

From Technical Literacy to AI-Integrated Pedagogy: A Scoping Review of Digital Competence Frameworks for Higher Education (2000–2026)

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ABSTRACT

Digital competence frameworks have multiplied over the past quarter century, and researchers in higher education must select among them with little comparative guidance. This scoping review, reported with the PRISMA-ScR checklist, charts a purposive corpus of 43 frameworks, standards, certification schemes and self-reflection tools in use between 2000 and 2026. Each entry was verified against its primary source in October 2026, and a search of ERIC, OpenAlex, Scopus, Web of Science and Google Scholar (6,598 records) then tested the coverage of the corpus. Explicit decision rules assign every entry to one of five clusters, which are general digital literacy, pedagogical integration, teacher-specific competence, national and regional policy, and the European Commission ecosystem with its derivatives. Five overlapping waves describe the movement from operational skills through pedagogical integration, structured progression and expanded professional dimensions towards AI competence. Only two entries were designed for higher education, 10 are accompanied by an assessment instrument, and peer-reviewed psychometric evidence was located for two, both from the DigCompEdu family. AI became the organising subject of corpus entries from 2023, although no issuing body has released an AI self-assessment instrument. The taxonomy gives researchers a transparent basis for selecting and justifying frameworks.

Keywords: digital competence, competence frameworks, scoping review, higher education, DigCompEdu, AI literacy

INTRODUCTION

Digital competence has become central to the quality of teaching in higher education. Universities expect their teachers to integrate technology into teaching, assessment and student engagement, and yet defining what digital competence means, and selecting appropriate tools to measure it, remains a difficult task. Governments, international organisations, research institutions and individual scholars have each produced frameworks, and each framework reflects its own assumptions about what digital competence includes and how it develops.

The result is a crowded landscape in which some frameworks define competence as technical skill, others emphasise pedagogical integration, and others again concentrate on measurement, policy implementation or, most recently, artificial intelligence (AI). For researchers who study the digital competence of teachers, this proliferation creates a practical problem, because the choice of a framework determines which constructs are measured and how the findings can be compared with other studies. The choice is rarely neutral, since every framework carries particular assumptions about the nature of competence.

Existing reviews have examined parts of this landscape. Zhang et al. (2026) reviewed 38 studies of the digital competence of pre-service teachers and found rising publication numbers, TPACK as the most widely adopted framework, and a growing tendency to integrate several frameworks in one study. Domínguez-González et al. (2025) reviewed 19 studies and identified DigCompEdu, the ISTE standards, the UNESCO ICT Competency Framework for Teachers and the Spanish national framework as the most recognised references. Saltos-Rivas et al. (2022) mapped 88 studies that evaluated digital competence in higher education and reported that more than half provided no joint evidence of reliability and validity, while most relied on ad hoc instruments. Flam et al.

(2025) compared 16 global, regional and national frameworks for a single national client, and earlier compilations listed frameworks for citizens (Law et al., 2018) and for teachers (Falloon, 2020). None of these sources, however, places frameworks from different traditions on a single map with explicit rules of classification.

Higher education presents a further difficulty of its own. Few frameworks have been written for university teaching, so researchers in the sector tend to borrow frameworks developed for citizens, for schools or for the workforce. A review confined to higher education frameworks would therefore miss most of the instruments that higher education research uses in practice. For this reason the present review maps the wider landscape, and it records for every entry whether higher education lies at the centre of its scope, within a wider scope, or outside it.

The review charts 43 frameworks and related instruments, assigns them to five clusters through explicit decision rules, and traces five waves of conceptual change, including the AI wave that has become visible since 2023. Three research questions guided the analysis.

RQ1. How have digital competence frameworks evolved conceptually between 2000 and 2026?

RQ2. What patterns emerge when frameworks are grouped according to their approach to defining and measuring competence?

RQ3. What gaps persist across the landscape that bear on future framework development and on the selection of instruments in higher education research?

METHOD

Design

The study followed the scoping review approach proposed by Arksey and O'Malley (2005), which is suited to questions about the extent and nature of a field where the purpose is to map concepts rather than to evaluate the effectiveness of interventions. Reporting follows the PRISMA extension for scoping reviews (Tricco et al., 2018). The unit of analysis is the framework rather than the study. The corpus was built in three stages, which are summarised in Figure 1. The first two stages were purposive, and the third stage, carried out in October 2026, verified every entry and tested the coverage of the corpus through a structured search.

Corpus Construction

Stage 1 formed part of the doctoral literature review conducted by the first author. Between April and May 2023, the researcher compiled a comparative inventory of 31 digital competence frameworks from the documents and web pages of the bodies that issued them, and charted each entry on its title, scope, dimensions, levels, indicators, target population and source. The inventory was built by reading the frameworks themselves rather than through a protocol-driven database search, and it had grown to 37 entries by February 2025. Its content overlaps with two published compilations, since seven of its entries also appear in Appendix 1 of Law et al. (2018) and eight appear in the appendix of Falloon (2020). Stage 2 followed in April 2026, when six frameworks addressing AI competence were added, which brought the corpus to 43 entries. The corpus is therefore a purposive selection of prominent and contrasting frameworks rather than a census of all frameworks in existence.

Source Verification and Structured Search

Stage 3 was carried out on October 2026 and consisted of two parts. In the first part, every corpus entry was checked against the document or web page of its issuing body, and its title, authorship, year, target population, structure, levels and assessment provision were charted from that source. All 43 entries were confirmed to exist, although the check corrected the recorded year, authorship or title of a majority of them. Successive versions of one framework were counted as a single entry, so that DigComp 1.0 to 3.0 form one entry, and the attributes describe the latest version consulted.

In the second part, a structured search was conducted to establish how far the purposive corpus covers the literature that proposes frameworks. ERIC and OpenAlex were queried through their public interfaces, Scopus and the Web of Science Core Collection through their advanced search pages, and Google Scholar through title-only searches, in each case with strings that combined competence terms with the terms framework, model and standard, in English and in Spanish (Appendix B). Scholars supply result snippets rather than abstracts, so its records were screened on less information than those from the other sources. So, it is treated here as a supplementary source rather than a principal one (Gusenbauer & Haddaway, 2020).

The searches returned 6,598 records, and after the removal of 2,392 duplicates, 4,206 records were screened on title and abstract against a written rubric. The researcher conducted this screening with the support of a generative

AI tool, and the records first marked as unclear were examined a second time, and final screening is done by the researcher. The search was not used to enlarge the corpus. Its purposes were to estimate the coverage of the corpus, to count how often other studies take up the corpus frameworks, and to date the AI wave.

