, students emphasised the importance of teachers in providing personal feedback and guidance, ensuring that AI complements and does not replace traditional teaching by a human being. They also mentioned the focus on personal interaction in learning: human interaction between teachers and students should be considered essential for effective education, with AI being seen as a supportive tool rather than a replacement.

In **Spain**, research participants recognised the potential of GenAI for the creation of personalised educational pathways. This personalization could radically transform teaching, making it more inclusive and tailored to individual differences. The policymaker interviewed for the study illustrated this potential with a concrete example:

> *"I think the part related to educational resources is enormous, the information that generative artificial intelligence can offer to provide totally personalised educational resources. Because in the end, we know that the student, when they have a resource adapted to their ability, to their interests, will take it with much more interest and will be able to work better. I think that artificial intelligence in this part can be very interesting. Because offering a wide database, I don't know, a very simple example: if a student can be more interested in analysing a rap piece instead of taking Garcilaso [de la Vega], perhaps one student will be offered Garcilaso and another will be shown information about that rap piece".* (Policymaker in Spain, translation)[38]

5.2.2.2. Assessment practices

The use of GenAI is challenging traditional assessment methods, as students can potentially use AI tools to generate answers and complete tasks effectively and rapidly, thereby compromising their ability to assess learning progression. This is making the need for innovative approaches to assessment a clear priority to educators, as well as school leaders and policymakers. There is need

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36 Original quote: "Tekoäly voi auttaa eriyttämään opetusta ja tarjoamaan oikean tasoisia tehtäviä oppilaille."

37 Original quote: "Tekoäly voi parhaimmillaan henkilökohtaista oppimista ja toimia opiskelun coachina."

38 Original quote: "Creo que es enorme la parte referida a recursos educativos, la información que puede ofrecer la inteligencia artificial generativa de ofrecer recursos educativos totalmente personalizados. Porque si al final sabemos que el alumno cuando tiene un recurso adaptado a su capacidad, a sus intereses, lo va a coger con mucho más interés y va a para poder trabajar mejor. Yo creo que la inteligencia artificial en esta parte sí que puede ser muy interesante. Porque ofreciendo una base de datos amplia realmente, yo que sé un ejemplo muy sencillo: si un alumno puede tener más interés en una pieza de rap para analizar un poema en vez de coger a Garcilaso, pues igual a un alumno le va a ofrecer Garcilaso y al otro le está viendo con la información que tiene sobre esa pieza de rap."

for new assessment methods with a focus on critical thinking, problem-solving, and creativity. As noted by a student in Spain:

> *"It's true that I think they [teachers] are going to have to learn to re-examine their methods and make a transformation in the way they teach. But I think it's going to be good for both the teachers and the students. The students, because they'll learn to use it and understand it, since I think it's going to be something common in daily life in just a few years. And the teachers, because I think it's inevitable that the students will use it. So, it's better that the teacher learns to show them how to use it and control its use in a way that doesn't just involve assigning old-fashioned homework and having them use it to solve it quickly."* (Secondary education student in Spain, translation)[39]

Teachers expressed significant concern about the implications of GenAI for all forms of assessment, specifically with regard to the potential for students to use it to cheat or plagiarise on assignments. Although some teachers acknowledged that plagiarism has been a problem in the past, with students copying from online sources, others pointed out that GenAI introduces new challenges that teachers must be aware of when evaluating student work, particularly in written assessments. As implied by an educator in Germany, GenAI could force whole educations systems to reimagine how student's performance is assessed through both formative and summative assessment strategies:

> *"So, we are moving away from product orientation to project-orientation, where performance is measured. And this basically means that the idea of competence orientation is now finally making a breakthrough, because this product orientation usually leads to declarative knowledge being tested. And now, of course, if I look at the processes, i.e. if I want to assess competences that are acquired, then I can of course do this in the process of being competent, i.e. when I am active, when I carry out the operation. Of course, I can show this much better than in the end product. Not only much better, but also in the process of being competent."* (School leader in Germany, translation)[40]

