# DEVELOPING AI LITERACY THROUGH A COMPETENCY-BASED APPROACH IN PRACTICE-ORIENTED EDUCATIONAL ENVIRONMENTS

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**Abstract**. *Purpose.* Artificial intelligence is increasingly reshaping educational environments and professional practice, creating a growing need to prepare graduates for responsible and effective interaction with intelligent technologies. This study aims to provide a theoretical foundation for the development of AI literacy within a competence-based educational paradigm and to examine how practice-oriented learning contributes to the formation of AI-related competencies. It further seeks to conceptualize AI literacy as a multidimensional educational competence that integrates cognitive, technological, ethical, and professional dimensions relevant to higher education. *Methodology.* The study adopts a qualitative theoretical design based on the analysis and synthesis of contemporary scientific literature, international educational frameworks, policy documents, and normative acts regulating competence-based education and digital transformation. Comparative, systemic, and conceptual analyses were employed to examine existing approaches to competence development and AI literacy. *Results of* the study demonstrate that AI literacy should be understood as a comprehensive educational competence rather than merely the ability to use AI-powered applications. Its structure encompasses technological understanding, critical evaluation, ethical reasoning, communication, data literacy, and responsible decision-making. The analysis confirms that competence-based education provides an appropriate methodological framework for integrating these dimensions through authentic learning experiences, project-based activities, professional simulations, and reflective practice. The proposed conceptual models illustrate the interdependence between competence-based education,

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intelligent communication technologies, AI literacy, and educational outcomes, highlighting the importance of learner-centred pedagogies and authentic assessment for sustainable competence development. *Practical implications.* The proposed framework may be applied in the design and modernization of higher education curricula, teacher education programmes, and institutional policies aimed at integrating AI literacy into educational practice. The conceptual models can support curriculum developers and educators in designing competency-oriented learning activities, selecting appropriate AI tools, and implementing assessment strategies that promote critical, ethical, and responsible engagement with artificial intelligence. *Originality/Value.* The study offers an original theoretical interpretation of AI literacy as an integrated competence developed through the interaction of competence-based and practice-oriented education. By bringing together educational theory, competence frameworks, and intelligent communication technologies within a unified conceptual model, it extends current understanding of AI literacy and provides a methodological basis for curriculum innovation and the modernization of higher education in the context of digital transformation.

## INTRODUCTION

The remarkable progress of artificial intelligence (AI) technology has become one of the most profound and transformative developments of the twenty-first century, significantly impacting economic, social, and educational systems worldwide. The challenge for educational institutions, therefore, is to prepare students not only to use AI technologies effectively but also to critically understand their capabilities, limitations, ethical implications, and societal impact. This has made the building of AI competencies a key educational priority and an integral part of competency-based education.

AI literacy constitutes a broad educational competence that integrates conceptual understanding, practical skills, ethical responsibility, and reflective attitudes required for the informed and responsible use of AI technologies. According to Stolpe K. and Hallström J., AI literacy involves considerably more than understanding how AI functions. It also requires learners to critically examine AI applications, recognize their impact on human judgment and decision-making, and engage responsibly in digitally mediated environments. Such an approach aligns with the broader educational

objective of developing key competencies that enable individuals to navigate complex and rapidly changing technological landscapes [22].

The growing significance of AI in education has been highlighted by numerous scholars (Bond M., Gouverneur F., Hrytsenchuk O., Hallström J., Kutsak L., Marín V. I., Melnychenko O., Stolpe K., Zawacki-Richter O.) who have identified both the opportunities and challenges associated with its implementation. Research by Kutsak L. and Melnychenko O. demonstrate that AI technologies can enhance personalized learning, support adaptive learning, automate administrative tasks, and improve access to educational resources. At the same time, the integration of AI raises concerns regarding data privacy, algorithmic bias, academic integrity, transparency, and the potential over-reliance on automated systems [3; 4]. These challenges necessitate strengthening learners' critical understanding of AI, thereby reinforcing AI literacy as a core educational competence.

The emergence of generative AI technologies has further intensified discussions regarding the role of AI in higher education. Educational institutions need to balance technological innovation with academic integrity while developing students' capacity to use AI tools ethically and responsibly (Francis et al. 2025). Generative AI systems have transformed traditional approaches to information retrieval, content creation, and problem-solving, requiring educators to reconsider pedagogical strategies and assessment methods. Therefore, the development of AI literacy is increasingly viewed as an essential prerequisite for meaningful participation in contemporary educational and professional environments [13].

From a broader educational perspective, AI literacy can be understood through the lens of the competency-based approach, which emphasizes the acquisition and practical application of interconnected knowledge, skills, values, and attitudes. A key aim of competency-based education is to equip learners with the ability to apply and adapt their knowledge and skills in authentic situations rather than merely recalling theoretical concepts. As noted by Škrinjarić B., competencies can be understood as multidimensional combinations of knowledge, skills, attitudes, and behaviors that enable individuals to respond effectively to a wide range of professional and social demands. This understanding provides a valuable framework for conceptualizing AI literacy as a complex and transferable competence applicable across disciplines and professional domains [21].