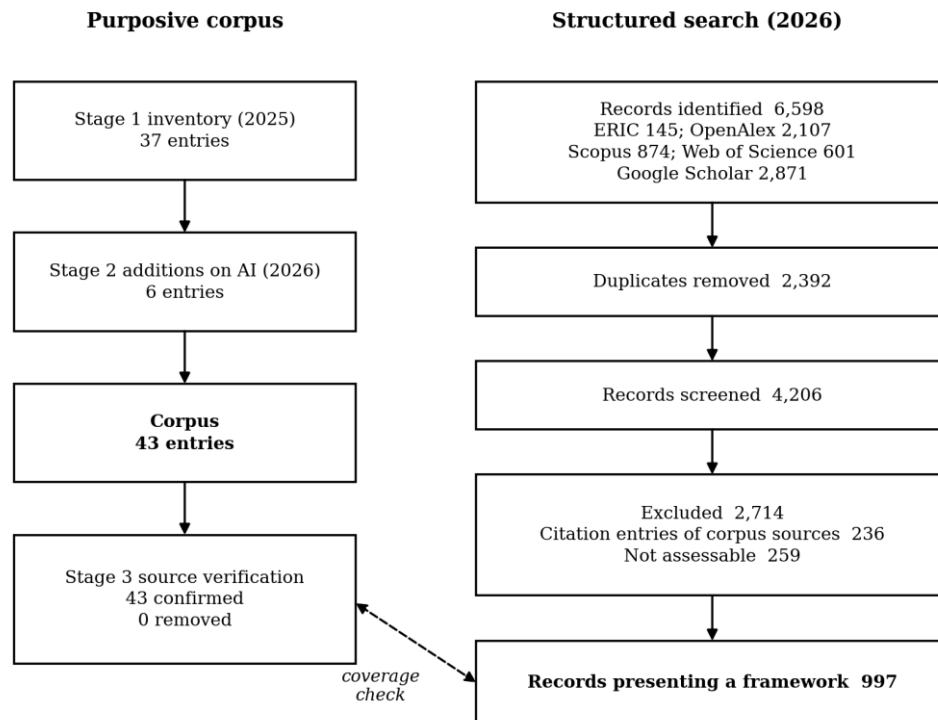


Figure 1: Construction of the corpus and the structured search

Note. Stages 1 and 2 were purposive. The search tested coverage and did not add entries to the corpus. Excluded records are broken down by reason in Table B2.

Eligibility

An entry was eligible when it satisfied four conditions. It had to set out components of digital, ICT or AI competence or literacy, or to model the use of technology in teaching; it had to address citizens, workers, learners or educators; its primary source had to be retrievable and readable; and it had to be in use at some point between 2000 and 2026. Studies that merely applied an existing framework were not eligible. Sources were read in English or Spanish, with the single exception of the Indonesian national roadmap, for which no official English edition could be found.

The corpus deliberately includes instruments that are not frameworks in the strict sense. Certification schemes, course curricula, national programmes and self-reflection tools were retained because they put competence into operation for large populations, and Table A1 labels each entry according to its type. Two entries, Kenya's Digital Literacy Programme and India's National Digital Literacy Mission, define no competence areas at all; they entered the inventory as national initiatives and are retained as contrasting cases.

Charting and Cluster Assignment

Each entry was charted on its source, year, developer, origin, type, target population, competence dimensions, levels and assessment provision (Tables A1 and A2). This template preserves the fields of the 2023 inventory and adds type, origin and evidence of validation. During the doctoral review the clusters had been formed inductively by grouping frameworks with a similar purpose, in the manner of thematic analysis (Braun & Clarke, 2006). For the present review the cluster boundaries were converted into five ordered decision rules so that any reader can reproduce the assignment. The first rule that applies determines the cluster.

Rule 1. The entry was issued by the European Commission, or its source states that it adapts or extends DigComp or DigCompEdu. It joins Cluster 5.

Rule 2. The entry was issued by or for a national or sub-national public authority as an instrument for its own population, workforce or education system. It joins Cluster 4.

- Rule 3. The entry models how technology enters teaching and learning without listing competences. It joins Cluster 2.
- Rule 4. The entry specifies what teachers or other educators should know or be able to do. It joins Cluster 3.
- Rule 5. Any remaining entry addresses citizens, learners or workers in general. It joins Cluster 1.

The order of the rules matters because many frameworks carry the features of several clusters. The UNESCO AI Competency Framework for Teachers illustrates the point, since it is at the same time an international policy instrument, a teacher competence framework and an AI framework. Rules 1 and 2 do not apply to it, because UNESCO is neither the European Commission nor a national authority, and Rule 3 does not apply because the framework lists competences. Rule 4 applies, so the framework joins Cluster 3, and Table A1 records its policy character as a secondary affinity. Lineage was placed first because derivation from DigComp or DigCompEdu is stated in the source document itself and can therefore be checked. The researcher applied the rules to all 43 entries.

Dating the Waves

The waves were dated by their onset rather than by closed periods, because each wave continues after the next one begins. A wave is dated from the year by which its defining feature had appeared in at least two corpus entries, and Table 1 states the feature and the marker entries for each wave. Two of the boundaries rest on additional counts. For the fourth wave, the educator-specific frameworks issued by organisations were counted by period (Table 2), and for the fifth wave, the entries with AI as their organising subject were counted both in the corpus and, separately, among the records returned by the structured search.

FINDINGS

The Corpus

The corpus consists of 43 entries, which are charted in Tables A1 and A2. Thirty-three of them are documents or web resources of organisations, nine are peer-reviewed journal articles and one is a conference presentation. Twenty-two entries are educator-specific, 19 define proficiency or progression levels, and 10 are accompanied by an assessment or self-reflection instrument from the issuing body, although peer-reviewed psychometric evidence was located for only two of these. Higher education lies at the centre of only two entries, CheckIn Higher Education and the Digital Education Council framework, while 11 further entries name higher or tertiary education within a wider scope. The remaining 30 entries address citizens, schools or the workforce.

Five Waves of Conceptual Evolution

The concept of digital competence developed through successive waves of thinking, each of which widened the understanding of what it means to engage effectively with digital technologies. Table 1 summarises the five waves identified in the corpus.

Table 1: Five waves in the conceptualisation of digital competence

Wave	Onset	Defining feature	Marker entries	Open limitation
1. Operational skills	By 2000	Technical and operational skills defined apart from teaching	ICDL (1996); SFIA (2000); IC3 (2002)	No pedagogical purpose
2. Pedagogical integration	2006	Models of how technology enters teaching	TPACK and SAMR (2006); Krumsvik's model (2007); DECK (2012)	No levels and no instrument in the source models
3. Structured progression	2013	Competence areas combined with progression levels	DigComp 1.0 and ICTE-MM (2013); precursor UNESCO ICT framework (2008)	Citizen or institutional focus; few educator-specific models
4. Expanded professional dimensions	2017	Educator frameworks from organisations that add professional engagement, ethics and learner empowerment	DigCompEdu, ISTE Standards for Educators, Norway and Spain (2017); CheckIn Higher Education (2021)	Uneven validation evidence; little specificity for higher education
5. AI competence	2023	AI as the organising subject	Ng et al. and AI Pioneers (2023); UNESCO AI framework (2024); Digital Education Council (2025)	No instrument from an issuing body

Note. Onset is the year by which the defining feature had appeared in at least two corpus entries. Waves overlap, and each continues after the next begins.

The earliest wave treated digital competence as operational skill. The European Computer Driving Licence, launched in 1996 and now known as ICDL, certifies module-based skills such as word processing and the use of spreadsheets (ICDL Foundation, n.d.). The Skills Framework for the Information Age, launched in 2000, describes the skills of ICT professionals at seven levels of responsibility (SFIA Foundation, 2024), and IC3 followed in 2002 as a certification of digital literacy (Certiport, n.d.). None of these three entries addresses teaching.

A second wave turned attention towards pedagogy. Mishra and Koehler (2006) argued that effective teaching with technology draws on the intersection of technological, pedagogical and content knowledge, and Puentedura (2006) described four levels of technology use ranging from substitution to redefinition. Krumsvik (2008, 2011) added a model for teachers with four components that run from basic ICT skills to digital Bildung. These models gave priority to pedagogy, but their source texts define neither proficiency levels nor instruments, although later researchers developed and validated TPACK surveys (Schmidt et al., 2009; Willermark, 2018).

