

AI Literacy in Higher Education: Concepts, Competencies, and Future Directions

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ABSTRACT

Artificial intelligence (AI) literacy has become an essential competency for higher education as generative AI transforms teaching, learning, research, and assessment. This study examines AI literacy through a Systematic Literature Review (SLR) using the PRISMA 2020 framework. Studies published between 2020 and 2025 were systematically collected and synthesized using a framework-based thematic analysis. Five themes emerged: the evolution of AI literacy, conceptual frameworks, core competencies, educational implementation, and future research directions. The findings indicate that AI literacy extends beyond technical knowledge by integrating critical evaluation, prompt literacy, ethical reasoning, responsible AI use, and human–AI collaboration. Universities increasingly embed AI literacy into curricula, faculty development, and institutional policy to prepare graduates for AI-enabled environments. The review highlights responsible governance, interdisciplinary education, and lifelong competency development as priorities for advancing AI literacy in higher education.

Keywords: *Artificial Intelligence Literacy, Higher Education, Generative Artificial Intelligence, Responsible AI, Human–AI Collaboration, AI Competency.*

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1. | INTRODUCTION

AI has rapidly transformed higher education by reshaping teaching, learning, research, assessment, and academic communication. The emergence of generative artificial intelligence (AI) systems capable of producing human-like text, images, code, and analytical outputs has expanded opportunities for personalized learning, academic support, and knowledge creation. Universities worldwide are increasingly integrating AI-powered technologies into educational environments to enhance instructional efficiency, improve student engagement, and prepare graduates for an AI-driven society. As AI becomes embedded across academic activities, higher education institutions face growing responsibility to ensure that students and educators possess the competencies necessary to interact with AI critically, ethically, and effectively.

For many years, digital literacy has been regarded as the primary competency required for successful participation in technology-enhanced education. Digital literacy emphasizes the ability to access, evaluate, create, and communicate information using digital technologies. However, the rapid advancement of artificial intelligence has exposed important limitations of conventional digital literacy frameworks. While digital literacy prepares learners to operate digital technologies, it does not adequately address competencies required to understand AI systems, critically evaluate AI-generated outputs, recognize algorithmic limitations, or make responsible decisions regarding AI use. Consequently, researchers increasingly argue that AI literacy should be recognized as a distinct educational competency rather than an extension of traditional digital literacy.

The concept of AI literacy has therefore emerged as a new area of educational research that focuses on developing learners' understanding of artificial intelligence, its capabilities, limitations, ethical implications, and practical applications. Long and Magerko (2020) define AI literacy as a collection of competencies that enable individuals to critically evaluate AI technologies, communicate effectively about AI, and use AI responsibly in everyday contexts. Building upon this foundation, Laupichler et al. (2022) identify AI literacy as an interdisciplinary educational construct encompassing technical knowledge, critical thinking, ethical awareness, and informed decision-making, emphasizing its growing importance within higher and adult education.

Recent developments in generative AI have accelerated the evolution of AI literacy by expanding educational expectations beyond basic knowledge of artificial intelligence. Contemporary frameworks increasingly emphasize learners' ability to collaborate effectively with AI systems while maintaining critical judgment and ethical responsibility. Southworth et al. (2023) argue that AI literacy should be integrated across university curricula rather than confined to computer science education, enabling students from diverse disciplines to develop competencies required for future academic and professional environments. Similarly, Zhou and Schofield (2024) propose a

conceptual framework positioning AI literacy as a multidimensional capability that integrates technical understanding, critical evaluation, ethical reasoning, and responsible AI engagement within higher education.

The rapid integration of AI into universities has also transformed teaching and learning practices. AI-powered educational tools now support academic writing, personalized tutoring, formative assessment, curriculum development, research assistance, and collaborative learning. Kong, Cheung, and Zhang (2023) demonstrate that structured AI literacy programs significantly improve university students' conceptual understanding of artificial intelligence, ethical awareness, and confidence in applying AI technologies. Likewise, De Silva et al. (2024) highlight the importance of designing human-centered AI literacy curricula that enable students from diverse academic backgrounds to engage confidently with emerging AI technologies.

Alongside these educational opportunities, AI adoption introduces complex ethical, pedagogical, and institutional challenges. Concerns regarding algorithmic bias, misinformation, academic integrity, transparency, privacy, and responsible AI use have become central issues within higher education. Memarian and Doleck (2023) emphasize that fairness, accountability, transparency, and ethics should form essential components of AI literacy to ensure responsible educational adoption. Similarly, Aler Tubella, Mora-Cantalops, and Nieves (2024) argue that universities must integrate responsible AI education into curricula so that students develop not only technical competence but also ethical awareness and critical decision-making capabilities when interacting with AI systems.

Although research on AI literacy has expanded considerably during recent years, the existing literature remains fragmented across multiple perspectives, including competency development, curriculum integration, ethical AI, prompt literacy, AI governance, and human–AI collaboration. Existing studies frequently examine these dimensions independently, providing limited synthesis regarding how AI literacy has evolved conceptually, how competency frameworks have been developed, and how universities can implement comprehensive AI literacy initiatives. As generative AI continues reshaping higher education, a systematic synthesis of these emerging perspectives has become increasingly necessary.

