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Work Package 2

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

National Report by Tilburg University

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Executive Summary

This report examines how Dutch universities, particularly Tilburg University, are addressing artificial intelligence (AI) within higher education. The analysis covers national strategies, institutional policies, and practical measures implemented between 2023 and 2025, with special attention to evolving AI competence frameworks.

Dutch universities benefit from significant autonomy in shaping their educational and technological strategies. However, their efforts are aligned with broader national and European objectives. Key national policies include the Strategic Action Plan for AI (2019), which sets a foundation for responsible, human-centric AI development, and the Vision on Generative AI (2024), which outlines the Dutch government's approach to ethical, transparent, and inclusive AI use. Additionally, the GDPR (AVG in the Netherlands) provides a binding legal framework for data protection in AI applications, while forthcoming EU AI Act regulations, expected to be fully enforced by 2026, are already shaping institutional preparations.

Several national initiatives support these policy goals. The GPT-NL project promotes digital sovereignty through an open-source Dutch language model, while the Npuls program advances AI and data literacy across educational institutions. Npuls encompasses projects such as the Algorithm Register, the Privacy and Ethics Reference Framework 2.0, and the EduGenAI platform—all designed to ensure transparency, ethical governance, and sector-wide implementation support for generative AI technologies in education.

Tilburg University has developed a coordinated approach to generative AI, involving collaborative policymaking, updated institutional regulations, and comprehensive training initiatives. Updates to Education and Examination Regulations (EER) explicitly define the unauthorized use of generative AI tools as academic misconduct unless explicitly permitted. Further guidance has been issued through documents by the Chief Information Security Officer (CISO), emphasizing privacy, GDPR compliance, and risk awareness when using tools such as ChatGPT or Copilot. In parallel, practical resources like tutorials, e-learning modules, and workshops have been deployed to build awareness and competence among students and staff.

This report also reviews and compares four key AI literacy frameworks:

- The UNESCO AI Competency Framework for Teachers (2024), outlines pedagogical, ethical, technical, and assessment-related competencies.
- The UNESCO AI Competency Framework for Students (2024), focuses on foundational understanding, critical thinking, ethical awareness, and responsible digital citizenship.
- The Faruqe et al. framework (2022), presents a five-dimensional model incorporating technical, critical, societal, relational, and adaptive literacies.
- The Velander et al. framework (2024), emphasizes interdisciplinary learning, system-level understanding, and long-term adaptability.

By examining these frameworks, the report highlights key overlaps and gaps. While the UNESCO frameworks offer structured guidance for educators and students, the academic models provide a broader, interdisciplinary perspective that includes sociotechnical systems thinking

and collaborative skills. Integrating insights from all frameworks could enhance AI literacy efforts by ensuring they are both pedagogically sound and societally aware.

Recommendations include:

- Embedding AI competencies into curricula, balancing technical skills with ethical reasoning and critical thinking.
- Aligning institutional policies with national and EU-level regulations to uphold transparency and academic integrity.
- Supporting continuous professional development for staff and students through modular learning pathways and communities of practice.
- Regularly reviewing educational strategies and frameworks to remain responsive to fast-changing AI developments.

The findings underscore the necessity of a holistic, forward-looking approach to AI literacy in higher education that prepares institutions, educators, and learners to engage critically and responsibly with emerging technologies.

Tilburg University

1. Introduction

In the Netherlands, universities enjoy substantial institutional autonomy, allowing them to independently develop AI strategies aligned with national and European guidelines. Relevant national initiatives include the **Strategic Action Plan for AI (2019)** and the Dutch government's recent **Vision on Generative AI (2024)**, emphasizing human-centric, ethical, and transparent AI. Additionally, collaborative projects such as **Npuls** and the **GPT-NL** initiative aim to promote digital literacy, ethical practices, transparency, and digital sovereignty.

This report outlines the main national policies, guidelines, and frameworks that shape the use of AI in Dutch higher education. It also includes a detailed overview of how Tilburg University (TiU) has addressed the use of generative AI in education between 2023 and 2025. This includes the development of internal guidelines, formal policies, and support initiatives.

Furthermore, this report includes a comparative analysis of three prominent AI literacy frameworks, identifying their core competencies, ethical principles, practical applications, and the challenges each address:

- **UNESCO AI Literacy Framework for Teachers (2024)**
    - Technical, pedagogical, ethical, and assessment competencies.
    - Teachers' roles in ethically integrating AI within educational settings.
- **UNESCO AI Literacy Framework for Students (2024)**
    - Foundational understanding, critical evaluation, ethical awareness, and practical use of AI.
    - Development of students as informed and responsible digital citizens.
- **General AI Literacy Frameworks (Faruqe et al., 2022; Velander et al., 2024)**
    - **An interdisciplinary** approach emphasizing technical, critical, societal, relational, and adaptive dimensions.
    - Comprehensive perspective on lifelong learning, societal impact, and responsible AI use.

