

THE ETHICS DIMENSION OF AI LITERACY: A PRACTICAL MODEL - AN INTEGRATIVE REVIEW

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Abstract

Artificial Intelligence-based technologies are becoming more widespread, reshaping the labour market and requiring new skills and educational approaches. The development of artificial intelligence (AI) literacy programmes is therefore crucial to prepare students for these challenges. By integrating AI education into school curricula, it is possible to support young students in acquiring the necessary skills to use new artificial intelligence technologies in an informed, critical and ethical manner. This study is based on an Umbrella Review conducted in December 2024, which examined 12 papers focusing on pedagogical approaches, learning content and outcomes related to AI literacy in K-12 education. Proceeding from these findings, the present study proposes a new practical model for developing a critical attitude towards artificial intelligence in secondary education through the Challenge-Based Learning approach (CBL) in which also the "ethical dimension" is reimagined taking into account the state of the art. CBL approach can be particularly effective in fostering critical and ethical thinking in relation to artificial intelligence. In fact, it emphasizes the importance of reflection and student agency, encourages the meaningful use of digital tools, and adopts a concrete approach by focusing on real-world problems: these elements are identified by the Umbrella Review as essential to foster the critical and ethical dimension of AI literacy in secondary education.

Keywords: AI Literacy, Practical Model, AI Ethics, Critical Thinking, Challenge-Based Learning.

1 INTRODUCTION

The ongoing digital transformation is significantly impacting both learning process and personal identity. Regarding the learning process, two key dimensions must be considered: what we learn and how we learn. The rise of automation, the Internet of Things (IoT), and Artificial Intelligence (AI) has shifted the focus from hard skills (technical competencies) to soft skills, which are transferable across different contexts and distinguish humans from machines. The European Framework of Personal, Social, and Learning-to-Learn Key Competence [1] underscores the importance of developing human-centered skills that are not easily replaced by AI. The learning-to-learn [2] competence encompasses several aspects, including reflection on past experiences [3], self-determined and self-regulated learning [4,5], and the cultivation of a growth mindset [6]. While AI, with its vast datasets, excels in data processing and analysis and appears to demonstrate creativity through generative AI models, its functionality is ultimately rooted in probabilistic calculations based on predefined datasets [7]. Unlike humans, AI does not experience the "aha! moment" - a hallmark of human insight and innovation [8]. Thus, while understanding how AI functions is essential for determining its utility in various tasks, adopting a critical approach allows individuals to leverage AI while avoiding potential pitfalls and enhancing their own (meta)cognitive abilities [9].

The digital revolution has created new ecosystems in which humans must retain their agentive roles, particularly in shaping future citizens [10]. This transformation has also led to changes in both learning and teaching practices. From a learning perspective, the integration of digital tools, online environments, and AI has influenced cognitive processes such as memory, attention span, and critical thinking [11]. At the same time, from a teaching perspective, educators must adapt their methods and approaches to align with the demands of the AI era [12]. Furthermore, the digital transformation has had profound implications for personal identity, affecting both students and teachers. Students may struggle to grasp the value of attending classes and engaging in traditional study practices when generative AI can produce essays and assignments for them. This raises fundamental questions about their roles and responsibilities as learners. Similarly, teachers may question their relevance in an era where vast amounts of information are readily accessible online. This shift prompts a crucial reflection on the evolving role of educators within the information society. Ultimately, while AI and digital technologies present both challenges and opportunities, it is essential to maintain a balance between technological advancements and human agency. Only this balance can foster meaningful learning experiences and preserve the integrity of personal and professional

identities. For the reasons outlined above, the state of the art claimed the importance of developing AI skills, integrating AI literacy paths into the school curriculum.