A third wave combined competence areas with levels of progression. UNESCO had taken this step for teachers in 2008, and the current version of its framework crosses six aspects with three levels (UNESCO, 2018). The pattern spread in 2013, when DigComp set out five areas and 21 competences for citizens at three levels, later extended to eight and now reduced to four (Carretero et al., 2017; Cosgrove & Cachia, 2025; Ferrari, 2013; Vuorikari et al., 2022), and when the ICTE-MM maturity model applied five capability levels to schools (Solar et al., 2013). From this point competence came to be understood as a continuum that could be described step by step.

The fourth wave arrived in 2017, when four organisations issued educator-specific frameworks within a single year. DigCompEdu defined 22 competences in six areas for educators at every level of education, with six stages running from Newcomer (A1) to Pioneer (C2) (Redecker, 2017). The ISTE Standards for Educators set out seven standards (International Society for Technology in Education, 2017), Norway published seven competence areas for teachers (Kelentrić et al., 2017), and Spain issued its common framework for teachers (Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado [INTEF], 2017). These frameworks reach beyond the use of tools and address professional engagement, ethics and the empowerment of learners.

Table 2 shows the scale of this shift. Organisations had issued one educator-specific corpus entry before 2017, compared with 10 between 2017 and 2022. CheckIn Higher Education extended the pattern in 2021 by adding open education as a seventh area for academics (European Commission, Joint Research Centre, 2021).

Table 2: Corpus entries by period of first issue and defining feature

Period of first issue	Entries	Educator models by scholars	Educator frameworks by organisations	AI as organising subject
1996–2005	3	0	0	0
2006–2012	6	4	1	0
2013–2016	7	1	0	0
2017–2022	21	2	10	0
2023–2026	6	2	2	6
All periods	43	9	13	6

Note. Scholars' models are educator-specific entries published as journal articles or presentations. Organisations' frameworks are educator-specific documents or tools of organisations.

A fifth wave is now emerging. Within the corpus, AI is the organising subject of no entry issued before 2023 and of all six entries issued from 2023 onwards. Ng et al. (2023) re-described the six DigCompEdu areas for the age of AI, and the AI Pioneers project supplemented the same six areas for vocational and adult educators (Bekiaridis, 2023). UNESCO subsequently published 15 competency blocks for teachers, formed by crossing five aspects with three levels (Miao & Cukurova, 2024). The Digital Education Council (2025) addressed students and faculty in higher education, the OECD and European Union (2026) addressed school learners, and Yoon et al. (2026) derived 17 competencies for Korean teachers through a Delphi study and aligned them with four career stages.

Established frameworks have also absorbed AI. DigComp 2.2 added examples of citizens interacting with AI systems, and DigComp 3.0 integrates AI across all 21 of its competences (Cosgrove & Cachia, 2025; Vuorikari et al., 2022). The structured search supports the dating of this wave independently. Among the retrieved records that present a framework, only 13 had AI as their organising subject up to 2022, whereas the figure rose to 29 in 2023, 54 in 2024 and 65 in 2025. These indications mark 2023 as the onset of the wave, but they do not yet show a settled reconceptualisation of digital competence, and the fifth wave is best understood as an emerging trajectory.

No wave has replaced its predecessor. Operational skill remains necessary, pedagogical integration remains central and structured progression remains useful, so that later frameworks add new concerns to earlier ones, with the AI wave as the most recent addition.

Cluster 1: General Digital Literacy

Cluster 1 gathers eight entries that address citizens, learners or workers without any teaching role in view. ICDL and IC3 are certification schemes with proctored tests, and ICDL reports availability in more than 100 countries. Microsoft offers six free courses without an assessment (Microsoft, n.d.). SFIA and the DELTAs describe workforce skills, and only 11 of the 56 DELTAs are digital (Dondi et al., 2021). The DQ framework aggregates 25 earlier frameworks into eight areas at three levels (Park, 2019), MediaSmarts (2022) organises digital media literacy for Canadian school students in nine topics, and the Digital Education Council (2025) brings AI literacy for students and faculty into the same tradition.

These entries define what any competent user should be able to manage, but they leave pedagogy aside. A teacher may hold a certificate in digital skills and still be uncertain how to design learning with technology.

Cluster 2: Pedagogical Integration

Cluster 2 holds four models of how technology enters teaching. TPACK remains the most studied of them, and reviews have catalogued both its literature and its many self-report instruments (Voogt et al., 2013; Willermark, 2018). SAMR describes levels of technology use and has framed professional development and classroom studies in varied settings (Aldosemani, 2019; Kihoza et al., 2016). DECK groups purposeful learning activity with technology into four categories, which are distributed thinking and knowing, engagement, community and communication, and knowledge building (Fisher et al., 2012), while PICRAT crosses the relationship of the student to technology with its effect on teaching practice (Kimmons et al., 2020). Teachers who evaluated models of this kind did not always find the most widely used ones the most useful (Kimmons & Hall, 2018).

The four models share one property. Their sources describe integration but do not specify competences, levels or instruments, and where measurement exists it was added by later researchers.

Cluster 3: Teacher-Specific Competence

Cluster 3 contains 10 entries that state what teachers should know or be able to do. Several of them were written by scholars. The model of Krumsvik (2008, 2011) emerged in Norwegian teacher education, Falloon (2020) joined curriculum competencies aligned with TPACK to personal-ethical and personal-professional competencies, Klebansky and Fraser (2013) built an information literacy framework for teacher education students at one university, and Yoon et al. (2026) addressed Korean school teachers. The others were issued by organisations. The ISTE standards come from a professional association (International Society for Technology in Education, 2017), the ProFuturo framework from a foundation (Trujillo Sáez et al., 2020) and the READY model from a European Union agency (European Training Foundation, 2022; Kampylis et al., 2024); these three define standards, identities or practices without levels. The two UNESCO frameworks, by contrast, cross their aspects with three levels (Miao & Cukurova, 2024; UNESCO, 2018).

One entry sits at the edge of the cluster. ICTE-MM assesses schools rather than teachers, who form one of its five domains (Solar et al., 2013), and it is also the only entry in the cluster that is accompanied by an assessment tool, which was tested in a small pilot. Researchers have since built instruments on some of these models; Tang et al. (2022), for example, drew on the broader conception of Falloon to validate a 35-item scale for online teaching.

Cluster 4: National and Regional Policy

Cluster 4 comprises 10 instruments issued by or for public authorities, and they differ widely in kind. Kenya's Digital Literacy Programme has supplied devices, content, connectivity and teacher training to public primary schools since 2016 (ICT Authority, n.d.), and India's National Digital Literacy Mission trained 5.37 million people between 2014 and 2016 through two certified courses (Ministry of Electronics and Information Technology, 2022). British Columbia defined six characteristics of digital literacy for school students (British Columbia Ministry of Education, 2013), and Quebec set out 12 dimensions for learners and staff from preschool to higher education, with a 2026 edition that integrates AI (Ministère de l'Éducation, 2026; Ministère de l'Éducation et de l'Enseignement supérieur, 2019).

Australia produced a draft framework for adult foundation skills and a proposed framework for the workforce outside the ICT sector (Department of Education, Skills and Employment, 2020; Gekara et al., 2019), Singapore mapped skills to 128 job roles in its ICT sector (SkillsFuture Singapore et al., 2022), and Indonesia organised a national roadmap and a national index around four pillars (Kementerian Komunikasi dan Informatika & Katadata

Insight Center, 2022). Two entries address teachers directly. Norway defined seven competence areas without levels (Kelentrić et al., 2017), and South Africa defined 13 educator competencies and supplied a diagnostic self-assessment tool (Department of Basic Education, 2018).