Research participants stressed that it is essential to rethink assessment strategies and avoid relying on formats that are amenable to GenAI-enabled cheating. This can be achieved by creating new types of exercises that challenge students beyond traditional approaches, encouraging them to think critically and engage deeply with the material rather than relying solely on AI-generated content. They highlighted that the focus should shift from trying to catch students who cheat to promoting values such as honesty and creativity, and educating students on how to use GenAI tools effectively and responsibly. By adopting adaptive teaching strategies, educators can ensure that students develop the skills and knowledge they need to succeed in a world where GenAI is increasingly prevalent. This includes designing assignments that are less susceptible to AI-generated responses and emphasising in-class discussions, which can help to promote critical

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39 Original quote: "Sí que es verdad que creo que [los docentes] van a tener que aprender a replantearse sus métodos y hacer una transformación de cómo enseñaban. Pero creo que va a ser bueno tanto para los docentes, como para los alumnos. Los alumnos porque aprendan a usarla y a entenderla, porque creo que va a ser algo común en la vida diaria a partir dentro de pocos años. Y los docentes, porque yo creo que va a ser inevitable que los alumnos lo usen. Entonces es mejor que el docente aprenda a decirles cómo usarla y a controlar ese uso de una forma que no simplemente seguir mandando trabajos a la antigua y que ellos lo usen para resolverlo rápidamente."

40 Original quote: "Also wir kommen weg von der Produktorientierung zur Projektorientierung, bei der Leistungsmessung. Und damit wird im Grunde auch der Gedanke der Kompetenzorientierung endgültig jetzt zum Durchbruch verholfen, weil diese Produktorientierung in der Regel dazu führt, dass deklaratives Wissen abgefragt wird. Und das ist natürlich jetzt, wenn ich die Prozesse betrachte, dann also wenn ich Kompetenz bewerten möchte, die erworben wird, dann kann ich das natürlich im Prozess des Kompetentseins, also wenn ich aktiv bin, wenn ich die Operation durchführe. Kann ich das natürlich dann viel besser zeigen als im Endprodukt. Gar nicht nur viel besser, also auch aufzeigen im Prozess des Kompetentseins."

thinking, creativity, and deeper engagement with the material, ultimately leading to a more holistic and effective learning experience.

GenAI may also prove to be helpful as a tool for self-assessment, enabling students to receive timely feedback that allows them to refine their work before submission. For example, this was the opinion of one of the STEM teachers in Ireland, who commented on how students can use GenAI to self-assess their own work and this can result in their work being of a much higher standard when the teacher evaluates it:

> *"I also find, even for some of my weaker students, that sometimes they'll put their information into AI to get it assessed, even before I'll correct it, and it gives them ideas. They're kind of self-assessing and they're more willing to work with AI than work with me. So, [by] the time it gets to me, it's of a much higher standard."*
> (Teacher in Ireland, original quote)

5.2.2.3. Teachers' workload

The potential effects of GenAI on teachers' workload might come in different forms and shapes. In this regard, teachers in most countries reported that this technology was particularly useful in streamlining lesson planning and managing administrative tasks, which in turn allowed them to spend more energy on direct interaction with students and teaching activities that require their expertise.

Likewise, GenAI tools were perceived to support educators in the simplification of complex concepts, making them easier for students to grasp. Teachers also made multiple references to how GenAI technologies can assist them in preparing differentiated materials and how this is enabling them to redefine their pedagogical approaches as they can now more easily cater for the wide range of students' interests and abilities, through the provision of personalised learning experiences tailored to individual student needs.

The challenge of the time taken to review work and provide constructive feedback to students was a workload issue repeatedly raised, especially by humanities teachers. The following words by a history teacher illustrate how GenAI may redefine the process of assessing students' work and providing feedback effectively:

> *"I would read through the essay, and comment on their title. Then I would make a comment for every single paragraph, I was able to talk into my phone [with] my normal butts and stutters trying to think of [constructive] feedback and I would say [to the GenAI tool that] these are rough notes and I want you to act as a leading history examiner and give this student constructive feedback [so that it] will move this draft onto the next level."* (Teacher in Ireland, original quote)

