Mapping Methodological Approaches to Critical Digital Literacy Among TVET Instructors: A Scoping Review

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Abstract
Digital competence frameworks for teachers have proliferated, but whether their critical, reflective dimension has been examined among technical and vocational education and training (TVET) instructors remains uncharacterized. This scoping review characterized the methodological approaches, conceptual operationalizations, and evidence gaps in peer-reviewed research on critical digital literacy (CDL) among TVET instructors. Following Joanna Briggs Institute guidance and reported per PRISMA-ScR, Scopus was searched on 3 July 2026 using a Population-Concept-Context strategy, restricted to English-language, peer-reviewed literature from 2013–2026. Eligible sources were charted against a framework combining bibliographic, PCC, and methodological data items. Eighty sources met the eligibility criteria. Results included sources concentrated in Western, Northern, and Southern Europe (30.0%) and Southeast Asia (27.5%, including Indonesia at 22.5%), with smaller shares from East Asia, Eastern Europe/Central Asia, and other regions. Quantitative survey designs accounted for roughly half of charted approaches, while qualitative, configurational, and computational designs were comparatively rare. Nine concept-operationalization categories emerged, with an explicit critical-reflective or ethical dimension reported in only 11.2% of sources. An evidence gap map identified 22 of 54 (40.7%) concept-by-context combinations with no charted source, most notably critical-reflective framing paired with Southeast Asian settings. Research on CDL among TVET instructors relies heavily on a single methodological mode and has not yet reconciled structured competence frameworks with the construct's critical-reflective dimension, particularly outside Europe. Priority directions include region-specific research on critical-reflective CDL in Southeast Asia, a dedicated CDL-specific instrument, and continued tracking of the emerging artificial-intelligence-related sub-theme.

1. Introduction

When the COVID-19 pandemic forced technical and vocational education and training (TVET) systems worldwide toward remote instruction, only 18 percent of TVET providers in low-income countries sustained training through online or offline distance learning, compared with a substantially higher share in high- and upper-middle-income countries (ILO et al., 2021, as cited in UNESCO-UNEVOC, 2022). That disparity exposed how unevenly TVET instructors' capacity to use digital technology critically, not only functionally, had developed before the disruption arrived. The stakes extend beyond emergency response: Sustainable Development Goal 4 Target 4.4 commits countries to substantially increasing youth and adults with relevant technical and vocational skills, and Target 4.c to increasing the supply of qualified teachers, commitments that depend partly on instructors able to use, evaluate, and teach with digital tools (United Nations, 2015).

Standardized frameworks for measuring digital competence have proliferated since the European Commission's DigComp framework was first published (Ferrari, Punie, & Brečko, 2013), followed four years later by DigCompEdu, its educator-specific adaptation (Redecker & Punie, 2017); both operationalize digital competence primarily as functional and pedagogical skills. A distinct, more recent strand of work argues instead that a critical, reflective dimension, awareness of the sociocultural, political, and ethical implications of digital technology use, deserves separate conceptual status, a position articulated early by Pangrazio (2016) and developed through systematic review by Ilomäki et al. (2023), whose work treats this reflective dimension as the feature distinguishing literacy from functional competence but confines its mapping to general school education. Whether, and how, this critical dimension has been operationalized for TVET instructors specifically, a population spanning formal secondary and tertiary institutions as well as non-formal and workplace-based training, has not yet been established.

Before the present review was undertaken, four reviews addressing digital competence among teaching populations adjacent to this one were identified and examined.

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Wu, Husnin, Mohamad, Jia, and Zhang (2025) systematically reviewed 25 studies (from 2,757 records, 2002–2023) on digital-competency frameworks and influencing factors among vocational education teachers globally, reporting that no comprehensive framework yet existed and that proficiency levels were generally low to moderate; study design was a secondary question, and the construct examined was general competency rather than its critical-reflective dimension.

Nguyen and Habók (2023) reviewed 33 instruments assessing digital literacy among general-education teachers, finding them dominated by self-evaluation formats never previously synthesized as a set; their instrument focus comes closest, among the four reviews, to this one's methodological orientation, though their population was not TVET-specific. Basilotta-Gómez-Pablos, Matarranz, Casado-Aranda, and Otto (2022) applied bibliometric co-word clustering to 56 articles on university teachers' digital competence (2000–2021), reporting a dominant self-assessment/reflection focus and low-to-moderate competence, characterizing thematic clusters rather than individual designs.

Velandia Rodriguez, Mena-Guacas, Tobón, and López-Meneses (2022) reviewed 77 studies on Ibero-American teacher digital-competence frameworks (2018–2022), identifying eight competing frameworks with no consensus and a pandemic-era surge in research interest, restricted to general-education teachers in one region.

Collectively, these four reviews map two adjacent territories: the status and diversity of digital-competence frameworks among teachers in general education, higher education, and one world region (Basilotta-Gómez-Pablos et al., 2022; Velandia Rodriguez et al., 2022), and the instruments used to assess that competence across educational levels (Nguyen & Habók, 2023). Only Wu et al. (2025) examines vocational or TVET teachers specifically, and its lens remains general digital competency rather than the critical, reflective dimension distinguishing literacy from functional skill; methodological characterization is, within that review, a secondary question. No identified review has systematically characterized how research on critical digital literacy among TVET instructors, specifically, has been conducted.

This absence is not simply a matter of an underexplored population. It reflects a specific gap in how the field has been synthesized: no review has characterized the methodological features, study designs, instruments, sampling strategies, and quality-appraisal practices of research investigating digital literacy among TVET instructors when that construct includes its critical-reflective dimension rather than a generic competence. As the frameworks and reviews above illustrate, terminology surrounding digital literacy, competence, skills, and fluency is applied inconsistently across studies, a conceptual ambiguity this review treats as a secondary, integrated question. A further complication follows from timing: research framing an artificial-intelligence-related dimension of digital literacy has emerged only recently, so synthesizing intervention effectiveness in this space would be premature without first establishing what has actually been studied.

The novelty of the present review lies precisely in this shift of focus. Rather than adding another map of digital-competence frameworks or another instrument validation study, this review is the first to systematically characterize how research on critical digital literacy among TVET instructors has actually been conducted, that is, the methods, instruments, sampling strategies, and operational definitions researchers have used to study CDL in this population, rather than the level or profile of competence those studies report. This distinction matters: prior reviews (Basilotta-Gómez-Pablos et al., 2022; Velandia Rodriguez et al., 2022; Nguyen & Habók, 2023; Wu et al., 2025) synthesize what teachers can do or which frameworks describe that capability, while none examines the methodological architecture, how CDL has been operationalized, measured, and sampled, specifically for TVET instructors. By mapping this architecture rather than competency outcomes, the review establishes the evidentiary and methodological groundwork a future systematic review of CDL interventions in TVET would require.

