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Work Package 2

AI Competence Frameworks and Policies in Higher Education: Analysis and Recommendations

National Report by University of Tartu

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Executive Summary

This National Report by the University of Tartu (Estonia) presents a comprehensive analysis of the current landscape surrounding artificial intelligence (AI) adoption in Estonian higher education institutions. By examining key AI policies and practices adopted in Estonian higher education and supplementing this national overview with relevant frameworks of AI competences, the report identifies critical competencies needed for AI literacy among educators and students.

Key Findings

Estonia has positioned itself as a forward-thinking nation in AI implementation through coordinated national policy efforts across multiple ministries. The "White Book of Data and AI 2024-2030" and "AI Action Plan for 2024-2026" establish strategic directions for AI integration in higher education, with implementation further supported by the ambitious national "AI Leap" program aimed at integrating AI tools across the country's educational institutions.

Several Estonian universities have independently developed AI guidelines tailored to their academic cultures. These guidelines consistently emphasize core values such as honesty, critical thinking, and responsibility. They provide practical guidance on appropriate AI use in teaching, learning, and research while clarifying citation practices for AI-generated content.

The University of Tartu case study demonstrates a systematic approach to AI integration through four key initiatives: (1) development of comprehensive guidelines for AI use in teaching and learning; (2) creation of training programs for staff and students; (3) regular monitoring of AI adoption patterns through surveys; and (4) research collaboration through the Estonian Centre of Excellence in Artificial Intelligence.

Analysis of four major AI competences frameworks—DigCompEdu, the 4D Competencies Framework, Long & Magerko's (2020) scholarly work on AI literacy, and the EU AI Act—reveals seven essential domains for AI readiness:

1. **Technical competencies** for utilizing digital tools and understanding AI systems
2. **Information content competencies** for working critically with digital content
3. **Ethical knowledge** for responsible AI use
4. **Communication and collaboration skills** for organizational effectiveness
5. **Teaching, learning, and assessment competencies** for core educational activities
6. **Character traits** supporting an appropriate mindset for AI utilization
7. **Reflection and development abilities** for professional growth in a rapidly changing environment

Key Challenges

The report identifies several barriers to effective AI integration in education:

- Ensuring equal access to AI technologies for all students regardless of socioeconomic status, disability, or learning differences.
- Limited public understanding of AI technologies and their capabilities.
- Vague conceptions of how AI systems actually work, leading to misconceptions.
- Ethical concerns including privacy, misinformation, algorithmic bias, and transparency issues.
- The need to reconceptualize teaching and learning approaches in response to AI capabilities.

Recommendations

Based on the analysis, the report recommends:

1. Developing explicit AI literacy frameworks that incorporate both technical and ethical domains.
2. Providing hands-on learning experiences with real-world, contextually relevant datasets.
3. Implementing transparent and explainable approaches to AI education that gradually unveil AI complexities.
4. Prioritizing pedagogy over technology by focusing first on learning objectives before integrating AI tools.
5. Maintaining human oversight in educational decision-making while using AI as a supportive tool.
6. Upholding robust data protection standards for student information.
7. Investing in ongoing professional development for educators to build AI literacy.

The report concludes that Estonia's approach to AI integration in higher education shows promise through its combination of national strategic planning (AI Leap) and institutional autonomy in implementation. By addressing both technical competencies and ethical considerations, Estonian higher education institutions are positioning themselves and their students for success in an AI-augmented future.

1. Introduction

In Estonia, there are three ministries that have been involved in compilation of key strategic or policy documents regarding AI on the level of government: Ministry of Economic Affairs and Communications [abbreviation in Estonian: MKM], Ministry of Justice and Digital Affairs [abbreviation in Estonian: JUM], and Ministry of Education and Research [abbreviation in Estonian: HTM]. Followed by two national AI action plans in 2018 and 2021 (MKM, 2019; MKM, 2021), the "AI action plan for 2024-2026" (MKM, JUM, HTM, n.d.) and "White book of data and AI 2024-2030" (HTM, JUM, MKM, n.d.) currently inform AI related policies and practices (incl in higher education). These national documents are synchronized with and support the EU-level legislation and activities, such as the EU AI Act (Regulation 2024/1689). Moreover, within the framework of the previous AI action plan, Estonia actively participated in the development of European Union and Council of Europe legislation and instruments regulating artificial intelligence in order to protect Estonia's interests in the development of a pan-European legal framework (MKM, JUM, HTM, n.d.).

The aforementioned AI-related strategy documents are linked to other Estonian strategy documents:

- Digiühiskonna arengukava 2030 [Estonia's Digital Agenda 2030],
- Teadus- ja arendustegevuse, innovatsiooni ja ettevõtluse arengukava 2035 [Estonian Research and Development, Innovation and Entrepreneurship Strategy 2021-2035],
- Haridusvaldkonna arengukava 2035 [Education Strategy 2021-2035].

In the field of education (incl higher education), the Ministry of Education and Research has launched a helpful website about "AI in learning and teaching" (HTM, n.d.), meant for school principals, teachers, and learners. AI guidelines have also been issued for school principals, teachers and learners (HTM, 2024). Teachers can find useful materials from the aforementioned website by the Ministry of Education and Research. It is important to note that in education, the Estonian guidelines have been optional and suggestive, granting educators academic freedom in AI usage.

In this report, we begin by outlining national policies and practices related to the use of AI in higher education in Estonia. We then focus on a specific higher education institution—the University of Tartu (UT)—and present a case study that illustrates how UT has approached the use of AI in teaching and learning since 2023.

For the second part of the report, following the project's deliverables, we identified and collected AI frameworks and policy documents at various levels and distributed them amongst the partners for analysis resulting in these forming the basis for the individual national reports. As such, we will give an overview of AI literacy on the basis of four resources: first, "European Framework for the Digital Competence of Educators: DigCompEdu" (Punie & Redecker, 2017), second, "Four-Dimensional (4D) Competencies

Framework, Rev 1.2" (Center for Curriculum Redesign, 2024),third, a scholarly paper on AI literacy competencies and design considerations (Long & Magerko, 2020), and, fourth, the EU AI Act (Regulation 2024/1689).

Finally, we will provide our conclusions and recommendations for using AI in higher education institutions based on the analysis of the aforementioned documents.

2. National policy and practice regarding AI in Higher Education in Estonia

AI usage in HE is integrated into various AI related national policies (HTM, JUM, MKM, n.d.; MKM, JUM, HTM, n.d.). By 2030, the aim is to integrate the subject of data management into different education levels (including higher education), to ensure that workforce skills are up-to-date and competitive (HTM, JUM, MKM, n.d., p. 23). To do so, the topic of AI will be integrated and taught systematically (HTM, JUM, MKM, n.d., p. 23), keeping also in mind the impacts of its application, possibilities, and threats (HTM, JUM, MKM, n.d., p. 27).

The generic goals mentioned in the “White book of data and AI 2024-2030” (HTM, JUM, MKM, n.d.) are in more detail introduced by “AI action plan for 2024-2026". This document focuses mostly on activities in public and private sector but also addresses AI related education and research, firstly presenting SWOT analysis of the situation, and secondly introducing actions in this field. Most noteworthy actions from the perspective of this report, mentioned in the AI action plan, involve various programmes to raise awareness about AI among citizens in general, enterprises, and educational institutions, and training programs for small and medium enterprises, IT specialists, teachers, etc.

