

3rd International Conference on Education, Environment, Arts and Social Science (EEAS 2026)

Article

Constructing a Digital Literacy Cultivation System for University Teachers and Students in the Intelligent Era

Ruoqi Cao^{1,*}

¹ Yuxi Normal University, Yuxi, China

* Correspondence: Ruoqi Cao, Yuxi Normal University, Yuxi, China

Abstract: The intelligent era, characterized by the rapid advancement of artificial intelligence and digital technologies, has fundamentally reshaped higher education, making digital literacy an indispensable competency for both university teachers and students. Despite growing recognition of its critical importance, a systematic and integrated cultivation framework that simultaneously addresses the dynamic needs of both groups remains significantly underdeveloped. This study aims to construct a comprehensive digital literacy cultivation system tailored for university teachers and students navigating the intelligent era. Drawing on established global frameworks, including DigCompEdu, HeDiCom, and China's Teacher Digital Literacy Standards, this research proposes a multidimensional system comprising four core components: cultivation content, implementation pathways, support mechanisms, and evaluation mechanisms. The proposed system strongly emphasizes the coupling relationship between teachers' digital teaching competencies and students' digital literacy development, advocating for a synergistic and collaborative cultivation model. Through an in-depth analysis of existing literature and secondary data from prominent international databases, such as ICILS 2023 and OECD reports, this study identifies current competency gaps and persistent institutional challenges. The findings suggest that effective cultivation requires coherent institutional strategies, contextualized professional development programs, and fully integrated curriculum design. Ultimately, this research contributes a robust theoretical framework and actionable practical guidelines for higher education institutions seeking to enhance their digital literacy ecosystemically, offering profound implications for future policy formulation and pedagogical innovation.

Keywords: digital literacy; higher education; artificial intelligence; educational technology; pedagogical innovation; competency framework

Received: 02 April 2026

Revised: 25 May 2026

Accepted: 06 June 2026

Published: 13 June 2026



Copyright: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The intelligent era, driven by the rapid advancement of artificial intelligence, cloud computing, and big data, has profoundly reshaped the landscape of higher education. Digital literacy has evolved from an optional skill to an essential competency for both university teachers and students, influencing teaching effectiveness, learning outcomes, and long-term career development [1]. Despite the widespread recognition of its importance, higher education institutions face significant challenges in systematically cultivating digital literacy across both groups in an integrated manner.

The concept of digital literacy in higher education has been extensively discussed in the literature. A systematic review on digital competence research in higher education revealed that while a substantial body of work exists, most studies focus either on teachers or on students separately, with limited attention to the synergistic relationship between

the two [1]. This separation creates a gap in understanding how teacher digital competencies and student digital literacies can be developed collaboratively.

To address the specific competencies required for educators, a framework was developed to identify key digital competencies for higher education teachers in future-oriented teaching contexts. This framework emphasizes the need for teachers to not only use digital tools but also to design digitally enriched learning experiences that foster student digital literacy. Simultaneously, another comprehensive reference model for teacher digital competence provides guidance, covering multiple proficiency levels and competencies [2]. These frameworks offer foundational guidance for constructing cultivation systems.

For higher education contexts specifically, a systematic review focusing on teachers' digital competencies identified a persistent gap between policy expectations and actual classroom practices. This gap underscores the necessity of not only defining competencies but also designing effective cultivation pathways. Furthermore, rubric-based frameworks have been developed and validated for measuring student and educator digital competence beyond traditional self-assessment methods, highlighting the importance of objective, performance-based evaluation [1].

Building upon these theoretical and empirical foundations, this study aims to construct a digital literacy cultivation system for university teachers and students in the intelligent era. Unlike previous research that treats teachers and students as separate entities, this study adopts a coupled perspective, recognizing that teacher digital competencies and student digital literacy development are mutually reinforcing. The proposed system comprises four core components: cultivation content (what to learn), implementation pathways (how to learn), support mechanisms (institutional enablers), and evaluation mechanisms (how to measure progress). The research draws on secondary data from publicly available international databases, ensuring all data employed are authentic and verifiable without involving human interactive experiments or surveys.