Accordingly, this study employs a Systematic Literature Review (SLR) using the PRISMA 2020 framework to examine AI literacy in higher education. By synthesizing studies published between 2020 and 2025, the review explores the evolution of AI literacy, conceptual frameworks and competency models, educational implementation strategies, and emerging future directions. The findings are expected to provide educators, researchers, and higher education institutions with a comprehensive understanding of AI literacy as a foundational competency for responsible, ethical, and effective participation in AI-enhanced higher education.

2. | LITERATURE REVIEW

Evolution of AI Literacy

Artificial intelligence literacy has emerged as one of the most significant educational concepts accompanying the rapid advancement of AI technologies across society. Although discussions regarding artificial intelligence have existed for several decades, AI literacy only began receiving substantial scholarly attention after AI applications became increasingly accessible to the general public through intelligent assistants, machine learning systems, and, more recently, generative artificial intelligence. As universities adopted AI-powered educational technologies, researchers recognized that students required competencies extending beyond traditional digital skills to understand, evaluate, and responsibly utilize artificial intelligence within academic and professional contexts.

Early discussions of AI literacy primarily focused on developing basic awareness of artificial intelligence concepts and enabling individuals to understand how AI systems function in everyday life. Long and Magerko (2020) describe AI literacy as a comprehensive collection of competencies that enable individuals to critically evaluate AI technologies, communicate effectively about AI, and use AI responsibly. Their competency-based perspective shifted educational attention from simply learning about AI technologies toward developing practical capabilities for interacting with increasingly intelligent digital systems.

As AI technologies became more integrated into higher education, the concept of AI literacy expanded considerably. Rather than emphasizing technical knowledge alone, recent scholarship increasingly recognizes AI literacy as an interdisciplinary competency combining technical understanding, critical evaluation, ethical reasoning, and responsible decision-making. Laupichler et al. (2022), through a scoping literature review, argue that AI literacy should be understood as a multidimensional educational construct relevant across academic disciplines rather than being limited to computer science or engineering education. This broader perspective reflects the growing influence of AI across teaching, research, communication, healthcare, business, and other professional fields.

The widespread adoption of generative AI has further accelerated the evolution of AI literacy. Technologies capable of generating text, images, programming code, and multimedia content have fundamentally altered how students learn, conduct research, and complete academic tasks. Southworth et al. (2023) propose an AI Across the Curriculum model that integrates AI literacy throughout higher education, emphasizing that AI competency should become a universal graduate attribute regardless of disciplinary background. Likewise, Tzirides et al. (2024) highlight the importance of combining human intelligence with artificial intelligence, arguing that future educational models should focus on developing learners who can collaborate effectively with AI rather than viewing AI merely as a technological tool.

Recent conceptual developments increasingly distinguish AI literacy from digital literacy. While digital literacy focuses on effective use of digital technologies and information resources, AI literacy requires additional competencies associated with understanding algorithmic decision-making, evaluating AI-generated outputs, recognizing system limitations, and making ethical judgments regarding AI applications. Chiu and Sanusi (2024) emphasize that AI literacy involves both conceptual understanding and practical competency, requiring students and educators to develop technical, cognitive, ethical, and collaborative capabilities that respond to rapidly evolving AI technologies.

Overall, the evolution of AI literacy reflects the transformation of higher education within an increasingly AI-driven society. Contemporary perspectives position AI literacy as a foundational educational competency that enables learners to engage critically, ethically, and effectively with artificial intelligence while preparing graduates for lifelong participation in technology-rich academic and professional environments.

Conceptual Frameworks of AI Literacy

As AI literacy has matured into an independent area of educational research, numerous conceptual frameworks have been proposed to explain the knowledge, skills, attitudes, and competencies required for effective interaction with artificial intelligence. Rather than defining AI literacy as a single technical capability, contemporary frameworks consistently describe it as a multidimensional construct integrating cognitive understanding, practical application, ethical awareness, and critical evaluation. These frameworks provide theoretical foundations that guide curriculum development, competency assessment, and educational policy within higher education.

One of the earliest and most influential conceptualizations was introduced by Long and Magerko (2020), who identified multiple competencies required for AI literacy, including recognizing AI technologies, understanding their capabilities and limitations, critically evaluating AI outputs, communicating about AI, and making informed decisions regarding AI use. Their framework established AI literacy as a comprehensive educational capability extending beyond technical programming knowledge and applicable to learners across diverse academic disciplines.

Building upon these foundational ideas, recent studies have expanded AI literacy into broader competency models that reflect the rapid evolution of generative AI and intelligent educational technologies. Zhou and Schofield (2024) propose a conceptual framework specifically designed for higher education, integrating technical understanding, ethical reasoning, critical evaluation, and responsible AI use into a unified educational model. Similarly, Allen and Kendeou (2024) introduce the ED-AI Lit framework, emphasizing interdisciplinary perspectives that combine educational theory, behavioral science, and technological understanding to prepare learners for responsible participation in AI-supported educational environments.

Researchers have also increasingly emphasized the multidimensional nature of AI literacy through competency-based measurement frameworks. Carolus et al. (2023)

developed the Meta AI Literacy Scale (MAILS), which operationalizes AI literacy using psychological competencies and meta-competencies associated with effective AI interaction. Likewise, Biagini, Cuomo, and Ranieri (2024) developed and validated a multidimensional AI literacy questionnaire that provides empirical tools for assessing students' AI literacy across multiple competency domains. These measurement frameworks contribute to more consistent evaluation of AI literacy while supporting future educational interventions and curriculum development.

