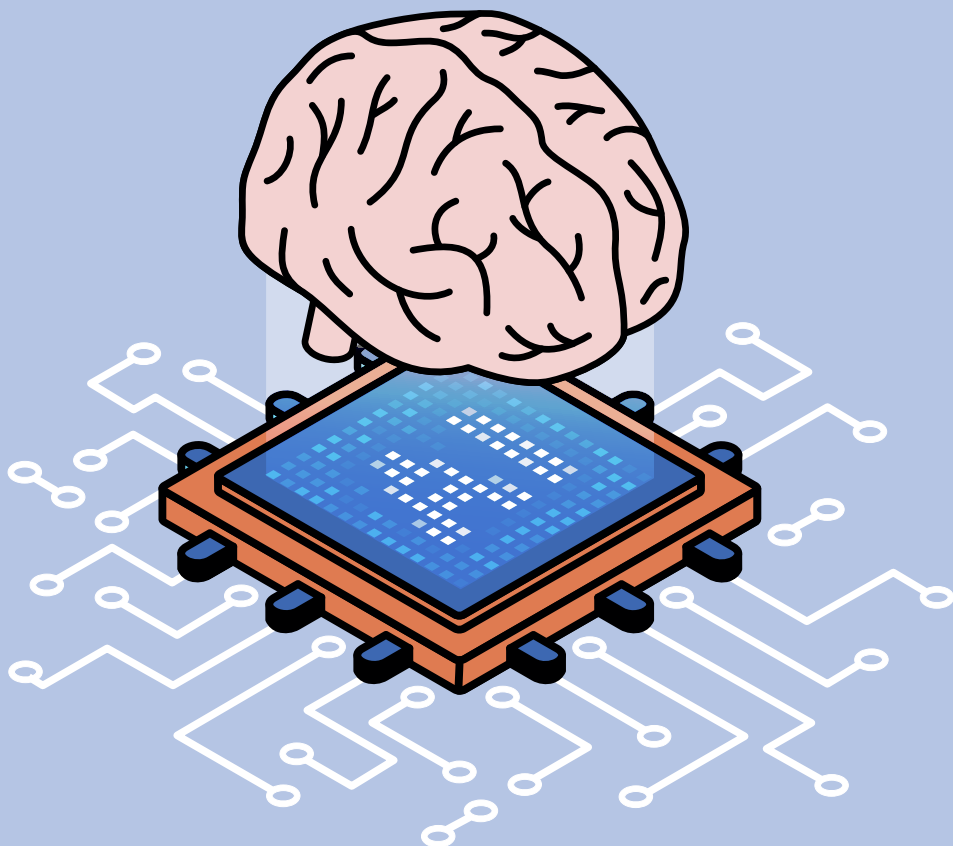




AI-GO!

A Framework for AI literacy in
Education (AI-GO Framework)

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(AI-GO Framework)

Npuls “AI and Data Literacy” Project

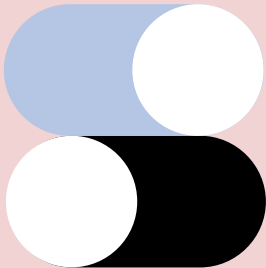
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1. Introduction

Background

Rapid developments in artificial intelligence (AI) have major implications for education (Crompton & Burke, 2023; Zawacki-Richter et al., 2019). AI applications are becoming increasingly common in the classroom. For instance, teaching staff may use AI to develop teaching materials and students may use it to get feedback (Chow et al., 2022). Teaching staff and students are increasingly encountering AI in their daily work. This expanding role of AI is significantly changing how students and teaching staff perform their tasks, which requires major adjustments to existing educational practices. It also requires students and teachers to acquire new knowledge and skills in AI, also referred to as AI literacy (Long & Magerko, 2020; Ng et al., 2021). This has also been acknowledged by the Dutch government¹ and UNESCO².

What is artificial intelligence (AI)?

AI is described and defined in various ways. This report uses the definition set out in the European Union's [AI Act](#). In the AI Act, AI (or an AI system) is defined as: *"... a machine-based system that is designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment, and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments."*

AI refers to a broad set of technologies that enable computers to perform tasks which would ordinarily require human intelligence (Tambe et al., 2019). It serves as an umbrella term for systems that distil patterns from data to achieve specific aims (Kaplan & Haenlein, 2019), such as predicting student dropout and providing personalised feedback (Zawacki-Richter et al., 2019). AI comprises various techniques, including machine learning, deep learning and neural networks, each of which refers to a distinct method for pattern recognition and predictions (Russell & Norvig, 2022).

¹ rijksoverheid.nl/documenten/rapporten/2024/01/01/overheidsbrede-visie-generatieve-ai

² unesco.org/en/articles/ai-competency-framework-students

A specific form of AI is generative AI (GenAI), which refers to computer techniques that use training data to generate seemingly new, “meaningful” content such as text, images or audio (Feuerriegel et al., 2024). Large Language Models (LLMs) are a commonly used type of GenAI which are used to create new texts, such as for lesson plans, when designing exam questions and when writing texts (Kasneci et al., 2023). Well-known examples are ChatGPT and Copilot. In this report, we apply the broad definition of AI provided above; this includes but is not limited to GenAI.

While AI literacy is crucial for the use of AI by teaching staff and students, there is insufficient insight into what AI literacy actually entails. It certainly goes beyond merely knowing what AI is and what it can do. However, precisely what the term means remains unclear, partly because there are many different definitions. In recent years, several frameworks on AI literacy have been developed. These are informative in nature and have helped lay important foundations in the field of AI literacy. Nonetheless, these frameworks also have shortcomings – such as not always being based on the latest literature and contemporary research. Moreover, they are often not – or insufficiently – focused on education. This is not surprising, for the rapid rise of GenAI in particular led to a pressing need to provide educational professionals with support frameworks. However, the time is ripe for a more in-depth and evidence-informed framework that can be used in education. Given that the AI Act requires organisations to promote the AI literacy of their staff, this need has become even more critical.