In the past, AI teaching focused on the transmission of practical knowledge into engineering and informatic fields [13], but it has gradually extended to broader educational contexts, including K-12 settings. However, as the Integrative Review by Gu and Ericson [14] highlights, the absence of a single definition of AI literacy has created ambiguity in its conceptualization, resulting in the proliferation of various frameworks aimed at developing AI competencies. For instance, the Association for the Advancement of Artificial Intelligence (AAAI) and the Computer Science Teachers Association (CSTA) developed the *Five Big Ideas* framework [15] to provide pedagogical guidelines for AI literacy, defining specific competencies that students should develop at different grade levels. Kong & Zhang [16] proposed a framework for AI literacy divided into three dimensions: cognitive, effective, and sociocultural. Long and Magerko [17], instead, organize their framework around five primary themes, each corresponding to a guiding question about AI: (1) *What is AI?*; (2) *What can AI do?*; (3) *How does AI work?*; (4) *How should AI be used?*; and (5) *How do people perceive AI?* For each question, the framework specifies the skills that students are expected to acquire. Ng et al. [18] identified four learning dimensions, grounded in Bloom's Taxonomy [19]: (1) understanding and acquiring knowledge about Artificial Intelligence; (2) applying Artificial Intelligence; (3) evaluating and creating Artificial Intelligence; (4) AI Ethics (e.g., fairness, accountability, transparency, ethics, and safety). Similarly, Cuomo et al. [20] delineated four core dimensions of AI literacy, derived from their Scoping Review (2022) on AI literacy. These dimensions include: (1) foundational knowledge of AI and its applications; (2) practical proficiency in applying AI concepts across various contexts; (3) critical evaluation skills related to AI (e.g., assessment, forecasting, and design) and its practical applications; and (4) ethical considerations, which emphasize human-centered AI principles, including equity, responsibility, transparency, privacy, and security.

Despite the proliferation of frameworks that identify the core dimensions of AI literacy [15-20], there remains a limited number of methodological proposals for incorporating AI into school curricula [21, 22]. While literature consistently emphasizes the ethical dimension of AI literacy, evidence from Liu & Zhong [23] and Almatrafi et al. [24] show that ethics and societal impact are less prioritized compared to the focus on technical processes and the knowledge of artificial intelligence. This integrative review aims to address this gap by proposing a practical model to promote ethics and critical dimensions of AI literacy in secondary education – a level identified by Ng et al. as particularly suitable for addressing these issues [25].

In line with this objective, the study is guided by the following research questions:

- 1 What is the current state of AI literacy practice in K–12 education?
- 2 How can the ethical dimension of AI literacy be implemented in secondary school teaching practice?

After presenting the research methodology, we examine the latest version of the Digital Competence Framework for Citizens, which includes a dedicated annex on Artificial Intelligence [26, p. 77]. Then we outline the key aspects that have also been incorporated into the most recent AI literacy framework published by the OECD [27]. Building on this analysis, we propose a new taxonomy – Knowledge, Skills and Attitudes, Ethics – designed to integrate these insights and guide the teaching of AI literacy. The final section examines the Challenge-Based Learning approach [28] and presents a practical framework to promote the ethical dimension of AI literacy within secondary education teaching practices.

2 METHODOLOGY

This study is an integrative review building upon an umbrella review conducted in December 2024, which synthesized evidence on AI literacy in K–12 education practice. The integrative review approach was chosen due to the extensive body of literature on AI literacy and its suitability for emerging topics and the development of new frameworks [29], both characteristics of our research. While critical and ethical dimensions are frequently emphasized in AI literacy definitions and frameworks, significant gaps remain in guidance for designing educational interventions that promote the responsible use of AI. By integrating both theoretical and empirical literature, this integrative review method provides a foundation for generating comprehensive insights to guide the development of practical models for AI literacy in secondary education, with a specific focus on ethical and critical dimensions.

2.1 Problem identification

In line with established guidelines for conducting integrative reviews [30, 31], the review began with defining the purpose and scope of the study. Although several frameworks recognize ethics and critical

thinking as core dimensions of AI literacy, evidence from the literature [23, 24] suggests that K–12 practice remains primarily focused on technical processes. This integrative review aims to examine how ethical and societal aspects can be incorporated into AI literacy teaching practice and to propose a practical methodological model for secondary education.