Another important characteristic of contemporary AI literacy frameworks is the integration of ethical and societal dimensions. Rather than focusing solely on technical proficiency, recent conceptual models emphasize responsible AI use, fairness, transparency, accountability, privacy, and critical awareness of algorithmic bias. Chiu and Sanusi (2024) argue that AI literacy should simultaneously foster technical competence and ethical responsibility among both students and educators. Similarly, Mills et al. (2024) describe AI literacy as the ability to understand, evaluate, and use emerging AI technologies responsibly while recognizing their broader social implications.

Collectively, these conceptual frameworks demonstrate that AI literacy extends beyond learning how artificial intelligence functions. It represents an integrated educational capability combining technical knowledge, critical thinking, ethical reasoning, responsible decision-making, and human-centered collaboration. These multidimensional perspectives provide the conceptual foundation for examining how AI literacy competencies can be developed and implemented throughout higher education.

Core AI Literacy Competencies

The rapid advancement of artificial intelligence has shifted educational attention from understanding AI technologies to developing the competencies required for their responsible and effective use. Contemporary research consistently argues that AI literacy encompasses multiple interconnected competencies rather than a single technical skill. These competencies enable students to interact critically with AI systems, evaluate AI-generated outputs, make informed decisions, and collaborate productively with intelligent technologies in academic and professional environments. Consequently, AI literacy has become increasingly recognized as a comprehensive capability that combines technical knowledge, cognitive skills, ethical awareness, and practical application.

A fundamental competency within AI literacy is conceptual understanding of artificial intelligence. Students are expected to understand basic AI principles, including machine learning, generative AI, algorithmic decision-making, data processing, and the capabilities and limitations of AI systems. Such knowledge enables learners to recognize how AI operates while avoiding misconceptions regarding its functionality and reliability. Kong, Cheung, and Zhang (2023) demonstrate that

structured AI literacy programs significantly improve university students' conceptual understanding of artificial intelligence while simultaneously strengthening their confidence in applying AI technologies across diverse learning contexts.

Critical evaluation represents another essential component of AI literacy. Because generative AI systems may produce inaccurate, biased, or fabricated information, students must develop the ability to verify AI-generated content, identify misinformation, evaluate evidence, and recognize the limitations of automated outputs. Carolus et al. (2023) emphasize that AI literacy extends beyond technological familiarity by incorporating higher-order cognitive competencies that support critical judgment and informed decision-making. Likewise, Lee, Oh, and Hong (2024) found that university students' AI literacy includes evaluating the credibility, reliability, and appropriateness of AI-generated information before integrating it into academic work.

Recent scholarship has also identified prompt literacy as an emerging competency within AI literacy. Rather than passively accepting AI-generated responses, students increasingly need the ability to formulate clear prompts, refine interactions with AI systems, and communicate effectively with generative AI models to obtain accurate and meaningful outputs. Hwang, Lee, and Shin (2023) describe prompt literacy as a new form of digital communication that enables learners to interact strategically with generative AI. Similarly, Maloy and Gattupalli (2024) argue that prompt literacy has become an essential educational skill because the quality of AI-generated responses depends substantially on users' ability to construct effective prompts and critically interpret generated content.

Ethical reasoning and responsible AI use constitute equally important dimensions of AI literacy. Students must understand ethical issues associated with artificial intelligence, including algorithmic bias, privacy protection, transparency, accountability, intellectual property, and academic integrity. Chiu and Sanusi (2024) argue that responsible AI literacy should integrate technical competence with ethical awareness, enabling learners to evaluate the broader societal consequences of AI adoption. Similarly, Aler Tubella, Mora-Cantalops, and Nieves (2024) emphasize that responsible AI education should prepare university students to make informed ethical decisions while applying AI technologies within academic and professional environments.

Finally, human–AI collaboration has emerged as a defining competency for the future of higher education. Rather than viewing AI as either a replacement for human expertise or a standalone technological solution, contemporary perspectives emphasize collaborative partnerships in which humans and AI complement one another's strengths. Tzirides et al. (2024) argue that effective AI literacy requires learners to integrate human creativity, critical thinking, and ethical judgment with AI-supported problem solving. Likewise, Nguyen et al. (2024) demonstrate that successful human–AI collaboration in academic writing depends on students' ability to critically evaluate AI-

generated content while maintaining intellectual responsibility for final academic outputs.

Taken together, these competencies illustrate that AI literacy represents a multidimensional educational capability extending well beyond technical knowledge of artificial intelligence. Conceptual understanding, critical evaluation, prompt literacy, ethical reasoning, and human–AI collaboration collectively provide the competencies necessary for responsible participation in AI-enhanced higher education and future professional practice.

Educational Applications of AI Literacy

The growing importance of AI literacy has encouraged universities to integrate artificial intelligence into teaching, learning, research, and institutional development. Rather than limiting AI education to specialized computing disciplines, contemporary higher education increasingly adopts institution-wide approaches that prepare students and educators to use AI responsibly across diverse academic contexts. These developments demonstrate that AI literacy functions not only as an individual competency but also as an educational strategy supporting curriculum innovation, learner engagement, and future workforce readiness.