A methodological characterization gap of this kind, prior to any question of intervention effectiveness, calls for a scoping review rather than a systematic review of effects (Munn et al., 2018): the aim is to map the extent, nature, and methodological features of available evidence, not to pool outcomes or judge which approach performs best. Given the terminological variation already evident and the unsettled state of the AI-related sub-theme, a systematic review attempting effect estimation at this stage would have no stable base to build on. The scoping review undertaken here is intended to supply exactly that base.

The review's boundaries follow directly from this aim. The temporal window begins in 2013, when the DigComp framework was first published and standardized digital-competence terminology entered education research and policy (Ferrari et al., 2013), and extends to the present to capture the field's full trajectory rather than only its recent phase. No geographic restriction was applied: where Velandia Rodriguez et al. (2022) confined their synthesis to the Ibero-American region, the present review maps globally, since establishing where methodological and conceptual patterns concentrate, or are absent, is itself part of the aim. The review is restricted to English-language, peer-reviewed literature, consistent with its population and concept definitions and the transparency that charting requires. The population definition is deliberately broader than "vocational

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teacher" alone: it spans in-service instructors, pre-service TVET teacher trainees, and non-formal or workplace-based trainers, since practice in this field is not confined to formally certified in-service teachers in secondary vocational schools.

Following the Joanna Briggs Institute's guidance for scoping reviews (Peters et al., 2020) and reported per the PRISMA extension for scoping reviews (Tricco et al., 2018), this review addresses one primary and three secondary questions. The primary question asks what methodological approaches, study designs, instruments, sampling strategies, and quality-appraisal practices have been used in peer-reviewed research on Critical Digital Literacy (CDL) among TVET instructors globally between 2013 and 2026. Three secondary questions extend this aim: what characterizes studies investigating CDL among TVET instructors (publication year, geographic origin, TVET setting, study design); how is critical digital literacy, and related constructs, conceptually defined and terminologically used; and what gaps in research design, instrumentation, or population and setting coverage are evident, and what precursor considerations do these raise for a future systematic review. Sources meeting the eligibility criteria were charted against a framework combining bibliographic, PCC, and methodological data items, described in full in Methods, to answer these questions in turn.

2. Method

This scoping review was conducted in accordance with the Joanna Briggs Institute (JBI) Manual for Evidence Synthesis, Chapter 11 (Peters et al., 2020), and is reported following the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018).

2.1. Protocol and Registration

A protocol specifying the review question, eligibility criteria, search strategy, and charting framework was developed before the search was executed but was not submitted for public registration. Scoping reviews are not eligible for registration in PROSPERO, since that registry is scoped to reviews with a health-outcome question rather than an evidence-mapping aim (Peters et al., 2020). A public registration route such as the Open Science Framework was considered during protocol development but was not pursued: by the time this option was evaluated, the primary database search had already been executed, so a subsequent registration would not have satisfied the a priori intent pre-registration is meant to demonstrate. The protocol was therefore retained as an internal working document, a departure from a pre-registered design acknowledged as a transparency limitation in the Discussion.

2.2. Eligibility Criteria

Eligibility was defined using a Population-Concept-Context (PCC) framework, consistent with JBI guidance for scoping reviews (Peters et al., 2020).

Population comprised TVET instructors: individuals teaching, training, or mentoring learners within formal or non-formal technical and vocational education and training programs. This included in-service instructors at vocational secondary schools and polytechnics, pre-service teachers enrolled in TVET-specific teacher-education tracks, and non-formal vocational trainers, including those in community-based or apprenticeship training. General K-12 teachers with no explicit vocational-track affiliation, non-vocational higher-education faculty, and TVET learners studied as the primary subject were excluded.

Concept comprised research investigating critical digital literacy among this population, operationalized as the technical capability to use, evaluate, and create digital technology combined with a reflective-critical awareness of the sociocultural, power, and ethical dimensions of that use (adapted from Ilomäki et al., 2023, for the TVET-instructor context). Because terminological heterogeneity around this construct is itself a phenomenon this review set out to map, records using variant surrogate terms, including digital literacy, digital competence, digital skills, digital fluency, and ICT literacy, were retained rather than screened out on terminological grounds alone.

Context comprised TVET settings worldwide, without geographic restriction, spanning formal institutions (vocational secondary schools, polytechnics) and non-formal settings (vocational training centers, apprenticeship programs). Eligible records were published in English between 2013 and 2026; the lower bound was anchored to the 2013 publication of the DigComp framework, which marked the point at which standardized digital-competence terminology entered education research.

Eligible document types were journal articles, review articles, conference papers, and book chapters, deliberately broadened beyond journal articles alone since a scoping review aims to characterize the range of available evidence types rather than a single format (Munn et al., 2018); items with insufficient extractable methodological detail were handled at full-text screening rather than excluded by format alone. A structured taxonomy of exclusion reasons, covering population, concept, and context mismatch, ineligible study design, language, duplication at title/abstract stage, and, at full-text stage, inaccessibility, insufficient methodological

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detail, and post-hoc duplication, was applied consistently at both screening stages and is reported in full in the supplementary PRISMA-ScR checklist.

2.3. Information Sources

Scopus (Elsevier) served as the sole bibliographic database for this review, rather than the multi-database strategy conventional in systematic reviews of intervention effectiveness, for three reasons. First, Scopus's multidisciplinary indexing is broad enough to span the education, vocational-training, and information-technology literatures this topic straddles, a coverage profile documented in comparative bibliometric analyses of major citation databases (Mongeon & Paul-Hus, 2016). Second, Scopus applies an independent content-selection process in which a Content Selection and Advisory Board reviews new-title submissions against defined technical and qualitative criteria, admitting roughly half of the titles that clear an initial screen each year from a pool of more than 7,000 publishers across 330 disciplines (Elsevier, 2026, accessed 3 July 2026); this curation suits a review that depends on source studies reporting their methods transparently enough to be charted. Third, for a mapping exercise rather than an exhaustive effect synthesis, single-database retrieval avoids the added complexity of cross-database deduplication without compromising the review's aim (Munn et al., 2018).

Single-database searching cannot, however, capture every relevant record. This limitation surfaced during protocol development, when one closely related study (Imama et al., 2025) traced to a journal not indexed in Scopus. To mitigate this, the protocol specified backward (reference-list screening) and forward (Scopus Cited-by) citation chasing, to be applied once full-text eligibility screening concluded, with records identified through this route screened against the eligibility criteria above and reported separately, under "other sources," in the PRISMA-ScR flow diagram (Figure 1).

The search was restricted to peer-reviewed literature; grey literature was not treated as a primary evidentiary source, since peer review is the mechanism most likely to compel the transparent methodological reporting this review depends on for charting, keeping the review's scope aligned with characterizing research methodology rather than practice guidance. The search was executed on 3 July 2026.