Although the competency-based approach has become an established foundation of higher education in Ukraine and many European countries, contemporary educational discourse increasingly focuses on its effective implementation. While educational standards and curricula are formally structured around learning outcomes and competencies, researchers emphasize that their successful acquisition requires learning environments in which students can apply acquired knowledge, skills, and values in authentic professional and social contexts. Hence, the current challenge for higher education institutions lies not in the implementation of the competency-based approach itself but in enhancing pedagogical practices that ensure the meaningful formation and demonstration of competencies through practical experience.

Recent educational research highlights that competency development is most effective when learning is organized around authentic tasks, problem-solving activities, project-based learning, professional simulations, and experiential learning [17]. Such approaches enable students to transfer theoretical knowledge to real-world situations, thereby fostering deeper understanding, critical thinking, adaptability, and professional readiness. From this perspective, practice-oriented learning complements competency-based education by creating learning environments in which students demonstrate their competencies through authentic activities instead of relying exclusively on theoretical learning [21].

Responding to the changing demands of contemporary society requires higher education institutions to move beyond the transmission of disciplinary knowledge and place greater emphasis on the development of transferable competencies. Critical thinking, problem-solving, communication, collaboration, ethical reasoning, and digital competence are now widely recognized as essential attributes of future professionals. UNESCO (2023) emphasizes that AI education should not be limited to explaining the principles underlying generative AI technologies. Instead, it should prepare learners to critically evaluate AI-generated information, use AI tools in a responsible manner, and understand the broader ethical and societal consequences of their application. Achieving these educational goals requires learning environments that engage students in authentic tasks, practical experiences, and competency-based assessment, enabling them to apply their knowledge and skills in meaningful contexts [16].

Further strengthening practice-oriented learning is closely linked to enhancing the quality and relevance of university education. Amid digital transformation, labor market changes, and post-war reconstruction, universities are increasingly expected to create educational environments that facilitate the practical application of competencies and prepare graduates for complex professional challenges. The development of AI literacy within a competency-based and practice-oriented educational process represents an important strategy for enhancing educational outcomes and fostering future-oriented competencies necessary for lifelong learning and professional success.

As artificial intelligence becomes more deeply embedded in education and professional practice, the development of AI competence frameworks has gained increasing attention. Rather than defining AI competence solely in terms of technical expertise, contemporary educational research conceptualizes it as an integrated combination of knowledge, practical skills, critical and analytical thinking, ethical reasoning, data literacy, and responsible engagement with AI technologies. These frameworks provide a valuable foundation for curriculum design by supporting the systematic integration of technological, cognitive, and ethical dimensions into AI education [15].

Modern educational approaches increasingly advocate authentic, experiential, and problem-based learning to strengthen the connection between conceptual knowledge and its practical application. Practice-oriented instruction enables students to apply AI technologies in realistic contexts, analyze authentic cases, address profession-related challenges, and consider the ethical and social dimensions of AI deployment. By engaging in these activities, learners acquire not only technical competence but also the critical, reflective, and ethical capacities necessary for the responsible use of artificial intelligence [22].

Teacher education has become an important context for AI literacy development because prospective educators must both incorporate digital technologies into their own teaching practice and prepare learners to use AI critically and responsibly. A systematic review highlights the growing role of AI-assisted learning environments in language education and emphasizes the need for prospective teachers to develop competencies for the pedagogically appropriate and ethical use of digital tools [20].

Moreover, the growing emphasis on explainable artificial intelligence (XAI) underscores the necessity of promoting transparency and interpretability in AI-supported decision-making processes. Studies on explainable AI indicate that transparent decision-making processes improve users' confidence in AI systems and facilitate more informed interpretation of algorithmic outputs. Similar principles apply to education, where AI literacy should include an understanding of transparency, accountability, and the limitations of algorithmic decision-making [16; 20; 22; 23].

The significance of AI literacy is particularly evident in the context of ongoing educational reforms in Ukraine. The full-scale war has intensified the need for resilient, flexible, and innovative educational systems capable of responding to rapid societal, technological, and economic changes [12]. Under these circumstances, the renewal of educational content and the advancement of future-oriented competencies have become strategic priorities for national educational policy.

According to the Law of Ukraine "On Education", the competency-based paradigm serves as a foundation for the national education system, emphasizing the formation of key competencies necessary for lifelong learning, responsible citizenship, innovation, and successful professional activity in the digital age. Within this framework, digital competence and the ability to work effectively with emerging technologies, including artificial intelligence, are increasingly recognized as essential components of contemporary education [5].

The transformation of the educational system during wartime requires not only ensuring continuity of learning but also preparing graduates to function in highly dynamic and uncertain environments. Accordingly, higher education institutions are expected to modernize curricula by integrating innovative technologies, interdisciplinary approaches, and practice-oriented learning experiences.

Recent studies examining the application of artificial intelligence in education emphasize that AI technologies are reshaping traditional pedagogical approaches by supporting personalized learning, adaptive assessment, intelligent tutoring systems, and data-informed decision-making [12; 19; 23]. At the same time, researchers stress the necessity of enhancing learners' understanding of the ethical, legal, and social implications associated with AI implementation. This perspective is

particularly important in Ukraine, where educational reform is closely connected with broader processes of digital transformation and post-war reconstruction in Ukraine.