Nevertheless, while many teachers appreciated the benefits in terms of potential for time saving, some remained cautious, expressing concerns about the accuracy and reliability of AI-generated content, which always requires careful verification and therefore the allocation of extra time for that process. At the same time, students' access to GenAI systems might also create new workload demands for teachers, mainly associated with the monitoring of technology use in learning and assessment or the implementation of more resource-intense approaches to assessment (e.g., oral examinations). Likewise, as noted by a language teacher in Finland, developing educators' AI literacy can be a time-consuming process itself:

> *"Artificial intelligence brings more work to the teacher because the teacher needs to learn it."* (Teacher in Finland, translation).[41]

In consequence, the use of GenAI could alleviate some aspects of a teacher's workload but equally increase others, depending on how it is integrated into their practice and the extent to which such an integration is facilitated by the institutional and social contexts where they take place.

5.2.2.4. GenAI and students' collaborative, emotional and ethical competence

GenAI also comes with important implications for the involvement of students in learning activities. For instance, it may support but also hinder collaboration dynamics. In this regard, the risk of a so-called "involution" on collaborative abilities among students emerged as part of the focus group with students in Spain:

> *"Well, I do think it does affect relationships with classmates. For example, before, I could ask each person for their opinion and everyone would do their part, but now with artificial intelligence, for example, everyone just looks it up on ChatGPT or some other tool, and the answer just comes up directly, so no one really has their own original idea, so to speak."* (Student in Spain, translation)[42]

Some of the implications that might arise from this perception point to a shift towards individual work for those students who rely on AI too heavily, possibly manifesting in reduced communication with both peers and teachers. Moreover, this isolation could curtail debates, peer feedback, and mentorship processes that are critical to collaborative learning. It could also entail a hindrance for the development of interpersonal competences, such as negotiation skills, empathy and emotional self-regulation.

It is essential to take into consideration all these aspects for the design of effective training programs that address fears and misconceptions surrounding technology adoption. For instance, it is important that students are made aware that they are interacting with an AI system and ensure they understand the nature of such systems and its potential impact on their emotional regulation. Also in Spain, the focus group with STEM teachers raised this reflection regarding students:

> *"Because if we are not training or educating our young people first [in the good use of GenAI], it's like giving them a gun and then telling them don't hurt them. If [as teenagers] they are not able to control their emotions, they are not able to control their day-to-day life: how are they going to be able to manage their emotions, their reality with tools as powerful as artificial intelligence? It's a bit of a strong topic, but that's how it is."* (Teacher in Spain, translation)[43]

The implications of GenAI for the development of certain soft skills, such as personal interaction, collaborative work, or emotional regulation — especially regarding the attribution of agency and veracity to AI — directly connects with the need for ethical awareness for students in the use of these technologies. Even more directly, it points to a broader social problem related to these

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41 Original quote: "Tekoäly tuo lisää työtä opettajalle, koska se tuo yhden maailman lisää haltuun otettavaksi."

42 Original quote: "A ver, yo creo que sí que afecta en torno a la relación con los compañeros de la clase. Ya que por ejemplo antes pues podría preguntarle a cada uno que tenga su opinión tal y que cada uno haga lo suyo, pero ahora con la inteligencia artificial, por ejemplo, pues cada uno lo busca en Chat GPT o en otra o lo que sea, y ya pues le sale directamente y nadie tiene su originalidad, por así decirlo."

43 Original quote: "Porque si no vamos formando o no vamos educando primero a nuestros jóvenes [en el buen uso de la GenIA], es como darles un arma y luego decirles no hagas daño. Si [como adolescentes] no son capaces de controlar sus emociones, no son capaces de controlar su día a día: ¿cómo van a ser capaces de gestionar sus emociones, su realidad con herramientas tan potentes como la inteligencia artificial? Es un tema un poquito fuerte, pero es tal cual".

resources: the identification of their biases. A lack of critical thinking in this sense may lead students, as well as teachers, to accept AI-generated outputs as trustworthy.

The lack of competence development opportunities in this area, to both students and teachers, is one of the greatest challenges facing education today, and it can only be addressed through a comprehensive approach that includes not only ethical concerns, but also education on how these technologies are developed and deployed. Without this kind of training and ethical culture, there is a risk of uncritically reproducing the very prejudices, exclusions, and misinformation that society should strive to avoid.