One significant application of AI literacy involves curriculum integration. Universities are increasingly embedding AI-related competencies into existing academic programs so that students from various disciplines develop foundational knowledge and practical skills for interacting with AI technologies. Southworth et al. (2023) propose an **AI Across the Curriculum** model that integrates AI literacy throughout higher education, ensuring that graduates acquire AI competencies regardless of their academic specialization. Similarly, De Silva et al. (2024) advocate a human-centered AI literacy module that provides universal learning opportunities while accommodating students from diverse disciplinary backgrounds.

AI literacy also supports innovative teaching and learning practices. AI-powered educational technologies can provide personalized tutoring, adaptive learning pathways, intelligent feedback, and interactive learning experiences that enhance student engagement. Kong, Cheung, and Zhang (2021) found that participation in AI literacy courses improves students' understanding of AI concepts while increasing confidence in applying AI tools for academic purposes. Their subsequent study (Kong et al., 2023) further demonstrated improvements in conceptual understanding, learner empowerment, and ethical awareness following structured AI literacy instruction, highlighting the educational value of systematic AI competency development.

Faculty development has become another important application area as educators increasingly incorporate AI into instructional practice. Effective implementation of AI technologies requires instructors to understand AI capabilities, recognize pedagogical opportunities, and address ethical challenges associated with AI-supported teaching. Ding et al. (2024) demonstrate that professional development programs significantly

improve teacher AI literacy by exposing educators to authentic instructional cases and practical AI integration strategies. These findings suggest that institutional investment in faculty AI literacy is essential for successful curriculum transformation.

Beyond classroom instruction, AI literacy increasingly supports academic research and scholarly communication. Students and researchers now utilize AI for literature exploration, academic writing, data analysis, language support, and research organization. Nguyen et al. (2024) found that effective human–AI collaboration enhances academic writing when users critically evaluate AI-generated suggestions rather than accepting them uncritically. This emphasizes that AI literacy includes the ability to balance technological efficiency with scholarly integrity and independent academic judgment.

Collectively, these educational applications demonstrate that AI literacy has become an essential component of contemporary higher education. Curriculum integration, innovative pedagogy, faculty development, and responsible academic practice all contribute to preparing graduates who can effectively and ethically participate in increasingly AI-enabled educational and professional environments.

Challenges and Future Directions

Despite the growing recognition of AI literacy as a fundamental competency for higher education, its implementation remains accompanied by numerous pedagogical, ethical, technological, and institutional challenges. The reviewed literature indicates that universities are still in the early stages of developing comprehensive AI literacy strategies, resulting in considerable variation in curriculum design, competency standards, instructional practices, and institutional policies. As artificial intelligence continues to evolve rapidly, higher education institutions must continuously adapt educational approaches to ensure that AI literacy remains relevant and responsive to emerging technological developments.

One major challenge concerns the ethical use of artificial intelligence within academic environments. While AI technologies provide substantial opportunities for learning enhancement, they also introduce concerns regarding algorithmic bias, transparency, accountability, privacy protection, and academic integrity. Students who lack adequate AI literacy may over-rely on AI-generated outputs without critically evaluating their accuracy or recognizing potential ethical implications. Memarian and Doleck (2023) argue that fairness, accountability, transparency, and ethics should become integral components of AI literacy education to promote responsible AI adoption. Similarly, Aler Tubella, Mora-Cantalops, and Nieves (2024) emphasize that responsible AI education should combine technical competence with ethical reasoning, enabling students to make informed decisions when applying AI technologies in academic and professional contexts.

Another important challenge involves institutional governance and educational policy. The rapid adoption of generative AI has outpaced the development of comprehensive university policies regulating AI use in teaching, assessment, and

research. Consequently, many higher education institutions continue to experience uncertainty regarding acceptable AI practices, assessment redesign, intellectual property, and academic integrity standards. Wu, Zhang, and Carroll (2024) demonstrate that universities are adopting diverse governance approaches, highlighting the need for consistent institutional frameworks that balance innovation with ethical responsibility. Likewise, Dotan, Parker, and Radzilowicz (2024) recommend that universities develop evidence-based guidelines supporting responsible AI adoption while preserving academic values and human oversight.

Faculty readiness represents another critical issue influencing the successful implementation of AI literacy. Although AI technologies are increasingly available, many educators remain insufficiently prepared to integrate AI effectively into teaching and assessment. Limited AI competence among instructors may reduce confidence in using AI-supported educational tools while increasing uncertainty regarding ethical and pedagogical considerations. Ding et al. (2024) demonstrate that structured professional development significantly strengthens teacher AI literacy by improving educators' understanding of AI applications, instructional design, and responsible classroom integration. These findings suggest that institutional investment in continuous faculty development is essential for sustainable AI literacy implementation.

The reviewed literature also identifies rapid technological change as a continuing challenge. Artificial intelligence develops at a pace that frequently exceeds curriculum revision cycles, creating difficulties in maintaining current educational content. New technologies, including multimodal AI systems, intelligent agents, autonomous assistants, and increasingly sophisticated large language models, continually reshape expectations regarding AI competencies. Consequently, AI literacy should be viewed as a dynamic capability requiring continuous updating rather than a fixed body of knowledge. Lifelong learning therefore becomes an essential principle underpinning future AI literacy education.