We seek to create transparency around AI literacy for education through the Npuls AI Literacy Project. That is why we are presenting this publication, the “AI Literacy in Education Framework” (AI-GO), for the benefit of teaching staff and students. Additionally, we describe – using case studies – how vocational education and training schools, universities of applied sciences and research universities are addressing AI literacy (see “In Practice”).

Research design

For a comprehensive overview of AI literacy, we have conducted what is known as an umbrella review – an overview study in which we compiled and analysed existing systematic reviews on AI literacy (Paré et al., 2015). This allowed us to bring together insights from previous research without having to collect new data ourselves. We deliberately included studies from other sectors, such as the medical sector, in addition to educational research.

After all, AI literacy is not only relevant for teaching staff and students but for anyone who uses AI applications in their professional (and social) life.

This broad approach has resulted in a richer and more versatile picture of how AI literacy is measured, developed and supported in different contexts.

We searched three major scientific databases (ERIC, Scopus and Web of Science) using a combination of search terms focused on AI, AI literacy and overview studies. Because the number of publications on AI has grown exponentially since 2016, the search period ran from 2016 to 2024.

We found a total of 1,792 publications. Using the ASReview smart selection tool (Van de Schoot et al., 2021) and through careful assessment by several researchers, we ultimately selected 31 high-quality overview studies (cf. Joanna Briggs Institute, 2017). These overview studies are listed with an asterisk (*) in the reference list of this publication. Based on these studies, we analysed how AI literacy is defined, which elements it comprises (such as knowledge, skills and attitudes) and the factors that promote or impede its development. A comprehensive and detailed description of this umbrella review is provided in our academic article (Renkema et al., in preparation).

To connect our findings from the literature review to the real world, we compared them with three existing initiatives by educational and knowledge institutions that focus on promoting AI literacy (see Table 1). These initiatives vary in their target groups and design and offer valuable insights into how AI literacy is currently implemented in practice. Through this comparison, it became clear how initiatives from practice create real-world applications based on the indicators and factors gleaned from the literature.

Initiative name	Institution
Visual aid cards	Curio
Toolkit AI-bestendig toetsen	HAN University of Applied Sciences (HAN)
E-learningmodule Generative AI in Education	University of Twente (UT)

Table 1. Initiatives aimed at promoting AI literacy covered in this publication

Finally, using the World Café method, we tested the preliminary findings of the umbrella review against the experiences of educational professionals (Schiele et al., 2022). This is a structured discussion technique in which small groups of participants reflect on a topic from different perspectives. We conducted six World Cafés, involving a range of students and educational professionals from vocational education and training schools, universities

of applied sciences and research universities. The insights gained from the World Cafés³ have been incorporated into the results of this Framework and are discussed in the conclusion and discussion.

Reading guide

In this publication, we present a framework for AI literacy based on a synthesis of existing review studies. We begin with a definition of AI literacy – positioning the concept as an interplay of knowledge, skills and attitudes, with ethical awareness as its foundation. We then elucidate the Framework and discuss its four central components. Within each component, we distinguish clusters and their corresponding indicators. Indicators with a delta (Δ) were also mentioned by participants in the World Cafés. For each component, we use case studies to explain how the component can be advanced in practice. We also address the pedagogical aspect of AI literacy. Subsequently, we discuss which factors influence AI literacy, namely the individual level, organisational level and policy level. These factors may promote or impede AI literacy. We wrap up with a discussion of our findings and their implications, followed by a conclusion.

³ Based on a preliminary analysis of the data.

2. AI Literacy in Education Framework (AI-GO Framework)

The AI Literacy in Education (AI-GO) Framework describes what AI literacy in education entails. The Framework consists of four components: Knowledge about AI, Skills with AI, Attitudes towards AI and Ethics in AI. Each component consists of a number of clusters and their corresponding indicators⁴. In addition, the Framework includes a pedagogical dimension (see italicised terms in the Framework) and factors that influence AI literacy (Influencing Factors, see the rings with Individual, Team, Organisation and Policy in the Framework). As the figure below shows, the four components are interconnected (see Figure 1).

How is AI literacy defined?

Defining AI literacy is not straightforward. Our literature review revealed that some authors do not provide a definition at all.

Those who do use a definition often use a variety of definitions, or combinations of definitions. Two definitions are most frequently cited. The first is by Ng and colleagues (2021), who describe AI literacy as “*Know & Understand AI, Use & apply AI, Evaluate & create AI, and AI ethics.*”

The second is the widely-cited definition by Long and Magerko (2020), who view AI literacy 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*”.

Yet, these definitions seem insufficiently aligned with the findings from our literature review. Both definitions position AI literacy as the sum of separate components, whereas our review shows that it is about the interaction between them.

⁴ The terms in bold in Figure 1 denote the clusters. The indicators do not appear in the figure, but are described below, by cluster.

And while the importance of ethical awareness is crucial, it receives only limited attention in existing definitions. Drawing on our literature review, we have therefore formulated the following definition of AI literacy:

“AI literacy refers to the interplay of knowledge, skills and attitudes, with ethical awareness as the foundation for engaging with AI systems critically, responsibly and effectively.”

AI literacy, therefore, comprises:

- understanding fundamental AI concepts, applications and their societal implications;
- applying AI-related skills to solve problems or collaborate with AI technologies;
- developing a reflective attitude towards AI's role in society, including one's own perspectives and assumptions;
- recognising ethics as the underlying principle when designing, using and evaluating AI applications.

The use of the word interplay underscores that AI literacy is not made up of separate components (such as knowledge, skills or attitudes) but stems from the dynamic interaction between them. It is about how these components are harnessed in integrated ways in engaging with and using AI. In practice, this means that teaching staff must not only know what AI is or how it works, but also how to use AI critically and in a pedagogically responsible way in their interaction with students and colleagues.