5.3. Subject-specific implications of GenAI

The impact of GenAI on teaching and learning practices can vary considerably depending on the subject area of implementation, reflecting the unique pedagogical goals, challenges, and opportunities presented by each discipline. In order to explore key differences and similarities, the interviews and focus groups conducted as part of this study paid particular attention to how this emerging technology may redefine pedagogical approaches across diverse subjects. The teacher educators interviewed in each of the Member States were recruited from selected areas of specialisation, including arts, languages, maths and technology education. Likewise, focus groups with teachers convened participants separately, based on whether they specialised in arts-humanities or STEM subjects.

Despite differences, educators across disciplines have recognised the potential of GenAI in their respective contexts, without ignoring important challenges at the same time. A key theme across all subjects was the potential role of GenAI in supporting critical thinking and problem-solving skills and the shift of focus to the process of learning, rather than just the outcomes. In STEM and Arts and Humanities subjects, GenAI may support these skills, which are crucial for leveraging AI's potential while mitigating risks like academic dishonesty. To effectively integrate AI into teaching, there is a consistent call for ongoing professional development for educators. This training should not only focus on technical skills but also include pedagogical strategies and an understanding of the ethical implications of AI use.

5.3.1. GenAI implications for teaching and learning in Humanities subjects

In the context of Humanities subjects[44], the integration of GenAI has significant implications for teaching and learning. Humanities subjects, including arts and languages, are characterised by the creation of content and the development of critical thinking, creativity, and analytical skills. Research participants highlighted how by automating routine tasks and generating new ideas, GenAI may facilitate artistic exploration and innovation, allowing students to focus on higher-level creative decisions.

GenAI can be a valuable tool for sparking inspiration, particularly when students are experiencing creative blocks. As noted by a teacher in Spain, this technology can be particularly empowering to those students who regard themselves as less talented for traditional arts forms:

> *"Often a student, due to lack of manual dexterity, has very good ideas, but when he is unable to carry them out, he gets frustrated, blocked and those ideas stay in his head and do not come back, and nobody knows them. So, giving them an option to release those ideas in a simpler, faster, easier way, I think, can help students who are blocked when it comes to expressing their creativity. With this tool, perhaps the final work of this artificial intelligence could not and should not be accepted, but as a first step in creating their own work. They could develop their ideas, ask for help from an artificial intelligence and from the images or texts generated, create their work. This eliminates one of the barriers I see most in my students, which is the fear of the blank page. They don't know where to start, they don't know*

[44] Humanities subjects consists of a range of subjects that study human culture, society and experiences, e.g., literature, history, philosophy and the arts.

which path to follow, they don't know how to generate an idea from scratch, or how to take it, or how to capture it on paper from scratch." (Teacher in Spain, translation).[45]

In arts education, respondents discussed how GenAI can also be used to support student learning by providing personalised feedback and guidance. For example, AI-powered tools can be used to analyse student artwork and provide suggestions for improvement, allowing students to refine their skills and develop their own unique style. However, ensuring originality in student work is an increasingly significant challenge, and there is a strong emphasis on ensuring that students use GenAI as a complement to, rather than a substitute for, their own creativity.

As noted by one of the teachers in Germany, language skills play a central role in determining our ability to use GenAI effectively. To benefit from this technology, students need to be able to craft prompts that can produce the desired outputs:

> *"The integration into cognitive processes happens the moment I use the AI for myself and experience how journalism uses it etc. or search engines like Google use it now. But it doesn't interrupt the relationship with writing and language, because I have to be incredibly linguistically competent in order to be able to interact with the AI at all. I have the feeling that it's even more conducive to language because I have to talk so intensively about prompting in order to be able to interact with the AI. I have to be able to express myself however I want."* (Teacher in Germany, translation)[46]

Participants saw in GenAI the potential to make language learning more inclusive by providing personalised learning experiences, tailored to individual students' needs and abilities. For example, they reported the use of GenAI to create interactive language lessons, allowing students to practice their language skills in a more engaging and immersive way. Moreover, GenAI can help to create a more inclusive and accessible learning environment, particularly for students who require additional support.