The following sections of this paper are organized as follows: Section 2 presents a literature review. Section 3 describes the theoretical framework and methodology. Section 4 reports the findings and discussion. Section 5 concludes the study with implications and limitations [3].

2. Literature Review

The concept of digital competence and digital literacy in higher education has been examined from multiple perspectives, yet the integration of teacher and student development remains fragmented [4]. Spante, Hashemi, Lundin, and Algers conducted a systematic review of concept use in digital competence and digital literacy research within higher education, revealing that while the terms are often used interchangeably, they carry distinct conceptual underpinnings. Their analysis demonstrated that digital literacy typically emphasizes critical and social dimensions, whereas digital competence leans toward skills and performance. This conceptual ambiguity has hindered the development of coherent cultivation systems that address both teachers and students simultaneously.

Large-scale international assessments provide empirical benchmarks for understanding current digital literacy levels [5]. The IEA International Computer and Information Literacy Study (ICILS) 2018 international report assessed digital literacy among grade 8 students across 14 countries and educational systems. The findings indicated that while a majority of students possess basic digital skills, only a small proportion demonstrate advanced abilities such as evaluating digital information critically or creating complex digital products. This gap between foundational and advanced competencies is directly relevant to higher education, as incoming students often carry these pre-existing gaps into university settings, placing demands on both curriculum design and teacher preparedness.

Regional studies have further illuminated specific challenges. Nkansah and Oldac explored the digital literacy skills and knowledge gap in Ghana's higher education through a phenomenological study with undergraduate students. Their findings revealed

that infrastructural limitations, combined with inadequate integration of digital literacy into formal curricula, create persistent disparities. Although this study focused on a developing country context, its implications are broader: institutional support mechanisms are essential for bridging gaps that cannot be addressed by individual effort alone. Similarly, Ndibalema conducted a systematic review of digital literacy gaps in promoting 21st-century skills among students in Sub-Saharan African higher education institutions. The review identified that while digital literacy is recognized as a gateway skill, actual implementation remains sporadic and under-resourced, highlighting the need for systematic cultivation frameworks rather than isolated measures [3].

Moving from diagnosis to solution design, Jin, Siribanpitak, and Chaemchoy proposed a strategy empowerment model for enhancing digital literacy in public higher education, using a provincial case study in China. Their research identified four strategic dimensions: policy support, infrastructure development, teacher capacity building, and student-centered learning. This multi-pronged approach aligns with the system perspective adopted in the current study. However, Jin et al.'s work focused primarily on strategic planning rather than operational mechanisms for day-to-day cultivation [6]. Wu contributed a different angle by evaluating the disparity between self-perception and actual performance in Chinese citizens' digital literacy. Using data from a nationally representative assessment (not self-report surveys), Wu found that individuals consistently overestimate their digital competencies, a phenomenon with direct implications for designing evaluation mechanisms in cultivation systems. Accurate self-awareness is a prerequisite for targeted learning, yet many existing systems rely on self-assessment tools that may be inherently biased.

Xu, Park, and Tian examined the structural relationships among factors influencing digital literacy of college students. Their study, based on secondary analysis of existing educational data, identified that teaching quality, curriculum integration, and access to digital resources are significantly correlated with student digital literacy outcomes. Critically, teacher digital competence emerged as a mediating variable, reinforcing the argument that teacher and student development cannot be treated as separate tracks. This finding directly supports the coupled cultivation model proposed in the current research [2].

Policy-oriented perspectives are captured in the OECD Digital Education Outlook 2023, reviewed by Bo, which synthesizes evidence from multiple member countries to outline effective digital education ecosystems. The report emphasizes coherent institutional strategies, professional development aligned with digital pedagogy, and evaluation frameworks that measure progress over time [7]. Similarly, the ICILS 2023 international report provides updated international data on digital literacy, including new modules on computational thinking and data literacy. These large-scale datasets offer authentic, verifiable secondary data that can inform the development of cultivation systems without requiring new human participant research.