One of the most significant initiatives aligned with these goals is the AI Leap 2025 programme, which signals a concrete step toward embedding AI into everyday educational practice. Announced in February 2025, this national initiative is designed to integrate artificial intelligence tools into the country’s education system, aiming to equip both students and teachers with the skills and technologies needed for the AI era.

Building on the legacy of the earlier Tiger Leap programme, which introduced digital infrastructure to schools, AI Leap will launch on September 1, 2025, providing free access to leading AI applications and training. Initially targeting 20,000 upper secondary students and 3,000 teachers, the programme will expand in its second year to include vocational schools and more student cohorts, reaching a total of 38,000 students and 2,000 teachers. Its core goals are to maintain Estonia’s high educational standards, enhance economic competitiveness by fostering AI literacy, and ensure equitable access to transformative technologies. The programme also includes significant investment in teacher training and partnerships with global AI leaders like OpenAI and Anthropic, positioning Estonia as a frontrunner in AI-driven education (e-Estonia, 2025).

While AI Leap represents a coordinated national effort, the adoption of AI tools and practices in educational institutions varies considerably across contexts. Considering the confusion around and rapid developments in affordable AI applications (such as AI powered chatbots) since early 2023, several Estonian HE institutions have independently compiled their own AI guidelines that take into account their academic cultures. By the beginning of 2025, out of 18 educational institutions offering higher education, a few had their AI guidelines available online (University of Tartu, Estonian University of Life Sciences, Tallinn University, Tallinn University of Technology, Estonian Academy of

Security Sciences, The Institute of Theology of the Estonian Evangelical Lutheran Church among them). The University of Tartu guideline (first version ready already in 2023, current version from 2024) will also be addressed later in this report.

Typically, at least in Estonian universities that have some sort of guideline on the use of AI technologies, the usage of AI technologies is not prohibited. Topics covered in AI guidelines usually include:

- Values such as honesty, ethical approach, and critical thinking (Eesti Maaülikool, n.d.; Tallinna Ülikool, 2024; Valk, A. & Paavel, K., n.d.), and the responsibility for the quality of one's own work (EELK Usuteaduse Instituut, 2024; Tallinna Tehnikaülikool, n.d.; Tallinna Ülikool, 2024; Valk, A. & Paavel, K., n.d.),
- Examples of learning activities where AI chatbots are allowed or even encouraged (Tallinna Tehnikaülikool, n.d.; Tallinna Ülikool, 2024; Valk, A. & Paavel, K., n.d.), some guidelines also provide a list of problems in AI technologies (Valk, A. & Paavel, K., n.d.).
- How to cite and refer to the usage AI tools (Eesti Maaülikool, n.d., Tallinna Tehnikaülikool n.d.; Valk, A. & Paavel, K., n.d., Tallinna Ülikool, 2024). However, the universities' guidelines distinguish a variety of AI tools' usage, and can even be controversial. While some guidelines recommend to cite and refer to AI tools in the list of references (Eesti Maaülikool, n.d., Valk, A. & Paavel, K., n.d.), some guidelines (EELK Usuteaduse Instituut, 2024; Tallinna Tehnikaülikool, n.d.) warn against using AI chatbots as independent information sources. In case of using AI applications as tools (for editing or translating some text, collecting ideas, creating a worksheet, etc), citing is not mandatory (Tallinna Tehnikaülikool, n.d.), but if the output from AI applications is used as a content (text from AI chatbot, a generated picture), the application has to be cited "as a method" (Tallinna Tehnikaülikool, n.d.).

Designing AI policies or strategies is a time-consuming and continuous process. Hence, at University of Tartu, it was supported by university's development fund in 2024 and by university's strategic funding in 2025, to bring together interested faculty members from related disciplines, and support staff (IT, data protection, educational technology) all over the university. The most important directions in guidelines have been under discussion in various decision-making bodies of the university, such as the Senate.

Some representative studies, attempting to cover either faculty members (Laak, Aru, Hint 2024) or students to find out about their AI use intentions and practices (Tamm, 2024; Tragel et al., in press), have been conducted in HE institutions in Estonia. During the completion of this report, the study about faculty members is being repeated at University of Tartu. Similar work is also in progress at Tallinn University (personal correspondence). In addition to large-scale studies, there are some more in-depth studies involving particular student groups (Jahilo & Veskimägi, 2024; Kotsar, 2024; Lepik, 2024).

3. Policy and practice at University of Tartu: case study

Since the release of OpenAI's ChatGPT in November 2022, the University of Tartu has placed a strong emphasis on staying abreast of the latest developments in large language models (LLMs) and has actively supported its staff in the adoption of AI tools in their professional activities. To this end, several initiatives have been undertaken to enhance the AI-readiness of both staff and students. These initiatives include i) the development of **guidelines and policies** for the use of AI tools in teaching and learning, ii) the provision of **training courses and seminars** for staff, iii) the observation and analysis of **UT current practices** and trends in AI use, iv) and the support of **research and collaboration** on AI-related topics. In this section, these activities at the University of Tartu will be discussed in more detail.

i) Guidelines and policies

At UT, the guidelines for using AI applications on teaching and learning (University of Tartu, n.d) have been available since April 2023. While the initial guidelines were developed by an ad hoc working group of university staff members, a more systematic approach to developing and updating the guidelines has been adopted since 2024, when a stable 'AI in Teaching' working group was formed.

According to the UT guidelines, using AI (including chatbots) in teaching and learning is encouraged to support education and develop students' learning and working skills. When using AI applications, focusing on i) purposefulness, ii) ethics, iii) transparency, and iv) a critical approach is essential.

The guidelines contain three main sections: i) general principles, ii) using AI chatbots in teaching and learning, and iii) the use of AI in thesis writing. In the thesis writing section, specific guidelines on how to refer to the use of AI applications have been given. These referencing guidelines mostly follow the principles of APA style, with some minor adjustments for the Estonian context. In addition to referring patterns, the thesis section also lists activities where the use of AI is allowed, and where it is prohibited.

The guidelines are formulated as 'living document', which can be updated by the university's AI in teaching working group members, if any updates are deemed necessary. For example, the initial suggestions for referring to AI use were updated and simplified in 2024, following the main trends across HE institutions and APA referring style.

Based on the direct feedback from the university members, the reception of the guidelines is generally positive, and the teaching staff finds it useful in their everyday work.

As an addition to the guidelines, the AI in teaching working group has provided UT's position statement on using AI detection software. The working group considers that using AI detection software to check students' work is unjustified and not recommended.

Currently, the university is developing a series of strategic lines of action documents, which will focus on five AI-related topics: i) building the AI competencies of university members; ii) the availability and use of AI applications; iii) making adjustments in the course content and in teaching and assessment; iv) using AI in research; v) developing support services using AI. However, since this is still a work in progress, its exact content will become clear during the next months.

ii) Training courses and seminars

In addition to the guidelines, the university's AI in teaching working group has developed an online beginner level learning resource (Hiiesalu et al. 2024) for both teaching staff and students. The learning material contains four chapters:

I) What is AI and how does it work?
II) Which AI applications to use and how is it done technically?
III) Why should I use AI in teaching and learning?
IV) For what should I use AI in teaching and learning?

The resource provides a practical introduction to these questions and includes interactive tests and exercises, enabling learners to assess their understanding and receive immediate online feedback.

The working group has strongly encouraged teaching staff to use this material in their courses as well, and to discuss the benefits and drawbacks of using AI with their students, too.