However, the use of GenAI in languages teaching also raises important questions about the nature of language learning, the value of human interaction, and the role of the teacher in the language learning process. While some teachers pointed out that GenAI could help to reduce their workload by automating tasks such as grading and feedback, it also raises questions about the potential for bias and mistakes in AI-generated feedback.

Overall, the integration of GenAI into secondary education has significant implications for the way Humanities subjects are taught and learned. While GenAI offers many benefits, such as facilitating artistic exploration and innovation, making language learning more inclusive, and providing

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45 Original quote: "Muchas veces un alumno, por falta de destreza manual, tiene ideas muy buenas, pero al no poder llevarlas a cabo se frustra, se bloquea y esas ideas se quedan en su cabeza y no vuelven, y nadie las conoce. Entonces, darle una opción para liberar esas ideas de una forma más sencilla, más rápida, más fácil, creo que puede ayudar a los alumnos que se bloquean a la hora de expresar su creatividad. Con esta herramienta, quizás no se podría ni se debería aceptar el trabajo final de esta inteligencia artificial, pero sí como un primer paso a la hora de crear su propia obra. Ellos podrían desarrollar sus ideas, pedir ayuda a una inteligencia artificial y a partir de las imágenes o textos generados, crear su obra. Así se elimina una de las barreras que más veo en mis alumnos, que es el miedo a la página en blanco. No saben por dónde empezar, no saben qué camino seguir, no saben generar una idea desde cero, ni llevarla, ni plasmarla en un papel desde cero."

46 Original quote: "Die Integration in die kognitiven Prozesse passieren in dem Moment, wo ich die KI für mich nutze, und im Alltag erlebe, wie Journalismus sie benutzt usw. oder Suchmaschinen wie Google sie jetzt nutzen. Aber sie unterbricht eben nicht die Beziehung zu Schrift und Sprache, weil ich ja gerade unheimlich sprachkompetent sein muss, um überhaupt mit der KI interagieren zu können. Ich habe das Gefühl, dass sie sogar eher sprachförderlich ist, weil ich so intensiv über das Prompting reden muss, um mit der KI interagieren zu können. Ich muss"

personalised feedback and guidance, it also raises important questions about the nature of creativity, human interaction, and the role of the teacher in the learning process.

5.3.2. GenAI implications for teaching and learning in STEM subjects

In STEM education, GenAI is being utilised to generate academic content, aid information searches, and facilitate collaborative learning and project-based approaches. Participants highlighted the potential of this technology to significantly transform the learning landscape by engaging students in real-world problem-solving tasks, such as generating data sets for analysis or simulating scientific experiments. By doing so, GenAI may support the practical application of theoretical knowledge, thereby developing critical thinking and problem-solving skills.

In practical problem-solving and technical exercises, GenAI is leveraged in STEM education with a focus on precision and understanding AI's limitations, such as potential errors in calculations. In subjects concerned with computer programming, for example, GenAI can help students articulate and solve coding problems. However, in order to be able to do so, it is essential that students develop certain competences:

> *..."they [students] don't know how to use it [GenAI] and we must teach them how to use it. They don't know how to word it. So, I'm literally sitting down. I say, imagine it's a person sitting here beside you. Let's start with this. What would you ask them? Well, I just want to know, tell me what you need to know how to do. It's getting them to define the problem that they're looking for. That's going to be the big skill. So, you're trying to help them to define this isn't working and explain why it's not working at that this piece of code is supposed to just present an average of this and it's not working. And this is the error message I'm getting. And so, you're getting them to articulate the problem we're trying to solve, and then they filter it down and down and down. So that is a big skill. And they're discussing that. And again, it takes as long as copying it, if not longer. But you're learning in the process."* (Teacher in Ireland, original quote)

Regarding its potential impact on assessment practices, some participants have argued that GenAI calls for a shift towards process-based assessment. This approach values the learning journey over the outcome, requiring students to gain a deeper understanding of the material by focusing on the underlying principles and algorithms. As GenAI systems can now easily provide solutions, the emphasis is on understanding the underlying concepts rather than just the solutions.