By comparing these frameworks, the report identifies opportunities for integrating competencies and ethical considerations to enhance AI literacy education. Ultimately, recommendations provided aim to support higher education institutions in cultivating an adaptive, robust, and ethically grounded approach to AI literacy, effectively preparing educators and students.

2. *TiU National policy and practice regarding AI in Higher Education in the Netherlands*

This section provides a comprehensive overview, drawing from key policy documents, existing national frameworks, and institutional practices, as well as available data, as of March 19, 2025.

National Policy and Strategy

There are no specific national regulations for AI in higher education in the Netherlands. Instead, universities develop their own guidelines, reflecting institutional autonomy and aligning with the national framework. The Dutch government's Strategic Action Plan for AI (2019) sets the overarching national direction, aiming to position the Netherlands as a leader in responsible, human-centric AI. In early 2024, the Dutch government published a vision document on generative AI.

The development of educational guidelines and policy in the Netherlands involves multiple stakeholders across different sectors. Key participants include the Ministry of Education, Culture and Science, university boards, UNL (Association of Universities in the Netherlands), the Netherlands AI Coalition (NL AIC), and SURF (the collaborative organization for IT in Dutch education and research).

National Activities

While primarily focused on primary and secondary education, the existence of the National Education Lab AI (NOLAI) indicates a broader governmental recognition of the importance of AI in education at all levels. NOLAI's mission is to promote the safe and responsible integration of AI technology within Dutch primary and secondary education.

Additionally, the GPT-NL project aims at the development of a national open-source generative AI language model, fostering digital sovereignty and innovation. Led by non-profit organizations (TNO, NFI, SURF), this initiative encourages experimentation across academia, government, and industry.

Further amplifying this strategy is the Nplus program, a nationwide National Growth Fund program by and for all public vocational and education training schools, universities of applied sciences, and research universities in the Netherlands. The program houses several projects and working groups:

- Algorithm Register: Addressing demands for transparency, Nplus is investigating the implementation of a comprehensive register to document and ethically manage algorithm use within educational institutions, enhancing accountability and trust.
- Privacy and Ethics Reference Framework for AI 2.0: This expanded framework is developed collaboratively with stakeholders to provide sector-wide ethical and privacy guidelines, ensuring AI tools are responsibly integrated into educational practices.
- AI and Data Literacy Initiative: Nplus promotes AI and data literacy through systematic research and practical interventions. The project includes an umbrella review of literature to establish a unified framework of AI literacy and the collection of over 125 practical examples from Dutch educational institutions, primarily focusing on generative AI.
- Vision on AI: A comprehensive vision document is being developed through broad stakeholder engagement, addressing AI's role in equity, curriculum relevance, assessment, and sustainability. This initiative provides clear, actionable guidelines for educational institutions.

- EduGenAI Platform: An innovative, vendor-independent platform supporting safe use of various large language models (LLMs) in education. Through iterative feedback from vocational and higher education sectors, this platform aims to enhance educational quality and ethical AI deployment.

Legislation and Regulatory Framework

AI in Dutch higher education is currently governed under general laws like AVG (the localized version of GDPR), with specific regulatory guidance anticipated with the forthcoming EU AI Act. Following the adoption of the EU AI Act in early 2024, Dutch higher education institutions have begun preparing for compliance, which will be fully required by 2026.

Comparison to EU and Global Strategies

The Dutch policy aligns closely with broader European strategies, emphasizing responsible, transparent, and human-centric AI. While adhering to EU guidelines such as the Digital Education Action Plan and forthcoming EU AI Act, the Netherlands put in place collaborative structures (e.g., NL AIC, Npuls) and substantial investments in pilot projects and research labs. Compared globally, the Dutch emphasis on ethical AI use, digital sovereignty, and data literacy stands in contrast to less regulated approaches elsewhere.

University-Specific Approaches

Dutch universities have developed their own approaches to AI in teaching and learning. Generally, institutions began with guidelines on the use of AI in education and are maturing towards policy. For example,

- **University of Amsterdam (UvA)** has an AI policy focusing on education, regularly reviewed to address rapid developments (UvA AI Policy). It supports lecturers in integrating AI into teaching, assessing its impact on exit qualifications, and preparing students for an AI-driven future. UvA, in collaboration with VU Amsterdam, established an AI task force to advise on educational use, highlighting concerns like plagiarism and privacy.
- **Maastricht University** has a policy framework for generative artificial intelligence (GenAI), providing guidelines for responsible use in education, research, and business (Maastricht University AI & Education). It emphasizes ethical integration into problem-based learning (PBL) curricula, offering training programs and an AI Prompt Library launched in October 2024.