In much of the literature reviewed, it also becomes apparent that ethics is not just one part of AI literacy but forms the very foundation on which all other components stand. Ethical awareness means that educational professionals are constantly aware of the moral, societal and personal implications of AI systems. Ethics guides curriculum development, other educational activities, the selection of AI applications and the supervision of students and AI. If we view ethics as the basis of AI literacy, then it is as much about pedagogical and societal responsibility as it is about technology and knowledge.

It is important to note that the AI-GO Framework is not layered; in other words, it does not distinguish between basic and advanced AI literacy. As a general rule, however, the more indicators a person has mastered, the higher their estimated level of AI literacy. Moreover, certain indicators are important for everyone, while others are context-specific.

For instance, basic knowledge of AI means, for an IT student, being able to analyse or even programme algorithms. For a psychology student, it is more about understanding the impact of AI on human behaviour and ethical issues. This demonstrates that AI literacy is not a fixed standard but depends on the discipline in which someone works or studies.

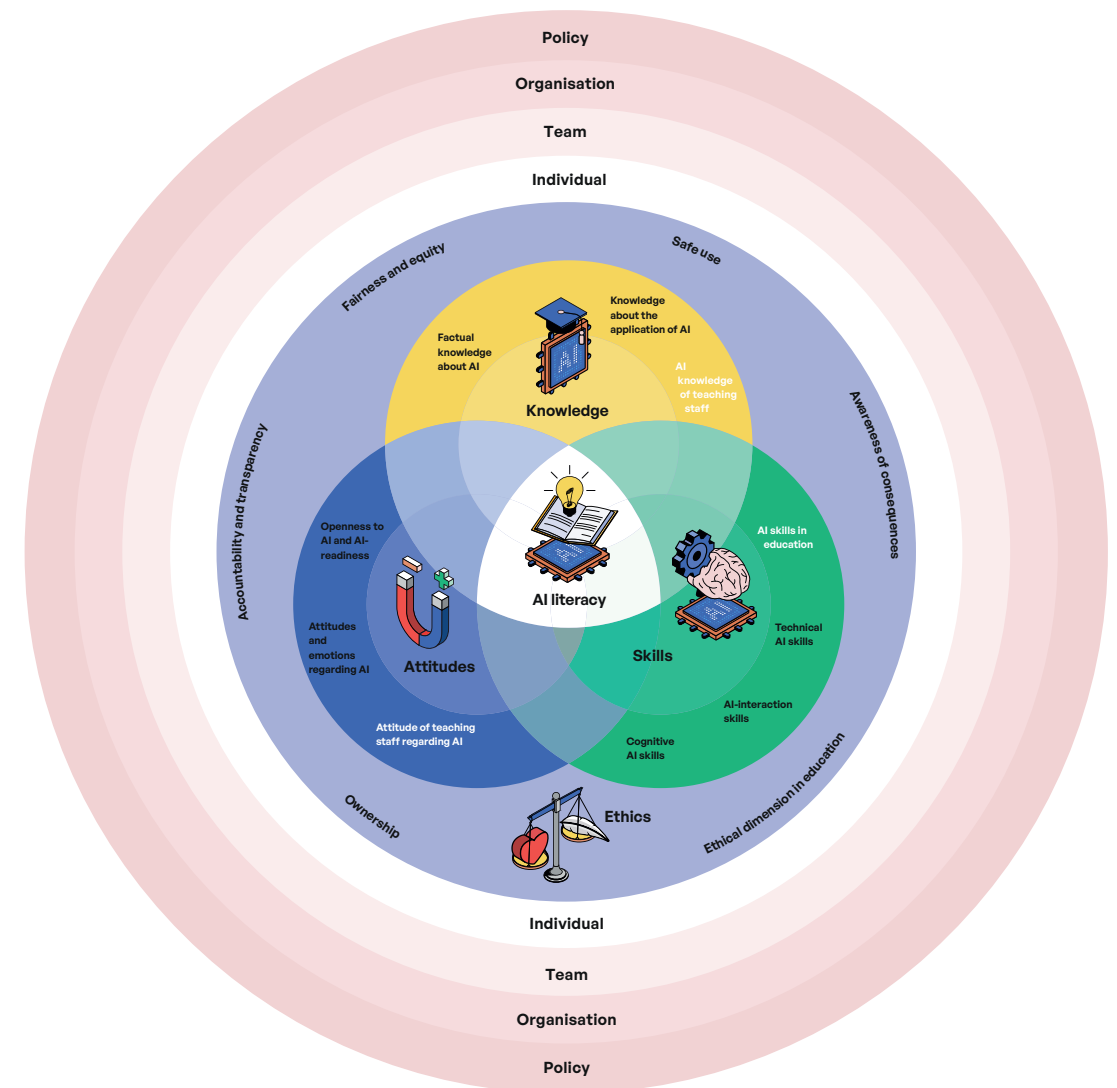
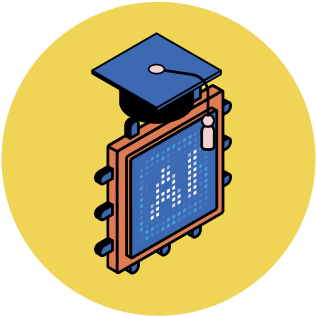


Figure 1. The AI Literacy in Education (AI-GO) Framework



Knowledge

The first component of the AI Literacy in Education framework is Knowledge about AI. Being AI literate means having factual knowledge of what AI is and is not as well as knowledge about how AI is (and can be) applied.

Factual knowledge about AI

The first knowledge cluster concerns factual knowledge about AI. This refers to general knowledge about AI that is not specific to a particular context. The table below lists and describes the indicators.