International organizations emphasize the necessity of integrating AI competencies into educational systems. Guidance for Generative AI in Education and Research (UNESCO) highlights the importance of equipping learners and educators with the knowledge, skills, and values required to use generative AI responsibly, ethically, and effectively. The document advocates curriculum innovation, teacher professional development, and institutional policies that promote critical thinking, academic integrity, transparency, and human-centered approaches to AI adoption. Collectively, these recommendations support the integration of AI literacy into competency-based curricula while encouraging innovation in higher education in response to emerging technological developments [16].

In this regard, practice-oriented education provides a particularly effective environment for AI literacy development. Through authentic tasks, project-based learning, real-world problem solving, and professional simulations, students can acquire not only theoretical knowledge about AI technologies but also practical experience in their responsible application. Such educational experiences facilitate the development of interrelated competencies that combine technological understanding, critical thinking, ethical reasoning, collaboration, and adaptability [20; 24]. Therefore, the development of AI literacy within a competency-based and practice-oriented educational process represents a promising direction for enhancing the quality and relevance of higher education in Ukraine in the context of educational transformation and societal change.

Considering these developments, there is a growing need to conceptualize AI literacy not merely as technological proficiency but as a comprehensive competence that integrates cognitive, practical, ethical, and social dimensions. Within a competency-based educational paradigm, AI literacy should foster a range of transferable competencies, including critical thinking, digital citizenship, collaboration, communication, and lifelong learning, thereby enabling responsible participation in a digital society.

Therefore, the purpose of this study is to theoretically substantiate and examine the development of AI literacy through a competency-based

approach within the context of practice-oriented education. The study aims to conceptualize AI literacy as a comprehensive educational competence that combines technological knowledge, critical thinking, ethical awareness, data literacy, problem-solving skills, and the responsible use of AI technologies. Special emphasis is placed on exploring the role of practice-oriented learning environments in fostering the acquisition and application of these competencies through authentic educational experiences, project-based activities, and real-world professional tasks.

Furthermore, the study seeks to identify the structural components of AI literacy and analyze their relationship with key competencies required for lifelong learning, digital citizenship, professional adaptability, and responsible participation in a technology-driven society. The research also aims to examine how the principles of competency-based education can support the effective integration of AI literacy into higher education curricula and educational programs, particularly within the context of ongoing educational transformation and digitalization.

Given the current challenges facing the Ukrainian educational system, including the need for educational resilience, innovation, and post-war reconstruction, the study further seeks to substantiate pedagogical approaches that contribute to the modernization of educational content and the development of future-oriented competencies. Special emphasis is placed on the preparation of future educators who are expected not only to use AI technologies effectively in their professional practice but also to cultivate AI literacy among their students in accordance with ethical, legal, and pedagogical principles.

Ultimately, this research aims to contribute to the theoretical and methodological foundations of literacy development in the field of artificial intelligence by following a competency-based and practice-oriented conceptual model that can foster innovation in educational programs, improve the quality of higher education, and promote the formation of key competencies necessary for career success and lifelong learning.

## 1. Research and Discussion

Many scholars, including Vozniuk O., Dubaseniuk O., Mukan N., Chubinska N. consider that the competency-based approach occupies a central position in the contemporary educational policy of Ukraine and

serves as one of the key methodological foundations for the modernization of the national education system [1; 6; 17]. The legislative basis for its implementation is established by the Law of Ukraine "On Education," which defines competence as a dynamic combination of knowledge, skills, abilities, ways of thinking, values, attitudes, and other personal qualities that enable a person to successfully socialize, engage in professional activities, and continue learning throughout their life. This understanding reflects a shift from a predominantly knowledge-oriented model of education to a results-based paradigm that focuses on students' ability to apply acquired knowledge and skills in practical, professional, and social contexts [5].

Based on the Law of Ukraine "On Education," the development of competencies is regarded as a fundamental objective of the educational process [5]. Educational activities are expected not only to provide learners with subject-specific knowledge but also to foster the holistic development of cognitive, social, civic, cultural, digital, and entrepreneurial competencies necessary for effective participation in contemporary society. The legislation further emphasizes that educational outcomes should contribute to the comprehensive development of the individual, support self-realization, and prepare learners for responsible citizenship, professional activity, and lifelong learning.

The competency-based approach is further reflected in the formulation of key competencies that constitute the expected educational outcomes. These competencies encompass communication in the state and foreign languages, mathematical literacy, competence in science and technology, innovation, environmental awareness, information and communication technology (ICT) competence, learning-to-learn skills, civic and social responsibility, cultural awareness, entrepreneurship, and financial literacy [10; 17; 19].

Importantly, the Law identifies a set of cross-cutting skills common to all competencies, including critical and systemic thinking, creativity, initiative, problem-solving, decision-making, collaboration, emotional self-regulation, and the ability to express and justify one's views [5]. This emphasis reflects the understanding of competencies as multidimensional constructs integrating knowledge, practical skills, values, and personal dispositions.

From a pedagogical perspective, the competence-based approach requires the alignment of educational content, teaching methods, learning environments, and assessment practices with clearly defined learning outcomes. It promotes active and learner-centered teaching and learning strategies that encourage inquiry, collaboration, reflection, and the application of knowledge in authentic situations. The role of the educator shifts from that of an information provider to a facilitator of competence development, while learners assume greater responsibility for constructing knowledge and managing their own learning trajectories [6]. The competency-based approach contributes to the formation of adaptable, innovative, and socially responsible graduates capable of responding effectively to the challenges of a rapidly changing and increasingly digitalized world [10]. It functions as a strategic mechanism for ensuring the quality, relevance, and sustainability of higher education in accordance with national educational priorities and international trends.

