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In search of artificial intelligence (AI) literacy in teacher education: A scoping review

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ABSTRACT

Artificial intelligence (AI) literacy has recently emerged on the educational agenda raising expectations on teachers' and teacher educators' professional knowledge. This scoping review examines how the scientific literature conceptualises AI literacy in relation to teachers' different forms of professional knowledge relevant for Teacher Education (TE). The search strategy included papers and proceedings from 2000 to 2023 related to AI literacy and TE as well as the intersection of AI and teaching. Thirty-four papers were included in the analysis. The Aristotelian concepts *episteme* (theoretical-scientific knowledge), *techne* (practical-productive knowledge), and *phronesis* (professional judgement) were used as a lens to capture implicit and explicit dimensions of teachers' professional knowledge. Results indicate that AI literacy is a globally emerging research topic in education but almost absent in the context of TE. The literature covers many different topics and draws on different methodological approaches. Computer science and exploratory teaching approaches influence the type of epistemic, practical, and ethical knowledge. Currently, teachers' professional knowledge is not broadly addressed or captured in the research. Questions of ethics are predominantly addressed as a matter of understanding technical configurations of data-driven AI technologies. Teachers' practical knowledge tends to translate into the adoption of digital resources for teaching about AI or the integration of AI EdTech into teaching. By identifying several research gaps, particularly concerning teachers' practical and ethical knowledge, this paper adds to a more comprehensive understanding of AI literacy in teaching and can contribute to a more well-informed AI literacy education in TE as well as laying the ground for future research related to teachers' professional knowledge.

Introduction

Member states should invest in the level of literacy on AI with the general public through robust awareness raising, training, and education efforts, including (in particular) in schools. This should not be limited to education on the workings of AI, but also its potential impact – positive and negative – on human rights. (Council of Europe, Commissioner for Human Rights, 2019: 14)

AI literacy has recently emerged in a landscape rich with a variety of literacies [1,2], necessitated by the pervasive presence of AI in contemporary society. As exemplified by the introductory quote from the Council of Europe, AI literacy is driven by a democratic imperative to enhance the knowledge of what AI is and its societal consequences, as well as by individuals lacking backgrounds in computer science, mathematics, or AI engineering. This imperative has become particularly directed toward compulsory education, putting teachers' professional knowledge at the centre of the AI literacy discourse. In parallel, the integration of AI based educational technologies into classrooms and universities raises pedagogical and ethical concerns, necessitating an understanding of how AI operates in educational contexts, both in theory and practice [3–5].

AI literacy is already being introduced in various national curricula [6–11], but initiatives to incorporate it into Teacher Education (TE) programmes remain scarce [12]. Given the growing presence of AI in the

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education sector, TE could play a crucial role in preparing both pre-service and in-service teachers with different forms of professional knowledge of how to engage reflectively with AI in their profession.

Several literature reviews and syntheses have explored AI literacy in various domains, such as K-12 education [13,14], higher education [15,16], and the workplace [17], as well as with respects to general AI literacy [18–20]. However, to the best of our knowledge, there exists no comprehensive literature review specifically dedicated to AI literacy in the context of TE. This study is a contribution to the emerging AI[1] literacy field. By focusing on teachers' professional knowledge, the paper adds to a more comprehensive understanding of AI literacy in teaching practices which could inform teacher educators and teachers education policy at large as well as lay the ground for future research related to teachers and TE. Accordingly, the aim is to examine how existing scientific literature conceptualises AI literacy in relation to teachers' different forms of professional knowledge relevant for TE. We address this through the following research questions:

1. What is the current scope and nature of the scientific literature on AI literacy relevant for TE?
2. How are teachers' different forms of professional knowledge reflected in the literature?

To address the second research question related to teachers' professional knowledge, we apply the Aristotelian tripartite division of knowledge: *episteme* (theoretical-scientific knowledge), *techne* (practical-productive knowledge), and *phronesis* (political-ethical knowledge or practical wisdom) as an analytic lens. This terminology, rooted in ancient philosophy has profoundly influenced the understanding of teachers' professional knowledge in higher education [21] and is reflected in qualification frameworks outlined in European governing documents (e.g., FQ-EHEA2[2]). While, in practice, teachers' professional knowledge cannot be fully disentangled or separated, the Aristotelian terminology, as elaborated in contemporary writing by e.g., Gustavsson [22] and Keeling [23], has been deemed valuable in further understanding of AI literacy related to teachers' work. The distinctions between different forms of professional knowledge allows us to be more specific in relation to how AI literacy can relate to the multifaceted dimensions of the teaching profession and TE, while uncovering blind spots and opportunities for future research gaps. The next section of this paper further points to the relevance of this terminology by examining the developmental trajectory of the literacy concept, and how it relates to teachers' professional knowledge as conceptualized in this article.

A plethora of literacies and teachers' professional knowledge

For a long time, the term literacy has been linked to written text and the ability to comprehend, employ, and express oneself through written language forms that are either mandated by society or valued by individuals [24,25]. However, in recent decades the expansion of digital technologies has affected and changed assumptions about literacy in society [26–31]. This means literacy has become a flexible concept, aligned with both socio- and technical practices across time, place, and space [28,2]. Hence, the concept inherently constitutes a constantly broadening range of capabilities associated with ICT, media and education for sustainable development, and global citizenship. Accordingly, the emergence of AI literacy can be aligned with the advent of other literacies aimed at enhancing critical awareness and "new" competences necessary in relation to particular technological constructs, such as *digital literacy* [32,33], *computational literacy* [34], *critical digital literacies* [1], *media literacy* [35,36], *information literacy* [37,2] *data literacy* [38,39], *visual and visualisation literacy* [40–42], and *algorithm literacy* [43]. Although there is no universally accepted definition of AI literacy, a frequently recurring definition within and outside of the scientific literature has been proposed by Long and Magerko [18], p.2]: "*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.*" This definition closely relates to the term *AI readiness*, which is often used to describe the understanding and implementation of AI-based technologies in education and beyond [44,45].

AI literacy initiatives, particularly in primary and secondary education, have significantly increased in number over the past five years (e.g. [10,46,47]). In some cases, AI literacy has been conceptualised as an extension of data literacy or digital literacy[20,48,49]. This view can be found in various national AI curricula for K-12 education, which predominantly take on a technological perspective by covering AI technologies and applications, including techniques like machine learning, and technologies such as natural language processing [50]. However, it is crucial to recognize that AI differs from many other digital technologies in that it often operates autonomously and can adapt according to the context [51]. As a result, teaching what AI is and does remains incomplete unless accompanied by explanations addressing crucial issues such as AI ethics, data biases, surveillance, and the potential impact on employment and sustainable development [52]. In an education context, AI literacy may encompass being aware of how data are collected and used by private EdTech companies or on what pedagogical foundations AI-based technologies operate and deliver teaching [4], and to teach and act accordingly. To better examine how AI literacy is reflected in relation to teachers' different forms of professional knowledge relevant for TE, we turned to Aristotle's classical division of knowledge: *episteme* (theoretical-scientific knowledge), *techne* (practical-productive knowledge), and *phronesis* (political-ethical knowledge, or professional judgement) as proposed by contemporary scholars in the field of education [22,53,54]. This holistic approach has either directly or indirectly influenced the foundational framework defining knowledge in TE across several Nordic countries, as well as the qualification frameworks outlined in European governing documents [55,23], which also motivates its relevance in this study. Although we acknowledge that this division of knowledge is specific whereas teacher education is country and context dependent, we find that the different concepts are open for interpretation and broad enough to be relevant in many different contexts.