3. Policy and practice at Tilburg University: case study

In this section, you will find Tilburg University's policies and guidelines for the responsible and ethical use of Generative Artificial Intelligence (GenAI). This is divided into General Principles at Tilburg University and includes guidelines regarding privacy and security established by the Chief Information Security Officer (CISO).

Guidelines for generative AI use

Tilburg University did not immediately impose top-down rules on generative AI in 2023; instead, it developed **guidelines and recommendations** through collaborative processes. Several official guideline documents and policies emerged between 2023 and 2025, each with different target audiences and purposes:

- **Working Group Recommendations (2023):**
  The ChatGPT/GenAI working group's two advisory reports in 2023 effectively served as the first official guidelines. The *first report* (May 2023) was intended mainly for teaching staff and Examination Boards, providing urgent guidance on handling AI in assessments. It was structured around key issues like exam regulations, plagiarism detection, and permissible use of AI in assignments. The *second report* (late 2023) was broader, aimed at faculty, support units, and university management for longer-term planning. It outlined 12 recommendations organized by theme (e.g. curriculum design, assessment methods, staff training, tool support) to facilitate "sustainable and effective integration" of generative AI in education.
- **Education and Examination Regulations (EER) Addendum (2023–2024):**
  As generative AI use grew, Tilburg University's formal exam regulations were updated. By the 2023–2024 academic year, the EER for at least some programs explicitly listed unauthorized AI-generated work as a form of fraud. For example, a clause was added stating that *"the use of generative AI tools and LLMs, such as ChatGPT, to generate materials for examinations without explicit permission by the examiner"* is prohibited. This rule, intended for students, makes clear that unless a lecturer permits AI assistance, any content produced by AI and submitted as a student's own work is an academic integrity violation. In practice, this codified what the earlier guidelines preached: each examiner decides if AI is allowed, and misuse is punishable. The exam committees across faculties advocated for such clearer rules, given the rising number of fraud cases involving ChatGPT since the pandemic year. Thus, by late 2023 Tilburg had moved to embed generative AI guidelines into its official policy framework (the EER), making expectations explicit for students university-wide.
- **Privacy & Security Guidelines (CISO Office, 2025):**
  In 2025, Tilburg University published a detailed advisory on *"Working responsibly with Generative AI: how to ensure privacy and security".* Developed by the Chief Information Security Officer (CISO) Office, this guideline is intended for **all staff, faculty, and students** who use generative AI for university work. It is structured as a set of principles and best practices to mitigate privacy, security, and ethical risks when using tools like ChatGPT, Copilot, DALL-E, etc. Key points include:

    - Do not input confidential or personal data into external AI tools (since data may be stored or reused)
    - Adhere to GDPR and Tilburg's data protection policies, noting that many GenAI services store data outside the EU.
    - Avoid using AI for any illegal or policy-violating activities.
    - And always critically verify AI-generated output, as it may contain errors or biases
- **Library and Academic Integrity Guidance:**
  The library provided practical guidance on citing AI and using it ethically. For instance, Tilburg's APA citation guide echoes the APA's recommendation that students document how they used AI tools in their research (e.g., in the methodology or an acknowledgement). These resources are aimed at students and researchers, structured as FAQs or libguides covering what AI is, how to credit its assistance, and the importance of critical evaluation of AI-provided information. They complement the formal policies by instilling good scholarly practice regarding AI (so that use of ChatGPT is transparent and doesn't veer into plagiarism).

General Principles TiU

At Tilburg University, we approach knowledge from an academic perspective, which means we always critically review, analyze, and evaluate information. This mindset is central to the Tilburg Education Profile (TEP) and forms the foundation of how the university educates their students. It also influences the approach of the lecturers and researchers, aligning closely with the Netherlands Code of Conduct for Research Integrity.