Furthermore, the working group regularly organizes trainings and seminars on AI-related topics. These events cover a range of topics, but the most usual topics are i) the practical workshops focusing on the use of particular AI applications and ii) experience exchange seminars where staff members who have used AI in their teaching share their experience and suggestions. The aim is to have at least two events in each faculty during each semester, that is, at least 16 events across the university per academic year. However, in faculties, the actual frequency of AI training courses is even higher, since faculties and individual institutes can decide to have more events.

Information about the university's AI-related resources, events, trainings etc. is presented on the AI working group website and any updates are communicated in the university's monthly newsletters. In addition, the AI working group team members introduce the resources to staff members at meetings, trainings etc.

iii) UT current practices in the use of AI

The University of Tartu's working group on AI in teaching regularly monitors how staff and students are responding to the opportunities and challenges presented by AI. To this end, a staff survey was conducted in February 2024 to explore: (i) the extent to which teaching staff use AI tools and which tools are preferred; (ii) whether and how teaching practices have been adjusted in response to the AI era; and (iii) what forms of support and training

are needed to navigate the rapidly evolving AI landscape. A follow-up survey is planned for April 2025 to identify any changes in usage patterns and to assess the impact of the support provided by the AI in teaching working group.

A student survey is currently being planned. However, in autumn 2024, students from all four faculties participated in an initiative in which course assignments were completed either entirely by students or entirely using AI tools. The aim was twofold: to assess whether lecturers could reliably distinguish between student-written and AI-generated work, and to highlight the urgent need to reconceptualise the types of assignments given to students.

This experiment showed that a student with no prior knowledge could use AI to complete assignments in just 20% of the expected time and still achieve an average grade of D, with AI successfully applied across all assignment types. While some instructors recognized signs of AI use, 36% failed to detect it, and detection had little impact on grading due to current assessment criteria—highlighting the urgent need to rethink assignment design and evaluation practices in the age of generative AI. (Laak, 2024)

iv) Research and collaboration

As can be inferred from the above-mentioned guidelines and resources, the university's central activities have mainly targeted the use of AI in teaching and learning. Concerning the use of AI in research and science, less central support has been offered, since faculties and disciplines can have quite different perspectives and needs in this area.

However, in 2024, the University of Tartu played a key role in founding the Estonian Centre of Excellence in Artificial Intelligence (EXAI). This national initiative brings together 13 research teams from three institutions based in Tartu and Tallinn. EXAI fosters collaborative work across disciplines, addressing both theoretical and practical aspects of AI. The centre is committed to developing reliable AI technologies while ensuring that their deployment aligns with societal values and the public good.

The Centre for Ethics of the UT has brought together a nationwide cooperation network focused on AI ethics. However, the network's main aim is to contribute to AI's development and responsible application in the local context, that is, on the science topics of AI development addressed by EXAI.

4. Analysis of AI competence frameworks

4.1 Methodology and documents included in the analysis

This section includes a qualitative content analysis to examine four documents (two frameworks, a scholarly paper, and a regulation) to get understanding on AI literacy in higher education.

The methodology applied in this report consists of following steps:

1) Data selection: The four documents were identified by the partner institutions of the project consortium, based on their relevance to AI literacy and their focus on either educational policy or competency development. Consortium members contributed to a collection of non-country-specific frameworks which was, in turn, divided amongst the consortium with each partner analysing their subset of documents. It is worth noting that the documents were not organised by theme or approach before this subdivision and, as such, the assignment of documents and the resulting sub-collections is effectively randomly determined.
2) Categorization: The content of the reports was reviewed according to the key themes the consortium agreed on: key concepts to define AI literacy, AI competencies, challenges, recommendations, examples, ethical considerations, and future trends.
3) Content analysis and interpretation: Recurring themes, similarities, and differences between the documents were identified to present a concluding interpretation of the findings in light of AI skills frameworks and the discourse on AI literacy. The frameworks analysed by UT are detailed in Table 1 with a composite analysis on the following pages. For a full picture of the international context, ensure that the below is reviewed in conversation with the other national reports.

Table 1. Documents included in the analysis

	DigCompEdu	4D Competencies Framework	"What is AI literacy?" article	The EU AI Act
Type of document (Framework, Policy, Guideline, ...)	Framework	Framework	Scholarly Work	Regulation
Date of publication	2017	2024	2020	2024
Responsible Institution(s)	Joint Research Centre (JRC), the European Commission's science and knowledge service	Centre for Curriculum Redesign	-	The European Commission; The European Parliament; The Council of the European Union)

Responsible Persons/ Authors (Position and Role)	Christine Redecker (author), Yves Punie (editor). Yves Punie is Deputy Head of Unit in DG JRC Unit Human Capital and Employment, European Commission.	n/a	Duri Long, Brian Magerko (Georgia Institute of Technology)	No person(s) or author(s) bare any responsibility over the compilation of the AI act. The following committees were involved in the reviewing and scrutinising of the proposal (the Committee on Internal Market and Consumer Protection; The Committee on Civil Liberties, Justice and Home Affairs)
Stakeholders who play a role in the frameworks/ policies	Educators Learners Parents Policymakers Educational institution Teacher training providers Curriculum developers Technology providers	Educators (teachers, professors, curriculum designers) Researchers (social scientists, learning scientists) Engineers (AI experts, learning engineers, software developers)	n/a	Operators in the AI value chain[1] Regulatory and governance bodies[2] Conformity assessment bodies Bodies supporting innovation and implementation[3] Stakeholders providing expertise and input[4]

[1] Provider (AI developers); Deployers (AI system builders); Product Managers of AI systems; Authorised Representatives; Importers; and Distributors.

[2] European Commission; European Artificial Intelligebce Board; European Artificial Intelligence Office; National Competet Authorities; European Data Protection Supervisors

[3] European Digital Innovation Hubs; Testing and Experimentation Facilities; AI Regulatory Sandboxes; Union AI Testing Support Structures; AI-on-demand platform

[4] Scientific Panel; Advisory Forum; Standardisation Organisations (e.g., CEN, CENELEC, ETSI)

				Affected persons and society[5] International stakeholders[6]
Target group(s)	Educators	Educators	AI developers Educators	See above - stakeholders

[5] Natural Persons; Vulnerable Groups; Consumers; Small and Medium-sized Enterprises (SMEs), including start-ups; Civil Society Organisations; Academia and Research Organisations; Trade Unions and Social Partners

[6] International Organisations; Public Authorities of Third Countries

4.2 Findings

4.2.1 Key concepts used in the documents to define AI literacy – for students and for teachers

Due to genre and target group differences, all four documents analysed in this report present their key concepts somewhat differently. The DigCompEdu framework, predating widespread usage of AI technologies in education, approaches digital competences in a variety of areas related to educators' professional and pedagogic competences, and learners' competences (Punie & Redecker, 2017). The 4D Competencies Framework proposes four dimensions (such as knowledge, skills, character, and meta-learning) relevant in educational environments, and points to their relevance in the 'AI world' (Center for Curriculum Redesign, 2024). The highly cited scholarly paper by Long & Magerko (2020) defines AI literacy and several 'neighbouring' literacies, particularly to distinguish AI literacy from similar concepts in their exploratory review of interdisciplinary literature. The EU AI Act takes a regulatory perspective, harmonising AI use in the internal market of the EU, and does not specifically lay down recommendations for the educational context in the traditional sense of non-binding advice. The act includes provisions that directly impact the use of AI systems within higher education settings by establishing classifications, requirements, and potential prohibitions (Regulation 2024/1689/56).