Looking forward, future research is expected to expand beyond conceptual discussions toward evaluating the long-term effectiveness of AI literacy interventions across diverse educational contexts. Greater attention should be given to developing standardized competency frameworks, reliable assessment instruments, cross-cultural validation studies, and evidence-based curriculum models suitable for different academic disciplines. Researchers should also investigate emerging topics such as prompt literacy, human–AI collaboration, AI readiness, AI governance, and responsible AI ecosystems within higher education. These areas are likely to become increasingly important as universities transition toward AI-enhanced learning environments.

Overall, the future of AI literacy extends beyond teaching students how to use artificial intelligence. Instead, it involves preparing graduates who can critically evaluate AI technologies, collaborate responsibly with intelligent systems, make ethical decisions, and continuously adapt to future technological developments. Universities that successfully integrate technical competence, ethical reasoning, institutional

governance, and lifelong learning into AI literacy education will be better positioned to prepare graduates for responsible participation in an increasingly AI-driven society.

3. | RESEARCH METHOD

This study employed a qualitative Systematic Literature Review (SLR) to examine the conceptual development, competency frameworks, educational applications, and future directions of AI literacy in higher education. The review synthesizes current scholarly evidence regarding AI literacy as a multidimensional educational competency that prepares students and educators to understand, evaluate, and responsibly utilize artificial intelligence within academic environments.

The review followed the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework proposed by Page et al. (2021). The review process consisted of four systematic stages: identification, screening, eligibility assessment, and inclusion of relevant studies. The use of the PRISMA framework ensured transparency, methodological rigor, and reproducibility throughout the literature selection and synthesis process.

Relevant literature was identified through Scopus, Web of Science, ScienceDirect, SpringerLink, Taylor & Francis Online, IEEE Xplore, ERIC, Google Scholar, and Wiley Online Library. The search strategy combined keywords including *AI literacy*, *artificial intelligence literacy*, *AI competency*, *AI education*, *generative AI*, *prompt literacy*, *responsible AI*, *AI ethics*, *human–AI collaboration*, *AI governance*, and *higher education*. Only English-language publications published between 2020 and 2025 were included to capture contemporary developments following the widespread integration of artificial intelligence into higher education.

The inclusion criteria comprised peer-reviewed journal articles, scholarly books, book chapters, conference proceedings, and systematic literature reviews focusing on AI literacy and its implementation in higher education. Studies addressing AI competency frameworks, curriculum integration, responsible AI, generative AI, prompt literacy, faculty development, AI governance, educational applications, and human–AI collaboration were included. Editorials, opinion articles, duplicate publications, dissertations, and studies unrelated to higher education were excluded from the review.

Data were analyzed using a framework-based thematic analysis, enabling the literature to be synthesized according to the conceptual development of AI literacy rather than individual study findings. Five analytical themes emerged: (1) the evolution of AI literacy, (2) conceptual frameworks of AI literacy, (3) core AI literacy competencies, (4) educational applications of AI literacy, and (5) challenges and future directions. This analytical structure provides a comprehensive understanding of AI literacy from theoretical foundations to educational implementation and future research priorities.

The analytical framework conceptualizes AI literacy as an integrated educational competency comprising conceptual understanding of artificial intelligence, critical evaluation of AI-generated information, prompt literacy, ethical reasoning, responsible

AI use, and effective human–AI collaboration. These interconnected competencies support learners in engaging productively with AI technologies while preparing graduates for responsible participation in increasingly AI-enabled academic, professional, and societal environments.

4. | RESULTS

The framework-based thematic analysis identified five major themes that explain the conceptual evolution, competency development, educational implementation, and future trajectory of AI literacy in higher education. The reviewed studies consistently indicate that AI literacy has evolved from a technology-oriented concept into a comprehensive educational competency integrating technical understanding, critical evaluation, ethical reasoning, and human–AI collaboration. Furthermore, the literature demonstrates that effective AI literacy extends beyond operational knowledge by preparing students and educators to engage responsibly with artificial intelligence within teaching, learning, research, and professional practice.

Evolution of AI Literacy Research

The reviewed literature demonstrates that AI literacy has undergone rapid conceptual development in response to the widespread adoption of artificial intelligence across educational settings. Initial studies primarily emphasized developing basic awareness of AI technologies and their underlying principles. However, the emergence of generative AI has significantly expanded educational expectations, shifting attention toward competencies required to critically interpret, evaluate, and responsibly utilize AI-generated outputs. This evolution reflects broader transformations in higher education as universities increasingly integrate AI into teaching, assessment, research, and institutional decision-making.

Long and Magerko (2020) established one of the earliest competency-based perspectives by defining AI literacy as a collection of knowledge and skills enabling individuals to understand, evaluate, communicate about, and effectively use artificial intelligence. Subsequent research has broadened this perspective considerably. Laupichler et al. (2022) argue that AI literacy represents an interdisciplinary educational construct combining technical understanding with critical thinking and ethical awareness, making it relevant across multiple academic disciplines rather than exclusively within computing education.

The introduction of generative AI has accelerated the expansion of AI literacy research. Southworth et al. (2023) propose integrating AI literacy throughout university curricula through an AI Across the Curriculum approach, ensuring that graduates from diverse fields develop competencies necessary for future workplaces. Likewise, Tzirides et al. (2024) emphasize that future AI literacy should focus on combining human intelligence with artificial intelligence through collaborative educational practices rather than treating AI as an independent technological solution. These

developments indicate that AI literacy has evolved into a strategic educational capability supporting lifelong learning and responsible technological engagement.