When using generative AI in learning and working environments, the university maintains this same critical mindset. The university carefully evaluates outputs generated by AI and takes responsibility for how we use this information. To guide this process, the university has developed four key principles for responsible generative AI use at Tilburg University:

1. AI exists to support people in making informed decisions. Human oversight is essential to guarantee this. Each user, student or employee, of generative AI within Tilburg University verifies the output generated by AI.
2. The output from generative AI remains the user's responsibility. Particularly when employing AI systems in critical processes, mechanisms to ensure accountability are necessary. Each user accepts this responsibility and ensures a human check to safeguard it.
3. The data used to train an AI tool determines the quality of its output, sometimes resulting in biased outcomes. Users are aware of this possibility and are capable of responding appropriately. Users also consider the ecological footprint, human rights impact, and working conditions associated with using generative AI tools.
4. Generative AI has the potential to enrich students' learning experiences and simplify employees' tasks. Tilburg University encourages initiatives involving generative AI for these purposes, provided they align with points 1, 2, and 3.

Support for staff and students in using Generative AI

Recognizing that guidelines alone are not enough; Tilburg University has invested in extensive support resources and training to help instructors and students navigate generative AI. Table 1 below summarizes the key support initiatives introduced from 2023 to 2025, including their format, organizers, and target audience.

Table 1. Support Initiatives for Generative AI at Tilburg University (2023–2025)

Support Initiative	Description & Content	Provider / Organizer	Target Users
Tilburg.ai Platform	Online platform (blog) offering tutorials, practical guides, and examples of AI use in education. Includes student and faculty insights.	AI in Education Working Group with tilburg.ai support.	All university staff and students.
Generative AI E-Module	Interactive e-learning (~2 hours) covering basics, responsible use, assessments, and prompt engineering for generative AI.	Teaching & Learning Center (TLC) Academy in collaboration with the University of Amsterdam.	Lecturers and teaching assistants.
Workshops & Seminars	Live training on assignment redesign, fraud prevention, prompt writing, and leveraging AI tools in education.	Teaching & Learning Center, AI working group, Studium Generale.	Primarily lecturers; some sessions for students.
TUNED IN Community	Community of practice via Teams for sharing experiences, challenges, and solutions related to educational innovation and AI.	Academic Affairs, coordinated by the Academic Lead of TUNED IN.	Lecturers, educational support staff, and program directors.
Library Guidance & Tools	Online resources and FAQ guides on responsible AI use, academic integrity, and citation practices.	University Library staff and information specialists.	Students, researchers, and lecturers.
Privacy & Security Advisory	Guidance on data privacy, GDPR compliance, and secure use of generative AI tools.	Chief Information Security Officer (CISO) Office.	All university employees and students handling university data.

Good practices in Teaching and Learning with generative AI

Re-design of Writing Assignments with AI

Following the framework developed by Nadia Klijn and Amy Hsiao, multiple programs (law, economics, social sciences) have overhauled traditional writing assignments to make them more AI-resilient.

A good practice emerging from this is to focus writing tasks on personal insight, synthesis, or application to a case – things that require original human thought, rather than generic prompts that ChatGPT could handle. For example, a marketing course replaced a standard "write an essay on marketing strategy X" with an assignment asking students to *prompt ChatGPT for a marketing plan on X, then critique the AI's plan using concepts from the course and improve upon it*. Students had to turn in the AI output with their own critique and revised plan, justifying each change.

Virtual Teaching Assistant

In 2024, a pilot was run in several courses where students could ask a GPT-based chatbot (fine-tuned on the course syllabus and readings) questions about the material. This VTA would answer with references to the textbook or lecture notes and could quiz the student. The good practice here is twofold: (1) it provides *personalized, on-demand support* to students outside of class (common questions get quick answers, freeing up instructors' time), and (2) it logs all interactions, which the instructor can review to identify concepts students struggle with.

To ensure quality, the AI's answers were monitored by teaching assistants, and students were told to verify answers (instilling a habit of not taking AI at face value). Feedback was positive – students felt more engaged and prepared, and the instructor could tailor review sessions to address frequent misconceptions the chatbot interactions revealed.

Transparent AI-Assisted Assignments:

Several instructors have designed assignments that *allow* the use of AI under certain conditions, thereby turning a potential integrity issue into a learning opportunity. For instance, in a humanities course, a lecturer permitted students to use ChatGPT to generate initial essay drafts on a given topic, *provided that students then critically edited the text and appended a reflection on how they used the AI and where the AI output was incorrect or required improvement*. This practice aligns with the university's recommendation that *"students indicate how and for which parts of the text AI tools were used."*

Academic Writing with AI

At Tilburg University, Dr. Janneke van der Loo leads a project integrating generative AI into academic writing education, aiming to adapt instruction to tools like ChatGPT while maintaining rigorous writing skill development. The project's goal is to ensure students can use AI writing tools responsibly to enhance their writing process and outcomes, rather than replacing their own skills.