The competency-based approach has become one of the most influential paradigms guiding contemporary educational reforms, particularly in the context of higher education modernization. Its emergence is closely associated with the global shift from knowledge-transmission models to outcome-oriented, learner-centred, and practice-integrated educational systems. Within this paradigm, education is increasingly understood not as the accumulation of disciplinary knowledge, but as the development of multidimensional and transferable competencies that enable individuals to respond effectively to complex professional, social, and technological challenges [7; 8; 17].

From a theoretical standpoint, competence is widely defined as a dynamic integration of knowledge, skills, attitudes, values, and personal attributes that together enable successful performance in specific contexts. This understanding is strongly reflected in the pedagogical tradition represented by the work of Dubaseniuk O., where competency-based education is interpreted as a systemic, activity-oriented, and practice-focused framework aimed at ensuring the readiness of future professionals for real-life problem-solving. Dubaseniuk O. emphasises that competence cannot be reduced to knowledge acquisition alone; rather, it emerges through purposeful educational activities that involve reflection, practice, and value-based engagement. In this sense, competence development is viewed as a

continuous process shaped by the interaction between theoretical learning and practical application in authentic or simulated professional contexts [6].

The competency-based paradigm aligns closely with European educational policy frameworks, particularly the European Union's Council Recommendation on Key Competences for Lifelong Learning (2018). This document defines key competences as combinations of knowledge, skills, and attitudes necessary for personal fulfilment, active citizenship, social inclusion, and employability. The EU framework identifies eight key competences, including multilingual competence, mathematical competence and competence in science, digital competence, personal and social competence, citizenship competence, entrepreneurship competence, and cultural awareness and expression [10; 11]. A central feature of this framework is its emphasis on lifelong learning, positioning competence development as a continuous and adaptive process that extends beyond formal education into professional and personal life.

Complementing the European perspective, the Organisation for Economic Co-operation and Development (OECD) research provides an additional conceptual layer through its focus on transformative competencies and the Learning Compass 2030 framework. The OECD highlights the importance of students' ability to navigate complexity, uncertainty, and rapid societal change. It introduces three key transformative competencies: creating new value, reconciling tensions and dilemmas, and taking responsibility [18]. These competencies reflect a shift toward educating individuals who are not only capable of applying knowledge but also of critically engaging with global challenges, demonstrating creativity, and acting responsibly in diverse contexts. The OECD framework thus reinforces the idea that modern education must prioritise adaptability, agency, and problem-solving skills in unpredictable environments [19].

The competency-based approach has gained prominence in higher education research because it seeks to align educational outcomes more closely with the knowledge, skills, and competencies expected in rapidly evolving labor markets. Technological advancement, digitalisation, and globalisation have significantly transformed professional requirements, necessitating graduates who possess not only subject-specific expertise but also transversal competencies such as critical thinking, communication, collaboration, digital literacy, and self-regulation. As a result, competency-

based education seeks to bridge the gap between theoretical knowledge and practical application by restructuring curricula around clearly defined learning outcomes that reflect authentic professional practice.

A key implication of this shift is the reconfiguration of pedagogical roles and teaching methodologies. Within competency-based education, the teacher is no longer positioned primarily as a transmitter of knowledge but rather as a facilitator, mentor, and designer of learning environments that support active learner engagement [1]. This includes the implementation of student-centred and activity-based pedagogies, including project-based learning, problem-based learning, case studies, simulations, and reflective practices. These methods encourage learners to take responsibility for their own learning processes, develop autonomy, and engage in continuous self-assessment and reflection [6; 9].

Equally important is the transformation of assessment practices. Conventional assessment approaches centered mainly on knowledge recall are increasingly being replaced by authentic and performance-based methods that evaluate learners' ability to apply their knowledge in practice. These include portfolios, project outputs, presentations, and reflective journals, which enable a more comprehensive evaluation of learners' ability to mobilize and apply competencies in practice. Such assessment approaches are aligned with the overarching goal of competency-based education, which is to measure not only what learners know, but also what they are able to do with their knowledge in varied and dynamic contexts.

Another significant dimension of competency-based education is its emphasis on interdisciplinarity and the integration of transversal skills. Modern professional environments require individuals to operate across disciplinary boundaries, combining knowledge from multiple fields to solve complex problems. Competency-based curricula increasingly prioritise cross-cutting competencies that support adaptability and innovation. These include digital competence, learning-to-learn skills, entrepreneurial thinking, and socio-emotional intelligence, which are widely recognised as essential for lifelong learning and sustainable professional development [17]. It supports the development of graduates who are not only professionally competent but also socially responsible, adaptable, and capable of contributing to innovation-driven economies.