Probably the broadest concept present in the documents is **digital literacy** (in Long & Magerko, 2020) or **digital competence** (Punie & Redecker, 2017). Digital literacy is seen as a "prerequisite for AI literacy, as individuals need to understand how to use computers to make sense of AI" (Long & Magerko, 2020, p. 2). Similar connection between digital competence and technologies is mentioned in the Digital Competence Framework for Educators (DigCompEdu) (Punie & Redecker, 2017), defining digital competence as "the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society." (p. 90).

In several definitions in the documents analysed for this report, the focus is on the technologies being used, while some documents also include the skills necessary to make sense of the information being stored and accessed with the help of these technologies – AI literacy stands in the meeting point of these other literacies or competences. Some literacies, such as **computational literacy** or **scientific literacy** are related to AI literacy, but they are not treated as prerequisites for AI literacy, as people do not need to know how to program AI code (as is the case for computational literacy), nor is scientific literacy essential to use AI technologies (Long & Magerko, 2020, p. 2). Some literacies, such as data literacy or information and media literacy may, however, have certain overlapping qualities with AI literacy. As **data literacy** is closely related to the AI subfield of machine learning, certain data literacy competencies, especially "ability to critically assess data and their sources" (Prado & Marzal, 2013 in Long & Magerko, 2020, p. 5) are noticeable in the framework of AI literacy. Similarly, **information and media literacy** related activities that require learners to "articulate information needs; to find information and resources in digital environments; to organise, process, analyse and interpret information; and to compare and critically evaluate the credibility and reliability of information and its sources." (Punie & Redecker, 2017, p. 23) can be embedded in AI literacy frameworks. These activities then become comparable to AI literacy competencies such as data literacy, critical interpretation of data, or ethics, in Long & Magerko (2020). Some information and media

literacy related competencies such as critical thinking or communication can also be found in the 4D Competences Framework (Center for Curriculum Redesign, 2024). However, while most of the aforementioned approaches are predominantly skill-oriented, the 4D Competencies Framework moves beyond, and proposes relevant *characteristics* (curiosity, courage, resilience, and ethics), and *metacognition and –emotion related subcompetencies* that need to be developed in learners to thrive in the 'AI world' (Center for Curriculum Redesign, 2024).

In the documents we have analysed, **AI literacy** is related to the above-mentioned literacies, being defined as "a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace" (Long & Magerko, 2020, p. 2) - the competencies in the educational context are in detail discussed in Long & Magerko (2020). In comparison, the EU AI Act (Regulation 2024/1689) takes a regulatory perspective and explicitly addresses the concept of AI literacy through Article 4, which places an obligation on providers and deployers of AI systems to ensure sufficient level of AI literacy among their staff. The Act itself is not targeted to students or teachers and places the responsibility for AI literacy on the shoulders of providers and deployers. In Article 3 (56), the Act defines AI literacy as encompassing the skills, knowledge, and understanding necessary to facilitate the informed deployment of AI systems and to gain awareness about the opportunities and risks associated with AI, including potential harm (hence, certain AI systems used in education are classified as 'high-risk AI systems'), as indicated earlier. The two frameworks in our analysis do not mention nor define AI literacy: digital competence as defined in the DigCompEdu (Punie & Redecker, 2017) can potentially involve AI literacy or using AI technologies, and the dimensions in the 4D Competencies Framework are adapted to the 'AI world' in general (Center for Curriculum Redesign, 2024).

4.2.2 Key AI competences (for students and for teachers)

As mentioned in the previous chapter, the genre and intended audience of the group of documents analysed for this report impact presentation of key concepts. Similarly, differences can be noticed in the scope and depth of domains and competencies of analysed documents (see Table 2). While the two frameworks (Punie & Redecker, 2017; Center for Curriculum Redesign, 2024) cover a variety of domains, thus providing multi-faceted approaches to competences related to the usage of digital technologies including AI, the scholarly paper (Long & Magerko, 2020) focuses first and foremost on technical competences, and the EU AI Act barely identifies 'digital skills & competences' (Regulation 2024/1689) that can be also relevant for teachers and learners. Although it is not explicitly stated, the timing of the publication and the importance of DigCompEdu and other Pan-European digital competence frameworks (Punie & Redecker, 2017, p. 7) suggests that the digital skills and competences mentioned in the EU AI Act are, in fact, being scrutinised through the lens of the DigCompEdu framework. Additionally, in a number of articles of the EU AI Act, there are some competences that can also be translated into educational settings.

In total, our analysis revealed seven domains of competences that may contribute to AI literacy in learners and educators.

- **Technical competences** that are needed to use digital tools,
- **Information content related competences** necessary to work with the digital content,
- **Ethics** supporting the responsible use of AI technology,
- **Communication and collaboration** are needed for organisational cooperation between teachers, learners, and other involved parties,
- **Teaching or learning, and assessment** related competencies as core activities in educational institutions. In our selection of documents, this domain is mostly reserved for educators who teach, guide, apply a variety of teaching strategies, and assess the progress of learners.
- **Characteristics or attitudes** to support appropriate mindset for AI usage,
- **Reflecting & development** to make sense of one's own practice as a professional, and to adapt in a rapidly changing 'AI world'.

Table 2. Overview of domains and competences in these documents

Domain	DigCompEdu	4D Competencies Framework	"What is AI literacy?" paper by Long & Magerko, 2020	The EU AI Act
Technical competences	Digital resources • Creating & modifying • Managing, protecting & sharing Facilitating Learners' Digital Competence • Digital problem solving	n/a	What is AI? • Recognizing AI • Understanding intelligence • Interdisciplinarity • General vs narrow • AI's Strengths & weaknesses • Imagine future AI How does AI work? • Representations • Decision-making Machine learning • ML steps • Human role in AI • Learning from data Robotics • Action & Reaction • Sensors Perceptions of AI • Programmability	Digital skills & competences, including awareness of AI risks
Information content related competences	Digital resources • Selecting • Creating & modifying Facilitating Learners'	Skills • Creativity • Critical thinking	Machine learning • Data literacy • Critically interpreting data	Digital skills & competences, including media literacy, and critical thinking

	Digital Competence • Information and media literacy • Digital content creation			
Ethics	Facilitating Learners' Digital Competence • Responsible use	Character • Ethics	How should AI be used? • Ethics	How should AI be regulated for use without risk to the users Societal impact & citizenship
Communication & collaboration	Professional engagement • Organisational communication • Professional collaboration Digital resources • Creating & modifying • Managing, protecting & sharing Empowering learners • Accessibility and inclusion • Differentiation and personalisation • Actively engaging learners Facilitating Learners' Digital Competence • Digital communication & collaboration • Digital content creation	Skills • Communication • Collaboration		Communication flows from tool designers and deployers of AI systems towards users. Transparency of data use and risks

Teaching or learning, and assessment	Teaching & learning • Teaching • Guidance • Collaborative learning • Self-regulated learning Assessment • Assessment strategies • Analysing evidence • Feedback and planning	Knowledge	In education, all users of AI systems need to be taught AI literacy
Characteristics or attitudes		Character • Curiosity • Courage • Resilience	Regulatory
Reflecting & development	Professional engagement • Reflective practice • Digital continuous professional development	Meta-learning • Metacognition • Metaemotion	Regulatory