The cluster shows that public authorities translate digital competence into very different instruments according to their infrastructure, their population and their policy aims, although McGarr et al. (2021) observed that national policies for teacher education nonetheless converge on supranational frameworks.

Cluster 5: The European Commission Ecosystem and Its Derivatives

Cluster 5 groups 11 entries by lineage. Five of them were issued by the European Commission, alone or together with the OECD, and six adapt or extend DigComp or DigCompEdu. The core of the cluster consists of DigComp for citizens and DigCompEdu for educators, and four derivatives carry the family into other systems. Spain followed DigComp in 2017 and DigCompEdu in 2022 (INTEF, 2017; Ministerio de Educación y Formación Profesional & Administraciones educativas de las comunidades autónomas, 2022), and the 2022 framework was accompanied by official accreditation routes for non-university teachers. In England, the Digital Teaching Professional Framework adapts DigCompEdu statements for further education (Education and Training Foundation, 2018). The framework proposed for SDG indicator 4.4.2 extends DigComp 2.0 to seven areas (Law et al., 2018), and CFRIDiL integrates DigComp 2.0 with language and intercultural frameworks (Sindoni et al., 2019).

Two self-reflection tools put DigCompEdu into operation. SELFIEforTEACHERS serves primary and secondary teachers with 32 items (Economou, 2023), and CheckIn Higher Education serves academics with 25 items in seven areas (European Commission, Joint Research Centre, 2021). The evidence behind these tools is uneven. The original 22-item Check-In was evaluated by its developers and validated with 2,262 university teachers in Andalusia (Cabero-Almenara et al., 2020; Ghomi & Redecker, 2019), and it was subsequently used with 30,407 academics in seven countries (Inamorato dos Santos et al., 2023). Chifla-Villón et al. (2025) reported a six-factor structure for a 22-item version among 166 university teachers in Ecuador, and SELFIEforTEACHERS was validated with 3,218 teachers in four countries (Economou et al., 2026). No peer-reviewed validation of the 25-item version for higher education was located.

Three recent entries bring AI into the lineage, which are the framework of Ng et al. (2023), the AI Pioneers supplement and the AILit Framework, and an update of DigCompEdu itself has been announced (OECD & European Union, 2026). Derivation also continues beyond the corpus; Santos et al. (2025), for example, validated e-DigCompEdu for online higher education through a Delphi panel.

Cross-Cluster Synthesis

Table 3: Comparison of the five clusters

Attribute (number of entries)	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	All
Entries	8	4	10	10	11	43
Documents or web resources of organisations	8	0	5	10	10	33
Educator-specific	0	4	9	2	7	22
Proficiency or progression levels defined	4	0	3	3	9	19
Instrument from the issuing body	2	0	1	3	4	10
Peer-reviewed psychometric evidence located	0	0	0	0	2	2
AI as organising subject	1	0	2	0	3	6
Higher education central or included	2	1	4	2	4	13

Note. Cluster 1 = general digital literacy; 2 = pedagogical integration; 3 = teacher-specific competence; 4 = national and regional policy; 5 = European Commission ecosystem and derivatives. Entries are charted individually in Tables A1 and A2.

Four patterns follow from Table 3. First, the corpus moves from operational skill towards pedagogical, professional and AI-related concerns, and the later waves add to the earlier ones rather than replacing them.

Second, assessment provision is limited and unevenly evidenced. Ten of the 43 entries are accompanied by an instrument from the issuing body. In order to test a claim that is often made for the European Commission ecosystem, four criteria were applied to every entry, which are that it is educator-specific, that it defines

proficiency levels, that it comes with an instrument from its issuing body, and that peer-reviewed psychometric evidence exists for that instrument. Two entries met all four criteria, DigCompEdu with its Check-In tool and SELFIEforTEACHERS, and both belong to Cluster 5.

This result is bounded in three ways. It describes what issuing bodies provide, whereas researchers have built validated instruments for other traditions, notably TPACK. It rests on the evidence located in this review, which did not search the psychometric literature systematically. And it does not extend to CheckIn Higher Education, whose 25-item version lacks published validation.

Third, no single framework has achieved universal adoption, although a few are taken up far more often than the others. Among the 4,206 screened records, 790 named a corpus framework. DigComp was named in 315 records, DigCompEdu in 199, TPACK in 70, the UNESCO AI framework in 56 and the UNESCO ICT framework in 50. Since the search strings favour competence vocabulary, these counts understate TPACK. Zhang et al. (2026) likewise found that researchers increasingly combine frameworks.

Fourth, context matters. Competence in Singapore's ICT sector differs from competence in Kenya's primary schools, and any framework applied across contexts should be examined for its assumptions about infrastructure, institutional support and culture.

Results of the Structured Search

Of the 4,206 records screened, 997 presented a framework, model or standard of their own, and a further 555 applied, adapted or validated an existing framework. The remaining exclusions were statistical or acceptance models (536), courses or programmes without a competence framework (851), reviews and commentaries (518), records on other topics (208) and non-documents (46). A further 236 Google Scholar records were citation entries for the source documents of corpus frameworks, and 259 records could not be assessed from the available title and abstract (Table B2).

The records that presented a framework addressed educators in 294 cases, learners in 285, sector or general workforces in 164 and citizens in 94, with the remainder addressing mixed or unstated populations. The source documents of 14 corpus entries were among the retrieved records, which reflects the fact that most corpus entries are organisational documents that bibliographic databases do not index. The purposive corpus of 43 entries therefore covers a small share of the frameworks proposed in the literature, most of which are single studies, and this breadth strengthens the case for a classification that later work can extend.

DISCUSSION

Selecting Frameworks for Higher Education Research

For researchers in higher education the taxonomy functions as a sequence of questions about the purpose of a study. Where the study concerns the baseline skills of staff or students, Cluster 1 offers certification schemes and general literacy frameworks, of which only one was written for higher education. Where it concerns how technology changes teaching practice, Cluster 2 offers conceptual lenses, and TPACK brings a large instrument literature of its own. Where it concerns what academics should be able to do, Clusters 3 and 5 supply competence statements, and where it concerns a national system, Cluster 4 shows how far instruments depend on their policy setting.

The scarcity of frameworks designed for higher education is itself a finding. Researchers in the sector mostly work with borrowed frameworks, so the question of fit deserves explicit attention. The tool with the largest validation study in the corpus, SELFIEforTEACHERS, was built for schools, whereas CheckIn Higher Education fits the sector by design but has not yet been validated in its current form, so researchers who adopt it should examine its measurement properties in their own samples. Frameworks for higher education also exist outside this corpus, such as the Jisc framework of six elements of digital capability for staff and students (Jisc, 2024).

The Prominence of the DigComp Family

Researchers who require an educator-specific model, proficiency levels and an instrument from the issuing body will find that combination, on the criteria used here, in the DigCompEdu family. This is a statement about what is provided rather than about conceptual merit, since TPACK and SAMR pursue different aims and third parties have measured TPACK extensively.

The prominence of one family raises a question of intellectual diversity. When a single lineage supplies both a common vocabulary and the most widely used instruments, research may converge on a single perspective. DigCompEdu was developed within European institutions, and its descriptors may assume resources and

institutional support that some education systems cannot guarantee. This does not invalidate instruments based on DigCompEdu in other settings, but it means that researchers who apply them across contexts should examine what the instrument captures and what it misses. Mixed-methods designs that pair self-reflection scores with qualitative inquiry offer one productive response.