2.2 Literature search and data evaluation

The umbrella review conducted a systematic search in ERIC, Scopus, and Web of Science database. The search was limited to English-language peer-reviewed journal articles and conference papers published between 2020 and December 2024, capturing studies published both before and after the release of ChatGPT. Results from the three queries were merged, and after removing 67 duplicates, a dataset of 275 records was obtained. Titles, abstracts, and keywords were screened according to three exclusion criteria: (1) studies not explicitly focused on AI literacy; (2) studies examining school levels other than K–12; and (3) studies that were not literature reviews. After the screening process, 12 articles were obtained and included in the review for full-text reading. The literature search process is shown in Fig. 1.

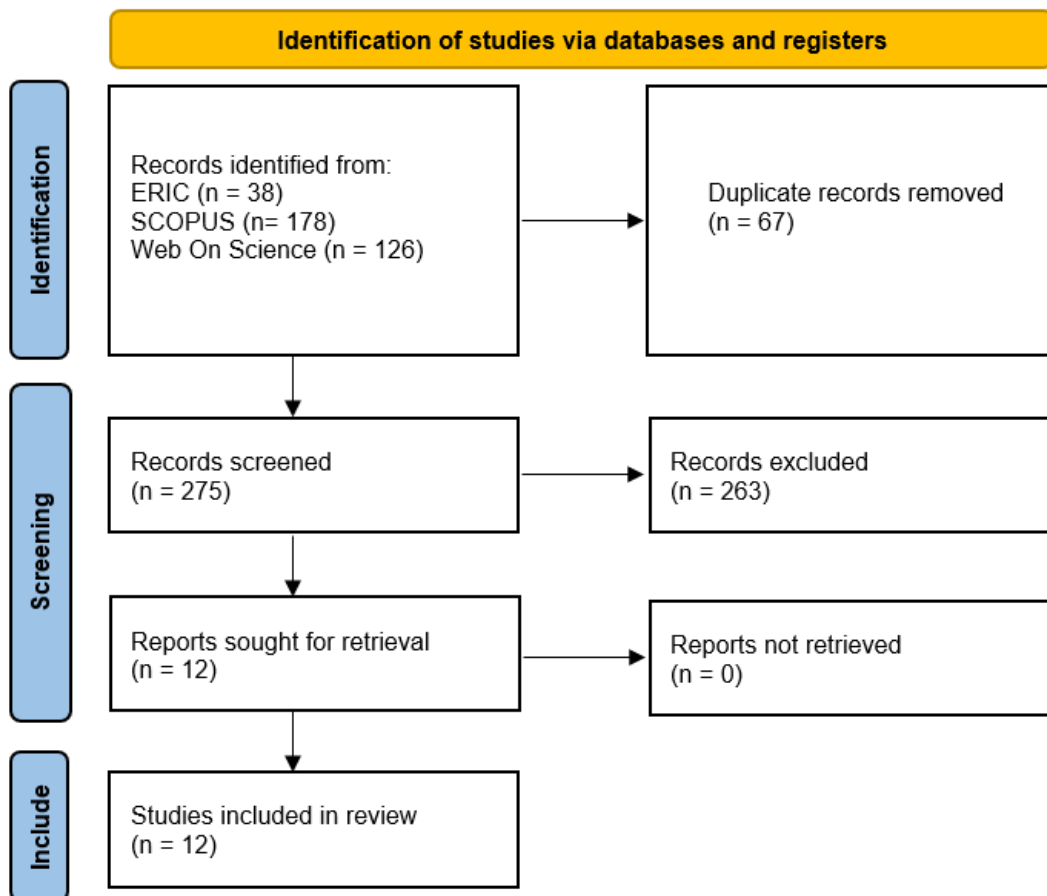


Figure 1. Study selection process.

2.3 Data analysis

To systematize the analysis, data were extracted from each study regarding key characteristics and methodological features (when applicable) about AI literacy in K-12 education. Then, the studies were coded according to the following dimensions (Table 1), which reflect the main research questions guiding the umbrella review.

Table 1. Encoding criteria for the data analysis.