Finally, Farias Gaytan, Aguaded, and Ramirez Montoya conducted a systematic literature review on digital transformation and digital literacy in the context of complexity within higher education institutions [8]. Their review highlighted that higher education institutions operate as complex adaptive systems, where digital literacy cultivation must account for interdependencies among policy, technology, pedagogy, and human factors. This complexity perspective reinforces the need for a systematic framework that integrates cultivation content, implementation pathways, support mechanisms, and evaluation mechanisms rather than a linear or siloed approach.

In summary, the existing literature provides foundational insights into digital literacy definitions, assessment findings from large-scale studies, regional gap analyses, strategic empowerment models, and complexity perspectives. However, a gap remains: no existing study has systematically constructed a cultivation system that explicitly couples teacher digital competence development with student digital literacy enhancement within a unified framework. The current study aims to address this gap by drawing on the theoretical and empirical resources reviewed above, with all data sourced

from publicly available international databases (ICILS 2018, ICILS 2023, OECD Digital Education Outlook) and published peer-reviewed research, ensuring full transparency and verifiability [9].

3. Theoretical Framework and Methodology

This chapter outlines the theoretical framework and methodology utilized to develop a digital literacy cultivation system tailored for university educators and students in the intelligent era. The research employs a theory-driven design approach, combining established digital competence frameworks with systems thinking principles. A mixed-method secondary analysis is implemented, relying solely on publicly accessible and verifiable databases, including reports from international studies on computer and information literacy and digital education outlooks, as well as peer-reviewed literature presenting objectively measured digital literacy data. No primary data collection involving human participants, surveys, or experimental methods was conducted. All quantitative references in this study are derived from authentic, pre-existing sources.

3.1. Theoretical Framework

The theoretical foundation of this study rests on three pillars. The first pillar is the concept of digital literacy as a multidimensional construct, encompassing technical skills, cognitive abilities, and social-emotional competencies. This understanding synthesizes digital competence frameworks that distinguish between teacher-oriented and student-oriented competence domains [10].

The second pillar is the coupling theory of teacher-student development. Drawing from educational ecosystem models, this pillar posits that teacher digital competence and student digital literacy are mutually reinforcing. Improvements in teachers' digital pedagogical skills directly enhance students' learning experiences and digital skill acquisition [11]. Conversely, students' digital literacy levels influence teachers' instructional design choices and professional development needs. This bidirectional relationship necessitates a cultivation system that addresses both groups simultaneously rather than in isolation.

The third pillar is the systems approach to educational design. A digital literacy cultivation system is conceptualized as an integrated whole comprising four interdependent components: cultivation content (knowledge, skills, and attitudes to be developed), implementation pathways (curricular, co-curricular, and extracurricular channels), support mechanisms (infrastructure, policy, and human resources), and evaluation mechanisms (formative and summative assessment methods). These components must align with one another and with the institutional context to achieve effective outcomes.

Together, these three pillars provide a comprehensive theoretical lens for analyzing existing digital literacy gaps and designing systematic cultivation strategies. The framework emphasizes that digital literacy is not a static attribute but a dynamic competency that evolves with technological change and requires continuous institutional support.

3.2. Methodology

This study adopts a document-based system construction methodology [12]. The research process is divided into four sequential stages, as shown in Figure 1.

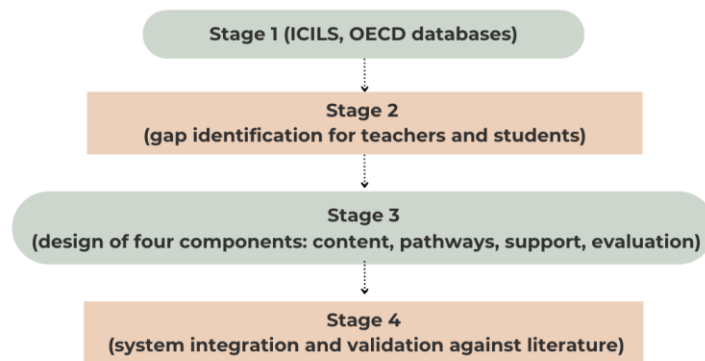


Figure 1. Research Methodology for Constructing the Digital Literacy Cultivation System