Indicator	Description from the reviews
Knowledge about the basic principles of AI Δ	What AI is, which basic concepts and techniques are used, which types of data are suitable for AI (such as sensor data and images) and what AI can and cannot do.
Knowledge about data, algorithms and statistics Δ	How data, algorithms and statistical methods are applied in AI. Key concepts here include: data science and machine learning techniques, natural language processing, predictive analytics, supervised and unsupervised learning, probabilistic reasoning, pattern recognition, classification models, neural networks, data structures, propositional logic.
Knowledge about programming and developing AI Δ	How AI applications are developed, programmed and built.

Knowledge about the application of AI

The second knowledge cluster relates to knowledge about how AI can be applied in one’s own professional or personal life. Please note that this does not concern knowledge about specific software but a more comprehensive understanding of how AI is used.

Indicator	Description from the reviews
Knowledge about using AI in a specific domain/field Δ	How AI can be applied in a professional or personal context.
Knowledge about the role of AI in interacting with people Δ	How human-AI interaction works, including the ability to understand, justify and assess AI output in one’s own context.
Knowledge about the strengths and weaknesses of AI Δ	Strengths and weaknesses of AI, such as limitations due to errors and bias in AI.
Knowledge about integrating domain-specific knowledge with AI	Effectively integrating one’s own domain-specific expertise with AI output.
Knowledge about how to adopt an interdisciplinary approach in the context of AI	Understanding how and why collaboration across different disciplines is important – for example, between one’s own field and areas like computer science and engineering – given that AI transcends disciplinary boundaries.

In Practice

A solid foundation of knowledge is critical to strengthening AI literacy. But how can teaching staff and students enhance their AI knowledge in practice? Various educational institutions support them with accessible, practical resources.

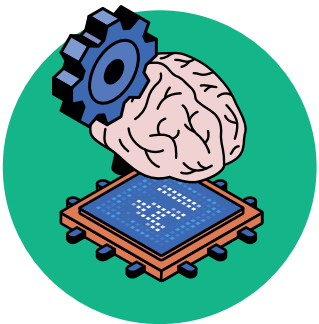
Curio, for example, has developed visual aid cards⁵ which help teaching staff understand the basic principles of AI and gain insight into the possibilities and limitations of AI applications.

⁵ The visual aid cards are part of a range of initiatives aimed at promoting AI literacy, such as microlearning modules and workshops by Npuls.

HAN University of Applied Sciences offers educational professionals the “AI-proof assessment” toolkit, through which they gain insight into how AI influences forms of assessment and the advantages and disadvantages of using AI for this purpose.

The University of Twente (UT) strengthens AI literacy through the “Generative AI in Education” e-learning module on Canvas. This module explains basic concepts such as algorithms and language models in an accessible way.

These initiatives give educational professionals concrete tools for expanding their knowledge and understanding of AI concepts. With this knowledge, they have a better understanding of how to apply AI in their own subject area.



Skills

The application of knowledge about AI so as to use AI effectively is classified as “AI skills”. We distinguish between technical AI skills focused on *using* AI, cognitive AI skills focused on *thinking* about AI and AI interaction skills with a focus on *interacting* with AI.

Technical AI skills

This cluster consists of skills that are needed to use AI applications, including basic skills in IT and data usage.

Indicator	Description from the reviews
IT skills Δ	Basic IT skills such as document processing, working with spreadsheets and databases form the foundation for technical AI skills like programming and building AI systems.
Data analysis and management Δ	Skills for interpreting, visualising and using data to make well-founded decisions.
Use of AI applications and systems Δ	Effectively using, evaluating and integrating AI applications and systems in learning or professional environments.
Programming and algorithmic thinking Δ	Skills to write programmes (e.g. in Python, R and SQL) and to design, debug and optimise algorithms as a basis for building and understanding AI applications.
AI development and modelling Δ	Skills to design AI systems and train models that can resolve real-world problems.

Cognitive AI skills

This cluster describes cognitive skills for thinking *with* AI (creative, problem-solving) and thinking *about* AI (critical, reflective).

Indicator	Description from the reviews
Critical thinking Δ	Assessing AI results for reliability, quality and intended or unintended effects. This involves recognising bias, incorrect assumptions or unreliable patterns in output, assessing whether it is relevant and applicable in a particular context and determining which role AI should play in decision-making.
Computational thinking	Solving problems by structuring them into steps, patterns, abstractions and logical rules – as a computer would. This includes input-processing-output and algorithmic thinking when designing solutions, such as search structures, decision rules or pattern recognition.
Problem-solving thinking Δ	Using AI to analyse and resolve complex or real-world problems. This includes choosing and using appropriate AI applications, applying them in the solution process and evaluating and adjusting the outcome as needed.
Creative thinking Δ	Designing innovative solutions or applications with AI, translating AI potential into new forms of expression, design or interaction and modifying one’s approach or strategy based on AI feedback or evolving circumstances.
Reflective thinking Δ	Thinking about (one’s own) AI use and its societal and ethical implications. This includes reflecting on when and why AI usage is possible, desirable or problematic – and linking personal experience to wider AI developments and societal issues.

AI interaction skills

This cluster specifies skills for interaction between humans and AI. These focus on communicating about and collaborating with AI.

Indicator	Description from the reviews
Communicating about AI output Δ	Clearly conveying AI output to others by tailoring language and approach to the audience’s knowledge level, experiences and context. This includes a clear explanation (What does this AI result mean?) as well as sensitivity to the audience’s background (How do I explain this to someone who has no AI expertise).
Discussing AI output in dialogue Δ	Engaging in conversation about the use and significance of AI with others, for instance in collective decision-making. This involves discussing, questioning and weighing AI output.
Collaborating on AI applications	Joining a team that designs, implements or evaluates AI with the focus on interaction between people around the subject of AI, for example in co-creation projects in education, research or practice.
Interacting with AI systems Δ	Effectively directing AI systems through language or other inputs (such as prompting), interpreting output and iteratively providing new input. This concerns the human-AI interaction applicable to LLMs, GenAI and decision support systems.