The Emerging AI Wave

AI-focused frameworks have multiplied since 2023, and established frameworks now integrate AI. Whether AI will reshape the concept of digital competence or be absorbed as one further dimension cannot yet be determined, because the evidence points in both directions. UNESCO placed a human-centred mindset and ethics alongside AI foundations and pedagogy, which suggests a reframing (Miao & Cukurova, 2024), whereas DigComp 3.0 distributed AI across its existing competences, which suggests absorption (Cosgrove & Cachia, 2025).

Measurement is developing rapidly, but outside the issuing bodies. None of the organisations behind the AI frameworks in the corpus has released an assessment or self-reflection instrument, whereas researchers have published scales with psychometric evidence, among them TAICS for school teachers, AICO_edu for vocational teachers and GAICS-TR for academics (Chiu et al., 2025; Delcker et al., 2025; Xia et al., 2026). These scales rest on their own models, and instruments derived directly from DigCompEdu-based tools remain at the pilot stage (Tenberga & Daniela, 2024). Lintner (2024) has reviewed AI literacy scales systematically. For research design, the practical question is whether to adopt one of the new scales or to wait for the updated DigCompEdu.

Limitations

Several limitations qualify these findings. The corpus is purposive, since Stages 1 and 2 followed no protocol for identifying frameworks, so that the selection may favour well-known frameworks, organisational documents and sources in English. The structured search covered five sources and titles only, and it under-retrieves traditions that do not use competence vocabulary. Google Scholar returned only part of its estimated results and provided snippets rather than abstracts, so its records were screened on less information than the others. The screening was supported by a generative AI tool, although it was reviewed by author but still relied on few partial records, so the resulting counts are approximate. Records are also not unique frameworks, and the counts therefore describe the literature rather than the number of frameworks.

Cluster assignment involves judgement. The decision rules make each assignment reproducible, but the order of the rules is itself a choice and one researcher applied them, so a second coder may place boundary cases differently, and no agreement statistic is reported. The restriction to English and Spanish sources probably under-represents national frameworks from Asia, Africa and the Middle East, and the Indonesian entry was charted from Indonesian-language official sources because its roadmap document could not be retrieved.

Evidence of validation means the evidence located in this review, and other studies may exist. The attributes describe the latest version consulted, and several entries changed during the period of the review, since the AILit Framework moved from draft to final in 2026, Quebec issued a new edition, and an update of DigCompEdu is pending. The account of the AI wave is therefore a snapshot taken in October 2026.

A Research Agenda

Four priorities follow from the analysis. First, the field needs validation studies from outside Europe, because the evidence cited here for DigCompEdu-based instruments comes from Europe and Latin America, and studies in South Asian and African higher education would test whether the instruments travel. Second, frameworks should treat infrastructure as a structural condition rather than as a background assumption, because where infrastructure is unreliable, competence takes forms that current instruments may not capture.

Third, AI competence needs instruments that issuing bodies stand behind, together with independent validation of the scales that researchers have already built, especially for academics. Fourth, the classification offered here should be tested and extended, since independent coders can apply the decision rules to this corpus and the frameworks identified by the structured search provide new cases.

CONCLUSIONS

This scoping review charted 43 digital competence frameworks and related instruments, verified each of them against its primary source, and tested the coverage of the corpus with a structured search. Five clusters organise the landscape. General literacy frameworks set baselines without pedagogy, pedagogical integration models describe teaching with technology without specifying competences, teacher-specific frameworks state what educators should know or do but mostly without instruments, and policy instruments vary with their national

settings. The European Commission ecosystem and its derivatives combine educator-specific models with levels and instruments, and two of its entries carry peer-reviewed validation evidence.

Five overlapping waves describe how the concept has widened, from operational skill to pedagogical integration, structured progression, expanded professional dimensions and, since 2023, AI competence. The fifth wave is an emerging trajectory whose frameworks are multiplying while its instruments come from researchers rather than from the issuing bodies.

For higher education the main gap is specificity. Few frameworks were designed for academic teaching, and the instrument built for the sector still lacks published validation of its current version. The decision rules, the full corpus tables and the search protocol are provided so that other researchers can check, contest and extend the classification.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR CONTRIBUTIONS

Muhammad Tayyab Ilyas was responsible for the conceptualisation, methodology, investigation, data curation and writing. Cristina Mercader contributed supervision, review and editing. Alejandra Bosco supervised the doctoral research from which the corpus derives, and all her contributions were made before her death in 2025.

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APPENDIX A. THE CORPUS

Tables A1 and A2 chart the corpus. Entries are numbered in order of first issue.

Table A1: Identification, origin, type, population and cluster of the corpus entries

No.	Framework and source	First issued	Developer and origin	Type	Target population	Cluster	Higher education
1	ICDL (formerly ECDL). ICDL Foundation (n.d.)	1996	ICDL Foundation, Ireland; international	Certification scheme	General public, students and workforce	1	Adjacent
2	Skills Framework for the Information Age (SFIA). SFIA Foundation (2024)	2000 (SFIA 9, 2024)	SFIA Foundation, United Kingdom; international	Occupational skills framework	ICT and digital professionals	1	Adjacent
3	IC3 Digital Literacy Certification. Certiport (n.d.)	2002 (Global Standard 6)	Certiport, United States; international	Certification scheme	Students and job seekers	1	Included
4	SAMR. Puentedura (2006)	2006	Puentedura, United States	Conceptual model	Educators and school districts	2	Adjacent
5	TPACK. Mishra and Koehler (2006)	2006	Mishra and Koehler, United States	Conceptual model	Teachers	2 (3)	Adjacent
6	Krumsvik's digital competence model. Krumsvik (2008, 2011)	2007 (English sources 2008, 2011)	Krumsvik, Norway	Conceptual model	Teachers and teacher educators	3 (2)	Included
7	Microsoft Digital Literacy. Microsoft (n.d.)	Online by 2007 (current courses)	Microsoft, United States; international	Course curriculum	Anyone with basic reading skills	1	Adjacent
8	UNESCO ICT Competency Framework for Teachers. UNESCO (2018)	2008 (Version 3, 2018)	UNESCO; international	Framework	Pre-service and in-service teachers, school to tertiary level	3 (4)	Included
9	DECK. Fisher et al. (2012)	2012	Fisher, Denning, Higgins and Loveless, United Kingdom	Conceptual framework	School teachers	2	Adjacent