2.4. Search Strategy

The full Scopus search string, reported here in its final form to support reproducibility (Tricco et al., 2018), combined three word clusters, a vocational/TVET domain-qualifier cluster, a teaching-role cluster, and a digital-literacy/competence concept cluster, joined with Boolean AND/OR logic:

```
TITLE-ABS-KEY(
("vocational*" OR "TVET" OR "VET" OR "polytechnic*" OR "technical and vocational*" OR
"trade" OR "apprenticeship*" OR "CTE")
AND
("teacher*" OR "instructor*" OR "trainer*" OR "educator*" OR "lecturer*")
AND
("critical digital literac*" OR "digital literac*" OR "digital competen*" OR "digital skill*" OR
"digital fluenc*" OR "ICT literac*" OR "ICT competenc*" OR "information and
communication technology literac*" OR "e-literacy" OR "AI literacy" OR "21st century
digital skill*" OR "digital pedagogical competenc*" OR "computer literac*")
)
AND PUBYEAR > 2012 AND PUBYEAR < 2027
AND LANGUAGE(English)
AND (DOCTYPE(ar) OR DOCTYPE(re) OR DOCTYPE(cp) OR DOCTYPE(ch))
```

Population terms were operationalized as two independently required word clusters, a domain qualifier and a role word, rather than fixed multi-word phrases; an earlier phrase-based draft under-retrieved relevant records because Scopus phrase search requires exact word adjacency, which many titles and abstracts do not follow. Filters restricted publication year to 2013–2026, language to English, and document type to article, review, conference paper, and book chapter. Subject-area and open-access filters were considered and deliberately not applied, since no eligibility criterion justified excluding studies on either basis; full-text access was instead pursued during screening. The search was executed once, on 3 July 2026. A search update is planned if the manuscript is not submitted within six months of this date, or within three months if more than half of charted records at the data-charting stage concern artificial-intelligence-specific literacy, given that sub-theme's fast-moving nature; any update will re-run the identical string with only the publication-year upper bound revised.

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2.5. Selection of Sources

Records were screened in two sequential stages against the PCC eligibility criteria above: first by title and abstract, then by full text for records that passed or remained uncertain at the first stage. Records whose eligibility could not be confidently determined from the title and abstract alone were carried forward to full-text assessment rather than excluded at that stage, consistent with the inclusive-bias default recommended for scoping reviews. Final inclusion required verification against the full text of each candidate record, and responsibility for every final inclusion decision rests with the author.

Figure 1 presents the PRISMA-ScR flow diagram summarizing this process across its four stages: identification, screening by title and abstract, full-text eligibility assessment, and final inclusion. The numerical breakdown for each stage, including records excluded and reasons recorded, is reported in the Results.

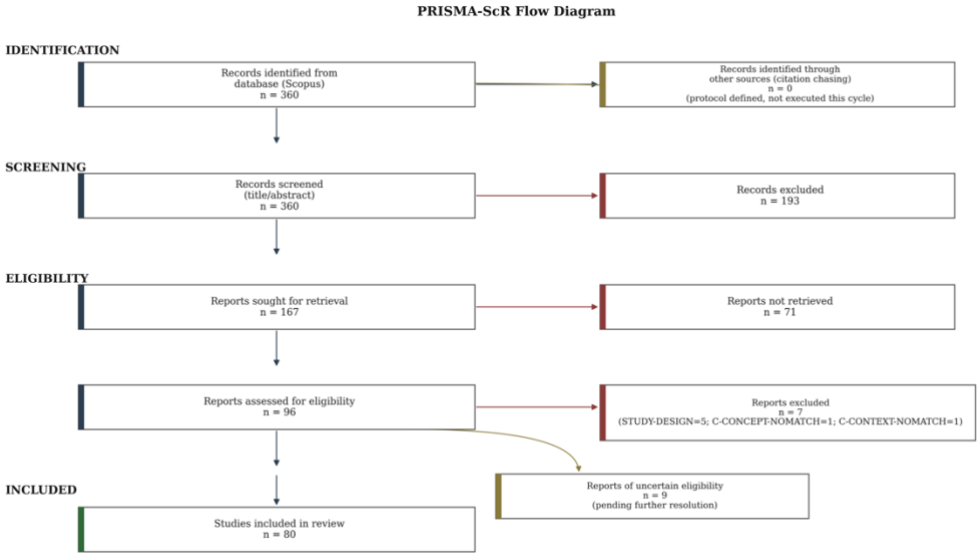


Figure 1. PRISMA-ScR Flow Diagram

Flow of records through identification, screening, full-text eligibility assessment, and inclusion, including the number of records excluded at each stage and reasons recorded; the "other sources" citation-chasing arm is shown as specified in the protocol but not executed within this review cycle.

2.6. Data Charting Process

Data charting, rather than data extraction, is the term used throughout this review, in line with scoping-review terminology (Peters et al., 2020). The charting form was built on the JBI standard framework for scoping reviews, structured around bibliographic and study-design metadata, the three PCC components, and a findings/gaps closeout, since the review's primary question concerns the methodological characteristics of included studies, their designs, instruments, sampling, and quality-appraisal practice, rather than a purely conceptual mapping. Charting proceeded iteratively: an initial form was piloted against a small subset of sources, which revealed that data-collection procedure and analytic technique were being conflated within a single field; the form was revised to separate these before charting continued across the remaining eligible sources (Levac et al., 2010). The form was applied to every eligible source, and each charted row was subsequently checked by the author against the corresponding source PDF before being treated as final.

2.7. Data Items

Charting captured three clusters of data items for each included source. Bibliographic and descriptive items, publication year, document type, country or region of the reported setting, and study design, support the corpus characterization called for in the study-characteristics question. PCC-descriptive items, population description, concept operationalization (which digital-literacy-related term a source used, and whether a critical or reflective dimension was explicitly framed), and context or setting, map directly onto the eligibility criteria above and support both the primary question and the question on terminological and conceptual definition. Methodological items, sampling strategy, data-collection method, data-analysis approach, and instrument or framework used, form the core evidence for the primary question on methodological approaches. Two further items, each source's own reported validity or reliability practice and any methodological gap the source itself acknowledged, feed the critical-appraisal step below and the question on gaps and precursor considerations.

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Where a source did not report a given item, the field was charted as "not reported" rather than inferred from adjacent text.

2.8. Critical Appraisal

Formal critical appraisal using a scored or tiered instrument, such as the Mixed Methods Appraisal Tool, was not performed. Critical appraisal is an optional step in scoping reviews, since their purpose is to map the extent and nature of available evidence rather than to weight or exclude studies by methodological quality (Peters et al., 2020); applying a scored tool retrospectively would risk conflating a quality signal with an eligibility decision, against this review's non-exclusionary mapping aim. Each source's own reported validity or reliability practice, reliability coefficients, expert or content validation, and triangulation among them, was instead charted descriptively as a data item (see Data Items above) rather than scored against a checklist. No source was excluded or down-weighted on this basis.