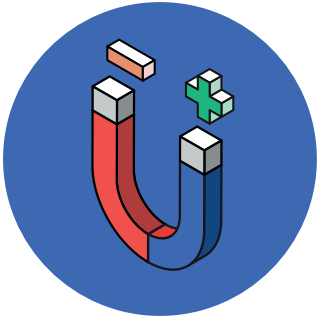
In Practice

In addition to knowledge about AI, teaching staff must also develop skills that allow them to use AI consciously and effectively. But can teaching staff and students practise using and evaluating AI in real life?

At Curio, teaching staff use visual aid cards to learn how to design effective prompts and develop critical perspectives on AI usage.

HAN University of Applied Sciences supports teaching staff with its “AI-proof assessment toolkit”, which helps them analyse AI usage with examples, key questions and decision trees. This way, they can make well-considered choices regarding whether or not to allow AI in their classes.

At the University of Twente, students and teaching staff actively practise writing prompts, checking AI outputs for misinformation and exploring application options. They do this in the “Generative AI in Education” e-learning module. This allows them to develop practical skills for communicating with AI and assessing the reliability of AI outputs.



Attitudes

The Attitudes component in the AI-GO Framework refers to the personal beliefs, perceptions and emotions that influence the use of AI. As with knowledge and skills, attitudes play a crucial role in how individuals approach and integrate AI in their educational practice. Remarkably, attitudes are seldomly mentioned in many frameworks. And in the World Cafés – where the focus lay mainly on knowledge, skills and ethics – attitudes were not or hardly discussed either. Nevertheless, the literature shows that attitudes form an essential part of AI literacy. Indeed, they are a critical link between *knowledge*, *ability* and *practical application*. Without a positive and reflective attitude, knowledge and skills are unlikely to be applied effectively. We have divided attitudes into two clusters: attitudes and emotions towards AI and openness to AI.

Attitudes and emotions towards AI

This cluster is about people’s feelings towards AI and their relationship to its use. The indicators below provide insight into elements of attitude that are significant for responsible and meaningful integration of AI in education.

Indicator	Description from the reviews
Confidence in AI	Confidence that an AI system operates effectively, is fair and supports their goals.
AI self-efficacy	Confidence in one’s own ability to use AI technologies effectively, including understanding, applying and integrating AI systems in specific tasks or contexts.
Interest in and motivation to use AI Δ	Enthusiasm and willingness to learn more about AI and explore its applications. Those who consider AI relevant and useful are more easily motivated to start using it.

Openness to AI and AI-readiness

This second cluster concerns how open a person is to using AI and the degree to which they feel ready to use it. The indicators below provide insight into factors that contribute to actively embracing and applying AI in educational practice.

Indicator	Description from the reviews
AI-readiness Δ	The sense of having sufficient knowledge, skills and resources to use AI, along with a positive attitude towards doing so.
AI acceptance	Recognising AI as a valuable addition and being willing to use this technology in practice. This is about more than just “tolerating” AI; it reflects a belief in the added value AI can deliver through active use.

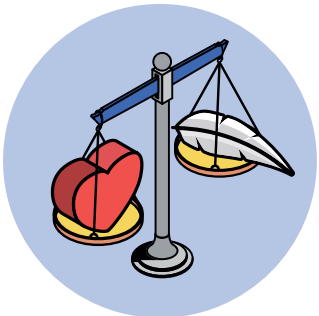
In Practice

AI literacy also requires a conscious and reflective attitude. But how can this be cultivated in practice?

Curio encourages teaching staff, through visual aid cards, to reflect on the reliability, purpose and appropriateness of AI applications in their educational practice.

HAN University of Applied Sciences encourages teaching staff to use the “AI-proof assessment” toolkit to discuss the desirability and risks of AI applications. AI applications. This fosters a shared, reflective attitude.

In its “Generative AI in Education” e-learning module, the University of Twente challenges participants – through assignments – to reflect critically on their own responsibility and the accountability for using AI in educational contexts.



Ethics

The importance of ethics is emphasised in many different papers. It was also a frequent topic of discussion in the World Cafés. Ethics is often seen as the foundation of AI literacy and includes several indicators.

Awareness of the consequences of using AI

This cluster centres on understanding the consequences of using AI for individuals and society and awareness of its economic implications.

Indicator	Description from the reviews
Knowledge about the consequences for individuals and society Δ	Understanding how AI impacts people and society. This includes applications of AI in different sectors but also preventing unintended consequences. The concept of “socially responsible AI use” is frequently referenced.
Knowledge about economic implications Δ	Understanding the impact of AI on the economy, such as changes in processes, professions (for example, roles being superseded by AI) and business operations.

Fairness and equity

This cluster is about the capacity to evaluate whether AI systems are inclusive, promote diversity and do not discriminate.

Indicator	Description from the reviews
Ability to assess whether AI is sufficiently inclusive and non-discriminatory Δ	Understanding that every AI model carries some degree of bias, which may result in discrimination. At the same time, AI can promote inclusion – for instance by adapting content and presentation to the needs of specific users, such as students with learning difficulties.

Accountability and transparency

This involves knowledge about the importance of transparency and explainable AI.

Indicator	Description from the reviews
Knowledge about the importance of transparency and explainable AI Δ	Understanding how data in an AI application is processed and used. The term “explainable AI” is widely used in this context.

Safe use

This concerns privacy, confidentiality and data protection.

Indicator	Description from the reviews
Knowledge about the importance of privacy, confidentiality and data protection Δ	Understanding the importance of the right to privacy, confidentiality and data protection. Knowledge of legal aspects of AI – such as rights in this area, legal provisions, data governance, liability and intellectual property – also play a role here.

Ownership

This involves taking responsibility for how AI is (or is not) used.

Indicator	Description from the reviews
Taking responsibility for how AI is (or is not) used Δ	Being aware of one’s own responsibility on how AI is used or not used. This also relates to authenticity of work, ownership and autonomy but also critically evaluating AI output and making adjustments where necessary.