Episteme, techne and phronesis

Teaching practice is, to a large degree, directed towards the interests of pupils and students, whether in primary, secondary or in higher education, by guiding them toward what is educationally beneficial [54]. This requires a holistic set of professional components that could be encapsuled by Aristotle's division of knowledge into *episteme, techne*, and *phronesis*.

Episteme pertains to knowledge of a universal and generalisable nature, meaning that something holds true in a specific manner, irrespective of the context, and can be conveyed through language [27]. Thus, episteme can be understood as representing a form of knowledge that pertains to factual and enduring information, such as Pythagoras' theorem or the definitive conclusion of World War II.

Techne encompasses practical skills acquired through teaching experiences in different subjects, such as structuring a history lecture, motivating students who have mathematics anxiety, designing geography courses or crafting clear instructions for writing assignments [54]. These skills can also manifest as embodied knowledge in which the hand or body inherently know how to perform actions, such as pipetting in the

[1] For the purpose of this study, we define AI as "machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations, or decisions that influence real or virtual environments" ([51], p. 16).

[2] "The Bologna Framework": Framework of Qualifications for the European Higher Education Area (FQ – EHEA) was adopted by the Bologna-Minister meeting in Bergen 2005. See appendix for the full text (Bologna Process, 2005)

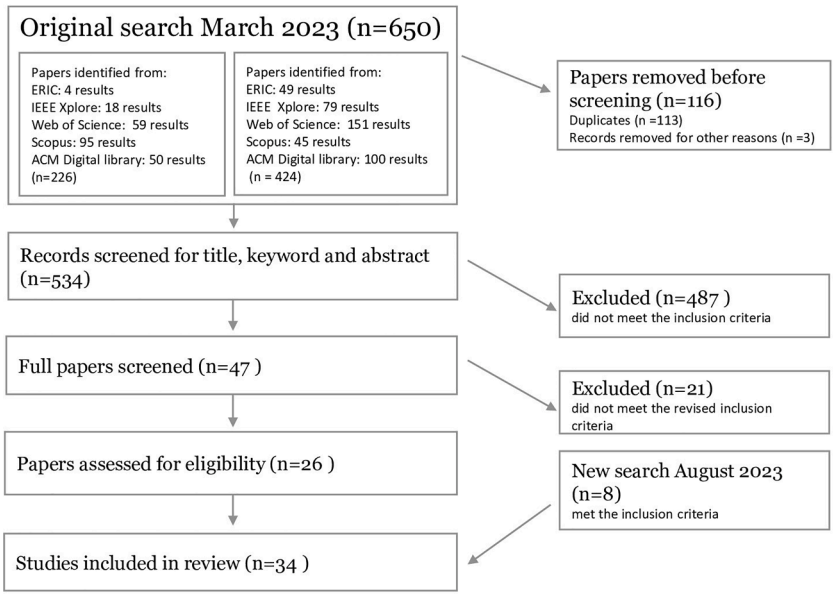


Fig. 1. Study selection.

laboratory or typing on a keyboard [56,57]. Techne has also been conceptualised as "tacit knowledge" [58,59], thus signifying a practical knowledge that is challenging to articulate through words. While techne has been recognized as a pivotal element in teaching, the everyday life of teaching and learning is relational and therefore often unpredictable and uncertain. A singular focus on techne within TE carries the risk of oversimplifying teaching practice into a mere collection of techniques and methods [27]. Therefore, teachers and teacher educators also need the ability to make thoughtful decisions when it comes to applying both knowledge (episteme) and technical skills (techne) in their teaching. In keeping with Aristotle, this form of knowledge has been identified as *phronesis.*

Developing phronesis means increasing the ability to work with the unknown and unpredictable [60]. Phronesis, as a form of professional discernment, differs from techne in that it is context-specific and based on experience. This type of knowledge cannot solely rely on specific theoretical and practical rules; instead, it must adapt to the unique nature of each situation [61]. According to Kinsella & Pitman [62], p.2] *phronesis involves deliberation that is based on values, concerned with practical judgement and informed by reflection.* This essentially positions phronesis as a moral and ethical capacity to act and the ability to predict [63].

With reference to the above, in this study we understand teachers' AI literacy as encompassing various dimensions of theoretical and practical knowledge, and where becoming a teacher extends beyond possessing scientific expertise (*episteme)* in the technical configuration and application of AI. More importantly the teaching profession centres on the ability to pedagogically guide (*techne)* subject-specific knowledge toward students, all while navigating the myriad challenges inherent in the teaching and learning process. Successful navigation depends on upholding ethical principles and demonstrating discernment (*phronesis)* towards the unknown in various educational situations, whether when teaching about or with AI. In practice, these forms of knowledge cannot be fully disentangled or separated.

Method

To answer our research questions, a scoping review was undertaken to map out the nature of the scientific, peer reviewed literature related to AI literacy in TE. Considering the novelty of our research topic (AI literacy in Teacher Education) and the explorative approach wherein we did not have a specific question formulated from the outset, we decided not to conduct a systematic review [64]. Instead, our goal was to identify key characteristics or factors related to a concept, which is why the scoping review methodology was deemed appropriate [65].

Initially, our first search focused on TE only. However, that yielded only a handful of peer-reviewed papers, which proved inadequate for our study. Therefore, we expanded our inclusion criteria to encompass studies that focused on K-12 teachers, pre-service teachers, or teacher educators in the context of AI literacy and AI education. We followed the five-stage framework for a scoping review proposed by Arksey and O'Malley [65], which involves: 1. Identifying the research question, 2. Identifying relevant studies, 3. Selecting studies, 4. Charting data, and 5. Collating, summarizing, and reporting results. This systematic approach allowed us to include papers stemming from various research designs concerning the given topic, and at the same time pinpoint existing research gaps [66].

Identifying the research questions

To gain a scientifically underpinned understanding of the emergence of AI literacy in research and identify relevant research questions, we sought guidance from two search engine experts (university librarians) and through multiple consultations with these experts, we devised an effective strategy for capturing literature that pertains to teachers' competencies in the context of AI literacy, specifically relevant to TE. In parallel with formulating specific research questions, we explored different search strategies and key words. Given that AI literacy is prevalent within the field of computer science and a global phenomenon, we chose to include both peer-reviewed scholarly articles and conference papers written in English.

Identifying relevant studies

We conducted two separate searches on 10 March 2023, using the following search query: ("AI literacy" OR "AI read*") AND (education OR learning) + (AI OR "artificial intelligence") AND "teacher education" in five highly regarded databases: Scopus, Web of Science, ACM, IEEE Xplore, and ERIC. Search limitations were applied to search for the titles, abstracts, and keywords. An initial search for literature on AI literacy in education and AI in teacher education between 2000 and 2023 in the five major databases resulted in 650 records (Fig. 1). As the field of AI

Table 1
Inclusion and exclusion criteria.