4. Analysis of AI competence frameworks

4.1 TiU Methodology and documents included in the analysis

	Document 1	Document 2	Document 3	Document 4
Type of document (Framework, Policy, Guideline, ...)	Framework	Literature research	Framework	Framework
Date of publication	30-12-2022	10-07-2024	2024	2024
Responsible Institution(s)	The George Washington University	-	UNESCO	UNESCO
Responsible Persons/Authors (Position and Role)	Farhana Faruqe (corresponding author). Ryan Watkins & Larry Medsker	Johanna Velander (corresponding author), Nuno Otero & Marcelo Milrad	Fengchun Miao & Kelly Shiohira	Fengchun Miao & Kelly Shiohira
Stakeholders who play a role in the frameworks/policies				
Target group(s)	Researchers	General users of AI	Students	Teachers

4.2 TiU Findings

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

The four publications present complementary yet distinct conceptualizations of AI literacy. UNESCO's teacher framework defines AI literacy through a professional lens, emphasizing competencies that enable critical evaluation, effective communication with AI systems, responsible use, and teaching abilities. This framework uniquely positions teachers as both users and instructors of AI, structuring literacy around four dimensions: understanding, using, evaluating, and teaching with/about AI.

The student framework adopts a more developmental perspective, defining AI literacy as a set of age-appropriate understandings and abilities that help students become informed digital citizens. This framework simplifies its structure to three core dimensions—understanding AI, using AI, and living with AI—reflecting students' roles as primarily users and ethical participants.

The general frameworks offer broader conceptualizations that bridge these specialized approaches. Faruqe et al. (2022) present a comprehensive five-dimensional model encompassing technical, societal, relational, design, and critical literacies. This multifaceted approach defines AI literacy as understanding what AI is, what it can do, and how to critically evaluate its roles in society, emphasizing AI systems as sociotechnical constructs. Velander et al. (2024) reinforce this interdisciplinary view, positioning AI literacy as a continuous learning process that extends beyond technical skills to include critical thinking and societal implications.

Integrating these approaches could create a more robust conceptualization of AI literacy. The UNESCO frameworks would benefit from incorporating the sociotechnical systems perspective and dimensional complexity from the general frameworks, while maintaining their focus on practical educational contexts.

4.2.2 Key AI competences (for students and teachers)

The analysis of key AI competences across the four frameworks reveals a spectrum of skills that varies according to the intended audience but shares fundamental elements. The teacher framework (UNESCO, 2024) presents a balanced approach to competences, organizing them into technical (understanding AI fundamentals and limitations), pedagogical (designing AI-enhanced learning experiences), ethical (addressing bias and privacy), and assessment domains (evaluating AI tools and student learning). This comprehensive approach reflects teachers' complex role in both implementing AI and guiding students' engagement with these technologies.

The student framework, while covering similar ground, emphasizes progression of competences from basic understanding to critical application. It prioritizes foundational understanding of how AI works, critical thinking about AI outputs, creative problem-solving with AI tools, ethical awareness, and digital citizenship. This framework places greater emphasis on developing students as informed users rather than implementers or designers.

The other two papers expand these competences with additional dimensions. The Faruqe (2022) paper emphasizes developing appropriate mental models of AI systems and understanding data, algorithms, and training processes at a deeper level. The Velander (2024)

research highlights collaborative skills when working with AI systems and interdisciplinary thinking about AI implementation. Both general frameworks place greater emphasis on system-level understanding and lifelong adaptability to technological change.

These varying approaches to AI competences reveal opportunities for integration. Teacher frameworks could incorporate more sophisticated mental models of AI systems, while student frameworks could strengthen their attention to collaborative skills. Both educational frameworks would benefit from the general frameworks' more detailed approach to technical competencies, particularly regarding data and algorithmic understanding. An ideal competency framework would create clear developmental pathways from basic student understanding through advanced teacher implementation, while maintaining connections to broader societal competences. The table below (Table 1) gives an overview of the competencies per framework and how they differ and how they could complement each other.

Table 1: overview of competencies across frameworks

Domain	Teacher Competencies (UNESCO)	Student Competencies (UNESCO)	Additional Competencies
Technical understanding	• Understanding AI fundamentals, capabilities, and limitations • Identifying different types of AI systems • Recognizing how AI systems are trained and function • Understanding data requirements for AI	• Understanding how AI works at age-appropriate levels • Recognizing AI systems in everyday life • Basic comprehension of algorithms and data • Understanding that AI systems learn from data	• Developing accurate mental models of AI systems (Faruqe et al., 2022) • Understanding the role of data quality and bias in AI training (Faruqe et al., 2022) • Comprehension of AI's computational foundations (Velander et al., 2024) • Understanding AI's historical development and trajectory (Velander et al., 2024)
Critical Evaluation	• Assessing AI tools for educational purposes • Evaluating AI-generated content	• Critical thinking about AI tools and outputs • Questioning AI-generated results	• Ability to diagnose failure modes in AI systems (Faruqe et al., 2022)