In Practice

Ethical awareness is a key foundation of AI literacy. But how does such awareness of AI ethics manifest in educational practice?

Curio includes topics like privacy, transparency and the safe selection of AI applications in its visual aid cards.

The HAN AI-proof assessment toolkit incorporates ethical considerations such as privacy, bias and fairness in assessment.

The “Generative AI in Education” e-learning module fosters ethical awareness through assignments where participants reflect on issues like privacy, transparency and the societal impact of AI. These examples show how ethical considerations can be systematically integrated into developing AI literacy.



The pedagogical and didactic dimension of AI literacy

The role of educational professionals is critical to advancing AI literacy in education. Teaching staff, trainers and other educational professionals are the ones responsible for embedding AI in the curriculum and translating this into meaningful learning experiences tailored to their students and the learning context. They are also the ones who supervise learning processes. It is not only about *what* is taught about AI but especially about *how* and *why* it is taught in connection to learning and development. In this section, we focus on the pedagogical and didactic dimension of AI literacy. For each main component of AI literacy – knowledge, skills, attitudes and ethics – we describe what educational professionals need and can do to develop AI literacy in a responsible and meaningful manner in their educational practice.

Knowledge of teaching staff about AI

The indicators below provide insight into the type of knowledge educational professionals need to integrate AI into their educational practice responsibly and meaningfully. The literature identifies six knowledge areas.

Indicator	Description from the reviews
Technological knowledge Δ	Insight into digital technologies and AI applications relevant to education. This also includes knowledge about digital applications, sustainability and the effective use of these technologies to support learning.
Pedagogical and didactic knowledge Δ	Knowledge about how to use AI in a pedagogically and didactically responsible and effective way, tailored to learning objectives, subject content and student characteristics. This includes familiarity with curricula, learning strategies and didactic approaches such as experiential and project-based learning.
Ethical knowledge Δ	Understanding the ethical implications of AI use for students and educational practice, including both personal and professional responsibility. This allows teaching staff to help students develop a critical, reflective attitude to AI.

Knowledge about how students use AI Δ	Insight into how and to what extent students use AI, including GenAI. Teaching staff should be able to assess what students know and do with AI so that they can tailor their supervision and teaching accordingly. This requires open communication about AI use and misuse, such as plagiarism.
Knowledge about AI literacy Δ	Understanding the concepts, definitions and indicators that underpin AI literacy. Teaching staff need a clear grasp of AI literacy to align and further develop their educational practice accordingly.

AI skills of teaching staff in relation to education

To integrate AI literacy meaningfully into education, teaching staff must have specific knowledge and skills so that they can use AI in a pedagogically responsible way, guide learning processes effectively and adapt the curriculum in response to technological developments.

Indicator	Description from the reviews
Pedagogical and didactic skills with AI Δ	The ability to design learning activities with a role for AI, such as the use of intelligent tutoring systems or simulations. Adapting instructional strategies to the possibilities AI offers. This requires insight into how AI supports or changes the learning process and how this can be implemented in a didactically responsible way.
Using AI to support learning Δ	Selecting, integrating and using AI applications to genuinely enhance learning. This requires a critical perspective on the added value of AI in learning activities.
Curriculum adjustment to AI developments Δ	The ability to interpret and adapt existing curricula to new AI developments. This requires contextualising and aligning AI applications with the needs of their students.
Structuring AI contexts Δ	Presenting complex AI content in an intelligible and structured manner so that students are not overwhelmed. This requires offering information in suitable portions and building up learning experiences.



Attitudes of teaching staff to AI literacy

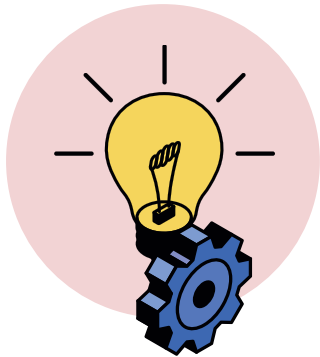
Attitudes play a crucial role in how educational professionals approach and integrate AI in their educational practice. Attitudes significantly determine whether and how teaching staff wish to use – and feel able to use – AI.

Indicator	Description from the reviews
Openness to AI in education Δ	Willingness to explore and integrate AI in educational practice, with both curiosity and critical reflection. Openness may be impeded by uncertainty, lack of knowledge or overconfidence without sufficient pedagogical justification.
Motivation for using AI in education	Teaching staff’s intrinsic motivation and a sense of ownership in using AI and innovating their educational practice.
Emphasising the importance of enabling students to critically evaluate the role of AI in society	The belief that students need to develop the ability to think critically about the societal impact of AI. This is achieved by asking questions about transparency, bias and the role of AI in decision-making but also employing didactic approaches such as explainable AI, which make the workings of AI systems transparent.

Ethical dimension in educational practice

Ethics are the foundation for responsible and meaningful use of AI in education. Educational professionals have a dual role – to behave ethically themselves and to guide students in critical and conscious use of AI. To this end we distinguish two pedagogical indicators.

Indicator	Description from the reviews
Ethically responsible use of AI in education Δ	Making conscious choices about the use of AI in educational practice, with due attention to the ethical implications of AI applications such as privacy, bias, transparency and autonomy. Aligning AI use with pedagogical aims and the context of their students. This requires a critical approach, knowledge about ethical frameworks and the ability to use AI in a safe, inclusive and fair way.
Teaching students about ethically responsible use of AI Δ	Guiding students in the development of ethical awareness regarding AI by integrating ethical themes into lessons, such as the societal impact of AI, biases in algorithms and the role of AI in future professions. Students are encouraged to reflect critically on when and how AI can be used responsibly and to formulate their own ethical guidelines.