Include	Exclude
Teaching about AI in school or teacher training or TE AI literacy in the context of education English 2000-August 2023	Teaching about AI outside of a school context Teaching about AI outside of teacher training or TE AI literacy with no focus on education AI as a means to assess teachers Grey literature All languages apart from English Focus solely on developing AI curriculum, without the involvement of teachers Teachers' digital competencies not related to AI AI as a technology used in TE Literature reviews

literacy is developing rapidly and has gained significant scholarly attention only in the past year, a supplementary search with the same search query and in the same databases as in on March 10th was carried out on 3 August 2023, to identify late and deferred publications. After applying the inclusion and exclusion criteria and removing those already included in the original search, this resulted in an additional 8 records.

Study selection

All search records from the first search ($n = 650$) were imported into reference management software (Zotero). In this process, we eliminated duplicates ($n = 113$) and records that did not fall into the categories of journal papers or conference proceedings ($n = 3$). We then conducted a two-stage screening process to identify publications that met our inclusion and exclusion criteria (Table 1). To ensure consensus on the inclusion and exclusion of papers, we randomly selected 40 papers from the library for screening by a minimum of the first author and any of the other authors (either author 2, author 3, author 4, author 5 or author 6). Next, the first author screened the abstracts of all remaining records (534) in accordance with the stated inclusion and exclusion criteria and excluded $n = 487$ papers, for example as articles discussing AI literacy outside of the primary and secondary school or teacher education context. This initial screening aimed for sensitivity rather than specificity, prioritizing the inclusion of papers rather than their exclusion. At this stage, no papers were excluded based on methodology.

Following the first screening, we identified a total of 47 titles for a second-stage screening by both the first author and the second author and additionally either author 3, 4 or author 5. During this phase, we decided to exclude literature reviews, refined our research question formulation and discussed relevant coding strategies. Based on this second screening, we selected 34 articles for further analysis in this scoping review.

Charting the data

The first and second author thoroughly reviewed all the articles to ensure a robust and unanimous interpretation. To extract relevant information from the studies, a data charting table was created. This table included not only bibliographic details but also information about the study, study type, theoretical frameworks employed, components related to AI literacy within the study, publication type, and the primary target audience. The first and second authors independently coded all 34 studies, and the remaining authors coded a selection of 10–15 papers each. All authors independently completed their respective entries in the table, and subsequently, these entries were compared and adjusted as necessary to reach a consensus. This approach allowed us to achieve robust validation in both descriptive and qualitative coding [67]. In cases where there was a disagreement among any of the authors, a third author was consulted to facilitate resolution.

Collating, summarising, and reporting results

In the final stage, the 34 papers underwent a comprehensive analysis that encompassed both quantitative and qualitative descriptive analysis and qualitative examination. The quantitative analysis shed light on the scope, characteristics, methods, and distribution of the included papers and grouped the topics into the main themes based on their aim and research questions. The qualitative analysis was conducted in two stages. In the first stage, existing themes were identified independently by the first and second authors, in a process that can be described as abductive [68], using the Aristotelian concept *episteme, techne* and *phronesis* as an analytic lens to explore how teachers' and teacher educators' forms of knowledge is conveyed. In the second stage, which involved two rounds of readings, the authors validated the analytical coding process, leading to the classification of explicit (clearly articulated) and implicit (underlying, assumed) dimensions of episteme, techne, and phronesis. For instance, explicit techne could involve specific recommendations on how to teach AI, whereas implicit techne could be found in the questions asked in surveys or interviews. Consequently, in studies that did not explicitly centre on a specific dimension, we were at times able to uncover the diverse forms of knowledge implicitly by delving further into the findings or methodological approaches. The analytical work and writing process were highly iterative and collaborative, involving all authors. Through extensive discussions that included revisiting the papers, the inductive and deductive analysis, the interpretation of the analytical as well as deliberations on borderline cases, we collectively arrived at a comprehensive understanding of how AI literacy is being conceptualised in the context of TE in the selected scientific literature.

Limitations

Whilst this scoping review was undertaken as rigorously as possible, it is limited by its search strategy. More than 500 scientific records were screened in five research databases that are large and international in scope. However, grey literature such as theses, posters and book chapters were not included in the review, and articles not published in English were excluded. This approach may have resulted in the omission of valuable insights, in particular when it comes to papers published in other languages. Nevertheless, our primary focus in this paper was to develop a comprehensive understanding of AI literacy pertaining to TE based on literature that is grounded in methodological and theoretical rigor. Moreover, our exploration went beyond the boundaries of our initial search strategy to fully grasp the contemporary discourse on AI literacy in the field of education. We are also aware of the limitations of our chosen analytical lens, which enabled us to capture certain aspects of teachers' knowledge but may have overlooked other facets presented in the papers.

Results

A total of 34 papers serve as the basis for our analysis. In response to our first research question, we describe the current nature and scope of AI literacy relevant to TE as stated in the literature. This section encompasses background details, including publication year, country of origin, and research methods. It also elicits the predominant topics and how AI literacy is framed within the papers. Next, we address how primary and secondary (K-12) teachers' and teacher educators' different forms of knowledge are reflected explicitly or implicitly in the literature, adopting the Aristotelian tripartite division of knowledge – *episteme, techne* and *phronesis.*

Research question 1: the scope and nature of AI literacy relevant to TE

AI literacy has grown in interest within the scientific community in the past two years,[3] with a relatively even distribution between conference papers ($n = 15$) and journals ($n = 19$) (Fig. 2.)

Proceedings primarily stem from conferences related to computer science education, artificial intelligence, educational technology, and technology-enhanced learning (TEL). The most frequently featured journals include "Computers and Education: Artificial Intelligence" ($n = 2$), "Education and Information Technologies" ($n = 2$), "Sustainability" ($n = 2$), "Künstliche Intelligenz" ($n = 2$), and the "British Journal of Educational Technology" ($n = 2$).

AI in the context of primary and secondary education is a subject of global interest, reflected in the geographical origins of the first author of the included papers. Notably, researchers hail from various countries, with the highest representation coming from Hongkong/China ($n = 9$) and the United States ($n = 7$). Other countries with researchers contributing to this discussion include Austria ($n = 2$), Slovenia ($n = 2$), the, Australia ($n = 1$), Belgium ($n = 1$), Brazil ($n = 1$), Canada ($n = 1$), Finland ($n = 1$), Germany ($n = 1$), India ($n = 1$), Israel ($n = 1$), Malta ($n = 1$), South Africa ($n = 1$) and Sweden ($n = 1$), Taiwan ($n = 1$), Turkey ($n = 1$), United Kingdom ($n = 1$) as illustrated in Fig. 3. For more detailed information about the origin country of all 34 papers, we refer to the Appendix.

Topics

The studies can be grouped into six main topics based on the aim and research questions: *Curriculum development, AI literacy frameworks, Teacher attitudes and (mis)conceptions, How to teach with and about AI, Professional development* and *AI ethics* (Table 2).