Overall, the literature demonstrates that the competency-based approach constitutes a comprehensive and multidimensional framework for educational transformation. It draws together theoretical insights from pedagogical research, particularly those of Dubaseniuk O., with supranational policy frameworks such as the European Union and the OECD. Together, these perspectives emphasise the importance of outcome-based education, learner autonomy, transversal skill development, and lifelong learning. As such, the competency-based approach represents a strategic foundation for the ongoing modernization of higher education systems, ensuring their relevance, flexibility, and responsiveness to contemporary global challenges [1; 6; 9; 18; 19].

The competency-based approach has become a central element of higher education modernization, emphasizing the development of learners' ability to integrate knowledge, skills, values, and prior experience to address complex professional and societal challenges. It shifts the emphasis from the transmission of disciplinary knowledge to the achievement of measurable learning outcomes, fostering adaptability, self-directed learning, digital competence, and reflective engagement in diverse educational and professional environments.

This approach is grounded in the principle that education should not be limited to the acquisition of theoretical knowledge but should also facilitate the development of comprehensive competencies that enable learners to apply their knowledge and skills in authentic and dynamic contexts. Competency development is viewed as a continuous process that combines cognitive, practical, social, and personal dimensions of learning, ensuring that graduates are prepared to respond effectively to the demands of contemporary professional practice and lifelong learning [6]. The educational content is designed to reflect real-world challenges and interdisciplinary connections, encouraging learners to transfer knowledge across different contexts and engage in meaningful problem-solving activities [1].

The competency-based approach also redefines the roles of both teachers and students. Educators function as facilitators, mentors, and designers of learning experiences that promote active participation, collaboration, and independent inquiry, while students assume greater responsibility for their own learning processes. This educational orientation promotes the

development of critical thinking, creativity, communication, collaboration, and decision-making abilities, all of which are widely regarded as fundamental elements of professional competence in the twenty-first century [17].

This approach encourages the integration of innovative pedagogical methods, including project-based learning, problem-based learning, experiential learning, and digital learning environments. These methods create opportunities for learners to engage in authentic tasks, reflect on their experiences, and construct knowledge through active participation. Assessment within this paradigm extends beyond the evaluation of content knowledge to focuse on the demonstration of competencies through performance-based tasks, portfolios, reflective activities, and other forms of authentic assessment that provide evidence of learners' ability to apply knowledge and skills in practice.

Amid ongoing educational transformation and accelerating digitalisation, the competence-based approach contributes to the formation of resilient, adaptable, and socially responsible graduates who are capable of effectively navigating uncertainty, engaging with innovation, and participating meaningfully in both professional and civic domains [11]. It serves as a strategic foundation for aligning higher education with contemporary societal needs, labour market expectations, and the broader objectives of sustainable educational development.

The transformation of educational content constitutes one of the most significant directions in the modernization of higher education in contemporary society. Digital technologies, the expansion of global knowledge networks, changes in labour market requirements, and the increasing complexity of professional activities necessitate reconsidering traditional approaches to curriculum design and educational outcomes [15]. In this context, the competence-based approach serves as a methodological foundation for the renewal of educational content, ensuring its relevance, flexibility, and responsiveness to societal needs.

Research on the modernization of higher education demonstrates that educational transformation should be understood not merely as the revision of academic disciplines or the introduction of innovative technologies but as a comprehensive process aimed at aligning educational goals, content, teaching methods, and assessment practices with the competencies required

for successful professional and social participation. The modernization of educational content therefore involves a shift from the accumulation of fragmented knowledge to the development of integrated competencies that enable learners to apply knowledge in authentic situations [13].

Within this framework, the competency-based approach contributes to overcoming the gap between theoretical preparation and practical application. Educational content is structured around learning outcomes that reflect the knowledge, skills, values, attitudes, and behaviours necessary for address complex professional challenges [14]. Such an orientation enhances the practical significance of education and promotes the formation of graduates capable of critical thinking, problem-solving, decision-making, collaboration, and continuous professional development. The focus shifts from what learners know to what they are able to do with their knowledge in diverse contexts.

A significant aspect of educational content transformation involves the integration of interdisciplinary and cross-curricular competencies. Contemporary professional environments increasingly require individuals to combine expertise from multiple domains, adapt to technological innovations, and engage effectively in collaborative problem-solving activities. Educational programs must move beyond narrow disciplinary boundaries to create opportunities for learners to develop transferable competencies that can be applied across professional and social contexts [9]. This tendency is particularly important under conditions of digital transformation, where the ability to learn, relearn, and adapt becomes a critical factor of professional success.

The modernization of educational content should be accompanied by the implementation of learner-centered and digitally supported learning environments. Such environments create favorable conditions for active knowledge construction, reflective practice, personalized learning trajectories, and the development of self-directed learning skills. As a result, competence development becomes a dynamic process that integrates cognitive, practical, social, and personal dimensions of learning. Educational content is no longer viewed as a fixed body of information but rather as a flexible system designed to support the holistic development of learners [9].

In addition, the competency-based transformation of educational content contributes to strengthening the relationship between higher education

institutions and the evolving demands of society. By orienting curricula toward competency development, universities are better positioned to prepare graduates who can function effectively under conditions of uncertainty, technological change, and global interdependence. Such graduates demonstrate not only professional expertise but also adaptability, innovation, social responsibility, digital literacy, and a commitment to lifelong learning. Therefore, the competency-based approach functions as a key mechanism for enhancing the quality, relevance, and sustainability of higher education while supporting the broader objectives of educational modernization and societal development (Table 1).