Encoding Criteria
Q1. Temporal and geographical distribution of publications
Q2. Type of literature review
Q3. Specific School Level
Q4. Didactic <ul style="list-style-type: none"> • Q4.1 Teaching approaches • Q4.2 Learning content • Q4.3 Learning outcomes/objectives • Q4.4 Learning tools
Q5. Assessment methods

2.4 Results

The umbrella review indicates rapid growth in AI literacy research in K–12 education following ChatGPT’s public release in 2022. In particular, five articles were published in 2024 [23, 24, 38–40], five in 2023 [25, 34–37], and two in 2022 [32, 33]. The majority of the studies are geographically concentrated in Hong Kong [25, 32, 33, 35, 36], a region actively investing in AI education. Most of the reviewed documents are scoping reviews [25, 35–38], highlighting that AI literacy remains an emerging field of research. Experiential approaches are frequently cited [23, 25, 32–35, 39] and widely implemented in secondary education. The literature also emphasizes that engaging students through concrete, real-world–oriented problem/project/case-based learning is crucial for enhancing pedagogical impact. Regarding learning content, three primary categories are identified: basic knowledge about AI, AI processes, and AI impacts. However, within K–12 education, attention is placed more on the technical functioning of AI and the ethical dimension remains comparatively less explored [23, 24]. In terms of tools, software-based applications are predominantly used in AI literacy courses [23, 25, 32–36, 39], followed by intelligent agents [23, 25, 32, 33, 35, 36, 39], hardware [23–25, 32, 33, 35, 36], and unplugged tools [23, 25]. Robots and unplugged tools are less frequently employed and are mainly used with younger students [23]. Reviewed studies also highlight the importance of these tools in fostering active student engagement; however, assessment practices remain dominated by qualitative methods [23–25], and the lack of validated instruments limits systematic evaluation of learning outcomes. Furthermore, the umbrella review underscores the importance of advancing AI curricula through an interdisciplinary approach that systematically integrates AI literacy into school subjects [33, 34].

In summary, the results of the reviewed documents indicate that the literature recommends problem/project/case-based learning to engage secondary school students, also through the application and experimentation of software and intelligent agents. In particular, secondary school students represent ideal participants for addressing complex topics that go beyond the technical functioning of AI to include its societal impact and ethical dimensions [25]. Despite this, the learning content most frequently taught focuses on operational or technical aspects, while the social and ethical implications of AI remain less emphasized [23, 24]. For these reasons, research on AI literacy should be advanced through an interdisciplinary approach, with careful consideration of assessment methodologies and with a particular focus on ethical and critical dimensions of literacy.

Building on the recommendations identified in the umbrella review, this study proposes a practical model to foster AI literacy in secondary school classrooms, with an emphasis on critical thinking and the ethical dimension of AI. In the following sections, several reference frameworks that guided the development of the project are described and combine. Based on this integration, an illustrative table is provided to demonstrate how Challenge-Based Learning (CBL) can be applied as a guiding pedagogical methodology to address the ethical and critical dimensions of artificial intelligence. CBL was selected for its close alignment with the teaching approaches and recommendations highlighted in the umbrella review.

3 TOWARD INTEGRATING AI COMPETENCY FRAMEWORKS: THREE CORE DIMENSIONS OF ARTIFICIAL INTELLIGENCE LITERACY

Drawing on the guidance offered by the Digital Competence Framework for Citizens (DigComp), this section examines and integrates additional key AI literacy frameworks to develop the proposed methodology for secondary school education.

DigComp provides a set of guidelines on digital competences, recognized as one of the eight key competences for lifelong learning. Initially published by the European Commission in 2013, the framework has undergone several updates. The most recent version DigComp 2.2, published in 2022 [26], includes further refinement, particularly through the addition of new examples of knowledge, skills, and attitudes, as well as an appendix addressing citizen interactions with AI systems. Significant is the opening statement of the appendix because it focuses on citizens' interaction with AI systems rather than on technical knowledge of AI. [26, p.77]. Although from the outset the emphasis has been on the emerging need to acquire basic knowledge about AI - which is linked to the meaning of AI literacy - nowadays learners need to be aware of critical and ethical issues related to the interaction between humans and artificial intelligence. Understanding which human aspects AI can simulate and, conversely, how it differs from human capabilities enables a perspective in which Artificial Intelligence is regarded as a tool to augment human potential rather than replace it [41]. In this context the learner is not passive in the acceptance of Artificial Intelligence results. On the contrary, she/he is agentive, questioning and reflecting on the results outlined and developing what the state of the art defines as "symbiotic agency" [42], e.g., a specific form of proxy agency that users and tools can enact within human technology interaction. It can be considered as a form of soft determinism encompassing both how technology mediates learner experiences, perceptions and behavior, and how human agency affects the uses of technological artifacts. The symbiosis, similarly, to entanglement, implies an obligated relationship - symbionts are completely dependent on each other for survival, it can be considered a proxy agentic relationship that may provide different benefits for the recipients. Humans need to know how to use and interpret Artificial Intelligence results; Artificial Intelligence needs interaction with humans in order to learn deeply how to improve [41, 42].