Curriculum development-oriented studies (1) focus primarily on students' AI literacy, rather than specifying the knowledge required by teachers and educators [69,71]. Studies emphasising *AI literacy frameworks* (2) identify different aspects of AI that students as well as teachers should understand [18,73]. Eleven studies address *teacher attitudes and (mis)conceptions* (3) about AI. They aim at formulating strategies for measuring AI literacy or apply existing frameworks to explore the different connections between various dimensions of AI literacy among teachers, e.g., teachers' willingness to embrace AI in education or their understanding of how AI works in theory and practice [79,74]. Studies centring on *How to teach with and about AI* (4), e.g., Druga et al. [82] and Wilton et al. [84], focus on the evaluation of AI EdTech. Studies within this theme also concern the application of AI technologies in teaching practice [83,86]. Studies focusing on *professional development* (5) often promote peer learning and co-design for fostering AI literacy[12,89]. There are also some studies addressing *AI ethics* (6) in relation to teachers' knowledge [92,93]. Some of the studies[18,81] cover several of the outlined topics.

Methods and theoretical approaches

Two-thirds of the papers ($n = 22$) are empirical, and the remaining one-third ($n = 12$) are conceptual in nature. Among the empirical articles, eight ($n = 8$) employ a qualitative methodology, eight ($n = 8$) rely on quantitative approaches, and six ($n = 6$) adopt a mixed-methods approach. In terms of data collection methods within the empirical articles, common methods include individual interviews and questionnaires [71,12]. Some studies use focus group interviews [75], statistical methods [76], or a combination of these methodologies [81]. No empirical studies are grounded in classroom observations. The conceptual papers explore definitions of AI literacy and highlights implementation frameworks [20,73], or extend AI literacy into specific pedagogies [83,85] or AI topics related to ethics [92].

[3] Our search does not include papers published later than 3 August 2023, meaning that it does not cover the entire 2023.

Appearance of AI literacy

The concept "AI literacy" is referenced in the majority of papers ($n = 23$). However, ways to define, operationalize and measure AI literacy varies widely, and just a limited few of the papers [88,20,75] elaborate on what AI literacy is. Such definitions draw primarily on the conceptual frameworks developed by Long and Magerko [18], Ng [48], and Luckin et al. [45]. Although these frameworks are tentative in their approach, and not explicitly designed for various teacher and student groups, they are also employed to chart teacher competencies and attitudes within highly specific contexts [40,69].

AI literacy is also often discussed in combination with other literacies, such as media literacy and digital literacy [70] and data literacy [81,20], and frequently used interchangeably with concepts such as AI readiness [45]; Wa [41], AI education [69,72], and AI thinking [12]. Given the focus of this review, it is important to note that there was just one study, an intervention study with 34 secondary school teachers in Computer Science, conducted by Vazhail et al. in 2021, that explored AI literacy in TE.

Research question 2: teachers' different form of professional knowledge

While all studies include some dimensions of theoretical knowledge (*episteme*), skills (*techne*) and practical, professional judgement (*phronesis*) relevant to AI literacy, we found that these aspects emerge either explicitly or implicitly. This is illustrated on a general level in Fig. 4. To exemplify, studies that explicitly explored epistemic dimensions of AI literacy proposed a clear-cut framework about desirable AI knowledge [18]. However, episteme could also be captured implicitly; for example, in studies that we have referred to as AI knowledge but that were focusing on a different topic, such as professional development [46] or teachers' attitudes [75]. The distinction between explicit and implicit knowledge as per episteme, techne and phronesis is further exemplified in Tables 3–5. Since many studies cover more than one knowledge dimension, either implicitly or explicitly, they may appear more than once in Fig. 4. The asterisks preceding each article title indicate the number of knowledge dimensions in which an article appears.

Theoretical knowledge: episteme

Two-thirds of the papers ($n = 23$) either explicitly or implicitly mention what theoretical knowledge teachers should possess regarding AI. For the most part, this knowledge appears in fragments, primarily in implicit ways, as illustrated in Fig. 4.

Explicit episteme. The conceptual studies by Kandlhofer et al. [88], Long and Magerko [18], and Schüller [20], offer a comprehensive overview of AI literacy, and among these Kandlhofer et al. [88] focus specifically on AI curricula content for primary and secondary (K-12) teachers. Here, authors introduce a professional and standardised framework tailored for the training and certification of educators and students in the fields of AI and robotics. Topics covered relate to the principles of AI, including AI definitions, practical applications of AI in everyday life, identification and recognition of AI systems, fundamental data structures, the basics of propositional logic, the theoretical as well as practical aspects of Python programming, principles of natural language processing, computer vision, and machine learning. The advanced modules, designed for teachers and students with prior knowledge in computer science, mathematics, and physics, delve deeper into the fundamental mathematical concepts that underpin AI. Notably, in this framework, robotics and AI are treated as separate topics [88].

Long and Magerko's conference paper titled 'What is AI literacy?' (2020) integrates robotics as one of 17 competencies covering a broad range of topics, including recognizing existing definitions of AI and intelligence, distinguishing between general and narrow AI, grasping the fundamentals of machine learning, identifying AI strengths and weaknesses, comprehending representations, decision-making processes,

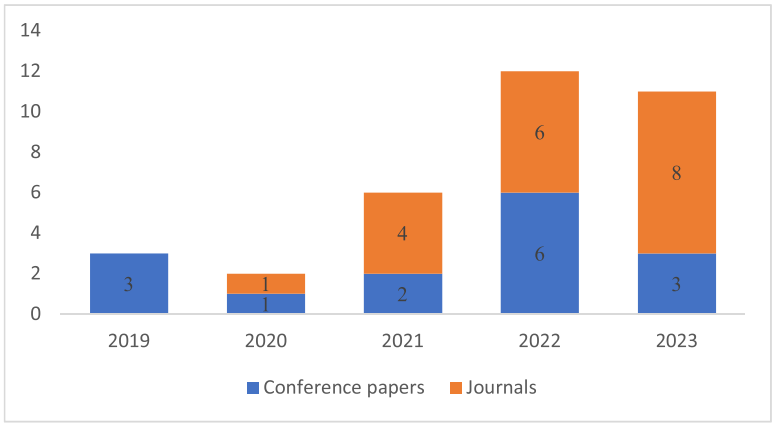


Fig. 2. Number of conference papers and journal articles from 2019 until 3 August 2023.