Influencing factors

Developing AI literacy is not a given; no one is innately AI literate. Whether and how educational professionals and students become AI literate depends on various factors, such as circumstances, characteristics and preconditions. These can promote or impede the development and application of AI literacy. These factors play a role at three levels: the individual professional, the educational organisation and national policy. Each level has specific influences which shape the ability and willingness to use AI in education. Below, we explain the most important factors for each level.

Individual factors

There are four factors at the level of the individual educational professional that can influence AI literacy.

Indicator	Description from the reviews
Instruction and training	Instruction and training support technical, didactic and reflective learning and provides scope to use AI appropriately within one’s own practice or professional context.
Experience with AI	Prior experience with AI enhances confidence in and understanding of the opportunities and limitations. Professionals without such experience often feel uncertain about how to integrate AI into their teaching or which subjects are relevant.
Professional role and context	The added value and deployment of AI vary by role. Daily practice and individual tasks determine what is valuable, relevant and achievable, as well as how AI can and cannot be used.
Coherence between the use of AI on the one hand and pedagogical and didactic understanding on the other	AI is used more effectively when it is aligned with learning objectives and the developmental stage of students.

Organisational factors

There are five factors at the level of educational institutions or organisations that can influence the AI literacy of educational professionals.

Indicator	Description from the reviews
Appropriate educational resources, learning pathways and frameworks	Clear, practice-oriented frameworks, learning resources and pathways for AI – developed in collaboration with professionals – strengthen ownership and AI literacy. Examples include interactive learning tools, series of lessons on AI concepts or collaboratively developed overviews of learning objectives and competencies.
Strategic integration of professional development	AI-focused professional development that includes developing AI literacy is part of a well-considered and ongoing learning pathway. It also allows for practice-based learning, reflection and collaboration.
Supporting infrastructure	Good technical facilities and clear data governance are basic requirements for AI literacy.
Interdisciplinary collaboration	Collaboration across disciplines stimulates knowledge sharing, joint learning and a broader understanding of AI.
Integration into leadership and policy	When AI literacy is made visible in policy, leadership and HR structures of an institution, professionals feel supported and that they have the time, space and motivation to work on it. This contributes to structural integration in the institution.

Policy factors

Policy decisions at the national and systemic level form the preconditions for AI literacy within educational organisations. Four factors at this level influence the scope and direction that institutions and professionals experience when working with AI.

Indicator	Description from the reviews
Structural and public investment and policy frameworks	Long-term, well-substantiated public investments in infrastructure, training and digital transformation provide the preconditions for educational institutions to shape AI literacy. Clarity of policy and continuity of funding bolster trust and planned development, especially in regions with limited access to technology.
Laws and regulations regarding AI, technology and inclusion	Clear legal frameworks enable ethical and transparent use of AI. This includes human rights legislation that safeguards digital inclusion, the EU AI Act and protocols for safe use of AI in educational settings.
Collaboration between sectors	Policy that fosters structured collaboration between educational institutions, technology companies and policymakers leads to richer and more sustainable forms of AI literacy. Such collaborations help develop AI curricula that are both technologically current and socially relevant.
Policy-based focus on professional development	The success of AI literacy also depends on policy aimed at lasting and comprehensive professional development for educational professionals, including technical knowledge and critical, inclusive and ethical perspectives on AI. Clear standards and ongoing support foster trust, expertise and the willingness to integrate AI into education.

3. Conclusion and discussion

An evidence-informed framework for AI literacy in education

This AI-GO Framework has been developed in an evidence-informed manner, based on an umbrella review. The added value of this Framework lies in the academic literature underlying this model. Furthermore, the model was developed with and by professionals in vocational education and training schools, universities of applied sciences and research universities⁶, ensuring that all three sectors of tertiary education are well represented.

The evidence-informed AI-GO Framework is a new model for AI literacy in education. AI literacy comprises four components, starting with **knowledge**. This concerns understanding fundamental AI concepts, applications and their societal implications. It also involves specific **skills** – such as using AI-related skills to solve problems and/or collaborate with AI technologies. Another important component is **attitude**; developing a reflective attitude towards AI's role in society, including one's own perspectives and assumptions. Last but not least is **ethics**, the underlying principle when designing, using and evaluating AI applications. These components determine the extent to which individuals understand AI, use AI responsibly, evaluate it critically and develop ethically responsible AI themselves.

The four components of AI literacy

Knowledge is a prerequisite for using AI appropriately. Several indicators relating to AI emerged from the review and contributions from World Café participants. However, no definitive statement can be made as to how advanced this knowledge should be; this is context-specific and sometimes programme-specific.

Likewise, for skills, it is recommended that each programme selects the skills that are important for teaching staff and students, with a view to their intended professions – and then provide these within the programme. The substance and depth of both knowledge and skills also depend on context and programme.

⁶ Members of the Npuls project group came from all three sectors of tertiary education, and World Cafés were conducted in each sector.

A notable finding was that many existing frameworks do not emphasise attitude. Moreover, attitude was not or barely mentioned in the World Cafés even though teaching staff and students encounter it regularly in practice. Consider, for example, fear and mistrust of AI. Fortunately, attitudes are dynamic and can change through experience, interaction and guidance. Education can influence attitudes positively by creating conditions in which teaching staff and students feel safe and competent to work with AI. This can be achieved by providing training that addresses attitudes, facilitating positive experiences with AI, allowing for mistakes and uncertainty and making emotions around technology open for discussion. This kind of safe learning environment fosters the right attitude and motivation in the long term.

Ethics is also essential for the safe and responsible use of AI. Almost all reviews mention the importance of ethics, yet rarely elaborate on it. We therefore advise drawing on established ethical frameworks, such as the Npuls Reference Framework 2.0⁷ (see, for instance, Díaz-Rodríguez et al., 2023; Floridi & Cows, 2022; UNESCO, 2021).

To explicitly address teaching staff's role in AI literacy, we have also included a section on the pedagogical and didactic aspects of AI literacy. We would have liked to devote the same attention to students' role, but the available literature offered insufficient starting points for this. Further research is required in this area.