	• Identifying potential biases in AI systems • Evaluating the reliability and validity of AI outputs	• Evaluation of AI trustworthiness • Recognizing when AI might be biased	• Understanding the "black box" problem in AI (Velander et al., 2024) • Assessing AI systems' societal impacts (Faruqe et al., 2022) • Evaluating AI through interdisciplinary lenses (Velander et al., 2024)
Practical Application	• Designing AI-enhanced learning experiences • Adapting teaching practices with AI tools • Using AI for assessment and feedback • Employing AI for administrative tasks	• Creative use of AI tools for problem-solving • Applying AI appropriately in learning contexts • Using AI tools for creative expression • Knowing when to use or not use AI tools	• Collaborative practices when working with AI systems (Velander et al., 2024) • Adapting to new AI tools and interfaces (Faruqe et al., 2022) • Participatory design of AI systems (Faruqe et al., 2022) • Practical skills for data preparation and cleaning (Velander et al., 2024)
Ethical Awareness	• Addressing bias and fairness issues • Managing privacy and data protection • Ensuring transparency in AI use • Maintaining human oversight of AI systems	• Ethical awareness of AI implications • Understanding privacy concerns with AI • Recognizing potential harms from AI • Considering how AI affects different groups	• Contextual understanding of AI's impacts across cultures (Faruqe et al., 2022) • Analyzing power dynamics in AI development (Velander et al., 2024) • Understanding AI's environmental

			impacts (Faruqe et al., 2022) • Ability to anticipate unintended consequences (Velander et al., 2024)
Pedagogical Implementation	• Teaching about AI as a subject • Integrating AI across curriculum areas • Facilitating student AI projects • Designing assessments around AI-enhanced learning	-	• Creating explanatory models of AI systems (Faruqe et al., 2022) • Developing age-appropriate AI learning progressions (Faruqe et al., 2022; Velander et al., 2024)
Social & Contextual Understanding	• Understanding AI's potential impacts on society • Considering inclusivity and accessibility • Addressing digital divide concerns • Recognizing cultural implications of AI	• Digital citizenship in an AI world • Understanding AI's role in society • Recognizing social impacts of AI • Considering how AI affects communities	• Analyzing AI within broader sociotechnical systems (Faruqe et al., 2022) • Understanding AI governance and policy (Velander et al., 2024) • Recognizing AI's role in media and information ecosystems (Faruqe et al., 2022) • Ability to engage in public discourse about AI (Velander et al., 2024)
Adaptive Learning	• Engaging in continuous professional development • Keeping up with AI developments	-	• Developing strategies for lifelong AI learning (Faruqe et al., 2022)

	• Participating in communities of practice • Adapting to changing AI capabilities		• Adapting to rapidly evolving AI capabilities (Velander et al., 2024) • Building learning networks around AI (Velander et al., 2024) • Self-directed exploration of new AI tools (Faruqe et al., 2022)
Communication & Collaboration	• Communicating effectively about AI • Collaborating with other educators on AI • Explaining AI concepts to students and parents • Participating in AI policy discussions	• Discussing AI capabilities and limitations • Collaborating on AI projects • Sharing AI learning with peers • Communicating about AI experiences	• Translating between technical and non-technical AI concepts (Faruqe et al., 2022) • Facilitating inclusive discussions about AI (Velander et al., 2024) • Communicating across disciplines about AI (Velander et al., 2024) • Collaborative meaning-making around AI systems (Faruqe et al., 2022)

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

The four frameworks identify a range of challenges in AI education that vary based on perspective. The teacher framework (UNESCO, 2024) highlights professional challenges including inadequate training, equity and access issues, data privacy concerns, potential overdependence on AI tools, and the risk of reinforcing biases. These challenges reflect teachers' immediate concerns about implementing AI in educational settings while balancing ethical responsibilities.

The student framework (UNESCO, 2024) identifies different but related challenges, focusing on age-appropriate understanding of complex concepts, digital divide issues affecting equitable access, keeping pace with rapidly evolving technology, and balancing technical skill development with critical thinking. These challenges reflect the considerations for student learning about emerging technologies.

The other frameworks bring attention to more systemic challenges that could affect educational contexts. Velander et al. (2024) emphasize how rapid technological change outpaces educational responses and how the complexity of AI systems creates a black box problem that impedes understanding. Faruqe (2022) highlights widespread misconceptions about AI capabilities and the technical complexity that creates barriers to understanding for non-specialists.