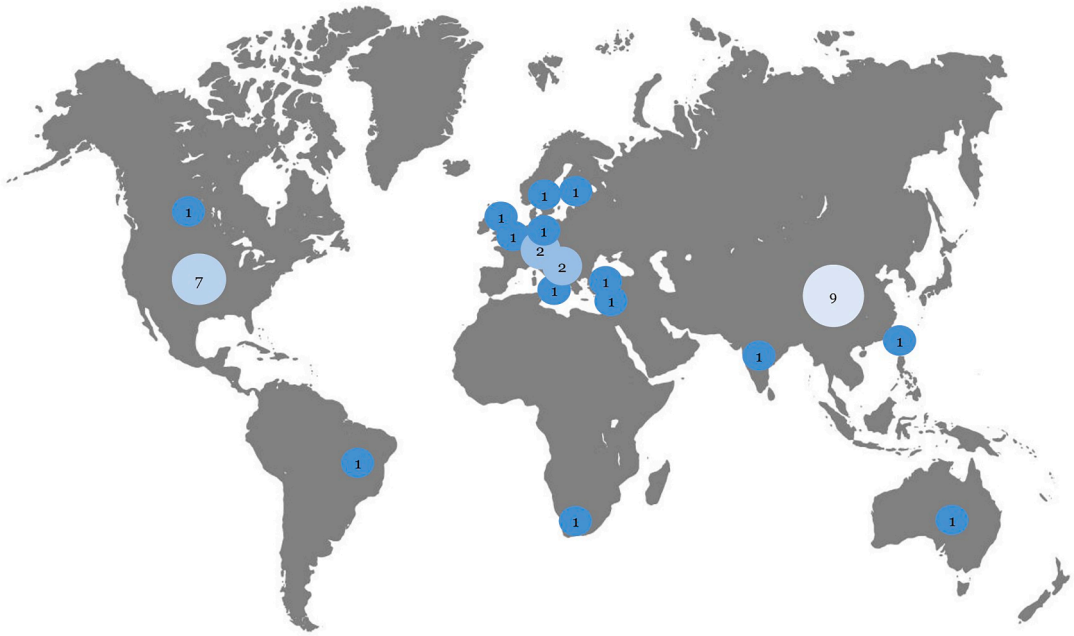


Fig. 3. Geographic distribution.

Table 2
Predominant topics reflected in the literature.

No.	Topics	Studies	Foci
1	Curriculum development	[69–72],a (*n* = 4)	Studies focusing on curriculum co-development – primarily student AI literacy curricula.
2	AI literacy frameworks	[14,18,20,41, 45,73] (*n* = 6)	Articles mapping different aspects of AI literacy frameworks.
3	Teacher attitudes and (mis) conceptions	][6,72, 74–81] (*n* = 11)	Studies developing quantitative frameworks for measuring conceptions about AI, AI literacy and willingness to adopt AI in education.
4	How to teach with and about AI	[82–86] (*n* = 5)	Studies that explore the adoption of AI applications and digital resources for teaching about AI in the classroom.
5	Professional development	[12,87–91] (*n* = 6)	Mapping ways to enhance teacher AI literacy through professional development programmes.
6	AI Ethics	[92,93] (*n* = 2)	Studies exploring ethical concerns and considerations in relation to AI in education.

various aspects of data literacy, insights into how the world is captured, measured and processed through AI, the programming of intelligent agents, along with considerations related to AI ethics. Their framework is, to a large extent, based on 'grey literature', encompassing materials such as AI, machine learning, cognitive science, and robotics courses in the US.

Similarly, Schüller [20] proposes a holistic framework in which data literacy and AI literacy are merged. The framework targets teachers and students, as well as policymakers and the general public, and expands on the German Data Literacy Framework which in turn focuses on data analysis, statistics, and mathematical concepts relevant to AI, along with computer programming. Here, individuals should understand how data is generated, possess the ability to manipulate data based on statistical principles, and have the capacity to create and use AI algorithms in decision-making processes. The comprehension of AI's technological configurations is also explicitly stated in various intervention studies, where teachers engaged in training activities were exposed to fundamental concepts and procedures related to machine learning (e.g., [81, 12]).

Particular attention is directed toward ethics as a form of epistemic knowledge, whether explicitly [41,70,92–94] or implicitly [48,75].



Fig. 4. The reported implicit and explicit knowledge dimensions (episteme, techne and phronesis) in the included literature.

Table 3
Example of explicit and implicit episteme.

Form of knowledge	Episteme	
Appears in the paper	Explicit	Implicit
Example	Mentions the theoretical concept of AI and the difference between AI, machine learning and deep learning [71,20]	Definitions of AI knowledge are expressed in questionnaire; states what students need to know in AI curricula but not explicitly teachers [79,90]

Table 4
Example of explicit and implicit techne.

Form of knowledge	Techne	
Appears in the paper	Explicit	Implicit
Example	Describes the use of certain AI applications to teach about or with AI[83,12]	Evaluations of AI applications; Meta-analyses of AI frameworks [82,73]

Table 5
Example of explicit and implicit phronesis.

Form of knowledge	Phronesis	
Appears in the paper	Explicit	Implicit
Example	Professional evaluations of AI; discussions on AI ethics [81]	Explorations of practical wisdom through questionnaires; acritical focus on implementation (e.g., [75, 80])

Here, ethics is conceptualised in relation to the technical configurations of data-driven AI technologies, emphasising the risk of biases and discriminatory decisions. As a result, ethics are turned into facts that teachers should know, rather than approached as a moral and adaptable way of thinking and acting in response to various unknown situations and contexts where AI is employed or adopted.

In parallel with the epistemic focus on AI ethics, a notable number of papers discuss the need for teachers to comprehend the principles underpinning various AI EdTech to effectively integrate them into their teaching practices [41,45,81,84,91,95]. This knowledge is often believed to enhance teachers' willingness to adopt AI EdTech. Thus, teachers need to understand the principles of where AI is making

decisions in the specific AI EdTech, where it offers guidance or information for human decision-making, and where it's tasked with identifying and interpreting patterns to become "AI-ready" and reap the advantages of AI in educational settings. In contrast, Wilton et al.'s [96] examination of the AI components within various AI technologies as a means to improve the AI literacy of pre-service teachers showed that many commercial applications do not provide sufficiently detailed information about the data collection methods employed by their AI tools, making it difficult to identify how these technologies influence factors such as bias, ethics, and explainability.

Implicit episteme. In the majority of the papers covering teachers' professional development (e.g., [86,87,89]) and curriculum development [70–72,90,91], teachers' epistemic knowledge is reflected in much more implicit terms, often briefly referring back to existing curricula or frameworks that are not further explained. For instance, in Lee et al. [89], the primary focus was on investigating a professional development model, rather than examining the DAILy curriculum adopted in the study. The DAILy curriculum[4] was designed by MIT educators and encompasses teaching resources, exploratory teaching activities, and computer-based exercises centred around AI concepts, ethical considerations in AI, creative expression using AI, and the relevance of AI to the future.

Epistemic knowledge also resides within the adopted methodological approaches. To provide an illustrative example, the study by Antonenko and Abramowitz [79], which focuses on teachers (mis)conceptions, depends on a specific understanding of what teachers ought to know. The authors identify certain beliefs as accurate, such as the idea that "AI cannot operate independently of humans" and that "AI technology is accessible to everyone". Conversely, they classify other beliefs, such as the notions that "AI is too intricate for non-experts to grasp", "AI lacks creativity", and "AI will replace human jobs", as misconceptions. Teachers' responses in relation to these statements are subsequently regarded as indicators of their epistemic knowledge about AI.

Practical knowledge: techne

In comparison to episteme, techne – teachers' practical knowledge – is less addressed ($n = 18$) in the literature.