Table 1

**Conceptual Model of the Competency-Based Approach in Higher Education Modernization**

| | |
|---|---|
| **Societal and Global Context** | digital transformation; knowledge economy; labour market change |
| **Competency-based Education Paradigm** | outcome-based; learner-centred; practice-oriented |
| **Normative Basis** | Law of Ukraine; EU Key Competences; OECD frameworks etc |
| **Educational Goals** | integrated competences; lifelong learning; holistic development |
| **Curriculum Design** | learning outcomes; interdisciplinarity; real-world tasks |
| **Core Competence Structure** | knowledge, skills, values, attitudes, experience; key competencies: digital, communication, civic, entrepreneurial; cross-cutting skills: critical thinking, creativity, collaboration |
| **Pedagogical Implementation** | project-based learning; problem-based learning; experiential learning; reflective practice |
| **Assessment System** | performance-based assessment; portfolios, projects; presentations |
| **Educational Outcomes** | critical thinking; adaptability; innovation; digital competence; AI literacy; lifelong learning readiness |
| **Digital Transformation and AI layer** | intelligent communication technologies; AI tools; personalized learning; data-driven decision-making; AI literacy |

*Source: based on national legislation and international frameworks on competence development [1; 5; 6; 9; 14; 17; 18; 19]*

Table 1 presents a holistic conceptual model of the competency-based approach as a multi-layered system embedded in higher education modernization. It illustrates how broader societal and global transformations such as digitalisation, the knowledge economy, and labour market changes, drive the transition toward competency-based education. This paradigm is grounded in national legislation (e.g., the Law of Ukraine "On Education") and international frameworks (e.g. the EU and OECD frameworks on key competencies), which provide the normative basis for educational transformation.

At the core of the model is the competency-based education paradigm, which emphasizes outcome-based, learner-centred, and practice-oriented learning. This paradigm guides curriculum design, where learning is structured around interdisciplinary, real-world tasks and clearly defined learning outcomes [15]. Competence development is conceptualized as the integration of knowledge, skills, values, attitudes, and experience, supported by transversal skills such as critical thinking, creativity, and collaboration, as well as key competencies including digital literacy, communication, civic, and entrepreneurial competences.

The model further highlights pedagogical implementation through active methodologies (e.g., project-based, problem-based, and experiential learning) and reflective practices, alongside an assessment system based on authentic performance (portfolios, projects, presentations). These elements collectively support the development of key educational outcomes such as adaptability, innovation, digital competence, AI literacy, and lifelong learning readiness [16]. Additionally, the model introduces a layer representing digital transformation and AI, reflecting the growing role of intelligent communication technologies, AI tools, personalized learning, and data-driven decision-making in contemporary education.

Overall, the figure demonstrates how competency-based education functions as an integrated framework that links societal needs, curriculum design, pedagogy, assessment, and technological innovation within higher education modernization (Table 1).

The growing emphasis on competence development is closely associated with the ongoing digital transformation of education and professional practice. As digital ecosystems increasingly shape learning, communication, and workplace environments, higher education must equip learners with

the knowledge, skills, and attitudes required to engage effectively with emerging technologies [10; 11; 18; 19]. Digital competence has evolved from a complementary skill into a fundamental component of professional competence across disciplines.

As digital transformation continues to reshape education and society, intelligent communication technologies have assumed a central role in this process. Their integration into educational settings not only enhances access to information and communication but also creates new opportunities for personalized learning, collaborative knowledge construction, adaptive assessment, and data-informed decision-making. As these technologies become embedded in educational practice, they simultaneously reshape the competencies expected of both learners and educators.

The expansion of artificial intelligence has further accelerated these changes by introducing advanced tools capable of supporting learning, communication, and professional activities. Higher education is increasingly expected to cultivate AI literacy as an essential dimension of competency-based education, ensuring that future professionals can use intelligent technologies critically, ethically, and effectively in diverse academic and workplace contexts [24].

The continuous evolution of digital innovation has profoundly reshaped communication practices, information exchange, and participation in educational, professional, and social activities. Among these developments, intelligent communication technologies have emerged as one of the most influential drivers of educational and societal transformation [23] These technologies integrate artificial intelligence (AI), machine learning, natural language processing, cloud computing, and data analytics to facilitate effective interaction between users and digital systems. Unlike conventional communication technologies, intelligent systems are capable of processing vast amounts of information, adapting to users' needs, providing personalized support, and automating routine cognitive tasks [13; 24]

In contemporary society, intelligent communication technologies have become an indispensable component of everyday life. They facilitate communication across geographical boundaries, support real-time collaboration, expand access to digital services, and enhance decision-making across diverse sectors, including education, healthcare, business, and public administration [12]. Their increasing accessibility has

accelerated digital transformation while creating new opportunities for lifelong learning, professional development, and international cooperation. At the same time, the widespread adoption of these technologies requires individuals to possess not only digital competencies but also the ability to critically evaluate AI-generated information, understand the capabilities and limitations of intelligent systems, and interact with them responsibly and ethically [14; 15; 19].