2.9. Synthesis of Results

Two synthesis approaches were used together to answer the review questions. Numerical characteristics of the corpus, publication year, geographic distribution, document type, study design, and PCC-component distributions, were summarized descriptively as frequencies and percentages, with accompanying figures. Reported content in the concept, context, study-design, and findings fields was additionally coded thematically. An initial set of codes was developed inductively from the charted data through constant comparison (Braun & Clarke, 2006), then reviewed and refined by the author into a final code structure applied across the full corpus; the author validated all resulting categorizations against the source data. Coded concept and context categories were then cross-tabulated to produce an evidence gap map, identifying combinations with dense, sparse, or absent coverage. Consistent with the descriptive, non-effect-estimating aim of a scoping review, no meta-analysis or pooled effect estimate was calculated at any stage.

3. Results and Discussion

3.1. Result

3.1.1. Selection of Sources

The database search identified 360 records. Following removal of one duplicate detected during screening, 360 records were screened by title and abstract, of which 193 were excluded and 167 proceeded to full-text retrieval. Of these, 71 reports could not be retrieved in full text and were not assessed further. The remaining 96 reports were assessed for eligibility against the full text: 80 met all eligibility criteria and were included, 7 were excluded, and 9 remained of uncertain eligibility when this review's evidence base was finalized. Figure 1 summarizes this process across its four stages: identification, screening, eligibility, and inclusion.

3.1.2. Characteristics of Included Sources

The 80 included sources comprised 64 journal articles (80.0%), 14 conference papers (17.5%), and 2 book chapters (2.5%) (Figure 2). Publication years ranged from 2017 to 2026, with a median of 2024. Only 8 sources (10.0%) were published before 2020, while 37 (46.2%) were published in 2025 or 2026 alone (Figure 3).

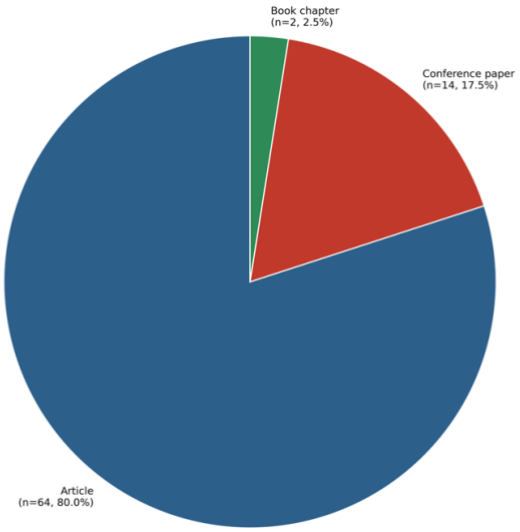


Figure 2. Document Type Distribution of Included Sources

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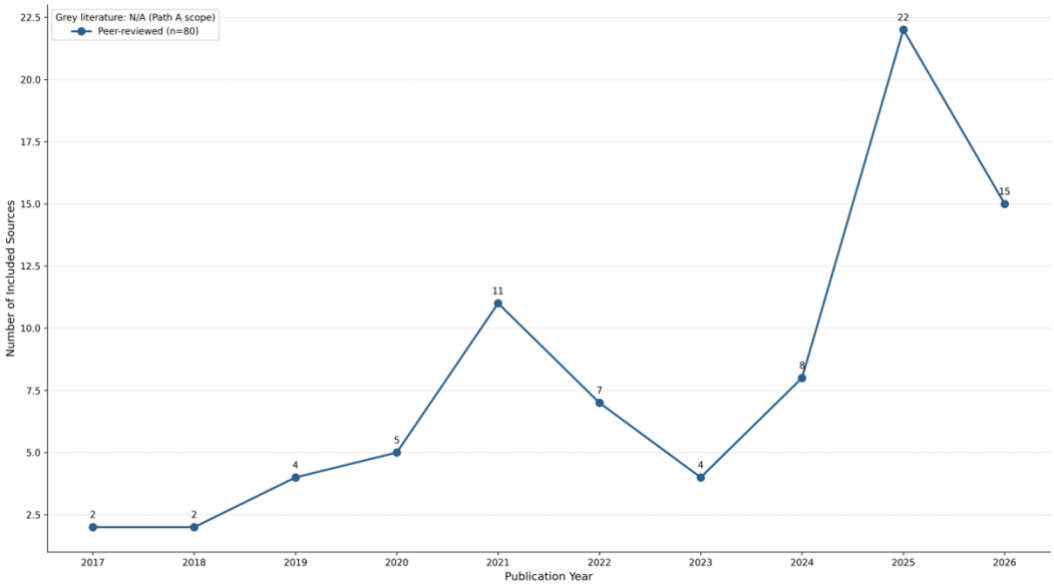


Figure 3. Temporal Distribution of Included Sources by Publication Year, 2017–2026

Geographically, sources originated from institutions in Western, Northern, or Southern Europe (24 sources, 30.0%), Southeast Asia (22 sources, 27.5%, of which 18 were set in Indonesia), East Asia (15 sources, 18.8%, concentrated in China), Eastern Europe, Central Asia, or wider Eurasia (14 sources, 17.5%), and a residual category spanning Africa, the Americas, and cross-regional studies (5 sources, 6.2%) (Figure 4; Figure 5). At the country level, Indonesia (18 sources, 22.5%) and China (15, 18.8%) were the two largest single-country contributors, followed by Spain (7, 8.8%), studies spanning multiple countries within a single design (6, 7.5%), Switzerland (5, 6.2%), and Ukraine (5, 6.2%).