No.	Framework and source	First issued	Developer and origin	Type	Target population	Cluster	Higher education
10	BC's Digital Literacy Framework. British Columbia Ministry of Education (2013)	2013 (draft)	British Columbia Ministry of Education, Canada (provincial)	Framework	School students, kindergarten to grade 12	4 (1)	Adjacent
11	DigComp (versions 1.0 to 3.0). Ferrari (2013); Carretero et al. (2017); Vuorikari et al. (2022); Cosgrove and Cachia (2025)	2013 (3.0, 2025)	European Commission, Joint Research Centre; European Union	Framework	Citizens	5 (1)	Adjacent
12	ICTE-MM. Solar et al. (2013)	2013	Solar, Sabattin and Parada, Chile	Maturity model	Schools; teachers are one of five domains	3	Adjacent
13	Teacher Education Information Literacy (TEIL). Klebansky and Fraser (2013)	2013	Klebansky and Fraser, University of Tasmania, Australia	Conceptual framework (single institution)	Teacher education students	3	Included
14	National Digital Literacy Mission (NDLM and DISHA). Ministry of Electronics and Information Technology (2022)	2014 (closed 2016)	Government of India	Training and certification scheme	One person without IT literacy in each eligible household	4 (1)	Adjacent
15	USE, UNDERSTAND & ENGAGE. MediaSmarts (2022)	2015 (renamed 2022)	MediaSmarts, Canada (charity)	Framework	School students, kindergarten to grade 12	1	Adjacent
16	Digital Literacy Programme (DigiSchool). ICT Authority (n.d.)	2016	Government of Kenya, ICT Authority	National programme	Pupils and teachers in public primary schools	4	Adjacent
17	Common Digital Competence Framework for Teachers (Spain). INTEF (2017); Ministerio de Educación y Formación Profesional and Administraciones educativas de las comunidades autónomas (2022)	2017 (replaced 2022)	INTEF, Ministry of Education, Spain	Framework	Teachers; the 2022 framework covers non-university teaching	5 (4)	Adjacent
18	DigCompEdu. Redecker (2017)	2017	European Commission, Joint Research Centre; European Union	Framework	Educators at all levels, early childhood to higher and adult education	5 (3)	Included
19	ISTE Standards for Educators. International Society for Technology in Education (2017)	2017	ISTE, United States; international	Standards	Educators	3	Adjacent
20	Professional Digital Competence Framework for Teachers (Norway). Kelentrić et al. (2017)	2017	Norwegian Centre for ICT in Education, Norway	Framework	Teachers, student teachers and teacher educators	4 (3)	Included

No.	Framework and source	First issued	Developer and origin	Type	Target population	Cluster	Higher education
21	Skills Framework for Infocomm Technology. SkillsFuture Singapore et al. (2022)	2017 (refreshed 2022)	SkillsFuture Singapore, Workforce Singapore and Infocomm Media Development Authority, Singapore	Sector skills framework	ICT-sector workforce, employers and training providers	4 (1)	Adjacent
22	Digital Literacy Global Framework. Law et al. (2018)	2018	UNESCO Institute for Statistics; authors at the University of Hong Kong; international	Proposed framework	Youth and adults (SDG indicator 4.4.2)	5 (1)	Adjacent
23	Digital Teaching Professional Framework. Education and Training Foundation (2018)	2018	Education and Training Foundation with Jisc, England	Framework	Teachers and trainers in further education and training	5 (3)	Adjacent
24	Professional Development Framework for Digital Learning. Department of Basic Education (2018)	2018	Department of Basic Education, South Africa	Framework	Teachers, school leaders and teacher trainers	4 (3)	Adjacent
25	Australian Workforce Digital Skills Framework. Gekara et al. (2019)	2019	National Centre for Vocational Education Research, Australia	Proposed framework (research report)	General non-ICT workforce	4 (1)	Adjacent
26	Common Framework of Reference for Intercultural Digital Literacies (CFRIDiL). Sindoni et al. (2019)	2019	EU-MADE4LL Erasmus+ project, led by the University of Messina, Italy	Framework	Students, teachers and researchers; built with university students	5 (1)	Included
27	DQ (Digital Intelligence) Global Standards. Park (2019)	2019	DQ Institute; international	Framework (IEEE standard 3527.1-2020)	All individuals, children to workforce	1	Adjacent
28	Digital Competency Framework (Quebec). Ministère de l'Éducation et de l'Enseignement supérieur (2019); Ministère de l'Éducation (2026)	2019 (updated 2026)	Gouvernement du Québec, Canada (provincial)	Framework	Learners, teachers and other professionals at all education levels	4 (1)	Included
29	Digital Literacy Skills Framework. Department of Education, Skills and Employment (2020)	2020 (draft)	Australian Government	Framework	Adults in foundation-skills programmes	4 (1)	Adjacent
30	Global Framework of Competence for Education in the Digital Age. Trujillo Sáez et al. (2020)	2020	Fundación ProFuturo, Spain; international	Framework	Educators, especially in Latin America, Africa and Asia	3	Adjacent

No.	Framework and source	First issued	Developer and origin	Type	Target population	Cluster	Higher education
31	PICRAT. Kimmons et al. (2020)	2020	Kimmons, Graham and West, United States	Conceptual model	Teacher candidates and teacher educators	2	Included
32	Teacher Digital Competency (TDC) framework. Falloon (2020)	2020	Falloon, Australia	Conceptual framework	Teacher education students and teacher educators	3	Included
33	CheckIn Higher Education. European Commission, Joint Research Centre (2021)	2021	European Commission, Joint Research Centre; European Union	Self-reflection tool	Academics teaching in higher and further education	5 (3)	Central
34	DELTA's (skills for the future world of work). Dondi et al. (2021)	2021	McKinsey & Company; international	Skills taxonomy	All citizens in the labour market	1	Adjacent
35	Digital literacy roadmap (Indonesia). Kementerian Komunikasi dan Informatika and Katadata Insight Center (2022)	2021	Ministry of Communication and Informatics with Siberkreasi, Indonesia	National roadmap and curriculum framework	General public	4 (1)	Adjacent
36	SELFIEforTEACHERS. Economou (2023)	2021 (launch)	European Commission, Joint Research Centre; European Union	Self-reflection tool	Primary and secondary teachers	5 (3)	Adjacent
37	READY model. European Training Foundation (2022); Kamylyis et al. (2024)	2022	European Training Foundation (European Union agency), Italy	Reference model	All educators, with emphasis on vocational and adult education	3	Adjacent
38	AI Pioneers supplement to DigCompEdu. Bekiaridis (2023)	2023	AI Pioneers Erasmus+ project, University of Bremen, Germany	Framework supplement	Vocational and adult educators	5 (3)	Adjacent
39	Teachers' AI digital competencies. Ng et al. (2023)	2023	Ng, Leung, Su, Ng and Chu, Hong Kong	Conceptual framework	Teachers	5 (3)	Included
40	UNESCO AI Competency Framework for Teachers. Miao and Cukurova (2024)	2024	UNESCO; international	Framework	Teachers who apply AI in core subject areas	3 (4)	Adjacent
41	AILit Framework. OECD and European Union (2026)	2025 (draft); 2026	OECD and European Commission; international	Framework	Learners in primary and secondary education	5 (1)	Adjacent
42	Digital Education Council AI Literacy Framework. Digital Education Council (2025)	2025	Digital Education Council; international membership body	Framework	Higher education students and faculty	1 (3)	Central
43	AI-Digital Competency Framework. Yoon et al. (2026)	2026	Yoon, Ryu, Kim and Kim, Republic of Korea	Framework (Delphi study)	In-service primary and secondary teachers	3	Adjacent

Note. Cluster shows the primary cluster and, in parentheses, a secondary affinity. Higher education is central when the entry was designed for the sector, included when the source names higher or tertiary education within a wider scope, and adjacent otherwise.