4.2.3 Challenges of AI use for Teaching & Learning addressed in the documents

In order to use AI technologies, first and foremost, citizens must have **equal access**. At regulative level, the EU AI act emphasises the importance of ensuring that AI systems do not lead to discrimination and that they are accessible to all, including persons with disabilities. To highlight a few examples from the EU AI Act: Regulation 80; Article 16 (l) ensure that the high-risk AI system complies with accessibility requirements in accordance with Directives (EU) 2016/2102 and (EU) 2019/882. Article 95 (2) e) assessing and preventing the negative impact of AI systems on vulnerable persons or groups of vulnerable persons, including as regards accessibility for persons with a disability, as well as on gender equality (Regulation 2024/1689). In the educational context, providing "equal access to the digital technologies used for all students" (Punie & Redecker, 2017, p. 71) is an educators' responsibility to empower students. Educators at all progression levels need to keep in mind accessibility (Punie & Redecker, 2017, p. 71), being at least knowledgeable or concerned, or at best, innovating strategies for accessibility and inclusion. Providing access to AI technologies is not only about students' gender (Long & Magerko, 2020, p. 10), or social or economic condition (as some cannot afford access to best paid technologies), but also about physical or mental constraints, or learning disorders that some learners may have (Punie & Redecker, 2017, p. 71).

Public understanding of AI technologies is often **limited** (Long & Magerko, 2020, p. 1). Opaqueness of algorithms on common platforms, so users do not often recognize they are interacting with AI (Long & Magerko, 2020, p. 1). At the same time, depending on their background, scholars also can provide contrasting definitions to intelligence, and hence, to artificial intelligence (Long & Magerko, 2020, p. 3). Therefore, for learners it is not only important to understand what AI is, but also, that it *is* interdisciplinary, and its capabilities in different domains vary (Long & Magerko, 2020, p. 4). Thus, it becomes important to understand **for what tasks AI applications are particularly good**, and furthermore, **for what purposes these applications *could* be used for in the future** (Long & Magerko, 2020, p. 4). The limited understanding of AI technologies is also addressed in the EU AI Act which emphasizes the importance of AI literacy for all stakeholders, including providers, deployers, and affected persons (which in our context would also mean teachers and students), to enable informed decision-making regarding AI systems (Regulation 2024/1689). This suggests an implicit recognition that as AI becomes more prevalent, including potentially in educational settings, it is crucial for everyone to understand its benefits, risks, safeguards, rights, and obligations.

Understandings of how AI works can be vague (even for IT professionals), especially understanding how computers make decisions: this "can aid in interpreting and understanding algorithms" (Long & Magerko, 2020, p. 5) - so 'explainable AI' could be used "to aid novices in understanding how AI works" (Long & Magerko, 2020, p. 5). Research shows that "students assume that computers think like humans and want to make connections between human theories of cognition and machine learning [ML]" (Sulmont et al., 2019, in Long & Magerko, 2020, p. 5). Students can also be "often surprised that ML requires human decision-making and is not entirely automated" (Long & Magerko, 2020, p. 5), and they often have "difficulty identifying the limits of ML and identifying constraints that may make ML unsuitable for solving a particular problem" (Long & Magerko, 2020, p. 5).

In their article, Long & Magerko (2020, pp. 6-7) mention several **ethical issues** related to AI usage that can also affect student papers. Concerns about **privacy** (related to the personal data that is collected, stored, and analysed in AI systems), **misinformation** (in the context of retrieving useful materials for student paper), **algorithmic bias**, and **transparency** could be particularly important when discussing AI use in teaching and learning. The EU AI Act addresses these concerns even in more detailed way to protect fundamental rights of the citizens. In terms of education, two regulatory factors have a direct influence on the organisation of teaching and learning: 1) risk assessment of AI and 2) AI literacy.

1. Risk assessment of AI – where the deployment of AI systems into the educational system has to be identified in terms of the risk they pose on users – with **AI systems intended to be used for the following purposes as "high-risk"**:
    a. for determining access or admission of natural persons to educational and vocational training institutions and programmes;
    b. for assigning natural persons to specific educational and vocational training institutions or programmes;
    c. for evaluating learning outcomes of natural persons;
    d. for assessing the appropriate level of education that an individual will receive or will be able to access, in the context of or within educational and vocational training institutions at all levels;

    e. for monitoring and detecting prohibited behaviour of students during tests in the context of or within educational and vocational training institutions at all levels" (Regulation 2024/1689/Annex III, C)
2. AI-Literacy – where the AI Act addresses the broader need for "AI literacy." Article 4 mandates that "Providers and deployers of AI systems shall take measures to ensure, to their best extent, a sufficient level of AI literacy of their staff and other persons dealing with the operation and use of AI systems on their behalf" (Regulation, 2024/1689/Article 4).

This suggests an implicit recognition that as AI becomes more prevalent, including potentially in educational settings, it is crucial for everyone to understand its benefits, risks, safeguards, rights, and obligations.

Interpreting AI systems can be problematic. "Humans understand the actions of other agents using theory of mind", yet "due to the differences between AI and human reasoning, theory of mind is not always a reliable way of making sense of AI" (Riedl, 2019, in Long & Magerko, 2020, p. 7). Thus, Long & Magerko (2020) warn against misconceptions that can arise when "interpreting interactions with intelligent systems" (p. 7). Authors mention the Eliza effect, Tale-Spin effect, and SimCity effect which "can arise in the relationship between the surface appearance of a digital system and its internal operations" (Wardrip-Fruin, 2007, in Long & Magerko, 2020, p. 7). According to the analysis by Long & Magerko (2020), we should not underestimate the impact of popular media (including news media, TV, movies, sci-fi, etc) on perceptions of AI, as these can also affect how students perceive AI applications. Previous studies have indicated that students may find computer science, including AI, to be "particularly demanding" and perceive computers as "mechanical" or "cold" (Papastergiou, 2008, in Long & Magerko, 2020, p. 10). Their **knowledge of AI**, including machine learning, **can be based on "popular, often sensationalized, media"** (Long & Magerko, 2020, p. 10). They may believe that "implementing machine learning is not accessible without having a background in computer science or mathematics" (Long & Magerko, 2020, p. 10).

Last but not least, **AI use itself challenges previous understandings of learning and teaching**, so instead of asking "What students should learn?" it is essential to focus on "Why students should learn?" (Center for Curriculum Redesign, 2024). For that, cross-dimensional drivers were developed by the Center for Curriculum Redesign: motivation, identity, agency, and purpose.

4.2.4 Recommendations for using AI in the context of teaching and learning

All four documents provide recommendations or 'design considerations' for using AI in the context of teaching and learning to varying degrees. These recommendations are either focused on AI literacy and explaining how AI works, and how to use it efficiently, or providing advice in the teaching and learning context in general.