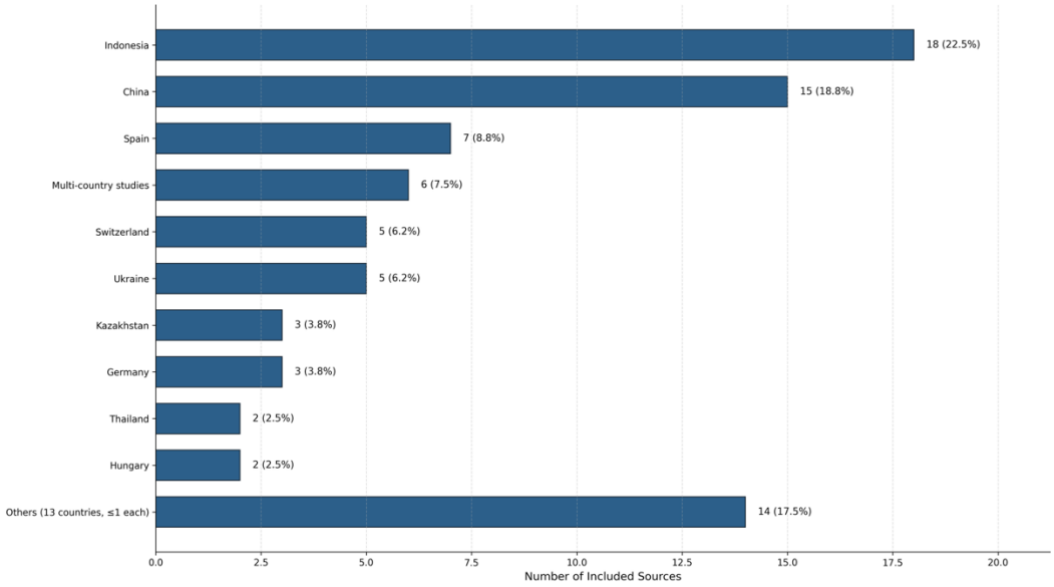


Figure 4. Geographic Distribution of Included Sources by Region and Country

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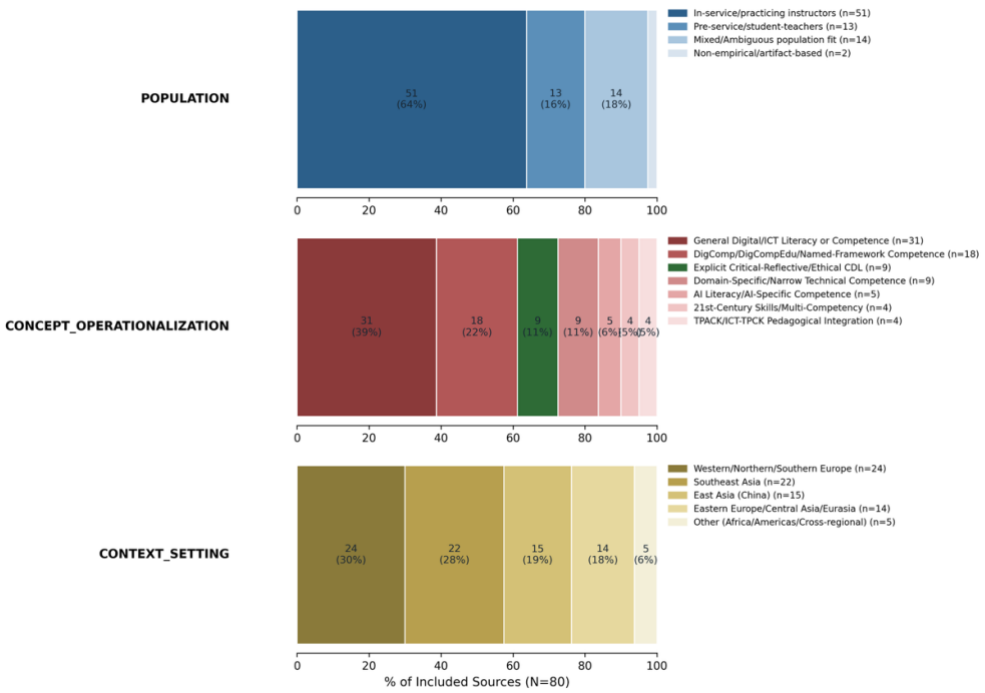


Figure 5. Distribution of Population, Concept, and Context (PCC) Components Across Included Sources

Study designs were distributed across seven categories: quantitative survey (39 sources, 48.8%), mixed-methods (13, 16.2%), qualitative (10, 12.5%), quasi-experimental or experimental (8, 10.0%), instrument development or validation (6, 7.5%), research-and-development or conceptual-model development (3, 3.8%), and computational or algorithmic modeling (1, 1.2%).

Population reporting distinguished in-service instructors (51 sources, 63.8%), a mixed or ambiguous population fit where vocational and general-education participants were not clearly disaggregated (14, 17.5%), pre-service or student-teacher populations (13, 16.2%), and non-empirical, artifact-based sources with no direct human sample (2, 2.5%) (Figure 5).

An individual-level sample size was explicitly reported in 38 of 80 sources (47.5%); among these, sample sizes ranged from 5 to 2,514 participants, with a median of 101.5. Table 1 summarizes these characteristics.

Table 1. Characteristics of Included Sources (N = 80)

Characteristic	n	%
Document type: Article	64	80.0
Document type: Conference paper	14	17.5
Document type: Book chapter	2	2.5
Publication year: pre-2020	8	10.0
Publication year: 2020–2024	35	43.8
Publication year: 2025–2026	37	46.2
Region: Western/Northern/Southern Europe	24	30.0
Region: Southeast Asia	22	27.5
Region: East Asia	15	18.8
Region: Eastern Europe/Central Asia/Eurasia	14	17.5
Region: Other (Africa/Americas/cross-regional)	5	6.2
Study design: Quantitative survey	39	48.8
Study design: Mixed-methods	13	16.2
Study design: Qualitative	10	12.5
Study design: Quasi-experimental/experimental	8	10.0
Study design: Instrument development/validation	6	7.5
Study design: R&D/conceptual-model development	3	3.8
Study design: Computational/algorithmic modeling	1	1.2
Population: In-service instructors	51	63.8
Population: Mixed/ambiguous fit	14	17.5
Population: Pre-service/student-teachers	13	16.2
Population: Non-empirical/artifact-based	2	2.5
Individual sample size reported	38	47.5
Reported validity/reliability practice	62	77.5

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3.1.3. Critical Appraisal Results

Each source's own reported validity or reliability practice was charted descriptively rather than scored against a formal instrument. Sixty-two of 80 sources (77.5%) reported at least one explicit reliability or validity practice, including internal-consistency coefficients such as Cronbach's alpha, factor-analytic checks (exploratory or confirmatory), expert- or content-validation panels, pilot-testing, and triangulation across data sources or methods. The remaining 18 sources (22.5%) did not report such a practice. No source was excluded or down-weighted on this basis, consistent with the non-exclusionary appraisal approach adopted for this review.

3.1.4. Results of Individual Sources

Source-level characteristics, population sub-type, country or region, study design, sampling strategy, and reported validity practice, are summarized in aggregate above and in Table 1; a full listing of included sources with source-level detail is provided in the supplementary material. No single source dominated the corpus: the largest contributing country, Indonesia, accounted for 18 of 80 sources (22.5%), and the six categories of study design each drew on multiple, independently conducted studies rather than a few closely related research programs. Reported sample sizes spanned a wide range, from small-N qualitative case studies with fewer than 15 participants to a large-scale national survey exceeding 2,500 respondents, reflecting the methodological range summarized in Table 1 rather than a single dominant study format.

3.1.5. Synthesis of Results

3.1.5.1. Methodological Approaches Used to Investigate Critical Digital Literacy Among TVET Instructors

Across 80 sources, quantitative cross-sectional survey was the most commonly reported approach. Of the 39 sources charted under this design category, 37 followed a standard cross-sectional or correlational survey format, and 2 used configurational or multi-criteria analytic techniques such as fuzzy-set qualitative comparative analysis or the analytic hierarchy process. Mixed-methods designs were reported in 13 sources and qualitative designs, including case study, phenomenology, and thematic or content analysis, in 10. A further 8 sources used a quasi-experimental or experimental pre-post design, and 6 centered on instrument development or validation. Computational or algorithmic modeling was reported in 1 source.