A key shortcoming across frameworks is the limited attention to integrating AI literacy within existing curricula and educational structures. The teacher framework doesn't adequately address keeping pace with rapid AI advancements, while the student framework lacks sufficient attention to making complex AI systems comprehensible. An integrated approach to challenges would recognize how issues at different levels—from classroom implementation to systemic educational change—interact and require coordinated solutions across technical, pedagogical, and policy domains.

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

Recommendations across the four frameworks reflect their different focal points while offering complementary guidance for AI in education. The teacher framework (UNESCO, 2024) emphasizes structural and professional development approaches, advocating for the integration of AI literacy into teacher education programs, the development of context-specific policies, the creation of communities of practice, balancing technological and human aspects of education, and encouraging critical evaluation of AI tools.

The student framework provides more curriculum-oriented recommendations, focusing on developing curricula, integrating AI literacy across subject areas, creating hands-on learning experiences, encouraging ethical discussions, and promoting collaborative AI projects. These recommendations emphasize active engagement that builds student competencies.

The general frameworks offer broader strategic recommendations. Velander et al. (2024) advocate for scaffolded learning approaches, multidisciplinary AI literacy programs, project-based learning, and connecting AI education to real-world applications. Faruqe et al. (2022) emphasize developing comprehensive frameworks, creating accessible resources for diverse audiences, experiential learning, and interdisciplinary approaches to AI education.

The teacher framework could benefit from greater emphasis on connecting AI education to real-world applications, such as working with true-to-life cases or collaborating with external stakeholders on wicked problems and how AI poses risks and opportunities in these situations. The student framework could incorporate more on participatory design principles, pulling from students' experiences with AI in different scenarios. Both educational frameworks would be strengthened by adopting interdisciplinary approaches and experiential learning to better prepare students for complex problems they might face in the future.

4.2.5 Examples of the use of AI in teaching and learning

The examples of AI applications in education presented across the four frameworks range from practical tools to conceptual exercises, revealing different visions of AI's educational role. The teacher framework (UNESCO, 2024) provides pragmatic examples focused on professional applications: using AI for personalized feedback, assessment tools, language learning applications, administrative assistance, and student project facilitation. These examples position AI primarily as a tool that supports and enhances teacher capabilities, while remaining vigilant of risk factors.

The student framework offers more creative and analytical activities designed to build student understanding: coding simple AI models, critically analyzing AI-generated content, creating AI art or music, role-playing ethical dilemmas, and conducting student-led research on AI applications. These examples emphasize hands-on engagement that builds both technical understanding and critical thinking.

The other frameworks present more conceptual approaches: case studies of AI implementation, simulations of AI decision-making, interdisciplinary projects examining AI impacts, critical media analysis, interactive demonstrations, and participatory design exercises. These examples focus more on understanding AI as a sociotechnical system with broad implications.

Several shortcomings exist across these examples. The teacher framework (UNESCO, 2024) lacks sufficient interdisciplinary AI project examples, while the student framework could better connect AI to non-STEM subjects. All frameworks would benefit from more concrete, detailed implementation examples across different educational contexts and resource levels. An integrated approach to examples would provide a progression from basic student activities to advanced teacher applications, with clear connections to broader societal examples. This would help educators select and adapt examples appropriate to their specific contexts while building toward comprehensive AI literacy goals.

4.2.7 Values, ethical principles, and security framework

Ethical considerations play a central role across all four frameworks, though they approach values and principles from different perspectives. The teacher framework (UNESCO, 2024) emphasizes professional ethics, focusing on transparency and explainability, fairness and non-discrimination, human agency and oversight, privacy and data protection, and technical robustness and safety. These principles reflect teachers' responsibilities both as AI users and as guides for student engagement with these technologies.

The student framework (UNESCO, 2024) emphasizes values more relevant to developing digital citizens: human autonomy and agency, privacy awareness, critical thinking about algorithmic decisions, responsible use of AI tools, and awareness of social impacts. These principles focus on preparing students to engage ethically with AI systems they encounter throughout their lives.

Velander et al. (2024) address elements of both the teacher- and student-focused frameworks, emphasizing transparency, social responsibility, equity considerations,

preservation of human autonomy, and balanced perspectives on AI benefits and risks. Faruqe et al. (2022) paper focuses on fairness and bias awareness, responsibility in deployment, privacy and data rights, transparency, and human-centered approaches to AI development.