Artificial intelligence tools constitute one of the most rapidly evolving categories of intelligent communication technologies. Contemporary AI applications include conversational agents, intelligent tutoring systems, automated translation services, adaptive learning platforms, content generation systems, data visualization tools, and virtual assistants. These solutions assist users in retrieving information, generating educational content, analyzing data, supporting creative activities, and facilitating communication in multilingual environments [16]. Within educational settings, AI-powered tools promote personalized learning by adapting instructional content to learners' individual needs, monitoring learning progress, and providing immediate feedback. Furthermore, they reduce educators' administrative workload, enabling teachers to devote greater attention to pedagogical interaction, student engagement, and instructional design [24]. The diversity of AI applications currently employed in educational contexts and their principal pedagogical functions are summarized in Table 2.

Nevertheless, the educational potential of AI tools depends not only on technological innovation but also on users' ability to employ these technologies effectively, critically, and ethically. AI literacy has gained recognition as a fundamental competence for the twenty-first century. AI literacy extends beyond the technical ability to operate AI-powered applications [15]. It encompasses a comprehensive understanding of AI systems functioning, the principles underlying algorithmic decision-making, the ethical implications of AI deployment, issues related to data privacy and security, the identification of algorithmic bias, and the capacity to critically evaluate AI-generated outputs. Accordingly, AI literacy integrates technological knowledge with critical thinking, digital ethics, information literacy, communication competence, and responsible decision-making [7; 8; 10; 16]. From the perspective of competency-based education, AI

literacy can be conceptualized as an integrated competence that comprises interconnected knowledge, skills, ethical dispositions, and professional abilities (Table 3).

Table 2

**AI tools and their educational applications**

| AI tool category | Main functions | Educational applications |
|---|---|---|
| Conversational AI | Answering questions, generating explanations, supporting dialogue | Tutoring, writing assistance, brainstorming, language learning |
| Intelligent tutoring systems | Personalized instruction and adaptive feedback | Individualized learning pathways and formative assessment |
| Automated translation tools | Translation and multilingual communication | Foreign language learning and international collaboration |
| Adaptive learning platforms | Personalized learning content based on learner performance | Self-paced learning and differentiated instruction |
| Content generation systems | Creating text, images, presentations, quizzes, and educational materials | Lesson planning, instructional content creation, student assignments |
| Data analytics and visualization tools | Processing and visualizing educational data | Learning analytics and evidence-based decision-making |
| Virtual assistants | Scheduling, information retrieval, task automation | Administrative support and student assistance |

*Source: compiled by the author based on [2; 3; 4; 7; 12; 13; 15]*

The development of AI literacy should be regarded as a continuous educational process rather than the acquisition of isolated technical skills. Higher education institutions play a particularly important role in preparing future professionals who can effectively integrate AI technologies into their academic and professional activities. Achieving this objective requires the implementation of learner-centred educational approaches that promote active participation, problem-solving, collaborative learning, and authentic practical experiences. Practice-oriented learning environments enable students to apply AI tools to real-world tasks, evaluate their effectiveness, reflect on their ethical implications, and develop confidence in the responsible use of intelligent technologies (Table 3).

Table 3

**AI literacy as a competence within competence-based education**

| Competence domain | AI literacy components | Supporting AI tools | Expected learning outcomes |
|---|---|---|---|
| Knowledge | AI concepts, algorithmic thinking, AI capabilities | Educational AI platforms | Understanding intelligent systems |
| Cognitive skills | Critical evaluation, problem-solving, information analysis | Conversational AI, analytics tools | Informed decision-making |
| Digital skills | Effective use of AI applications | Content generators, adaptive learning systems | Digital competence |
| Communication | Human–AI interaction, multilingual communication | Chatbots, translation tools | Effective collaboration |
| Ethical competence | Privacy, bias, transparency, responsible AI use | All AI technologies | Ethical decision-making |
| Professional competence | AI integration into discipline-specific practice | Domain-specific AI tools | Workplace readiness |
| Lifelong learning | Continuous adaptation to technological innovation | Emerging AI applications | Sustainable professional development |

*Source: compiled by the author based on [7; 8; 12; 13; 15; 17; 23]*

In competency-based higher education, the development of AI literacy in practice-oriented educational environments is increasingly conceptualized as an experiential and context-dependent process through which theoretical knowledge is continuously reinforced through authentic task performance [20; 22; 24]. In line with the competency-based paradigm, which emphasizes the integration of knowledge, skills, values, and practical experience for real-world problem solving, AI literacy is most effectively developed when learners are actively engaged in meaningful professional simulations, project-based activities, and interdisciplinary tasks that require the application of intelligent technologies [1; 2; 6]. Such an approach is consistent with contemporary European and OECD perspectives, which highlight the importance of transversal and transformative competencies that support adaptability, agency, and responsible participation

in complex digital environments (European Commission, 2020; OECD, 2019).

In practice-oriented learning settings, AI literacy is not limited to the acquisition of operational skills but is gradually formed through iterative cycles of action, reflection, and evaluation. Learners interact with AI tools to solve authentic educational or professional tasks, critically assess the reliability of generated outputs, and make informed decisions regarding their use in specific contexts. This process fosters the development of metacognitive awareness and supports the internalization of ethical and responsible patterns of AI engagement. From this perspective, AI literacy becomes a situated competence that emerges through continuous interaction between learners, technologies, and task environments rather than through isolated instruction [3; 4].