By providing dynamic learning environments, GenAI can encourage practical application of theoretical knowledge. In immersive virtual settings, students can engage with abstract concepts, making learning more tangible and engaging. For instance, a mathematics professor proposed using virtual environments to help students visualize and navigate through mathematical functions, thereby enhancing their understanding of complex concepts. By leveraging engaging settings like video games, the approach aims to make learning math more effective and engaging.

> *"For example, that a child can navigate through a function, that is, that he, for example, decides to get on a trigonometric function and evaluate. If we are looking at functions and discontinuity points, he can see what happens to them. That is, he will be able to handle the mathematical concepts, which are abstract. He will be able to visualize them and navigate through them. That is why one of the ideas I have come up with is that in an environment that is not the typical formal one of a function, of a graph, but that this graph can be*

associated, for example, to an environment that he likes, such as games"]. (Teacher in Spain, translation)[47]

Collaborative learning is another area where GenAI may be of assistance in STEM subjects, with educators noting that AI tools could enhance teamwork by providing features that support online collaboration and collaborative activities.

[47] Original quote: "Por ejemplo, que un niño pueda navegar a través de una función, es decir, que él, por ejemplo, decida subirse a una función trigonométrica y evaluar. Si estamos viendo las funciones y los puntos de discontinuidad, que él vea qué le pasa. Es decir, él podrá manejar los conceptos matemáticos, que son abstractos. Podrá visualizarlos y navegar a través de ellos. Por eso una de las ideas que se me ocurren es que en un entorno que no sea el típico formal de una función, de una gráfica, sino que esa gráfica la pueda asociar, por ejemplo, a un entorno que a él le guste, como los juegos."

6. Discussion and conclusions

This exploratory study investigates the implications of GenAI for education in five EU Member States: Finland, Germany, Ireland, Luxembourg, and Spain. The research yields valuable insights into the potential benefits and challenges associated with integrating GenAI in educational settings, drawing from the perspectives of relevant stakeholders: policymakers, teacher educators, teachers, school leaders, and students. Key findings underscore the importance of thoughtful consideration regarding GenAI in secondary education, with a focus on addressing AI literacy gaps and harnessing the potential benefits of this technology while minimising the risks. The study also considers differences and similarities across school subjects.

Employing a qualitative research approach and utilising a purposive sampling strategy, the study targeted a range of educational stakeholders who had prior experience with GenAI, aiming to capture different perspectives and experiences. By prioritising diversity and mapping the emerging landscape of GenAI integration into teaching and learning across different educational systems and institutional contexts, the study acknowledges the complexity and variability of GenAI adoption in secondary education. Rather than striving for generalisability, the study aims to provide a comprehensive and nuanced perspective on potential responses to the advent of GenAI, highlighting the diverse needs, challenges, and opportunities that arise from its integration into education.

GenAI is increasingly integrated into human cognitive processes, redefining traditional relationships with writing, language, and learning (Fügener et al., 2022). This raises important questions about the content students need to learn as part of the formal and informal curriculum of secondary education, the activities and experiences that can aid in the acquisition of knowledge, skills, and attitudes, and the roles that teachers and technology can and should play in the learning process (Eager et al., 2023).

The uptake of GenAI in secondary education presents a complex scenario, with both enthusiasm for its possibilities and caution about the challenges it imposes. In contrast to their teachers, students in the study reported widespread adoption of GenAI in their daily academic routines. Although they acknowledged the significant risks associated with GenAI, students tended to focus more on its potential benefits and opportunities, such as personalised learning and enhanced teaching effectiveness. Students believed they were integrating GenAI into their daily lives more frequently than their teachers, leveraging it as a supportive tool for skill practice, feedback, simplifying complex concepts, generating summaries, and simulating exams. They utilised GenAI tools for creative tasks like writing and art, language development through chatbots and language apps, and creating learning resources such as concept maps and flashcards. Moreover, some students had begun to rely on GenAI as a personal assistant, using it to support both academic and everyday tasks.