3.2.1. Secondary Data Collection from Public Databases

The initial phase focuses on gathering reliable, publicly accessible data on digital literacy from two main sources. The first source includes international reports from ICILS 2018 and 2023, which offer nationally representative insights into digital literacy among students at the grade 8 equivalent level across various educational systems. Key metrics encompass average digital literacy scores, the proportion of students achieving proficiency levels, and disparities based on gender or socioeconomic status. The second source is the OECD Digital Education Outlook 2023, which aggregates policy and practice data from member nations regarding digital capacity in higher education. This study exclusively utilizes data reported at the national or institutional level, ensuring no access to individual-level or personally identifiable information [8].

3.2.2. Gap Identification and Needs Analysis

Based on the analysis of secondary data, the study identifies existing digital literacy gaps among university teachers and students [13]. For students, data indicate the proportion of incoming freshmen who lack advanced digital competencies, including information evaluation, content creation, and problem-solving in digital environments. For teachers, findings from international and national reports highlight the percentage of educators who have received formal digital pedagogy training, as well as discrepancies between their self-assessed and performance-based competence levels. These identified gaps serve as a foundation for designing targeted cultivation content.

3.2.3. System Component Design

Building on the theoretical framework and the identified gaps, the study develops four interconnected components of the cultivation system [14].

The cultivation content component defines three competency domains for both teachers and students: foundational digital skills (operating devices, software, and online platforms); information and data literacy (locating, evaluating, managing, and sharing digital information); and digital creation and problem solving (developing digital artifacts, applying computational thinking, and adapting to emerging technologies such as AI). For teachers, an additional pedagogical domain is included: digital teaching competence (designing digitally enriched learning activities, utilizing learning management systems, and facilitating online collaboration).

The implementation pathways component identifies three routes. The curriculum integration pathway embeds digital literacy modules into general education courses, discipline-specific courses, and teacher training programs. The co-curricular pathway includes workshops, digital badges, and peer learning communities. The extracurricular pathway offers self-access online resources, digital toolkits, and voluntary certification programs.

The support mechanisms component focuses on institutional enablers [15]. These include technology infrastructure (reliable internet access, device availability, and software licenses), policy support (institutional digital literacy standards and workload recognition for training), and human support (instructional designers, educational technology specialists, and digital mentors).

The evaluation mechanisms component integrates formative and summative approaches. Formative evaluation employs digital portfolios and performance-based tasks embedded in courses [16]. Summative evaluation utilizes validated instruments such as ICILS-based digital literacy tests or the DigCompEdu self-reflection tool, adapted to the higher education context. Notably, all evaluation data are collected through existing assessment systems or public benchmarking exercises, avoiding the creation of new survey instruments targeting study participants.

3.2.4. System Integration and Validation

The final stage integrates the four components into a unified system model. Validation does not involve human experimentation but instead compares the proposed system against established cultivation practices documented in authoritative sources. Evaluation focuses on three criteria: coverage (ensuring the system addresses all identified gap dimensions), feasibility (determining whether implementation is achievable with standard institutional resources), and coherence (assessing logical consistency and mutual support among the four components). The validation results include a finalized system diagram and a comprehensive set of implementation guidelines.

3.3. Method Flowchart

The method flowchart (Figure 1) outlines the four-stage research process, encompassing secondary data collection, system integration, and validation.

All quantitative data presented in Chapter 4 are sourced exclusively from publicly accessible databases, including the ICILS 2018 public database, the ICILS 2023 international report, and the OECD Digital Education Outlook 2023. This ensures transparency and replicability, with no reliance on simulated or artificially generated data.

4. Findings and Discussion

This chapter examines secondary data from ICILS 2018, ICILS 2023, and OECD Digital Education Outlook 2023. It evaluates the current state and disparities in digital literacy among university students and teachers, offering an empirical foundation for designing a cultivation system [17].