Levels of AI literacy

Unlike previous research, the AI-GO Framework does not go into levels of AI literacy or a layered structure of AI literacy. That said, the Framework does not assume that everyone must meet every indicator. Indeed, expectations for teaching staff and students depend on context, institution and programme. As an initial step, this Framework proposes that choices should be made at institutional or programme level. Decide which indicators are relevant for the institution and/or programme and for the society and labour market for which the students are being prepared. These indicators can then serve as the basis for what is expected of teaching staff and students.

It is also possible to differentiate, for instance according to programme, year of study or subject content. To promote AI literacy in the relevant context, programme directors, teaching staff and students can use the Framework to develop profiles or personas. It is important to determine from the individual role where AI can or may be deployed and which AI literacy indicators are applicable.

⁷ npuls.nl/wp-content/uploads/2025/06/Referentiekader-2.0-Npuls.pdf

Education and professional development in AI literacy

Once it is clear which AI indicators are to be used⁸, it is important that teaching staff and students can actually work with them. For students, this means that AI literacy becomes part of the curriculum and so for many programmes, part of the curriculum may need to be redesigned. AI literacy should be included as a learning objective, with due attention to its consequences for learning activities and assessment ("constructive alignment"). We are currently designing a practical guide for the toolkit this Framework belongs to. This guide offers programme directors and teaching staff tools for redesigning education⁹.

Professional development is also a must for teaching staff. Encouragement from the organisation and fostering a positive critical attitude are essential for this to succeed (see also the "Attitudes" component). Furthermore, teaching staff must have access to professional development and support for the acquisition of knowledge, skills and ethical application of AI. This Framework provides three examples of how this can be achieved. We will also expand the Npuls toolkit with a guide for designing professional development around AI literacy.

Organisational level plays an important role in AI literacy. While AI literacy is often considered an individual attribute, our research shows that it operates at different organisational levels: from the individual teacher, lecturer or student to the institution, up to the level of national policy. Together, these levels make up what we call multilevel AI literacy. Organisations wishing to promote AI literacy must therefore address this at all levels, taking into account the influencing factors discussed in this Framework.

Knowledge gaps, additional indicators based on the World Cafés and further research

One limitation of the AI-GO Framework is that it does not distinguish the relative importance of the different clusters and indicators. Based on the current literature, we cannot determine which indicators are more important than others. As discussed above, this is likely to vary between contexts, institutions and programmes. Furthermore, we have not addressed the measurement of AI literacy (or making this measurable) in this Framework. There is also comparatively little research available on the AI literacy of students. These are subjects that will be addressed in further research.

Moreover, our fieldwork from the World Cafés shows that there are factors and aspects which are important in practice but are not (or not yet) reflected in the literature. These

⁸ By, for instance, using a measuring tool to map the current state of AI literacy, which is something we are working on at Npuls.

⁹ To this end, we use the Educational Design Research (EDR) method by McKenney and Reeves (2018).

factors and aspects are therefore not or only marginally included in the AI-GO Framework. Indicators that emerged here included knowledge and skills on learning how to learn with AI, knowledge about which types of AI applications to use for specific tasks, knowledge about sustainability in the use of AI and how to assess the AI literacy of students.

It also emerged in the World Cafés that alternative ways of clustering might better align with educational practice. For example, it was proposed to follow the TPACK (Technology, Pedagogy and Content Knowledge) framework by Koehler and Mishra (2009) for this purpose. This Framework centres on how teaching staff can provide effective education with the help of technology. Another suggestion was to categorise the indicators as: 1) designing and delivering education with AI, 2) learning (to learn) with AI and 3) preparing students for a society and labour market with AI. We recommend adopting a clustering method that aligns as closely as possible with frameworks routinely used within one's own institution.

Participants in the World Cafés also indicated that the Framework does not sufficiently address the organisational aspect. They cited, for example, the importance of developing a vision for AI use as well as the need for substantiated development of AI initiatives, such as events, AI hubs and guidelines. They also highlighted the possibility of distinguishing levels of literacy. Finally, they mentioned attention for AI literacy beyond direct teaching, such as in support services, management and examination boards. In the World Cafés, the organisational level was seen as an important dimension of AI literacy. At a more fundamental level, discussions also touched on AI literacy in relation to how AI deployment affects knowledge development, the value of knowledge and potential adjustments to science itself¹⁰.

These valuable contributions from the World Cafés underline the importance of discussing and aligning AI literacy frameworks with educational practice. Although the Framework – built on the basis of literature reviews – covers broadly applicable concepts, educational professionals indicate that translating it into educational practice requires a certain level of detailing and nuance. How this detailing and nuance is provided must be closely aligned with how AI and AI literacy are developing and becoming visible in each specific educational context.

Finally, developments in AI are moving so rapidly that we aim to position this Framework as a dynamic one. We will continue to monitor advances in AI and may adjust this Framework in the future. For instance, prompt engineering is still frequently listed as a skill. However, generative AI systems such as ChatGPT can now formulate good answers even without

precise prompts. ChatGPT, for instance, now independently asks follow-up questions, such as about the target audience and preferred language. As such, this knowledge is already becoming less critical and might not be necessary at all in the future.

Conclusion

We hope this Framework gives institutions a starting point for developing and refining the AI literacy of their staff and students. This is particularly important in light of the new EU AI Act. On the basis of thorough research, we have provided as complete a picture as possible of all possible indicators that play a role in this. It is our belief that this evidence-informed AI-GO Framework should form the basis for initiatives in the area of AI literacy. Now it is up to institutions to make a choice: what do they want to focus on and how do they wish to go about it? We have already provided a number of examples in this Framework. The Npuls toolkit will be expanded with a practical guide for designing education and professional development in the area of AI literacy.

¹⁰ This also ties in with discussions around how AI is changing the role of academics (Renkema & Tursunbayeva, 2024).

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