Table A2: Competence dimensions, levels and assessment provision of the corpus entries

No.	Framework	Major competence dimensions	Levels	Assessment availability and evidence located
1	ICDL (formerly ECDL)	Modular syllabus from basic computer use to advanced digital skills; no fixed set of dimensions	None within modules; module groups	Certification tests at accredited centres; no psychometric evidence located
2	Skills Framework for the Information Age (SFIA)	Professional skills described through autonomy, influence, complexity, business skills and knowledge	7 levels of responsibility	None in the framework; third-party credentials can be aligned to it
3	IC3 Digital Literacy Certification	7 domains: technology basics; digital citizenship; information management; content creation; communication; collaboration; safety and security	3 levels	Proctored certification examinations; no psychometric evidence located
4	SAMR	4 levels of technology use: substitution, augmentation, modification, redefinition	None for teachers; the levels describe technology use	None
5	TPACK	Technological, pedagogical and content knowledge and their intersections	None	None in the source; third-party surveys with validation evidence (Schmidt et al., 2009)
6	Krumsvik's digital competence model	4 components: basic ICT skills; didactic ICT competence; learning strategies; digital Bildung	None formal; 4 developmental phases (adoption, adaptation, appropriation, innovation)	None
7	Microsoft Digital Literacy	6 courses: work with computers; access information online; communicate online; participate safely and responsibly online; create digital content; collaborate and manage content digitally	None	None at present; earlier versions carried a certificate test
8	UNESCO ICT Competency Framework for Teachers	6 aspects crossed with 3 levels, giving 18 competencies	3: knowledge acquisition, knowledge deepening, knowledge creation	None official
9	DECK	4 categories: distributed thinking and knowing; engagement; community and communication; knowledge building	None	None; qualitative testing with 12 teachers
10	BC's Digital Literacy Framework	6 characteristics: research and information literacy; critical thinking, problem solving and decision making; creativity and innovation; digital citizenship; communication and collaboration; technology operations and concepts	None; grade bands	None

No.	Framework	Major competence dimensions	Levels	Assessment availability and evidence located
11	DigComp (versions 1.0 to 3.0)	5 competence areas and 21 competences; version 3.0 integrates AI across all competences	3 (2013); 8 (2017, 2022); 4 (2025)	Self-assessment grid in the 2013 report; no instrument in later reports
12	ICTE-MM	5 leverage domains (educational management; infrastructure; administrators; teachers; students) and 25 key domain areas	5 capability levels	Web-supported assessment tool for schools; small pilot only
13	Teacher Education Information Literacy (TEIL)	7 information literacy elements drawn from the ANZIIL standards	Developmental, from novice to advanced	None
14	National Digital Literacy Mission (NDLM and DISHA)	No competence areas defined; two courses (appreciation of digital literacy; basics of digital literacy)	2 course levels	External certification examination; no psychometric evidence located
15	USE, UNDERSTAND & ENGAGE	9 topics: reading media; media representation; ethics and empathy; privacy and security; community engagement; media health; consumer awareness; finding and verifying; making and remixing	None; grade bands	None
16	Digital Literacy Programme (DigiSchool)	No competence areas; components are devices, digital content, connectivity and teacher training	None	None
17	Common Digital Competence Framework for Teachers (Spain)	2017: the 5 DigComp areas and 21 competences; 2022: 6 areas adapted from DigCompEdu and 23 competences	6: A1 to C2	Self-assessment in a teacher portfolio (2017); official accreditation routes since 2022; no psychometric evidence located
18	DigCompEdu	6 areas (professional engagement; digital resources; teaching and learning; assessment; empowering learners; facilitating learners' digital competence) and 22 competences	6: A1 Newcomer to C2 Pioneer	Check-In self-reflection tool, 22 items (Ghomi & Redecker, 2019); validation with 2,262 university teachers (Cabero-Almenara et al., 2020)
19	ISTE Standards for Educators	7 standards: learner, leader, citizen, collaborator, designer, facilitator, analyst	None	None in the standards
20	Professional Digital Competence Framework for Teachers (Norway)	7 competence areas: subjects and basic skills; school in society; ethics; pedagogy and subject didactics; leadership of learning processes; interaction and communication; change and development	None	None
21	Skills Framework for Infocomm Technology	8 tracks and 128 job roles; technical skills and competencies with critical core skills	6 proficiency levels for technical skills and competencies	None
22	Digital Literacy Global Framework	7 competence areas and 26 competences, extending DigComp 2.0	None	None; expert consultation only
23	Digital Teaching Professional Framework	Elements and components with competency statements adapted from DigCompEdu	3 stages: exploring, adopting, leading	Training modules with badges; no psychometric evidence located

No.	Framework	Major competence dimensions	Levels	Assessment availability and evidence located
24	Professional Development Framework for Digital Learning	13 educator competencies in 3 areas: professional growth and knowledge; curriculum focus; leadership	None for the competencies	Diagnostic self-assessment tool for teachers and a school rubric; no psychometric evidence located
25	Australian Workforce Digital Skills Framework	4 skill categories (digital tools for working; digital ways of working; digital ways of thinking; living in the digital age), 8 sub-categories and 17 indicators	5: literacy, competency, proficiency, fluency, savvy	None; the authors call for further validation
26	Common Framework of Reference for Intercultural Digital Literacies (CFRIDiL)	3 dimensions (multimodal orchestration; digital technologies; intercultural communication) plus transversal skills; integrates the CEFR and DigComp 2.0	3: waystage, intermediate, proficient	No standalone test; peer and teacher assessment forms in appendices
27	DQ (Digital Intelligence) Global Standards	8 areas crossed with 3 levels, giving 24 competencies	3: digital citizenship, creativity, competitiveness	A DQ assessment is referenced outside the report; not verified
28	Digital Competency Framework (Quebec)	12 dimensions of a single digital competency; the 2026 edition integrates AI	None in the 2019 framework	None
29	Digital Literacy Skills Framework	2 indicators in 4 focus areas: connect, communicate and collaborate; digital identity and safety; digital technologies and systems; create, organise, present and problem solve	4 performance levels, pre-level 1 to level 3	None
30	Global Framework of Competence for Education in the Digital Age	3 identities (citizen, teacher, connector) and 9 roles	None, by design	None built on the framework; content validation by a two-round Delphi panel
31	PICRAT	Student relationship to technology (passive, interactive, creative) crossed with effect on practice (replacement, amplification, transformation)	None	None
32	Teacher Digital Competency (TDC) framework	Curriculum competencies aligned with TPACK; personal-ethical competencies; personal-professional competencies	None	None in the source
33	CheckIn Higher Education	25 items in 7 areas: the 6 DigCompEdu areas and open education	Progression levels revised on an adapted Bloom's digital taxonomy	Self-reflection tool; evidence concerns the 22-item predecessor; no peer-reviewed validation of the 25-item version located
34	DELTA's (skills for the future world of work)	4 categories (cognitive, interpersonal, self-leadership, digital), 13 skill groups and 56 elements, of which 11 are digital	None published	Research survey of 18,000 people in 15 countries; instrument not published
35	Digital literacy roadmap (Indonesia)	4 pillars: digital skill; digital ethics; digital safety; digital culture	None; national index scored from 1 to 5	National index survey of 10,000 respondents; no psychometric evidence located

No.	Framework	Major competence dimensions	Levels	Assessment availability and evidence located
36	SELFIEforTEACHERS	32 items across the 6 DigCompEdu areas	6 per item, A1 to C2	Self-reflection tool; validation with 3,218 teachers in four countries (Economou et al., 2026)
37	READY model	6 domains of professional activity plus a context-specific domain, 22 professional practices and 73 descriptors; digital technologies is one domain	None	None
38	AI Pioneers supplement to DigCompEdu	The 6 DigCompEdu areas, each extended with AI-related activities	6: Newcomer to Pioneer	None
39	Teachers' AI digital competencies	The 6 DigCompEdu areas re-described for AI, with a revised P21 framework	None	None
40	UNESCO AI Competency Framework for Teachers	5 aspects (human-centred mindset; ethics of AI; AI foundations and applications; AI pedagogy; AI for professional learning) crossed with 3 levels, giving 15 competency blocks	3: acquire, deepen, create	None official; derived third-party tools are preliminary
41	AILit Framework	4 domains: engage with AI; create with AI; manage AI; shape AI	3: basic, intermediate, advanced	None; informs a planned PISA 2029 assessment
42	Digital Education Council AI Literacy Framework	5 dimensions: understanding AI and data; critical thinking and judgement; ethical and responsible AI use; human-centricity, emotional intelligence and creativity; domain expertise	3 levels	None
43	AI-Digital Competency Framework	3 dimensions, 8 categories, 17 competencies and 51 behavioural indicators	None; competencies aligned with 4 career stages	None; content validity through a two-round Delphi

Note. Evidence located means peer-reviewed psychometric evidence found during this review. Absence of located evidence does not show that none exists.