One major conclusion of the study is that GenAI has the potential to enhance teaching and learning, but its effective and safe adoption in education is highly dependent on educators' AI literacy. Therefore, it is essential that all educators have the necessary competences to harness the potential benefits of GenAI while minimising potential risks. This includes understanding how GenAI works, at least to a minimum level required to perform their jobs to a suitable standard, gaining awareness of the positives and negatives of using GenAI, and being able to critically evaluate the outputs of GenAI systems (Ng et al., 2022).

The variability in readiness to integrate GenAI into teaching practices highlights the need for more robust and targeted continuous professional development opportunities, aimed at providing educators with support to develop their skills in using GenAI tools. These training opportunities should not only increase AI literacy from a technical point of view but also equip educators with the skills to critically engage with GenAI tools and ensure that they are used effectively and responsibly

in teaching and learning (Mittelstadt, 2019). It is also important to take in account the needs of teachers, as not all teachers require the same AI training. But before that, a first step they need to be able to undertake is to determine when these tools should be used and when not, taking into account the wider pedagogical, legal and ethical implications of uptake. Looking forward, the AI Act is expected to play a key role in ensuring that all stakeholders in the education and training sector develop an adequate level of AI literacy.

It will also be essential to update initial teacher education programs to ensure pre-service teachers have the required levels of competence to deal with AI before entering the profession. Similarly, it will be crucial to assess the extent to which relevant EU initiatives, such as the AI Continent Action Plan[48] or the Union of Skills,[49] can support the development of AI literacy in the education sector. Specific educational sandboxes could also be helpful to provide educators with a space for exploration before transferring such processes to the classroom.

Furthermore, the study highlights the need for clear guidance and policies on the use of GenAI in education. Establishing clear guidelines and policies is essential to ensure that GenAI is used responsibly and effectively in education and that students are protected from potential risks such as bias and misinformation (UNESCO, 2021). The study also emphasizes the importance of addressing the digital divide and ensuring that all students have access to GenAI tools and resources. This includes providing support for students who may not have access to GenAI tools outside of the classroom and ensuring that GenAI is used inclusively and equitably for all students.

Looking at the day-to-day practices of teachers, the study illustrates how GenAI has the potential to shape key aspects of the teaching profession and affect their workload. For instance, teachers are experimenting with using GenAI for lesson planning and creating educational resources, as well as helping alleviate the burden of tasks ancillary to teaching (e.g., administrative work, communication with families). However, educators acknowledged the importance of keeping educators in the loop when integrating AI into education and, more generally, balancing digital education with teaching methods that do not depend on technology, ensuring that the human element in education is preserved (Darvishi et al., 2024).

The potential to enhance student engagement in education through GenAI was identified in the study as one of the most promising areas of impact. For example, by using this technology to personalise resources and experiences, teachers can ensure they are as relevant and meaningful as possible to individual students and classes based on their interests, capacities, and other contextual factors.

Assessment emerged as an area deeply affected by the rise of GenAI. On one hand, this technology may assist teachers in accelerating the creation or adaptation of tasks designed to assess students' achievement of learning outcomes, whether summatively or formatively. On the other hand, GenAI renders ineffective activities that have traditionally played a central role in assessment practices for many subjects in secondary education, particularly essay writing.

While GenAI may save teachers time in some areas, it also raises concerns about accuracy and reliability, requiring extra time for verification. Additionally, AI may create new workload demands, such as monitoring technology use and implementing new assessment methods. Teachers may also need to invest time in developing their own AI literacy and dealing with unintended consequences, which could offset any potential time savings. Ultimately, the impact of AI on a teacher's workload

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will depend on how it is integrated into their practice and the support they receive from their institutions and the wider education system.

The integration of GenAI into teaching and learning practices has varying impacts across different subject areas in secondary education. In STEM subjects, GenAI can transform the learning landscape by engaging students in real-world problem-solving tasks, such as generating data sets for analysis or simulating scientific experiments. GenAI can also help students articulate and solve coding problems, but it is essential to teach students critical thinking skills and how to use GenAI effectively and develop certain competences that allow them to use AI more effectively and also more ethically. Furthermore, GenAI calls for a shift towards process-based assessment, valuing the learning journey over the outcome and requiring students to gain a deeper understanding of the material. By providing dynamic learning environments, GenAI can encourage practical application of theoretical knowledge, making learning more tangible and engaging.