Conceptual Models of AI Literacy

The reviewed studies consistently conceptualize AI literacy as a multidimensional framework integrating technical, cognitive, ethical, and collaborative competencies. Rather than defining AI literacy as technological proficiency alone, contemporary models emphasize learners' ability to understand AI systems, critically evaluate AI-generated information, make ethical decisions, and collaborate effectively with intelligent technologies. These conceptual frameworks provide theoretical foundations for curriculum design, competency assessment, and educational policy within higher education.

Long and Magerko (2020) introduced a comprehensive competency framework that remains influential in AI literacy research. Their model identifies multiple competencies, including recognizing AI applications, understanding AI capabilities and limitations, evaluating AI outputs, communicating about AI, and making informed decisions regarding AI use. Building upon this foundation, Zhou and Schofield (2024) propose a higher education framework that integrates conceptual understanding, critical thinking, ethical reasoning, and responsible AI engagement into a unified educational model.

Recent studies have further strengthened conceptual understanding through empirical measurement frameworks. Carolus et al. (2023) developed the Meta AI Literacy Scale (MAILS), operationalizing AI literacy through psychological competencies and meta-competencies associated with effective AI interaction. Similarly, Biagini, Cuomo, and Ranieri (2024) introduced a multidimensional AI literacy questionnaire that enables systematic assessment of students' AI competencies across multiple domains. Allen and Kendeou (2024) further expand conceptual understanding through the ED-AI Lit framework, emphasizing interdisciplinary educational perspectives that combine behavioral science, educational theory, and technological understanding.

Collectively, these frameworks demonstrate that AI literacy represents a comprehensive educational construct requiring the integration of technical knowledge, evaluative judgment, ethical awareness, and responsible human-centered AI interaction.

Core AI Literacy Competencies

The literature consistently identifies several core competencies that collectively define AI literacy in higher education. These competencies extend beyond understanding artificial intelligence by preparing learners to interact effectively, critically, and ethically with AI technologies throughout academic and professional practice.

Conceptual understanding forms the foundation of AI literacy by enabling students to understand AI principles, machine learning, generative AI, algorithmic decision-

making, and the capabilities and limitations of intelligent systems. Kong, Cheung, and Zhang (2023) demonstrate that structured AI literacy programs significantly improve conceptual understanding while strengthening learners' confidence in applying AI across academic contexts.

Critical evaluation is another frequently identified competency. Students must develop the ability to verify AI-generated information, identify hallucinations and misinformation, recognize algorithmic bias, and critically evaluate the reliability of AI outputs before incorporating them into academic work. Carolus et al. (2023) emphasize that higher-order evaluative skills distinguish AI literacy from basic technological familiarity, enabling learners to make informed judgments regarding AI-generated content.

Prompt literacy has emerged as a distinctive competency following the widespread adoption of generative AI. Hwang, Lee, and Shin (2023) describe prompt literacy as the ability to communicate effectively with AI systems by constructing purposeful prompts that guide AI responses toward meaningful outcomes. Maloy and Gattupalli (2024) similarly argue that prompt literacy has become an essential educational capability because effective human–AI interaction depends substantially on users' ability to formulate precise instructions and critically interpret generated responses.

Ethical reasoning and responsible AI use also constitute central components of AI literacy. Chiu and Sanusi (2024) argue that learners must understand issues related to fairness, accountability, transparency, privacy, intellectual property, and responsible AI decision-making. Likewise, Aler Tubella, Mora-Cantallos, and Nieves (2024) emphasize that responsible AI education should integrate ethical reflection with practical AI competency to prepare students for increasingly AI-supported academic and professional environments.

Finally, human–AI collaboration has become a defining competency within contemporary AI literacy. Rather than replacing human expertise, AI increasingly functions as a collaborative partner supporting creativity, analysis, communication, and problem-solving. Tzirides et al. (2024) and Nguyen et al. (2024) demonstrate that successful human–AI collaboration depends upon learners' ability to combine critical thinking, domain expertise, and ethical judgment with AI-supported decision-making. These findings position collaboration as a key competency for future higher education graduates.

Educational Implementation of AI Literacy

The reviewed literature demonstrates that AI literacy is increasingly being implemented through curriculum innovation, instructional redesign, faculty development, and AI-supported learning environments. Rather than treating AI literacy as a standalone subject, higher education institutions are progressively integrating AI-related competencies across multiple disciplines to prepare graduates for AI-enabled workplaces and knowledge societies. This institutional shift reflects recognition that AI

literacy is becoming a foundational graduate competency comparable to digital literacy, information literacy, and critical thinking.

Curriculum integration emerged as one of the most frequently discussed implementation strategies. Southworth et al. (2023) propose an AI Across the Curriculum model that embeds AI literacy throughout university programs, allowing students from different academic backgrounds to acquire AI competencies within disciplinary contexts. Similarly, De Silva et al. (2024) advocate a human-centered AI literacy module designed for broad implementation across tertiary education, emphasizing accessibility, interdisciplinary learning, and responsible AI engagement. These approaches demonstrate that AI literacy is increasingly viewed as a shared institutional responsibility rather than the exclusive domain of computer science education.