Explicit techne. Out of the 18 papers, four directly focus on methods to train teachers, enabling them to feel confident in teaching AI in their classrooms [12,87–89]. Lee and colleagues [89] report on their ongoing professional development programme, AI Book Club, which aimed to equip teachers with epistemic knowledge about AI and foster an understanding of ethical issues related to bias in AI. During each week of the programme, participants dedicated an hour to independent reading, reviewing AI activities, and watching videos of other educators teaching these activities, and met online for another hour to discuss the materials and brainstorm ways to adapt them for their classrooms. Teachers appreciated this spaced approach, as it allowed them time to reflect, experiment, make mistakes, and ask questions. A crucial component of the programme was the establishment of a collaborative learning environment, where teachers felt at ease grappling with AI concepts collectively. Similarly, Vazhail et al. [12] reflect on how teachers appreciated peer learning when engaging in professional development activities related to AI. These involved hands-on activity and exploratory teaching using the programming language Scratch.[5]

The integration of AI EdTech in education stands out as a means to enhance teachers' instructional methods and simultaneously bolster their AI literacy. This perspective is explicitly evident in the works of Nazaretsky et al. [81], Ng et al. [94], Zhao [77], Pretorious [83], and Yetişensoy [85], and implicitly in e.g., Akgun and Greenhow [92] and Luckin et al. [45]. Pretorius [83] underscores the significance of cultivating prompt engineering skills among students, drawing from her own experience as an educator applying ChatGPT in courses with pre-service teachers. Similarly, Yetişensoy and Rapoport [85] advocate for the benefits of incorporating generative AI into social studies education, suggesting how this can be put into practice.

Nazaretsky and colleagues (2022) explore the role of trust in practitioners' acceptance of (or resistance to) AI EdTech, and conceptualise AI literacy to "mitigate teachers' biases" regarding automated grading and to instil trust in AI EdTech as a technology that can alleviate teachers' workload while resulting in a higher degree of reliability and fairness. The paper aims to address teachers "misconceptions related to human 'super-powers' and to expectations that AI-Graders' recommendations should always be perfect" (p. 920). To provide teachers with a deeper understanding of both the capabilities and constraints of human intelligence and AI EdTech, the authors developed, implemented, and evaluated a training programme revolving around a specific application of Natural Language Processing (NLP) and AI for automating the grading of constructed responses in biology. Authors conclude that teachers often exhibit a "strong confirmation bias" and hold "algorithm aversion" when arguing that automated assessment cannot capture "the big picture" or "read between the lines" as effectively as humans.

A couple of studies highlight, either explicitly [71] or implicitly [72], how teachers have to transform and negotiate the content of a predefined AI curriculum, to make the instruction more concrete and aligned with students' experiences. In line with these recommendations, Henry et al. [70] propose an AI curriculum tailored for children aged 10–14 that was co-produced with teachers and presented as an analogue, role-playing game, inspired by the game "Guess Who?".

Implicit techne. Teachers' practical knowledge related to AI literacy can be found implicitly within the 15 design considerations outlined in the AI literacy framework by Long and Magerko [18]. These considerations involve factors such as embedded interactions, collaborative experimentation with AI technology, aligning data with relevance to learners, gradually unveiling information to prevent cognitive overload, and exploring ways for individuals to programme and/or instruct AI agents. Importantly, these considerations take into account factors like age, prior experience, preconceptions, and the learners' identities, values, and backgrounds.

In many of the papers, teachers' practical knowledge regarding AI literacy implies the adoption of digital resources for teaching about AI or the integration of AI EdTech into teaching, and the use of digital resources for teaching about AI is often proposed as the most effective and suitable method for instructing both students and teachers [73,82,86,87,91]. Although there seems to be a plethora of digital AI learning resources, these are of varying quality, which, may in turn present challenges to teachers. In an analysis of over 50 AI resources, primarily centred around hands-on activities and exploratory teaching approaches, and originating from initiatives such as AI4K12, CSTA, and MIT AI Education, Druga and colleagues (2022) found that existing AI resources often fall short in adequately addressing the needs of teachers for implementing and customising them in their teaching practices. The resources seldom cater to diverse age groups or varying levels of prior knowledge. Additionally, the coverage of AI is quite diverse, primarily emphasising the technological dimensions of AI related to perception and learning, as stated in the proposed curriculum by Touretzky et al. [12], while paying notably less attention to the societal impacts of AI.

Professional judgement: phronesis

Phronesis has been referred to as the professional competence based on values, concerned with practical judgement, and informed by reflection in an explicit manner. Some of the studies adopt different qualitative and quantitative methods to measure ethical concerns and

[4] Daily – RAISE (mit.edu)

[5] https://scratch.mit.edu/about

teachers' anxieties related to AI [75], teachers' readiness and willingness to embrace AI in education [40,76,96], the cultivation of teachers' critical thinking proficiencies [9,96], teachers' attitudes and self-determination [74,69], and the considerations teachers make when adopting an AI curriculum [71].

Several of the qualitative empirical studies that address teachers' ethical concerns or reflections related to AI, rarely pick up on these dimensions. For example, in the study by Vazhayil et al. [12], which aimed to enhance AI literacy among pre-service Indian teachers, teachers' concerns or reflections were mostly not acknowledged as components of teachers' competencies. The authors concluded that the exploratory teaching interventions with Scratch were successful, but as reflected in their quotes, the teachers remained unconvinced that the proposed teaching approach was suitable for Indian schools. This scepticism stemmed from various factors, including concerns related to internet access, availability of computer labs, and pedagogical considerations regarding computer use during lessons. Instead of affirming teachers' professional judgments, the authors concluded that teachers' perspectives can act as a barrier to teaching AI. This suggests that there exist specific ideas regarding how AI should be taught in schools, and which attitudes and values are deemed desirable within the context of AI literacy.

Discussion

This study aimed to examine how the scientific literature conceptualises AI literacy in relation to teachers' different forms of professional knowledge relevant for TE. In doing so, we focused on two research questions: 1. What is the current scope and nature of the scientific literature on AI literacy relevant for TE? and 2. How are teachers' different forms of professional knowledge reflected in the literature? Our findings support previous research [16,18,48], in that AI literacy is a rapidly emerging research topic and term, globally. Even though our study highlights a rise in the number of published papers in journals and conferences over the past two years, it also demonstrates how the term "AI literacy" is, with one exception [12], not yet a research focus in the field of TE. More importantly, our findings can contribute to the understanding of AI literacy within the teaching profession and set the stage for future research within this topic that acknowledges the intricacies and situatedness of teaching. In the next sections, we discuss the findings we consider most crucial for future consideration of the nature of AI literacy, its background in computer science, the related emphasis on digital resources for teaching about AI and AI EdTech in teaching, and how ethics are reflected.