As perceptions of AI can be misled and understandings of how AI works often remain vague, Long & Magerko (2020) propose **explainability, promoting transparency and gradual unveiling** as design considerations in AI education. Better explanations about AI include "graphical visualizations, simulations, explanations of agent decision-making processes, or interactive

demonstrations to aid in learners' understanding of AI" (Long & Magerko, 2020, p. 5). They recommend "promot[ing] transparency in all aspects of AI design (i.e. eliminating black-boxed functionality, sharing creator intentions and funding/data sources, etc.). This may involve improving documentation, incorporating explainable AI, contextualizing data, and incorporating design features such as interpretative affordances or the Sim-City Effect." (Long & Magerko, 2020, p. 8). "To prevent cognitive overload, consider giving users the option to inspect and learn about different system components; explaining only a few components at once; or introducing scaffolding that fades as the user learns more about the system's operations." (Long & Magerko, 2020, p. 8). Ensuring transparency and explainability is implied in the EU AI Act: educators should seek solutions that provide clear explanations of how AI tools operate and the reasoning behind the outputs to foster trust and understanding among students and staff.

To support understanding of machine learning, Long & Magerko (2020) suggest embodied interactions and contextualizing data. Firstly, the **embodied interactions** involve "interventions in which individuals can put themselves "in the agent's shoes" as a way of making sense of the agent's reasoning process. This may involve embodied simulations of algorithms and/or hands-on physical experimentation with AI technology." (p. 6). Active engagement of learners is also recommended in DigCompEdu, by involving "learners themselves in hands-on activities, scientific investigation or complex problem solving, or in other ways increase learners' active involvement in complex subject matters" (Punie & Redecker, 2017, p. 22). Secondly, to **support contextualizing data**, learners could be encouraged "to investigate who created the dataset, how the data was collected, and what the limitations of the dataset are. This may involve choosing datasets that are relevant to learners' lives, are low-dimensional, and are "messy" (i.e. not cleaned or neatly categorizable)." (p. 6). Also, "recognizing when personal data is being used to train ML and interpreting the results of algorithms in the context of the data they were trained on are two particularly relevant data literacy issues for AI." (Long & Magerko, 2020, p. 5) A similar critical approach to resources is also present in DigCompEdu, as in the frames of information and media literacy, learners are encouraged to "analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content" (Punie & Redecker, 2017, p. 78).

There are some design considerations (Long & Magerko, 2020) that are more child-oriented (like considering developmental milestones or supporting parents), but most of their design considerations, keeping in mind the educational context, are also applicable to university students. These recommendations include:

- "providing **ways for individuals to program** and/or teach AI agents. Keep coding skill prerequisites to a minimum by focusing on visual/auditory elements and/or incorporating strategies like Parsons problems and fill-in-the-blank code" (Long & Magerko, 2020, p. 9);
- "encouraging "learners—and especially young learners—to be **critical consumers** of AI technologies by questioning their intelligence and trustworthiness"" (Long & Magerko, 2020, p. 9);
- considering "how learners' **identities, values, and backgrounds** affect their interest in and preconceptions of AI. Learning interventions that incorporate personal identity or cultural values may encourage learner interest and motivation" (Long & Magerko, 2020).

In a similar vein, but in the context of learning in general, the 4D Competency Framework warns that "traditional "one-size-fits-all" instructional methods insufficiently address the various backgrounds, abilities, and learning strategies of all students, and fail to engage all students equally, often leading to underachievement" (Center for Curriculum Redesign, 2024). Thus, personalisation is the key to lead students to deeper learning;

- "designing AI learning experiences that foster **social interaction and collaboration**" (Long & Magerko, 2020). This recommendation corresponds to DigCompEdu which encourages educators to implement a variety of collaborative learning activities with digital technologies (Punie & Redecker, 2017, p. 56);
- "**leveraging learners' interests** (e.g. current issues, everyday experiences, or common pastimes like games or music) when designing AI literacy interventions." (Long & Magerko, 2020).

Considering the impact of popular media to perceptions of AI and its usage, the educators need to **acknowledge (politicized or sensationalized) preconceptions of AI**, and consider "how to address, use, and expand on these ideas in learning interventions" (Long & Magerko, 2020, p. 10). It is also useful to introduce **new perspectives about AI**, ones "that are not as well-represented in popular media (e.g. less-publicized AI subfields, balanced discussion of the dangers/benefits of AI)." (Long & Magerko, 2020, p. 10)

As students may perceive topics of AI or ML too complicated, and believe they need a background in computer science or mathematics, Long & Magerko (2020) suggest "**lowering barriers** to entry in AI education" (p. 10).

As indicated previously in the chapter about challenges of AI use in teaching and learning, the widespread use of AI technologies in education not only sets demands for AI literacy, but it also **transforms fundamental aspects or processes in teaching and learning**. Firstly, the question "Why students should learn?" is echoed by the EU AI Act which recommends prioritising pedagogy over technology. Hence, educators and educational institutions should first consider their teaching objectives and then explore how AI can help achieve them effectively. Secondly, maintaining human oversight is still needed as teachers should retain control over critical education decisions, such as assessment and feedback, and use AI as a supportive tool rather than a replacement for human judgement. Thirdly, keeping in mind the privacy issues in AI technologies, data protection standards are more relevant than ever before. Educational institutions should prioritise the anonymisation and secure handling of student data when using AI tools, ensuring compliance with privacy regulations and consent. Finally, as rapid developments in AI technologies are not always easy to follow, investments into AI literacy are needed. Therefore, educational institutions should provide recommendations for ongoing professional development to equip teachers with the skills and knowledge to understand, evaluate, and effectively use AI tools in their teaching practices.

The 2024 update of the Center for Curriculum Redesign's (CCR) **4D Competency Framework** offers a forward-looking response to the challenges and opportunities posed by artificial intelligence (AI) in education. The framework emphasizes the cultivation of uniquely human traits—such as imagination, ethical judgment, and adaptability—that remain vital in an AI-mediated world. Key updates include the introduction of four cross-dimensional drivers (Motivation, Identity, Agency, and Purpose), the restructuring of the Meta-Learning dimension,

and a shift in emphasis within core competencies to support learner autonomy and ethical AI engagement. These changes provide a comprehensive model for integrating AI readiness into contemporary teaching and learning practices.

4.2.5 Examples of the use of AI in the teaching and learning

Due to genre peculiarities of the four documents analysed for this report, we cannot provide many examples of the use of AI in teaching and learning contexts. As mentioned earlier, DigCompEdu framework predates the widespread use of AI technologies, and does not provide any AI related examples. The 4D Competencies Framework mostly lists competencies. Beyond the regulatory nature of the EU AI Act, the Act also does not provide any specific examples of the use of AI for teaching and learning. Most examples could be found in Long & Magerko (2020) as part of the literature review process.

In Long & Magerko (2020, pp. 5-6), there are several examples of tactics proposed to promote critical engagement with data and ML:

- "Hautea et al.(2017) suggest having young learners creatively engage with data that is collected about them online.
- D'Ignazio (2017) and Sulmont et al. (2019) encourage educators to carefully select the datasets they use in class, favoring datasets that are low-dimensional when initially introducing concepts (Sulmont et al., 2019); datasets that are "messy" (i.e. not cleaned and neatly categorizable) when demonstrating issues of bias (D'Ignazio, 2017); and incorporating personally relevant datasets that learners can easily relate to and understand (D'Ignazio, 2017).
- Finally, D'Ignazio (2017) suggests writing "data biographies" (i.e. contextual explanations of datasets and their origins) as a way of helping learners better understand the limitations and origins of data."