In particular, DigComp framework addresses AI across five sections, which the authors have reframed into three main dimensions: (1) What do AI systems do and what do they not do?; (2) How do AI systems work?; (3) When interacting with AI systems; (4) The challenges and ethics of AI; (5) Attitudes regarding human agency and control. For each section the document takes into account three markers: knowledge (awareness of what AI systems do and do not do, including their benefits and limitations), skills (ability to use, interact with, and provide feedback on AI systems), and attitudes (critical thinking, ethical considerations, and human agency in AI use). Having a glance at the description of the five sections, it is possible to note that, even for the first two more knowledge-related sections, the whole document suggests a critical reading. A similar competence categorization and emphasis on learner agency is present in the AI literacy Framework (AILit Framework) published by OECD in May 2025. Builds on different frameworks [15, 26, 43, 44] it outlines essential knowledge, skills, attitudes, and competences regarding AI, with focus on concepts that transcend specific tools. The framework also supports interdisciplinary connections across subjects – as suggested in our umbrella review – and empowers learners to engage with AI critically, ethically, and creatively. The AILit Framework is composed by four domains (Engaging with AI, Creating with AI, Managing AI, Designing AI) and highlights that while competences may evolve over time, the framework's knowledge, skills, and attitudes provide a durable foundation for AI literacy. Therefore, the AILit demonstrates a clear alignment with DigComp 2.2 dimensions.

Ng et al. [18], as mentioned earlier, identified four learning dimensions grounded in Bloom's Taxonomy [19], which progresses from the simple to the complex and from knowledge to competence. Similarly, Cuomo et al. [20], based on the Scoping Review they conducted in 2022, identified four dimensions of literacy that served as the foundation for the development of their framework.

Table 2 compares the key markers of DigComp 2.2 with the dimensions of Bloom's Taxonomy and the frameworks proposed by Ng et al. [18] and Cuomo et al. [20]. This comparison highlights how cognitive processes such as analyzing, evaluating, and creating reflect both the critical and ethical perspectives necessary for AI use.

Table 2. DigComp 2.2 [26] and Bloom Taxonomy [19] dimensions underpinned within both Ng et al. [18] and Cuomo et al. [20] frameworks.

Competences Frameworks		AI Literacy Frameworks		Ethics
DigComp 2.2 key markers [26]	Bloom's Taxonomy dimensions [19]	Ng et al. [18]	Cuomo et al. [20]	
Knowledge	Remembering	Acquiring knowledge about Artificial Intelligence	Foundational knowledge of Artificial Intelligence	
	Understanding	Understanding knowledge about Artificial Intelligence	Knowledge of Artificial Intelligence applications	
Skills/ Attitude	Applying	Applying Artificial Intelligence	Practical proficiency in applying Artificial Intelligence concepts across various contexts	
Attitude	Analyzing	Evaluating Artificial Intelligence. Creating Artificial Intelligence	Critical evaluation skills related to Artificial intelligence (assessment, forecast, design)	
	Evaluating			
	Creating			

The following Table simplifies Bloom's Taxonomy in alignment with the key markers of DigComp 2.2 and integrates it with the dimensions proposed by Ng et al. [18] and Cuomo et al. [20]. The key indicators for the proposed practical framework are knowledge, skills and attitude, and ethics. The knowledge dimension encompasses fundamental concepts of Artificial Intelligence and its applications, while the skills and attitude dimension includes practical proficiency in applying AI across different contexts, as well as cognitive processes of analysis, evaluation, and creation. Finally, ethics is framed through a critical perspective, incorporating reflection and agency as essential metacognitive components. Table 3 presents this revised version.