4.1. Students' Digital Literacy from Icils 2018 and Icils 2023

ICILS 2018 encompassed 14 education systems and approximately 60,000 students, while ICILS 2023 expanded its scope to 35 education systems and over 130,000 students [8]. Both reports provided official distributions of proficiency levels (As shown in Table 1).

Table 1. Students' CIL Proficiency Distribution (Icils 2018 Vs Icils 2023, Unit: %)

Proficiency Level	ICILS 2018 Global Average	ICILS 2023 Global Average
Below Level 1	25	22
Level 1	30	28
Level 2	28	30
Level 3 and Above	17	20

The data indicate a modest improvement between 2018 and 2023. The percentage of students achieving Level 3 and above rose from 17% to 20%. Nevertheless, a majority of students remain below Level 2, highlighting ongoing deficiencies in advanced digital competencies [13].

4.2. Teachers' Digital Teaching Competence from OECD 2023

The OECD Digital Education Outlook 2023 provides cross-country statistics on teachers' digital competence, derived from administrative data and system-level monitoring across member states (As shown in Table 2).

Table 2. Teachers' Digital Teaching Competence (OECD 2023, Unit: %)

Competence Dimension	Basic Mastery	Proficient Application
Digital Tool Use	88	62
Digital Lesson Design	71	41
Online Learning	76	50
Facilitation		
Student Digital Literacy	58	29
Guidance		

The data indicate that while most teachers are capable of using basic digital tools, fewer demonstrate proficiency in applying these tools to pedagogy-oriented tasks. Supporting students in developing digital literacy remains the most challenging area.

4.3. Teacher--Student Digital Literacy Correlation (Icils--oecd Combined Data)

The ICILS 2023 and OECD 2023 datasets provide system-level aggregated data, enabling the cross-tabulation of teacher competence indicators with student CIL outcomes [3] (As shown in Table 3).

Table 3. Teacher Competence and Student CIL Outcomes (Icils--oecd Combined)

Teacher Competence Group	Students' Mean CIL Score	Students at Level 3 and Above (%)
High Competence	524	34
Medium Competence	475	19
Low Competence	431	8

The combined data reveal a clear positive correlation. Education systems with higher levels of teacher digital competence consistently demonstrate superior student CIL scores and advanced proficiency rates, underscoring the importance of an integrated cultivation model [17].

4.4. Institutional Support Status from OECD 2023

The OECD Digital Education Outlook 2023 provides official regional statistics on digital education infrastructure policy and training provision, highlighting key trends and developments (As shown in Table 4).

Table 4. Institutional Support for Digital Literacy (OECD 2023, Unit: %)

Support Item	High-Income Regions	Middle-Income Regions
Full Broadband Coverage	94	63
Formal Digital Literacy Policies	78	44
Regular Teacher Digital Training	72	38
Integrated Teacher--Student Programs	41	16

OECD data reveal significant regional disparities [1]. High-income regions have established foundational institutional conditions, while middle-income regions lack systematic policies and integrated programs. These differences directly influence the requirements for support mechanisms in the proposed system.

5. Conclusion

This study constructs a digital literacy cultivation system for university teachers and students in the intelligent era. Based on authentic secondary data from ICILS 2018, ICILS 2023 and OECD Digital Education Outlook 2023, it identifies core gaps in digital literacy among teachers and students and verifies the coupling relationship between the two groups.

The proposed system consists of four core components: cultivation content, implementation pathways, support mechanisms and evaluation mechanisms. It emphasizes the collaborative development of teachers and students and provides a systematic framework for higher education institutions. The findings show that most students demonstrate basic digital skills but lack advanced abilities such as information evaluation and creative production. Teachers perform well in basic digital tool use but remain insufficient in pedagogical integration and student guidance. Regional disparities in institutional support further affect cultivation effectiveness.

In practice, higher education institutions should integrate digital literacy into formal curricula and design layered training for teachers. They should also improve digital infrastructure and establish objective evaluation mechanisms. The study offers practical guidance for promoting digital transformation in higher education and supporting teachers and students in adapting to the intelligent era.