Some examples can also be found to foster ethical use of AI technologies:

- "The current ACM guidelines for undergraduate CS curricula include an ethics course in which students learn about ethical theories and apply them to evaluate technology, focusing on many of the issues described above. Such skills can help both computing professionals and everyday users to identify when it is appropriate to use AI." (Long & Magerko, 2020, p. 7) This particular example is well in line with the EU AI Act which focuses not only on the end users of AI technology but also on developers and deployers.
- "AI ethics education initiatives use a variety of interdisciplinary strategies to communicate key ethical concepts, including creating "ethical matrices" to consider values of different stakeholders in technology, imagining future AI and its implications, reflecting on AI representations in popular media and the news, discussing and debating key ethical questions, and engaging in programming activities that spur learners to critically examine algorithms and bias. In informal spaces, artists and researchers have created interactive art experiences that spur participants to question the implications of technologies like facial recognition." (Long & Magerko, 2020, p. 7) These examples

indicate the diversity of problems related to AI use, and the need for finding creative ways to introduce and discuss these issues with learners.

4.2.6 Values, ethical principles, and security framework

According to the four analysed documents, AI use is related to several ethical issues. While the two frameworks and a scholarly paper deal with ethics as part of AI literacy, the EU AI Act *is* explicitly aimed at ensuring that AI systems respect the fundamental rights, safety and ethical principles. Due to prominent role of the EU AI Act in safeguarding citizens' rights and determining rules for AI systems' deployment, we will firstly introduce the role of the EU AI Act, and after that, discuss the ethical issues what other documents warn us against.

The EU AI Act aims to promote the uptake of human-centric and trustworthy AI. It seeks to balance innovation with ethical considerations and safety. The Act prohibits AI systems that are considered to contradict Union values, the rule of law, and fundamental laws. The core design principles emphasize pedagogy before technology, transparency, human oversight, the right to object, and data protection. The Act aims to ensure AI systems used in the EU are safe, transparent, traceable, non-discriminatory, and environmentally friendly, and it emphasizes the importance of fairness and reducing biases in AI systems.

For developers and deployment, the Act requires high-risk AI systems to ensure a high level of robustness, cybersecurity, and accuracy. Providers of high-risk AI systems must have a quality management system in place, which includes procedures and techniques for the design, development, quality control, and quality assurance of the AI system, as well as data management systems and procedures. The Act mandates logging of activity to ensure the traceability of results for high-risk AI systems. Providers of high-risk AI systems are obligated to take appropriate measures to detect, prevent, and mitigate possible biases. The Act emphasizes the need for data security and privacy, especially concerning student data in educational applications.

According to the rest of the documents analysed for this report, the ethical issues related to AI use can come in many shapes and forms:

- **Privacy/surveillance** is one of the key issues related to AI use in education. **"**The amount of personal data that is collected, stored, and analyzed in order for many AI systems to function has raised concerns about user privacy, government surveillance, and data security" (Long & Magerko, 2020, p. 6). Similarly, DigCompEdu stresses understanding "safety and security measures" (Punie & Redecker, 2017, p. 84) and protection of "personal data and privacy in digital environments" (Punie & Redecker, 2017, p. 84).
- **Ethical decision making** is strongly related to severe consequences that AI technologies can have on people's (learners) lives, hence the classification of some AI technologies in education as high-risk systems in the EU AI Act. "Most computing ethics syllabi and textbooks emphasize that embedding ethical decision making strategies in technical systems is a challenging problem. Giving decision-making power to AI can result in ethical dilemmas such as the trolley problem or unexpected results due to AI

executing actions that people tell it to do rather than doing what people intend it to do (e.g. a self-driving car driving at 125 mph because it was told to get to the airport "as fast as possible")." (Long & Magerko, 2020, p. 7) The ethical decision making is closely bound to the **accountability** issue: "A major issue with AI being used to make life-altering decisions in areas such as hiring or recidivism is that there is often no way to report algorithmic errors, receive feedback on why decisions were made, or hold anyone accountable for errors that adversely affect people's lives. The EU's recent GDPR legislation mandates that "data subjects" have the right to challenge decisions made by AI and receive an explanation, but this remains challenging in practice." (Long & Magerko, 2020, p. 7)

- As learners are exposed to the contents created by AI technologies, the issues of bias, transparency, and diversity need to be addressed. "**Algorithmic bias** is often directly related to bias present in training datasets" (Long & Magerko, 2020, p. 7). As "many AI algorithms (especially in ML) are black-box", the developers need to take care of issues of "**transparency** (e.g. developing explainable AI, testing and documenting models, and promoting bias awareness")(Long & Magerko, 2020, p. 7). Also, as the workforce in AI-related jobs is mostly identified as male, "lack of workforce **diversity** can affect who systems are developed for—a significant issue in AI, where biased algorithms can have pronounced adverse effects on marginalized subgroups." (Long & Magerko, 2020, p. 7)
- The quality of content produced by AI technologies can also be problematic. The problem of **misinformation** is one of the issues that predates the widespread use of AI technologies in education. "The spread of misinformation and "fake news" has been exacerbated by AI algorithms on social media and search engines that promote "clickbait" articles and create "filter bubbles"." (Long & Magerko, 2020, pp. 6-7). In the context of digital content creation, DigCompEdu demands from educators to "respect and correctly apply privacy and **copyright rules**." (Punie & Redecker, 2017, p. 20). Educators are also suggested "to teach learners how copyright and licenses apply to digital content, how to reference sources and attribute licenses." (Punie & Redecker, 2017, p. 23). However, some AI technologies that are used to create 'new' content, are notorious for violating copyright rules.
- Some ethical issues need to be addressed to better face the possible future – students as future workforce need skills to protect themselves. For example, "advancements in AI have heightened **concerns about technology replacing the human workforce**" (Long & Magerko, 2020, p. 6) In addition, the singularity or "the time when machine intelligence surpasses human intelligence" can raise concerns "about AI intentionally causing harm to people" (Long & Magerko, 2020, p. 7).

4.2.7 Future trends in AI and education

Most of the documents analysed in this report do not refer to any future trends regarding AI and education. As can be seen in 4D Competencies Framework, the document itself can be designed to anticipate future trends, by providing revised versions of it. Also, some frameworks anticipate future trends by treating current learners as future workforce. Even so, frameworks still focus on the present.

However, because of the rapid developments in AI technologies and its use in education, most of the topics discussed in this report can be considered as future trends (in hope they are not already obsolete by the time of publishing of this report). The challenges change over time: some problems may be regulated by acts, some issues solved with continuous research, and related to the developments in AI technologies, there can be challenges we cannot even yet anticipate. The recommendations and examples (especially the ones collected in Long & Magerko (2020)) are carefully collected from scholarly literature and often consist of exploratory ideas that still need to stand the test of time. The ethical issues, when raised, are usually articulated as 'work in progress' as there are no final solutions yet to the issues of transparency, bias, etc – what can be done at best, is to create a regulatory framework to cover some near-future ethical issues, as was done in the EU AI Act.

The regulatory nature of the EU AI Act provides a framework which ensures a sustained future supporting enhanced learning experiences. The Act aims to foster the development and deployment of high-quality AI systems in education, which is expected to lead to enhanced learning experiences and better academic outcomes for students (Werner, 2024). To bring but a few examples of future trends in AI and education, the market of learning and educational see the potential that AI will be able to analyse students' learning patterns and provide customized content and recommendations, addressing individual needs and learning styles with adaptive learning platforms being able to adjust the difficulty level of tasks based on student performance in real-time (Werner, 2024). According to Werner (2024), AI can also predict student performance and identify those at risk of falling behind, allowing for early interventions. These potentials correspond well to the recommendation about personalisation (Center for the Curriculum Redesign, 2024). In addition, AI-powered tutors may provide one-on-one instruction, answering questions and offering explanations, supplementing classroom instruction (Werner, 2024). In administration, AI can streamline tasks such as grading, scheduling, and resource allocation, reducing the burden on educators. AI can facilitate continuous learning and skills development through personalized training programs, which is important in rapidly changing job markets (Werner, 2024) - a threat mentioned previously in Long & Magerko (2020). However, to safeguard the users of such futures and to make sure these AI systems are safe and reliable, the EU AI Act will only contribute to improve the teaching practices through regulatory practice leading to better management of educational resources within institutions.