Table 3. New Taxonomy for teaching AI literacy

Key indicators	Description
Knowledge	Guiding learners to acquire fundamental knowledge on Artificial Intelligence and its applications
Skills and attitude	Working on practical proficiency of learners in applying Artificial Intelligence concepts, eliciting assessment, forecast and design skills
Ethics	Providing an interactive environment where enhancing critical dimensions related to Artificial Intelligence, such as reflection and agency

4 A HYPOTHETICAL PRACTICAL MODEL TO FOSTER ETHICS USING THE CHALLENGE-BASED LEARNING (CBL) APPROACH

Starting with the formulation of the proposed framework, the conclusive section focuses on the practical application of the integrative review's findings. It illustrates how Challenge-Based Learning (CBL) can be used in secondary school classrooms to teach AI literacy. This methodology was selected for its characteristics, which are in line with the findings of the umbrella review on effective learning methods and pedagogical approaches, particularly with regard to the ethical and critical dimensions of AI literacy.

Challenge based learning (CBL) is part of *Apple Classrooms of Tomorrow - Today (ACOT2)* project, which proposes essential principles for the 21st century learning environment for high school students. CBL framework aimed to promote active learning, critical thinking, collaboration, and problem-solving skills. The elaboration of the framework started from a set of considerations, such as: (1) Secondary school students have immediate access to all kinds of information thanks to new technologies; (2) There is a lack of connection between the subjects taught in school and the real world; (3) Students need to be more involved in the learning process. These principles serve as the foundation for the definition of CBL, which is described as «an engaging multidisciplinary approach to teaching and learning that encourages students to leverage the technology they use in their daily lives to solve real-world

problems» [28, p. 1]. More specifically, Challenge Based Learning is built on twelve foundational ideas [45], emphasizing reciprocal teaching and learning, the importance of extending learning beyond traditional classroom setting, learner-centered and challenge-driven experiences, space for the use of technology, the integration of content and 21st-century skills, and the value of reflection, documentation, and safe experimentation to support critical and creative thinking. These principles highlight that Challenge-Based Learning (CBL) is designed to promote active learning and leverage new technologies, fostering an authentic learning experience that engages students in addressing real-world challenges. Given these characteristics, the framework can be considered consistent with the objectives of the research.

CBL is structured into three interconnected phases: (1) *Engage*, (2) *Investigate*, and (3) *Act*, each involving continuous reflection and collaborative sharing. In the *Engage* phase, students begin with a broad concept, referred to as a *Big Idea*, which can be explored through *Essential Questions* to identify a concrete and manageable *Challenge*. Examples of *Big Ideas* include data transparency, bias in AI, the protagonism of algorithms, and how to use ChatGPT ethically and critically. The *Investigate* phase involves formulating *Guiding Questions* to determine key aspects of the *Big Idea*. From these questions, students develop a specific challenge that aligns with their interests and concerns. This phase is supported by *Guiding Activities* – such as simulations, games, and lessons – as well as *Guiding Resources*, including podcasts, videos, databases, and websites, which assist students in developing *Analysis* and potential solutions. In the *Act* phase, students create and implement a concrete solution to the identified challenge and assess its effectiveness. To enhance the impact of their work, they are encouraged to publish and share their final outcomes.

After redefining the taxonomy (see Table 3) and outlining the Challenge-Based Learning (CBL) approach, Table 4 presents the proposed practical model aimed at fostering *Ethics*, the third key indicator of the revised teaching taxonomy. This model seeks to create interactive learning environments that enhance critical dimensions of Artificial Intelligence, such as reflection and agency. The *Big Idea* provided is just an example in order to start the flow process. Furthermore, due to its nonlinear nature, the model permits teachers to guide students for both knowledge and skills and attitude dimensions.

Table 4. Hypothetical Practical Model to foster Ethics dimension.