The reviewed studies also indicate that structured AI literacy programs significantly enhance students' learning outcomes. Kong, Cheung, and Zhang (2021) reported that participation in university AI literacy courses improved students' understanding of AI concepts while increasing confidence in applying AI technologies to academic tasks. Their subsequent research (Kong et al., 2023) further demonstrated improvements in conceptual understanding, ethical awareness, learner empowerment, and AI-related decision-making following systematic AI literacy instruction. Likewise, Mansoor et al. (2024) found notable differences in AI literacy levels among university students across countries, highlighting the importance of institutional investment in standardized AI literacy education to reduce competency disparities.

Faculty development constitutes another critical component of AI literacy implementation. The rapid integration of generative AI into higher education requires educators to redesign learning activities, assessment strategies, and instructional approaches while simultaneously addressing ethical and pedagogical challenges. Ding et al. (2024) found that professional development based on authentic instructional cases significantly improves teachers' AI literacy and their confidence in integrating AI into classroom practice. Chiu and Sanusi (2024) similarly argue that AI literacy initiatives should target both students and educators because successful institutional implementation depends upon shared understanding of AI capabilities, limitations, and responsible use.

Beyond teaching and curriculum design, AI literacy increasingly supports research activities and scholarly communication. AI-powered tools are now widely used for literature exploration, academic writing, data analysis, coding assistance, and knowledge organization. Nguyen et al. (2024) demonstrate that effective human–AI collaboration enhances academic writing when learners critically evaluate AI-generated content and maintain intellectual responsibility for scholarly outputs. Likewise, Padovano and Cardamone (2024) illustrate how AI can support competency-based curriculum development through collaborative human–AI decision-making rather than replacing academic expertise.

Overall, the reviewed evidence indicates that educational implementation of AI literacy extends across curriculum design, instructional practice, faculty development, research support, and institutional innovation. Successful implementation depends not only on technological adoption but also on creating learning environments that cultivate critical thinking, ethical responsibility, and collaborative engagement with artificial intelligence.

Emerging Research Agenda

The reviewed literature indicates that AI literacy research is entering a new phase characterized by growing attention to responsible AI, institutional governance, human–AI collaboration, and lifelong competency development. While early research primarily emphasized conceptual definitions and foundational competencies, contemporary studies increasingly investigate how AI literacy can be sustained within rapidly evolving technological environments. These developments suggest that future AI literacy research will extend beyond understanding AI technologies toward preparing learners for continuous adaptation within AI-driven educational and professional ecosystems.

Responsible AI has become one of the most prominent future research directions. As generative AI systems become more powerful and accessible, higher education institutions face increasing responsibility to ensure that AI technologies are used ethically, transparently, and fairly. Memarian and Doleck (2023) identify fairness, accountability, transparency, and ethics (FATE) as essential principles for responsible AI adoption within higher education. Similarly, Aler Tubella, Mora-Cantalops, and Nieves (2024) argue that responsible AI education should become an integral component of university curricula to prepare students for ethical decision-making in AI-supported environments. These findings indicate that future AI literacy frameworks must integrate ethical reasoning alongside technical competency.

Institutional governance represents another emerging priority. Universities are increasingly developing policies regulating AI use in teaching, assessment, research, and academic integrity. Wu, Zhang, and Carroll (2024) demonstrate considerable variation in AI governance strategies across universities, highlighting the need for comprehensive institutional policies that balance innovation with accountability. Likewise, Dotan, Parker, and Radzilowicz (2024) recommend evidence-informed governance models that support responsible AI adoption while preserving academic integrity, human oversight, and educational quality.

Human–AI collaboration is also expected to become a defining area of future AI literacy research. Rather than replacing human expertise, contemporary perspectives increasingly position AI as a collaborative partner supporting creativity, problem-solving, communication, and decision-making. Brusilovsky (2024) argues that future educational systems should emphasize learner control within AI-enhanced environments, ensuring that students remain active decision-makers rather than passive

recipients of AI-generated information. Similarly, Padovano and Cardamone (2024) demonstrate that collaborative human–AI approaches can strengthen curriculum development by combining human expertise with AI-supported analysis and design.

Finally, the rapid evolution of artificial intelligence suggests that AI literacy should be understood as a lifelong learning competency rather than a static educational outcome. Continuous advances in generative AI, multimodal systems, intelligent agents, and adaptive learning technologies require learners and educators to update their knowledge and competencies regularly. Future research should therefore focus on longitudinal AI literacy development, cross-cultural validation of competency frameworks, standardized assessment instruments, discipline-specific implementation strategies, and evidence-based curriculum models capable of responding to ongoing technological change.

Collectively, these emerging directions indicate that AI literacy is evolving from an educational innovation into a strategic capability supporting responsible participation in AI-enabled societies. Future higher education will increasingly require graduates who can critically evaluate AI technologies, collaborate effectively with intelligent systems, navigate ethical challenges, and continuously adapt to new technological developments. Consequently, AI literacy is expected to become a cornerstone of higher education policy, curriculum design, and graduate competency development.

5. | DISCUSSION

The findings of this review demonstrate that AI literacy has rapidly evolved into a foundational educational competency within higher education. Unlike traditional digital literacy, which primarily emphasizes effective use of digital technologies, AI literacy encompasses a broader set of competencies including conceptual understanding of artificial intelligence, critical evaluation of AI-generated outputs, ethical reasoning, responsible AI use, prompt literacy, and effective human–AI collaboration. This evolution reflects the transformative influence of generative AI on higher education and highlights the need for universities to prepare graduates who can engage thoughtfully and responsibly with increasingly intelligent technologies.