Practice-oriented environments provide a structured framework for integrating AI tools into collaborative learning processes, where students jointly analyse data, co-construct knowledge, and negotiate meaning while using intelligent systems as cognitive partners. This perspective aligns with the broader understanding of competence formation as a dynamic interaction between theoretical learning and practical application in authentic or simulated contexts [6; 17]. Consequently, AI literacy development in such environments contributes not only to digital proficiency but also to the formation of critical judgment, professional responsibility, and adaptive expertise required in rapidly evolving technological landscapes.

The integration of intelligent communication technologies is reshaping the role of educators, shifting it from the transmission of knowledge toward the facilitation and design of technology-enhanced learning. This educational transformation necessitates that teachers acquire the competencies needed to critically assess and appropriately select AI technologies, create inclusive learning environments, and encourage the ethical and responsible integration of AI into educational practice. As digital technologies continue to evolve, ongoing professional development has become essential for enabling educators to adapt their pedagogical practices and effectively integrate emerging technologies into teaching and learning [2; 15; 17; 20].

Despite the considerable benefits offered by intelligent communication technologies, their implementation also presents significant challenges. Concerns regarding data protection, academic integrity, the transparency

of AI algorithms, unequal access to digital resources, and the reliability of AI-generated information require careful consideration [22; 24]. Therefore, educational institutions should establish clear ethical guidelines, promote responsible AI governance, and cultivate students' awareness of both the opportunities and the potential risks associated with intelligent technologies (Table 4).

Table 4

**Conceptual Structure of AI Literacy within Competency-Based Education**

| Concept | Key elements |
|---|---|
| Digital transformation | Digital ecosystems, competence-based education, emerging technologies |
| Intelligent communication technologies | Artificial intelligence, machine learning, natural language processing, cloud computing, data analytics |
| AI tools | Conversational agents, intelligent tutoring systems, translation tools, adaptive learning platforms, content generators, visualization tools, virtual assistants |
| AI literacy | Technical understanding, critical evaluation, ethical awareness, data literacy, information literacy, communication competence, responsible decision-making |
| Educational implementation | Personalized learning, adaptive assessment, collaboration, authentic learning, practice-oriented activities |
| AI pedagogical competence | AI tool selection, pedagogical design, facilitation, professional development, inclusive learning |
| Challenges and governance | Data privacy, algorithmic bias, transparency, academic integrity, equitable access, ethical AI governance |

*Source: compiled by the author based on [1; 2; 8; 9; 10; 14; 15; 21; 22; 24]*

Table 4 provides a conceptual synthesis of the major components of intelligent communication technologies and AI literacy, demonstrating their interconnections within a competency-based educational framework.

Intelligent communication technologies and AI tools are reshaping contemporary education and society by expanding opportunities for communication, collaboration, knowledge creation, and lifelong learning [18; 19]. Their successful integration depends not only on technological infrastructure but also on the development of comprehensive AI literacy, which combines technical competence, critical thinking, ethical awareness, information literacy, and effective communication skills.

## CONCLUSIONS

The competency-based approach provides a comprehensive methodological foundation for the modernization of higher education in the context of digital transformation and the intensive advancement of artificial intelligence technologies. Contemporary educational systems increasingly require graduates who possess not only disciplinary knowledge but also integrated competencies that enable them to adapt to technological change, solve complex problems, make informed decisions, and participate responsibly in digitally mediated professional and social environments.

AI literacy should be conceptualized as an integrated educational competence rather than as a collection of isolated technical skills. It encompasses interconnected dimensions of technological knowledge, critical thinking, data literacy, ethical awareness, communication, problem-solving, and the responsible use of AI technologies. Within the competency-based paradigm, these dimensions function as complementary components of professional competence and contribute to the development of learners capable of critically evaluating, effectively applying, and ethically using AI-supported solutions.

The findings further indicate that the effective development of AI literacy requires the integration of practice-oriented educational approaches into competency-based curricula. Authentic learning environments, project-based activities, professional simulations, interdisciplinary collaboration, and reflective practice create conditions under which theoretical understanding is transformed into sustainable competencies through meaningful interaction with AI tools. Such educational experiences foster not only digital proficiency but also adaptability, professional judgment, lifelong learning readiness, and responsible participation in technology-rich environments.

The conceptual models proposed in this work synthesize the relationships between competency-based education, intelligent communication technologies, AI literacy, pedagogical implementation, and expected educational outcomes. These models provide a theoretical framework that can support curriculum design, educational policy development, and the integration of AI-related competencies into higher education programs. They also emphasize the evolving role of educators as facilitators of AI-enhanced learning who require corresponding pedagogical and digital competencies.

The development of AI literacy should become an integral component of competency-based higher education. In the context of educational modernization, digital transformation, and post-war reconstruction in Ukraine, strengthening AI literacy through practice-oriented learning constitutes an important strategy for improving educational quality, fostering innovation, and preparing future professionals for sustainable participation in an increasingly AI-driven society.

**Future research** should focus on the empirical validation of the proposed conceptual framework, the development of instruments for assessing AI literacy competencies, and the design and evaluation of practice-oriented pedagogical models that facilitate the effective integration of AI literacy into higher education across diverse academic disciplines.

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