A computer science centric initiative

Despite the surge in and adoption of "AI literacy" in the educational context, also in TE, the concept remains notably underdefined and underexplored in relation to what it means in both educational theory and practice. Our study highlights a prevailing focus on computer science subjects, exploratory teaching approaches, and the incorporation of AI EdTech into classroom teaching. We therefore conclude that the term "AI literacy", instead of being discussed in depth, appears to serve the specific interests of different professional groups, notably researchers, educators in higher education, and teachers affiliated with the fields of computer science and computer science education [2]). This is not surprising, as AI at its core is a computer science subject, and discussions on what and how to teach in relation to AI have been ongoing for decades. However, it is important to note that AI literacy emerges from a domain not specialized in teachers' professional knowledge and the educational context, and draws on epistemological traditions that, to a high degree, may differ from the educational sciences. This can be reflected in, for example, the high expectations that all teachers and teacher educators in all subjects and across all levels of schooling will be able to actually *recognize and describe examples of how computers reason and make decisions* ([18] p.598) or to have the knowledge to critically assess and interpret data [20]. Furthermore, a significant portion of the epistemic knowledge pertains to what students should understand about AI, and there is comparatively little emphasis on what teachers need to convey about AI or incorporate into their teaching within the appropriate educational context, not to mention the essential requirements for teacher educators to prepare future teachers within this domain. Thus, we cannot help but wonder how the relatively advanced content presented in the referenced frameworks can be made relevant for TE.

The implicit conceptualisation of AI literacy

The vague and inconsistent use of "AI literacy" in the material stands in contrast with the predominantly implicitly reflected dimensions of knowledge that teachers are expected to possess. In other words, although there still does not exist an agreed definition of what AI literacy entails in relation to teachers' theoretical, practical, and ethical knowledge, research initiatives assume this knowledge to be of a specific type. These assumptions as demonstrated by our study, are largely implicit. This in turn influences how AI literacy is advocated for, theorised, methodologically researched and, in extension, understood (c.f. [21]). Arguments suggesting that AI "can liberate teachers from tedious administrative and instructional tasks, allowing them to focus on innovative endeavours" [41], are considered crucial "for the future workforce" [6], and hold the potential to "enhance the capabilities of K-12 educational systems and promote the social and cognitive development of both students and educators" [92], are very common and highlight a perspective that can be described as *techno-solutionist* [95,97,98].

In a similar spirit, AI literacy is predominantly reflected as something that can be taught, evaluated, and measured independently of the specific situated and work-practice-oriented contexts in which it is employed, and where ethical consequences of the implementation and use of AI are framed in terms of technical challenges that can be addressed through better design and development of AI. While there exists some nuanced approaches that underscore the significance of developing AI literacy skills to critically evaluate, communicate with, and effectively use AI [18,75], the specific components of what it means to critically evaluate AI often remain unexplained.

The implicit conceptualisation is also reflected in some of the quantitative studies, where several of the questionnaires used in the surveys, and the hypotheses being tested, were insufficiently presented. This points to a need for greater transparency and scientific rigor, and empirical research to gain a deeper understanding of what AI literacy entails in different domains of education [41]. In this regard, we need to point out that even if a significant number of studies in our review were qualitative in nature, no study was based on classroom observations, which in turn provides limited insights into what AI literacy entails in teachers' practice.

The focus on digital resources and AI EdTech in teaching

There is a strong inclination toward exploratory teaching pedagogies involving digital resources for teaching about AI (c.f. [99,100]). Such approaches assume that; 1) the most effective learning experience is to have learners collaboratively experiment with specific digital technology with their peers, and 2) the pedagogic content of the learning experience is identical to the methods or epistemology of the discipline being studied [24]. Building on this pedagogical bias, different digital resources are believed to address teachers' and students' AI literacy. Therefore, a prevailing trend is to provide pre-packaged solutions for teachers to experiment with, delving deeper into how these solutions affect what can be taught in the classroom. As put in one of the few critical notes regarding this pedagogical bias, by Druga and colleagues (2022, p.96): *these technologies and their designs matter as they shape and constrain what content knowledge can be taught.*

The literature also reflects a somewhat uncritical promotion of AI

EdTech in teaching practices, not considering the growing number of critical studies pointing to its problematic implications related to e.g., the power structures [101,96], ethical dimensions related to datafication and dataveillance [102,103], and educational implications of AI technologies in education[104–106]. Thus, the focus on digital technology in the realms of teaching with and about AI marks how, rather than being tied to a specific body of professional knowledge, AI literacy depends on the existence and use of digital artifacts.

Ethics as epistemic knowledge

The heightened emphasis on ethical concerns and risks linked to AI systems is manifested implicitly or explicitly in many of the papers, reflecting the growing research focus on AI ethics as a comprehensive domain [107,108]. However, the papers included in this review predominantly conceptualise ethics in relation to the technical configurations of data-driven AI technologies, emphasising that both teachers and students should and can act ethically by being aware of how biases in AI can result in discriminatory decisions. As a result, ethics is often reduced to an epistemic knowledge centred around data and computational approaches, rather than a moral and adaptable way of thinking and acting in response to various unknown situations and contexts where AI is employed or adopted. As stated elsewhere [4,52], considering that AI in education involves the application of various types of AI EdTech, the ethics of AI literacy should encompass considerations related to teachers' expectations, resource allocation, biases, the role and value of assessment, teachers' roles, teacher-student relations, and specific pedagogical approaches such as instructionism and constructivism, among others. While teachers' attitudes and (mis)conceptions is a prevalent topic in the literature, our observations that phronesis is the least displayed dimension of knowledge, reflects a methodological gap in the literature, as well as crucial research gaps to fill in years to come.

AI literacy in TE–future directions

Undeniably, teachers' different dimensions of knowledge will be imperative to how AI literacy will play out in the realms of education. Our literature review suggests that currently, teachers' knowledge is not comprehensively addressed or captured in the research. More importantly, teachers' expected knowledge is not what is currently shaping the concept of AI literacy. Based on these insights, we suggest three significant research foci for TE that warrant specific attention. Firstly, there is a pressing need to reach a broader consensus of what the theoretical knowledge (episteme) of AI literacy, particularly regarding TE and teachers, should entail. This should, to a much greater degree, include research from the educational sciences. Secondly, it is essential to actively involve teachers in the process of exploring the practical dimensions of AI literacy (techne) to ensure that a broad set of situated professional skills, relevant for different contexts and age groups, are considered. Here, teachers should be involved in the process of defining what AI literacy can mean in their classrooms, not simply by co-developing or trying out teaching resources founded on specific ideas of teaching and learning. Thirdly, a deeper investigation into the implications of AI literacy in authentic teaching and learning contexts is warranted to capture AI ethics and teachers' professional judgment (phronesis), as AI literacy, both as a concept and material artifact, is being introduced in classrooms. Already here we would like to stress a situated and contextualized approach of AI literacy, which means that teachers' episteme, techne and phronesis will never look the same throughout the entire educational system. However, making all dimensions visible and explicit may bring about a more solid foundation of AI literacy in TE and education in general, one that is aligned with the teaching profession and that serves the best interests of students.