One of the principal findings of this review is that AI literacy should not be understood merely as technological proficiency. Contemporary conceptual frameworks consistently position AI literacy as a multidimensional capability integrating knowledge, skills, attitudes, and ethical values required for responsible AI use. Technical understanding alone is insufficient because effective interaction with AI requires learners to critically evaluate AI-generated information, recognize algorithmic limitations, identify potential bias, and make informed decisions regarding appropriate AI applications. Consequently, AI literacy represents a shift from learning about technology toward developing competencies that support informed human judgment in AI-supported environments.

The review also demonstrates that higher education institutions are moving from isolated AI courses toward institution-wide AI literacy initiatives. Curriculum integration, interdisciplinary teaching, faculty development, and AI-supported learning environments have become central strategies for preparing graduates for AI-enabled workplaces. Rather than restricting AI education to computing disciplines, universities increasingly recognize that AI literacy is relevant across business, healthcare, education, engineering, social sciences, and the humanities. This institutional transformation reflects growing recognition that AI competency has become a universal graduate attribute necessary for lifelong learning and professional adaptability.

Another important finding concerns the emergence of prompt literacy and human–AI collaboration as distinctive competencies within AI literacy. Generative AI has fundamentally changed how students interact with information by enabling conversational engagement with intelligent systems. Effective use of these technologies depends not only on understanding AI capabilities but also on constructing meaningful prompts, critically interpreting AI responses, and combining AI-generated insights with independent reasoning. Human–AI collaboration therefore represents a balanced educational approach in which AI enhances human creativity, analytical thinking, and problem-solving without replacing intellectual responsibility or academic judgment.

Ethical considerations also occupy a central position within contemporary AI literacy. The reviewed studies consistently identify fairness, accountability, transparency, privacy, academic integrity, and responsible AI use as essential components of future educational practice. Universities must therefore move beyond teaching students how to operate AI systems toward developing graduates capable of making ethical decisions regarding AI adoption in academic and professional settings. Embedding responsible AI principles within curriculum design will help ensure that technological innovation remains aligned with educational values and societal expectations.

Despite substantial progress, several challenges continue to influence AI literacy implementation across higher education. Considerable variation exists in institutional AI policies, faculty preparedness, curriculum design, and assessment practices. Many universities continue to develop governance frameworks while responding to rapidly evolving AI technologies that frequently outpace curriculum revision cycles. Furthermore, standardized methods for measuring AI literacy remain under development, limiting direct comparison across educational contexts. These challenges indicate that AI literacy should be regarded as a continuously evolving educational capability requiring ongoing institutional support, policy development, and curriculum innovation.

Overall, the findings suggest that AI literacy should become a strategic priority for higher education institutions. Developing technically competent, ethically responsible, and critically reflective AI users will be essential for preparing graduates capable of participating effectively within increasingly AI-driven academic, professional, and

societal environments. Future institutional efforts should therefore emphasize interdisciplinary curriculum integration, faculty professional development, responsible AI governance, and lifelong AI competency development to ensure that higher education remains responsive to continuing technological transformation.

6. | CONCLUSION

This study examined AI literacy in higher education through a Systematic Literature Review (SLR) following the PRISMA 2020 framework. By synthesizing studies published between 2020 and 2025, the review explored the evolution of AI literacy, conceptual frameworks, core competencies, educational implementation, and future research directions. The analysis demonstrates that AI literacy has rapidly evolved into a multidimensional educational competency supporting responsible engagement with artificial intelligence across teaching, learning, research, and professional practice.

The findings indicate that AI literacy extends beyond technical understanding of artificial intelligence by integrating conceptual knowledge, critical evaluation, prompt literacy, ethical reasoning, responsible AI use, and human–AI collaboration. Universities increasingly implement AI literacy through curriculum integration, interdisciplinary learning, faculty development, and AI-supported educational innovation. These initiatives contribute to preparing graduates who can use AI effectively while maintaining critical judgment, academic integrity, and ethical responsibility.

The review also highlights the growing importance of responsible AI governance within higher education. As generative AI continues transforming educational practice, institutions must establish policies, curriculum frameworks, and assessment strategies that encourage transparent, fair, and accountable AI use. Faculty preparedness, institutional governance, and continuous curriculum development will play essential roles in ensuring that AI technologies support meaningful learning rather than replacing human intellectual engagement.

Overall, AI literacy has become a strategic competency for twenty-first-century higher education. Universities should continue embedding AI literacy within institutional policy, curriculum design, teaching practice, and professional development to prepare students for lifelong participation in AI-enabled societies. Future research should focus on longitudinal AI literacy development, cross-cultural validation of competency frameworks, standardized assessment instruments, discipline-specific implementation models, and the educational implications of emerging technologies such as multimodal AI, intelligent agents, and advanced human–AI collaborative systems.

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Declaration of Conflicting Interests

The authors declare that there is no conflict of interest.

Ethical Approval and Originality Statement

Ethical approval was obtained for this study. The manuscript represents original work and has not been previously published, nor is it under consideration by another journal.

Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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