These ethical frameworks could be better integrated to create a comprehensive approach to AI ethics in education. The teacher framework could incorporate a stronger emphasis on social responsibility from the general frameworks, while the student framework would benefit from more explicit attention to bias awareness. Both UNESCO frameworks could strengthen their treatment of equity considerations in AI deployment. An ideal ethical framework would connect individual ethical responsibilities to broader societal implications, while providing concrete guidance for ethical decision-making in specific educational contexts. This would help educators and students navigate the complex ethical terrain of AI implementation while developing values-based approaches to emerging technologies.

4.2.8 Future trends in AI and education

The four frameworks present complementary visions of AI's future in education, though with varying timelines and expectations for what future developments will entail. The teacher framework (UNESCO, 2024) predicts increasing AI integration in educational systems, more personalized learning experiences, shifting teacher roles toward facilitation and guidance, and a growing need for ongoing professional development. These trends focus primarily on how AI will transform teaching practices and professional requirements.

The student framework (UNESCO, 2024) emphasizes AI literacy becoming essential for future workforce participation, growing integration across education levels, the need for continuous updating of AI literacy frameworks, and increased student involvement in AI development. These trends reflect concerns about preparing students for future technological environments.

The general frameworks present broader societal visions. Velander et al. (2024) highlight the growing need for AI literacy across sectors, shifting toward more participatory AI development, increasing focus on equity, and the need for adaptable literacy frameworks. Faruqe et al. (2022) emphasize AI literacy for civic participation, lifelong learning approaches, participatory development, and the importance of AI literacy across educational contexts.

Although the frameworks address several valid concerns about the impact of AI, it does miss or gloss over several elements that are heavily impacted by AI. The teacher framework doesn't sufficiently address AI's potential to transform assessment practices fundamentally. The student framework lacks attention to how AI literacy will influence civic participation beyond workforce preparation. All frameworks could provide more specific visions for how AI literacy education might evolve in response to technological changes that cannot yet be fully anticipated.

An integrated approach to AI futures would connect educational trends to broader societal developments, helping educators prepare for multiple possible scenarios rather than a single technological trajectory. This would include attention to how AI might transform not just teaching methods but educational goals and structures themselves, requiring continuous adaptation of literacy frameworks to address emerging capabilities and challenges.

4.3 TiU Discussion

Although both UNESCO frameworks provide detailed guidance and consider various perspectives of the possible impacts of AI, comparing it to other frameworks reveals some inadequacies that might leave teachers and students with a blind spot in their AI literacy. This indicates that it is never wise to blindly follow a single framework, but rather build from existing frameworks with recent findings and to examine fitting competencies for specific scenarios.

5. Conclusions and recommendations

The growing presence of artificial intelligence in education demands a shift from basic tool use to a deeper understanding of its implications and responsible application. Our analysis reveals that AI literacy is far more than a technical skill—it's a multifaceted competency that requires a holistic approach to understanding, evaluating, and engaging with AI technologies.

Core Competencies for the AI Era

AI literacy requires more than basic technical skills. Educators and students alike need to build robust mental models of how AI systems function, how they are trained, and where they may fail. This includes understanding the ethical risks, such as bias and privacy concerns, and the social impact of deploying these systems at scale.

This calls for **interdisciplinary learning pathways** that integrate technical knowledge with ethical reasoning, societal context, and critical thinking. It also means rethinking current curricula to include AI literacy not as a separate subject, but as a core capability across disciplines.

Because AI technologies are evolving so rapidly, AI literacy must be seen as a lifelong, adaptive process. Teachers and students should be empowered with self-directed learning skills and supported by professional learning communities, practical training modules, and access to trusted tools.

Based on our analysis, we recommend that these aspects and competencies be not only translated into AI literacy frameworks but also **embedded in curricula**. This means rethinking assessment strategies and fostering a culture of academic integrity that includes transparency about AI use. This allows both teachers and students to understand the impact, uses, and risks of AI in relevant contexts.

The meaning of Higher Education in the age of AI

It is undeniable that the increased accessibility of AI to, especially, students present challenges in terms of assessment. While we recommend that universities take measures to prevent fraud, we see it as unrealistic to try and ban the use of AI and would rather advocate for responsible use. It highlights the importance of regularly updating curricula, introducing new areas of study, and assessing whether existing components still align with future needs. That is why we encourage conversations within and between Higher Education institutions to discuss the value of Higher Education in the age of AI.

AI literacy is not a destination, but rather a continuous journey of learning, adaptation, and critical reflection. As AI technologies continue to evolve, so too must our approaches to understanding and engaging with them. By embracing a holistic, adaptive, and ethically grounded approach, we can prepare teachers and students to navigate the complex technological landscape of the future.

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