Our data indicates that GenAI may redefine the way students learn and engage with artistic and linguistic concepts. It can facilitate artistic exploration and innovation, enabling students to focus on higher-level creative decisions, while helping teachers to provide personalised feedback and guidance to support student learning in arts education. Additionally, GenAI can make language learning more inclusive by offering tailored learning experiences that cater to individual students' needs and abilities. On the other hand, it can also limit true creativity by reinforcing homogeneity if misused.

Common themes emerged across Humanities and STEM subjects. The need for ongoing professional development for educators is crucial to ensure they can effectively integrate GenAI into their teaching practices. It is also essential to ensure that students use GenAI as a complement to, rather than a substitute for, their own creativity and critical thinking skills. Additionally, GenAI has the potential to support collaborative learning and provide personalised feedback and guidance, which can enhance student learning outcomes. Overall, the integration of GenAI into secondary education has significant implications for teaching and learning practices, offering many benefits while also raising important questions about the nature of creativity, human interaction, and the role of the teacher in the learning process.

7. Policy considerations

In response to the perceptions and uses of early adopters of GenAI in secondary education across the five EU Member States included in this study, the following considerations have been formulated to support the work of policymakers with responsibilities in this area.

1. The responsible, appropriate and effective adoption of GenAI may require **strengthening guidance and capacity building** for all stakeholders involved in the delivery of secondary education, including teachers, school leaders, teacher educators and teacher students. In order to be relevant, these measures should address ethical, technical and practical aspects of GenAI integration into education.

   (a) School leaders and teachers would benefit from clarity on when, why and how to make use of GenAI in their practice, drawing on legal, ethical, pedagogical and technical expertise.

   (b) Building capacity among all secondary education teachers requires addressing competence gaps throughout all career stages, from the initial teacher education (ITE) programmes for pre-service teachers to the continuous professional development (CPD) aimed at in-service teachers.

2. Coordinated efforts across EU Member States with regard to **research on the implications of GenAI** for secondary education would contribute to mitigating potential risks while maximising opportunities for the enhancement of teaching and learning.
3. The ambition to enable learners to engage, create with, manage, and design GenAI, while critically evaluating its benefits, risks, and ethical implications, can be further enabled by strengthening the presence of **AI literacy within** the curriculum. Knowledge, attitudes and skills specific to GenAI should be covered as part of wider efforts aimed at tackling AI literacy and digital competence gaps. The European Commission offers resources to support the work of policymakers and educators in this regard, such as:
   a. AILit - The *AI literacy Framework for Primary and Secondary Education*, designed in partnership with the OECD.[50]
   b. DigComp 3.0 - *The European Digital Competence Framework.*[51]
4. Ensuring an ethical and equitable integration of GenAI into secondary education at sectoral level across the EU would require that all schools have access to suitable **infrastructures and systems**.
5. **Further research** is needed to better understand how AI is being used in the classrooms across the EU and its impact on the learning process and teaching practices.

[50] AILit Framework

[51] DigComp 3.0 - The Joint Research Centre: EU Science Hub

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List of abbreviations and definitions

Abbreviations	Definitions
AI	Artificial Intelligence
AIED	AI in education
CPD	Continuous professional development
DE	Germany
DG CNECT	Directorate-General for Communications Networks, Content and Technology
DG EAC	Directorate-General for Education, Youth, Sport and Culture
EC	European Commission
EdTech	Educational technology
ES	Spain
FI	Finland
FMEC	Finnish Ministry of Education and Culture
FNAE	Finnish National Agency for Education
GenAI	Generative AI
IE	Ireland
IDoE	Irish Department of Education
ISCED	International Standard Classification of Education
INTEF	Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado
ITE	Initial teacher education
JRC	Joint Research Centre
KMK	German Conference of the Ministers of Education
LU	Luxembourg
OECD	Organisation for Economic Co-operation and Development
SMEVTS	Spanish Ministry for Education, Vocational Training and Sport
STEM	Science, Technology, Engineering, Mathematics
UNESCO	United Nations Educational, Scientific and Cultural Organization

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