Instrumentation was similarly varied. A named framework from the DigComp or DigCompEdu family was reported in 16 sources (20.0% of the corpus), while another 2 sources used a different named, formally published instrument. The remaining sources relied on author-adapted or unnamed measurement tools; an instrument or measurement approach was reported in 77 of 80 sources (96.2%), with the remaining 3 (3.8%) not describing one. As reported above, an explicit reliability or validity practice was charted in 62 of 80 sources (77.5%), with no formal scored quality-appraisal tool applied across the corpus (see Critical Appraisal Results).

Reporting completeness varied across the remaining methodological items charted for this review. A sampling strategy was reported in 73 of 80 sources (91.2%); a data-collection method in all 80 (100%); and a data-analysis approach in 78 of 80 (97.5%). Methodological limitations acknowledged by the source's own authors were reported in 65 of 80 sources (81.2%), with the remaining 15 (18.8%) not including such a statement.

3.1.5.2. Characteristics of Studies Investigating CDL Among TVET Instructors

As reported in Table 1, publication activity was concentrated in recent years, with 46.2% of sources published in 2025 or 2026 and only 10.0% predating 2020. Geographic origin was concentrated in Western, Northern, and Southern Europe (30.0%) and Southeast Asia (27.5%), with smaller contributions from East Asia (18.8%), Eastern Europe and Central Asia (17.5%), and other regions combined (6.2%). Formal secondary and tertiary vocational institutions, vocational secondary schools and polytechnics, were the setting reported in the large majority of sources; non-formal or apprenticeship-based training settings did not emerge as the primary setting in any of the 80 sources. Study designs followed the distribution reported above, with quantitative survey designs accounting for approximately half of the corpus and qualitative and mixed-methods designs together accounting for just under a third.

3.1.5.3. Conceptual and Terminological Definition of Critical Digital Literacy

Nine categories of concept operationalization were identified across the corpus (Table 2; Figure 6). Unframeworked general digital or ICT competence language was the most frequently reported operationalization (29 sources, 36.2%), followed by competence framed via the DigComp or DigCompEdu family

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(16 sources, 20.0%). An explicit critical-reflective or ethical dimension was reported in 9 sources (11.2%). Platform- or task-specific framing and population-specific adapted framing, two further domain-specific adaptations, accounted for 9 sources combined (11.2%), while AI-specific literacy constructs were reported in 5 sources (6.2%) and Technological Pedagogical Content Knowledge (TPACK)-structured pedagogical-integration models in 4 (5.0%). A smaller category explicitly labeled "ICT literacy" or "ICT competence" (rather than "digital literacy/competence") was reported in 6 sources (7.5%), and a named instrument outside the DigComp family in 2 sources (2.5%). The term "critical digital literacy" itself, as a verbatim label, was reported in a minority of sources relative to these nine categories combined.

Table 2. Thematic Categories of Concept Operationalization (N = 80)

Category	n	%
Unframeworked general digital/ICT competence	29	36.2
DigComp/DigCompEdu-based competence	16	20.0
Explicit critical-reflective/ethical CDL	9	11.2
Platform/task-specific competence	7	8.8
ICT literacy/integration framing	6	7.5
AI literacy/AI-specific competence	5	6.2
TPACK/ICT-TPCK pedagogical integration	4	5.0
Other named instrument (non-DigComp family)	2	2.5
Population-specific adapted competence	2	2.5

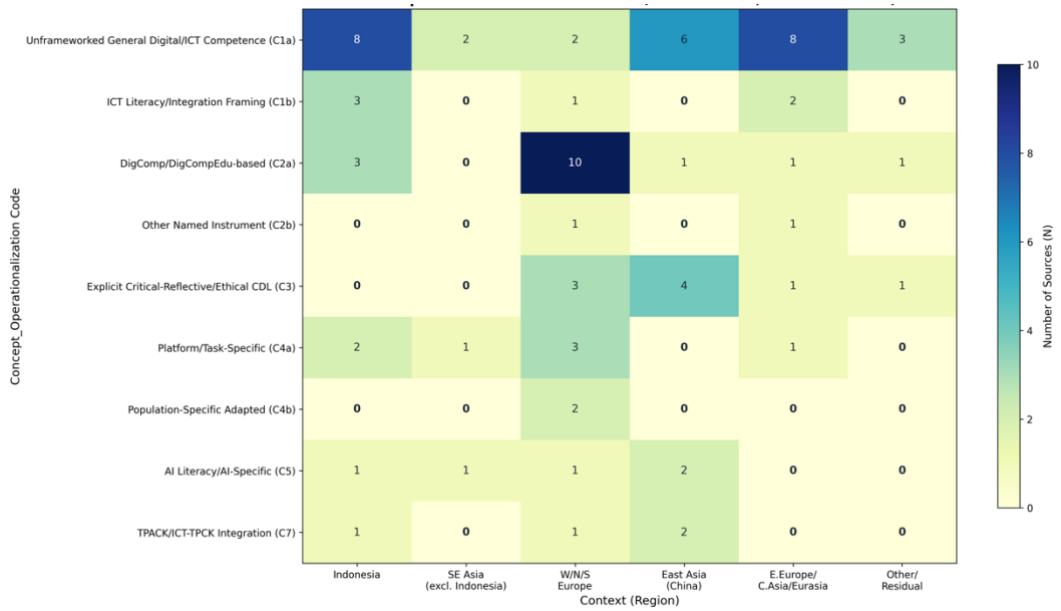


Figure 6. Cross-tabulation of Concept-operationalization Categories by Geographic Context

3.1.5.4. Gaps in Research Design, Instrumentation, and Population/Setting Coverage

Cross-tabulating the nine concept-operationalization categories against the six regional context categories (Figure 6) produced 54 possible combinations, of which 22 (40.7%) contained no charted source. The combination of explicit critical-reflective or ethical CDL framing with a Southeast Asian setting was among these 22, despite Southeast Asia contributing 22 sources overall. Named instruments outside the DigComp family and population-specific adapted competence framing were each reported only in Western, Northern, or Southern Europe, with no sources reporting either combination in any other region. Configurational or computational analytic approaches were reported in 3 sources combined, against 37 using a standard survey format. Full detail on these combinations is presented in the Evidence Gap Map below and the accompanying gap inventory.

3.1.6. Evidence Gap Map

Figure 7 presents the concept-by-context cross-tabulation restructured as an evidence gap map, with combinations containing no charted source marked for visual identification. Of the 54 possible combinations, 22 (40.7%) are evidence gaps. The single densest combination is DigComp/DigCompEdu-based competence paired with a Western, Northern, or Southern European setting (10 sources); two further dense combinations are unframeworked general digital/ICT competence paired with Indonesia and with Eastern Europe, Central Asia, or Eurasia (8 sources each). Explicit critical-reflective or ethical CDL framing was not reported with either Indonesia or Southeast Asia excluding Indonesia, meaning the entirety of the Southeast Asian sources in this

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corpus (22 sources) fall outside this concept-context combination. Named instruments other than DigComp/DigCompEdu, and population-specific adapted competence framing, were each reported only in the European context category, with no sources reported for either combination elsewhere.