CBL dimensions	Description
Engage	<p>Big Idea: Artificial Intelligence and Ethics.</p> <p>Essential Question: How we can use AI ethically in the school context.</p> <p>Challenge:</p> <ul style="list-style-type: none"> • Create an AI-driven educational solution (for example an AI Chat bot that personalizes learning experiences), ensuring adherence to ethical principles and standards. • Making students aware of the ethical implications of using Chatgpt. • Design an initiative that promotes the responsible and ethical use of AI in your school, addressing issues such as bias, privacy, transparency, and social impact.
Investigate	<p>Guiding Questions:</p> <ul style="list-style-type: none"> • What is AI? • What AI can do? • What are the main applications of AI in school? • What are the ethical risks associated with AI (privacy, data transparency, bias)? • How can we design an inclusive AI system? • What is the role of the government in the use of AI? <p>Guiding Activity and Resources:</p> <ul style="list-style-type: none"> • Articles on AI and case studies on the use of AI in education and its impact on learning. • Videos, webinars and documentaries about how AI is applied in the field of education. • Open-source AI platforms and software. • Interviews with AI experts. <p>Analysis: Students will explore potential and challenges of AI in education. The key concepts from their research will be highlighted in the summary.</p>

Act	<p>Solution: Can be of different nature, as:</p> <ul style="list-style-type: none"> • Educational campaign for students. • School improvement project. • Podcasts. • Website. • etc. <p>Implementation: Students develop an implementation plan including, for example, the audience involved, dates, activities, and team roles.</p> <p>Evaluation: Offers the opportunity to evaluate the effectiveness of the solution and implement necessary adjustments.</p>
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5 CONCLUSIONS

Digital revolution, particularly the integration of artificial intelligence (AI) in teaching and learning, has reshaped the roles and identities of both educators and students, prompting them to question: «What aspects of human identity does AI reflect? »; «What aspects of humanity does AI distort? »; «How do we perceive ourselves in the reflection of the machine? » [41]. Whether AI is viewed as a tool to mimic or replace human capabilities, (re)imagining the value of both schooling and the role of educators remains a challenge. The entangled presence of AI in daily life underscores the necessity of incorporating AI literacy programs into school curricula. Despite the increasing development of AI literacy frameworks in education, a previous study - an Umbrella Review conducted in December 2024 on AI literacy in K-12 education - highlighted that there remains a gap in practical models that explicitly outline how to integrate ethical dimension of AI literacy into curricula. The study tried to fulfil that gap.

In section Three, Ng et al., [18] and Cuomo et al., [20] have been compared with the Bloom Taxonomy [19] and the DigComp 2.2 framework [26] (Table 2) in order to build a new taxonomy that would merge all the key markers of the AI literacy path from a teaching perspective. With the definition of the new taxonomy (Table 3) was given a definition of ethics that responded to the principles of reflection and agency that the teacher should elicit, and the student should develop in the AI-driven era. On this basis, in Section Four, a practical model has been developed considering the Challenge-Based Learning (CBL) approach [28, 45] as a foundational reference for developing a practical AI literacy model. CBL proves to be suitable for achieving the objectives of the study: (1) emphasizing the value of reflection, critical thinking and agency; (2) enhancing the use of digital tools, fostering autonomy and mastery in their application; and (3) directing attention to real-world problems, ensuring a concrete and practical approach. These elements emerged from the umbrella review conducted in December 2024, which showed that experiential learning is the most effective method for AI literacy in secondary schools, with problem/project/case-based learning highlighted as particularly suitable for meaningful learning. Furthermore, the umbrella review noted that, although frameworks and literature emphasize the importance of ethical dimension of AI literacy, this aspect remains less represented as a learning outcome compared to application and knowledge. Challenge-based learning methodology, therefore, addresses the second research question posed in our integrative review, demonstrating its effectiveness in teaching the ethical dimension of AI literacy and fostering the development of critical thinking.

The limits of the research are linked to the hypothesis of the model, which will have to be developed and tested with future works. Moreover, the umbrella review was conducted last year in a rapidly evolving field, so it may not include significant articles on the topic and potential biases may result from language and datasets restrictions.

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