Conclusion

We conducted a scoping review focusing on how AI literacy relevant to TE is represented in the scientific literature. Based on a screening of more than 500 papers, we conclude that AI literacy is a rapidly emerging research topic that has not reached the field of TE. Our focus on teachers' professional knowledge helped us to capture AI literacy in the context of teachers' theoretical-scientific knowledge, practical and professional judgement. We found that computer science and pedagogies based on exploratory teaching influence what type of epistemic, practical, and ethical knowledge is desirable. Questions of ethics are predominantly addressed as a matter of understanding technical configurations of data-driven AI technologies, and teachers' practical knowledge tends to translate into the adoption of digital teaching resources for teaching about AI or the integration of AI EdTech into teaching. Our results points to three distinct implications: 1) there is a need for educational scientists to engage in and define AI literacy in different educational contexts, and particularly in TE; 2) teachers need to be in the frontline of developing the content and teachings methods of AI literacy; and 3) *in-situ* studies are needed to capture, analyse, and further develop teachers' practical and ethical knowledge in relation to AI literacy.

Statements on potential conflicts of interest

All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Statements on open data and ethics

Research data can be shared upon request.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the first author used Chat GPT to check text for spelling, grammar errors and clarity. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

CRediT authorship contribution statement

Katarina Sperling: Writing – original draft, Visualization, Validation, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Carl-Johan Stenberg:** Writing – review & editing, Visualization, Validation, Investigation, Formal analysis. **Cormac McGrath:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Anna Åkerfeldt:** Writing – review & editing, Validation, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Fredrik Heintz:** Writing – review & editing, Validation, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Linnéa Stenliden:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

None.

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Appendix

Author/ Year	Study title	Study focus	Country
[92]	Artificial Intelligence (AI) in Education: Addressing Societal and Ethical Challenges in K-12 Settings	Different aspects of ethical issues surrounding AI, evaluating AIEd tools	US
[79]	In-Service Teachers' (Mis)conceptions of Artificial Intelligence in K-12 Science Education	Exploring teachers' (mis)conceptions of AI	US
[40]	Teachers' readiness and intention to teach artificial intelligence in schools	Examining what factors determine the behavioural intention and readiness to teach about AI	South Africa
[74]	Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education	Developing methods to measure TPACK/AI literacy among teachers	Finland
[69]	Sustainable curriculum planning for artificial intelligence education: A self-determination theory perspective	Using SDT to explore how teachers prepare, implement, and refine an AI curriculum	China
[71]	Collaborative construction of artificial intelligence curriculum in primary schools	Investigating how creating and implementing an AI curriculum is negotiated with external influences.	China
[87]	Make-a-Thon for Middle School AI Educators	Implementing a PD-programme for teachers with a focus on community of practice and Co-design	US
[82]	The Landscape of Teaching Resources for AI Education	Classification and evaluation of AIEd-tools	US
[93]	Artificial Intelligence in Education - Ethical framework	Ethics in AI education	Slovenia
[70]	Teaching Artificial Intelligence to K-12 Through a Role-Playing Game Questioning the Intelligence Concept	Develop, implement, and evaluate a role-playing game aimed at learning children some basic concepts in AI; Curriculum development.	Belgium
[109]	The Artificial Intelligence Learning Anxiety and Self-Efficacy of In-Service Teachers Taking AI Training Courses	Examining teaching learning anxiety and self-efficacy using MLSE and AILA.	Taiwan
[80]	Are Pre-Service Teachers Disinclined to Utilise Embodied Humanoid Social Robots in the Classroom?	Examining pre-service teachers attitudes toward introducing social robots in the classroom.	Slovenia
[88]	Enabling the Creation of Intelligent Things: Bringing Artificial Intelligence and Robotics to Schools	Developing and testing AI/robotics curriculum for teachers, acting as multipliers	Austria
[89]	AI Book Club: An Innovative Professional Development Model for AI Education	Developing and testing a PD-programme for teachers and educators	US
[90]	Engaging Teachers to Co-Design Integrated AI Curriculum for K-12 Classrooms	How to co-design an AI curriculum for core subjects and give design recommendations for future curricula development	US
[18]	What is AI Literacy? Competencies and Design Considerations	Defining a set of competencies and design considerations relating to AI literacy	US
[45]	Empowering educators to be AI-ready	How to enhance AI readiness in an educational setting	UK
[91]	A Scaffolding Empathic Methodology in the Robotics Teacher Formation Using Log Book and the BNCC References	Developing a methodology for teaching teachers about AI and robots (PD), with a special focus on methods of feedback to improve learning among participants	Brazil
[81]	Teachers' trust in AI-powered educational technology and a professional development programme to improve it	Teachers' knowledge and reflections on using AI-grading	Israel
[48]	AI Literacy: Definition, Teaching, Evaluation and Ethical Issues	Reviewing current (2021) literature on the concept of AI literacy and what specific competencies this concept implies.	China
[41]	Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world	Identifying challenges and opportunities in implementing AI technology. It also synthesizes different frameworks and identifies core AI competencies	China
[83]	Fostering AI literacy: A teaching practice reflection	How one can use generative AI as a tool; how to circumvent certain risks associated with generative AI	Australia
[20]	Data and AI literacy for everyone	Mapping out the competencies implied in data/AI literacy. Highlighting some German frameworks and applications for teaching about AI	Germany
[73]	A Differentiated Discussion About AI Education K-12	Mapping out different projects and programmes aimed at fostering AI Literacy.	Austria
[12]	Focusing on Teacher Education to Introduce AI in Schools: Perspectives and Illustrative Findings	Testing a PD- for programme teachers; reflections on implementing education with AI	India
[75]	Artificial Intelligence in K-12 Education: eliciting and reflecting on Swedish teachers' understanding of AI and its implications for teaching & learning	Teachers and teacher educators' conceptualizations of AI-literacy; identifying problems in implementing AI	Sweden
[96]	Preparing for AI-enhanced education: Conceptualizing and empirically examining teachers' AI readiness	Teachers' readiness to use AIED, ethics surrounding AI-use	China
[76]	Does the Perceived Organizational Support and AI Literacy Affect Teachers' AI Instructional Creative Performance?	A quantitative study examining what determines teachers' creativity when teaching about AI.	China
[84]	Where Is the AI? AI Literacy for Educators	Defining AI Literacy and responding to the need for AIED Understanding and AILE courses. Identifying issues with common AIEd-tools on the market today	Canada
[72]	Co-designing Artificial Intelligence Curriculum for Secondary Schools: A Grounded Theory of Teachers' Experience	CO-designing of an AI curriculum for secondary students	China
[72]	A Phenomenographic Approach on Teacher Conceptions of Teaching Artificial Intelligence (AI) in K-12 Schools	Examining teacher conceptions of teaching AI and categorizing them into six outcome spaces	China
[85]	Artificial intelligence literacy teaching in social studies education	Learning with AI in social studies	Turkey
[86]	The road to ai literacy education: From pedagogical needs to tangible game design	Addressing the need to teach children about basic concepts of AI/ML through a computer game. Misconceptions about AI	Malta
[77]	Developing AI Literacy for Primary and Middle School Teachers in China: Based on a Structural Equation Modeling Analysis	Using Ng's "four dimensions of AI literacy" to quantitively examine teachers AI literacy as well as the correlation between these different dimensions	China

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