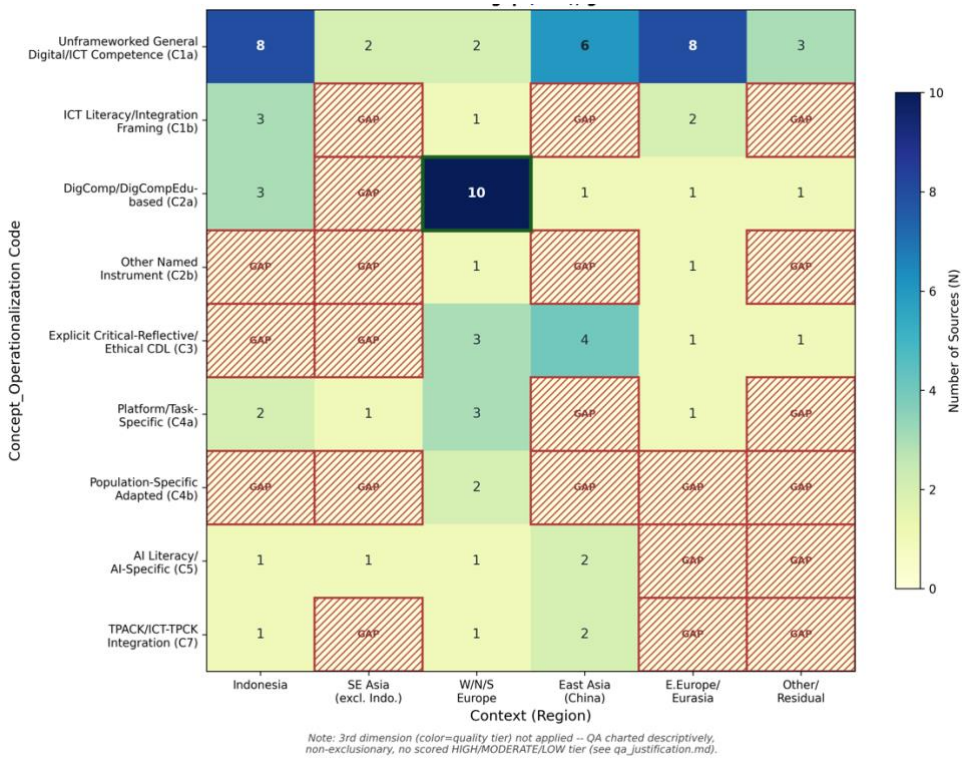


Figure 7. Evidence Gap Map of Concept Operationalization by Geographic Context

3.1.7. Identification of Gaps

Four categories of gap emerge from the mapping above. Sparse or absent PCC combinations, detailed in the Evidence Gap Map (Section 3.6), center on the absence of explicit critical-reflective or ethical CDL framing from Indonesian and wider Southeast Asian settings, and on named instruments and population-specific adapted framing being confined to Western, Northern, or Southern Europe. Conceptual and terminological heterogeneity is reflected in the nine categories of concept operationalization reported in Section 3.5.3 (Table 2), with no source combining a DigComp/DigCompEdu-structured framework with an explicit critical-reflective dimension. Methodological gaps include the underuse of configurational or computational analytic techniques relative to standard surveys (Section 3.5.1), the small share of critical-reflective-framed sources using a qualitative or mixed-methods design, the absence of any formally validated instrument specific to critical digital literacy, and the 15 sources (18.8%) that did not acknowledge a methodological limitation. Temporal gaps concern the 8 sources (10.0%) predating 2020 despite DigComp's 2013 publication, and the AI-specific-construct sources concentrated entirely within 2025–2026 (Section 3.2).

3.2. Discussion

3.2.1. Summary of Evidence

Across the mapped literature, a single methodological mode, the quantitative cross-sectional survey, accounts for roughly half of all charted approaches, while qualitative and configurational designs remain a minority, possibly reflecting convenience: surveys are comparatively low-cost and easily scaled to reach dispersed instructor populations (Evans & Mathur, 2005). Yet critical digital literacy, as operationalized here, includes a reflective and evaluative dimension self-report instruments are not naturally suited to capture in depth, since a respondent's self-rated reflectiveness on a checklist does not guarantee a corresponding depth of actual reflective capacity (Kember et al., 2000). Among the small subset of sources framing this critical dimension explicitly, only a minority used a qualitative or mixed-methods design capable of examining reflection as a process rather than a scored trait a mismatch between construct and method that, more than survey dominance overall, is the more telling methodological signal here.

This mismatch is not merely instrumental but conceptual: critical and reflective engagement with digital technology unfolds as a situated, iterative process, shaped by context and typically revealed through sustained action, discourse, or judgment over time, rather than as a stable trait a single cross-sectional item can register

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(Kember et al., 2000). A survey administered at one point in time cannot distinguish an instructor who has internalized critical evaluation of digital tools from one who has merely learned to endorse the socially desirable response, a distinction only observational, longitudinal, or discourse-based methods are positioned to draw out. The consequence extends beyond a methodological footnote: proficiency estimates reported by the survey-dominated literature mapped here, including the low-to-moderate levels Wu et al. (2025) report for the broader vocational-teacher population, describe self-perceived competence rather than demonstrated critical-reflective capacity, and the two need not coincide.

Relatedly, no charted source combined a structured competence framework, such as DigComp or DigCompEdu, with an explicit critical-reflective operationalization. DigComp-family instruments carry an established measurement infrastructure, translated scales, piloted items, and comparative benchmarks accumulated across successive framework updates and national adoption (Vuorikari et al., 2016), while the critical-reflective strand has so far developed largely apart from it. A future instrument that is both conceptually faithful and practically comparable across studies would need to bridge these two traditions.

This separation is geographic as much as conceptual. Southeast Asia, and Indonesia in particular, contributes the second-largest share of sources in this corpus, yet none frame digital literacy in the explicitly critical-reflective terms this review used to define its Concept: a research community can be prolific on general digital-competence measurement while the critical dimension remains largely untested in the same setting, the kind of precursor signal a scoping review is designed to surface.

3.2.2. Geographic and Contextual Honesty

It is necessary to state plainly where this evidence originates. Combined, sources situated in Western, Northern, and Southern Europe and in Southeast Asia account for more than half of the mapped corpus, and Indonesia alone contributes close to a quarter; Africa, the Americas, and cross-regional studies together contribute only a small fraction. The patterns described throughout this Discussion, the methodological tendencies, the conceptual fragmentation, the concept-by-context gaps, are therefore most defensibly read as a characterization of TVET-instructor CDL research as currently practiced in European and, especially, Indonesian and wider Southeast Asian research communities, rather than a universal statement about vocational-education systems worldwide. This caveat is consistent with broader concerns about the limited generalizability of evidence drawn from a narrow band of the world's research-producing regions (Henrich et al., 2010), and applies to every unqualified reference to "the literature" below.