APPENDIX B. SEARCH PROTOCOL

The Scopus, Web of Science, Google, ERIC and OpenAlex searches were updated on 6 of October 2026. The Scopus and Web of Science Core Collection search through the advanced search pages of each database with institutional access, and the records were exported with citation information, bibliographical information, abstracts and keywords. The Spanish title-field search returned no records in Web of Science, which indexes Spanish-language articles under English titles, so the same terms were run once more in the topic field (S7b). Google Scholar shows 5529 estimated results where 2871 relevant records were retrieved, and they carry result snippets rather than abstracts. Google Scholar is treated here as a supplementary source. Table B1 gives each string exactly as submitted, the time of execution and the number of records returned. No limits were applied beyond those shown in the strings.

Table B1: Search strings, execution times and records returned

Search	String	Records
S1. ERIC, title field	title:("digital competence" OR "digital competency" OR "digital competencies" OR "digital competences" OR "digital literacy" OR "digital literacies" OR "digital skills" OR "digital capability" OR "digital capabilities" OR "ICT competence" OR "ICT competency" OR "ICT competencies" OR "ICT competences" OR "AI literacy" OR "AI competence" OR "AI competency" OR "AI competencies" OR "artificial intelligence literacy") AND title:(framework OR frameworks OR model OR standard OR standards) AND publicationdateyear:[2000 TO 2026]	145
S2. OpenAlex, title field, English terms	title.search:("digital competence" OR "digital competency" OR "digital competencies" OR "digital competences" OR "digital literacy" OR "digital literacies" OR "digital skills" OR "digital capability" OR "digital capabilities" OR "ICT competence" OR "ICT competency" OR "ICT competencies" OR "ICT competences" OR "AI literacy" OR "AI competence" OR "AI competency" OR "AI competencies" OR "artificial intelligence literacy") AND (framework OR frameworks OR model OR standard OR standards),publication_year:2000-2026,language:en es	1,820
S3. OpenAlex, title field, Spanish terms	title.search:("competencia digital" OR "competencias digitales" OR "alfabetización digital" OR "competencia digital docente" OR "alfabetización en inteligencia artificial") AND (marco OR modelo OR estándar OR estándares),publication_year:2000-2026	287
S4. Scopus, title field, English terms	TITLE("digital competence" OR "digital competency" OR "digital competencies" OR "digital competences" OR "digital literacy" OR "digital literacies" OR "digital skills" OR "digital capability" OR "digital capabilities" OR "ICT competence" OR "ICT competency" OR "ICT competencies" OR "ICT competences" OR "AI literacy" OR "AI competence" OR "AI competency" OR "AI competencies" OR "artificial intelligence literacy") AND TITLE(framework OR frameworks OR model OR standard OR standards) AND PUBYEAR > 1999 AND PUBYEAR < 2027 AND (LANGUAGE(english) OR LANGUAGE(spanish))	844
S5. Scopus, title field, Spanish terms	TITLE("competencia digital" OR "competencias digitales" OR "alfabetización digital" OR "competencia digital docente" OR "alfabetización en inteligencia artificial") AND TITLE(marco OR modelo OR estándar OR estándares) AND PUBYEAR > 1999 AND PUBYEAR < 2027	30
S6. Web of Science, title field, English terms	TI=("digital competence" OR "digital competency" OR "digital competencies" OR "digital competences" OR "digital literacy" OR "digital literacies" OR "digital skills" OR "digital capability" OR "digital capabilities" OR "ICT competence" OR "ICT competency" OR "ICT competencies" OR "ICT competences" OR "AI literacy" OR "AI competence" OR "AI competency" OR "AI competencies" OR "artificial intelligence literacy") AND TI=(framework OR frameworks OR model OR standard OR standards) AND PY=(2000-2026) AND LA=(English OR Spanish)	593
S7a. Web of Science, title field, Spanish terms	TI=("competencia digital" OR "competencias digitales" OR "alfabetización digital" OR "competencia digital docente" OR "alfabetización en inteligencia artificial") AND TI=(marco OR modelo OR estándar OR estándares) AND PY=(2000-2026)	0

Search	String	Records
S7b. Web of Science, topic field, Spanish terms	TS=("competencia digital" OR "competencias digitales" OR "alfabetización digital" OR "competencia digital docente" OR "alfabetización en inteligencia artificial") AND TS=(marco OR modelo OR estándar OR estándares) AND PY=(2000-2026)	8
S8a. Google Scholar, title only, digital competence terms	allintitle: ("digital competence" OR "digital competency" OR "digital competencias" OR "digital competences") (framework OR frameworks OR model OR standard OR standards)	831 of about 1,780
S8b. Google Scholar, title only, digital literacy and skills terms	allintitle: ("digital literacy" OR "digital literacies" OR "digital skills" OR "digital capability" OR "digital capabilities") (framework OR frameworks OR model OR standard OR standards)	1,123 of about 1,960
S8c. Google Scholar, title only, ICT competence terms	allintitle: ("ICT competence" OR "ICT competency" OR "ICT competencias" OR "ICT competences") (framework OR frameworks OR model OR standard OR standards)	129 of about 205
S8d. Google Scholar, title only, AI terms	allintitle: ("AI literacy" OR "AI competence" OR "AI competency" OR "AI competencias" OR "AI competences" OR "artificial intelligence literacy") (framework OR frameworks OR model OR standard OR standards)	441 of about 892
S8e. Google Scholar, title only, Spanish terms	allintitle: ("competencia digital" OR "competencias digitales" OR "alfabetización digital" OR "competencia digital docente") (marco OR modelo OR estándar OR estándares)	347 of about 692
All searches		6,598

Note. For Google Scholar the first number is the records retrieved and the second the estimate that Scholar displayed for the same query.

Records were merged and duplicates removed by DOI and then by normalised title and year. This step removed 2,392 records and left 4,206 for screening. Of the 874 Scopus records, 701 duplicated records already retrieved from ERIC or OpenAlex, and of the 601 Web of Science records, 548 duplicated records already retrieved from the other sources; of the 2,871 Google Scholar records, 979 did. Each record was screened on title and abstract against one question. Does the record itself present, propose, develop, revise or extend a framework, model, standard or competence profile that specify components of digital, ICT or AI competence or literacy for citizens, workers, learners or educators? The researcher applied the rubric in Table B2. The record-level screening log is available from the corresponding author.

Table B2: Screening codes and outcome

Code	Decision	Records
I	Presents or revises a framework, model, standard or competence profile	997
E1	Applies, adapts, translates or validates an existing framework or instrument	555
E2	Statistical, causal, predictive or acceptance model	536
E3	Course, curriculum, training model or programme without a competence framework	851
E4	Review, comparison, critique or commentary without a new framework	518
E5	Not about the digital, ICT or AI competence or literacy of people	208
E7	Not a document, or not in English or Spanish	46
S	Citation entry for the source document of a corpus framework (Google Scholar only)	236
N	Not assessable from the available title and abstract	259
	All screened records	4,206