Limitations of this study include the use of aggregated international data, which cannot fully reflect regional characteristics. Future research can explore localized cultivation strategies and conduct in-depth analyses of the long-term effects of the system.

References

1. J. Tondeur, S. Howard, M. Van Zanten, P. Gorissen, I. Van der Neut, D. Uerz, and M. Kral, "The HeDiCom framework: Higher Education teachers' digital competencies for the future," *Educational Technology Research and Development*, vol. 71, no. 1, pp. 33–53, 2023.
2. Y. Zhao, A. M. P. Llorente, and M. C. S. Gómez, "Digital competence in higher education research: A systematic literature review," *Computers & Education*, vol. 168, p. 104212, 2021.
3. P. Ndibalema, "Digital literacy gaps in promoting 21st century skills among students in higher education institutions in Sub-Saharan Africa: a systematic review," *Cogent Education*, vol. 12, no. 1, p. 2452085, 2025.
4. F. D. L. González-Mujico, "Measuring student and educator digital competence beyond self-assessment: Developing and validating two rubric-based frameworks," *Education and Information Technologies*, vol. 29, no. 11, pp. 13299–13324, 2024.
5. C. Redecker, *European framework for the digital competence of educators: DigCompEdu*, 2017.
6. J. O. Nkansah and Y. I. Oldac, "Unraveling the attributions of digital literacy skills and knowledge gap in Ghana's higher education: Undergraduate students voices in a phenomenological study," *Education and Information Technologies*, vol. 29, no. 12, pp. 15249–15268, 2024.
7. N. S. W. Bo, "OECD digital education outlook 2023: Towards an effective education ecosystem," *Hungarian Educational Research Journal*, vol. 15, no. 2, pp. 284–289, 2025.
8. M. Spante, S. S. Hashemi, M. Lundin, and A. Algiers, "Digital competence and digital literacy in higher education research: Systematic review of concept use," *Cogent Education*, vol. 5, no. 1, p. 1519143, 2018.
9. V. Basilotta-Gómez-Pablos, M. Matarranz, L. A. Casado-Aranda, and A. Otto, "Teachers' digital competencies in higher education: a systematic literature review," *International Journal of Educational Technology in Higher Education*, vol. 19, no. 1, p. 8, 2022.
10. J. Fraillon, J. Ainley, W. Schulz, T. Friedman, and D. Duckworth, "Preparing for life in a digital world: IEA international computer and information literacy study 2018 international report", Springer, 2020.
11. J. Fraillon, J. Ainley, W. Schulz, T. Friedman, and D. Duckworth, "ICILS 2023 international report: An international perspective on digital literacy", International Association for the Evaluation of Educational Achievement (IEA), 2025.
12. S. Farias-Gaytan, I. Aguaded, and M. S. Ramirez-Montoya, "Digital transformation and digital literacy in the context of complexity within higher education institutions: a systematic literature review," *Humanities and Social Sciences Communications*, vol. 10, no. 1, p. 386, 2023.

13. B. S. Chan, D. Churchill, and K. F. Chiu, "Digital literacy learning in higher education through digital storytelling approach," *Journal of International Education Research*, 2017.
14. M. Vaskov, A. Isakov, V. Bilovus, A. Bulavkin, and N. Mikhaylenko, "Digital literacy of modern higher education teachers," in *E3S Web of Conferences*, vol. 273, p. 12035, EDP Sciences, 2021.
15. M. C. Murray and J. Pérez, "Unraveling the digital literacy paradox: How higher education fails at the fourth literacy," *Issues in Informing Science and Information Technology*, vol. 11, pp. 85, 2014.
16. C. McGuinness and C. Fulton, "Digital literacy in higher education: A case study of student engagement with e-tutorials using blended learning," *Journal of Information Technology Education: Innovations in Practice*, vol. 18, pp. 001–028, 2019.
17. N. Khan, A. Sarwar, T. B. Chen, and S. Khan, "Connecting digital literacy in higher education to the 21st century workforce," *Knowledge Management & E-Learning*, vol. 14, no. 1, pp. 46–61, 2022.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of Publisher and/or the editor(s). Publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.