4.3 Discussion

As this report covers four documents of various genre and target audiences, the four documents inevitably place their foci on different aspects of the umbrella term 'AI literacy' - some providing extensive overview of technical skills (like Long & Magerko (2020) or Punie & Redecker (2017)) while some focusing on communication & collaboration, or teaching or assessment skills (Punie & Redecker, 2017). Despite differences, we could see that all four documents have addressed critical evaluation skills to work with the information content provided by AI technologies, and ethical aspects to ensure safe and reliable use of AI. Despite the dissimilarities in documents, we can propose a holistic approach to AI literacy, covering seven domains of competencies as suggested in chapter 4.2.2.

The analysis of AI literacy documents also reveals both alignment and tension between current educational aims and the complex realities of AI use. For example, DigCompEdu appropriately emphasizes the importance of respecting privacy and copyright. However, these principles become more complicated when applied to AI technologies—particularly AI chatbots—where underlying mechanisms for data storage and processing are often opaque. As Panwar (2025) notes, users frequently lack clarity about what happens to the information they input, raising significant privacy and intellectual property concerns. This gap highlights the need to go beyond normative guidelines and equip educators and learners with the critical thinking skills required to navigate such uncertainties.

Furthermore, while many technical skills related to AI use can be taught through relatively straightforward instruction, the ethical dimensions of AI literacy are more elusive. Students, especially those with limited life experience, may struggle to identify nuanced issues such as algorithmic bias, data gaps, or misinformation. It is therefore crucial to foreground content evaluation in AI literacy education—encouraging learners not only to assess the information they see but also to question what might be omitted or distorted.

To support lessons in AI literacy, hands-on approaches should be prioritised, allowing learners to work with real, and sometimes messy, data that connects to their own lives or interests. Publicly available datasets—such as those found on Kaggle (e.g., education-related data), Google Dataset Search, UCI Machine Learning Repository, or World Bank Open Data—offer valuable resources for these activities – especially when keeping in mind the need to safeguard the privacy of learners. Such experiential learning can foster deeper understanding of both the technical and ethical dimensions of AI, bridging the gap between abstract frameworks and practical engagement.

Finally, the four documents analysed in this report provide us with a balanced approach to AI literacy. When using AI technologies, the aphorism that “not all that glitters is gold” is a useful reminder of its limitations, particularly when considering the lengthy list of challenges and ethical issues related to AI usage (including in teaching and learning). At the same time, AI technologies provide us also with a range of new possibilities that allow us to treat the challenges as valuable means to update our approaches to teaching and learning.

5. Conclusions and recommendations

Our analysis of the four documents (DigCompEdu, 4D Competencies Framework, Long & Magerko's paper "What is AI Literacy?" (2020), and the EU AI Act), reveals comprehensive insights for developing AI Literacy frameworks for higher education:

Core competences to include:

1. **Technical understanding of AI**
    a. Recognition and understanding of AI systems and their capabilities
    b. Knowledge of how different AI technologies function (machine learning, neural networks, etc.)
    c. Ability to identify AI strengths and limitations in educational contexts
    d. Practical skills for interacting with AI tools in learning environments
2. **Critical evaluation skills**
    a. Data literacy for analysing and interpreting AI-processed information
    b. Ability to assess the reliability and validity of AI-generated outputs
    c. Skills to identify potential biases in AI systems and their outputs
    d. Capability to distinguish between human and AI-generated content
3. **Ethical awareness and responsibility**
    a. Understanding of privacy implications when using AI systems
    b. Knowledge of copyright and intellectual property considerations
    c. Awareness of potential biases and fairness issues in AI systems
    d. Responsible approach to AI deployment in teaching and learning
4. **Pedagogical integration**
    a. Skills to design effective learning activities incorporating AI
    b. Ability to determine when AI use is appropriate versus inappropriate in educational contexts
    c. Competence in explaining AI concepts and implications to students
    d. Approaches for redesigning assessments in response to AI capabilities
5. **Metacognitive and adaptability skills**
    a. Self-reflection on one's AI usage patterns and effectiveness
    b. Continuous learning mindset to keep pace with AI developments
    c. Resilience and flexibility when facing AI-related challenges
    d. Capacity to evaluate one's own AI literacy development

What's missing in existing frameworks:

1. **Contextual application in higher education**
    a. Most frameworks are either too general or not specifically targeted to higher education settings
    b. Limited guidance on discipline-specific AI applications and challenges
    c. Insufficient attention to academic integrity issues specific to higher education

2. **Collaborative AI competences**
    a. Frameworks emphasize individual AI literacy but need more focus on collaborative interactions with AI
    b. Insufficient guidance on AI-mediated peer interactions among students
3. **AI-specific communication skills**
    a. Need for more emphasis on how to communicate about AI use with transparency
    b. Limited guidance on effective prompting techniques as a specific skill set
    c. Insufficient attention to explaining AI-related decisions to students and colleagues
4. **Assessment redesign competences**
    a. More guidance needed on creating "AI-proof" or "AI-enhanced" assessments
    b. Limited frameworks for evaluating students' own AI literacy levels
    c. Insufficient attention to authentic assessment in an AI-rich environment

Particularly useful elements from analysed documents:

1. **From Long & Magerko (2020)**: The detailed breakdown of AI literacy competencies and the emphasis on hands-on, contextual learning with "messy" data provides practical guidance for implementation.
2. **From DigCompEdu**: The progression levels for competence development (from awareness to innovation) offer a clear pathway for educators' professional growth.
3. **From 4D Competencies Framework**: The emphasis on character qualities and metacognitive skills acknowledges that AI literacy goes beyond technical skills to include mindsets and dispositions.
4. **From EU AI Act**: The risk-based approach and emphasis on transparency, human oversight, and data protection provide important regulatory context for educational AI use.

Recommendations for framework development:

1. **Adopt a holistic approach** that integrates technical, ethical, pedagogical, and metacognitive dimensions rather than treating them as separate competences.
2. **Incorporate progression pathways** that acknowledge different starting points and development trajectories for educators and students.
3. **Include concrete examples and case studies** of effective AI integration in various disciplines to make the framework actionable.
4. **Emphasize critical thinking** throughout all competence areas, not just as a standalone skill.
5. **Balance innovation with ethics** by ensuring that creative applications of AI are always considered alongside ethical implications.
6. **Design for flexibility and future-proofing** so the framework can adapt to rapidly evolving AI capabilities and applications.
7. **Incorporate collaborative development processes** that involve students as stakeholders in designing learning experiences with AI.

8. **Build assessment methods** into the framework that allow educators and institutions to evaluate their progress in developing AI literacy.

The ideal AI literacy framework should empower educators and students not only to use AI tools effectively but to develop a critical, ethical, and forward-looking approach to technology that enhances rather than diminishes human agency in education.

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