3.2.3. Conceptual Fragmentation and Dialogue with the Literature

The operational definition guiding this review, technical capability paired with reflective-critical awareness of the sociocultural, political, and ethical dimensions of digital technology use, adapted from Ilomäki et al.'s (2023) school-level formulation, is only partially reflected in how the mapped literature describes its own constructs. A little over a third of sources use unframeworked general competence language; a fifth adopt the DigComp or DigCompEdu family, foregrounding functional competence rather than critical reflection; and roughly one in nine frame an explicit critical or ethical dimension, typically without reference to a named framework. Imposing a single unified definition retroactively would therefore misrepresent a genuinely heterogeneous body of work. A plurality-with-labeling approach, in which future studies state explicitly whether they measure functional competence, critical reflection, or both, better reflects the field's actual practice while making the terminological choice visible, consistent with recommendations for arresting jingle-jangle confusion once it has already taken hold (Hanfstingl et al., 2025).

The methodological emphasis adopted here extends, rather than repeats, the closest available prior synthesis on vocational-education teachers' digital competence. Wu, Husnin, Mohamad, Jia and Zhang (2025) treated study design as a secondary question within a broader synthesis of competence frameworks and influencing factors, concluding that no comprehensive competence framework yet existed for this population. The present mapping is consistent with that conclusion at a finer grain: no source charted here combines a structured framework with an explicit critical dimension and named frameworks cluster heavily in specific regions rather than being applied evenly. Where Wu et al. (2025) treated methodological characterization as background, this review makes it the central aim, identifying a temporal extension their 2002–2023 window could not capture: a distinct cluster combining artificial-intelligence-specific literacy constructs with the corpus's most recent publication years, a sub-theme too recent to register within their period and grounded increasingly in dedicated AI-literacy competency frameworks (Long & Magerko, 2020) rather than the general frameworks discussed above.

Two further prior reviews addressed instrumentation and self-assessment practice in populations distinct from the one mapped here. Nguyen and Habók (2023) characterized the instruments available to measure general teachers' digital literacy and found them dominated by self-evaluation tools never previously synthesized as a set; the present corpus shows a comparable reliance on self-report and adapted instruments, extended here to TVET instructors and to the critical dimension their general-education scope did not address.

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Basilotta-Gómez-Pablos, Matarranz, Casado-Aranda and Otto (2022) reached a related conclusion through bibliometric co-word clustering of university-teacher research, reporting a dominant focus on self-assessment and reflection alongside generally low-to-moderate reported competence. The present mapping's survey-based self-report dominance aligns with this pattern, suggesting a convention that recurs across educational levels rather than one specific to vocational education, though their bibliometric method could not surface the survey-versus-qualitative imbalance this narrative charting documents.

The strongest evidence that this review's central conceptual gap is not an artifact of a narrow search comes from Velandia Rodriguez, Mena-Guacas, Tobón and López-Meneses (2022), who identified eight competing digital-competence frameworks across Ibero-American teacher populations, with no consensus among them, and called explicitly for framework unification following the pandemic-era shift to remote instruction. The nine-category fragmentation identified in this broader mapping indicates this lack of consensus is not confined to the Ibero-American workforce they examined; it recurs among TVET instructors globally. Their reported surge in research interest from 2020 also echoes in this corpus, where sources published in 2025–2026 alone account for close to half the total, though the more recent surge coincides with the AI-specific literacy sub-theme rather than the pandemic-era shift their period covered.

3.2.4. Nature and Extent of the Evidence

The evidence mapped here is overwhelmingly empirical rather than conceptual: the large majority of sources report original data collection, and only a small number are limited to conceptual proposals or research-and-development work. Self-report survey instruments predominate over observational, experimental, or computational approaches, and nearly every source describes some form of measurement instrument, whether named or adapted, even where the underlying construct is defined in markedly different terms. This combination, near-universal instrumentation alongside limited conceptual convergence on what it should measure, characterizes a field that has matured methodologically faster than conceptually, a sequencing in which measurement practice outruns the conceptual clarity needed to interpret it (Hanfstingl et al., 2025). The field appears to agree, in practice, that digital literacy should be measured well before agreeing what distinguishes a critical version of the construct from a general one, consistent with the broader jingle-jangle problem in measurement, whereby similarly labeled instruments capture different constructs and differently labeled ones capture the same one.

3.2.5. Evidence Gaps and Triple-Track Implications

3.2.5.1. Gaps Identified

Four categories of gap, each addressed at greater depth above or in the Future Research Agenda that follows, warrant brief note here. Coverage of the concept-by-context matrix is sparse, most notably the pairing of explicit critical-reflective framing with Southeast Asian settings. Conceptual and terminological categorization remains fragmented across nine distinct operationalizations with no single integrating source. Configurational, computational, and qualitative designs applied to the critical-reflective construct are markedly underused relative to conventional surveys. Temporal coverage is thin before 2020 and, for the AI-specific sub-theme, concentrated entirely within the most recent two years mapped.

3.2.5.2. Implications for Research

The gap types motivating this review carry distinct implications rather than a single prescription. The next conceptual task is not to adopt Ilomäki et al.'s (2023) school-level formulation wholesale, but to adapt it to the workplace-based learning and industry-linked curricula that distinguish TVET from general schooling, a contextualization not yet undertaken in the charted literature. The methodological-characterization gap that motivated this review is substantially addressed by the mapping itself; what remains is a shift toward developing measurement approaches, particularly qualitative and configurational designs, capable of examining the critical-reflective dimension at the depth the construct implies. The AI-specific-literacy gap remains only partly updated: its concentration within the past two years indicates a fast-moving sub-theme a single mapping cycle cannot treat as settled, warranting a targeted evidence update before any systematic effectiveness review is attempted.

3.2.5.3. Implications for Practice

For curriculum developers and instructors in Indonesian SMK (vocational secondary schools) and politeknik programs, and in *Balai Latihan Kerja* or Vocational Training Centers (VTC) and other non-formal centers under Kemnaker (Ministry of Manpower), the most direct implication is what this mapping does not show. No source charted here combines an Indonesian or wider Southeast Asian setting with explicit critical-reflective framing of digital literacy. Professional-development materials addressing the critical or evaluative dimension of digital engagement, as distinct from general tool proficiency, therefore cannot currently draw on an empirically tested local framework; adapting approaches documented in the Chinese or Ukrainian contexts identified elsewhere would require explicit local validation, consistent with established cautions against

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assuming measurement invariance across cultural and linguistic contexts without testing it directly (Vandenberg & Lance, 2000). For VTC -based non-formal training specifically, this setting did not emerge as a distinct focus in any charted source, so even general, non-critical digital-competence evidence remains sparse.

3.2.5.4. Implications for Policy

For Kemendikbudristek (Ministry of Education, Culture, Research, and Technology)'s Direktorat Vokasi and Kemnaker's VTC network, both mandated under Indonesia's commitments to SDG Target 4.4 and 4.c (United Nations, 2015), this mapping carries a cautionary implication: the evidence base specific to critical-reflective digital literacy among TVET instructors in Indonesia or wider Southeast Asia does not merely appear thin, it does not exist within this corpus. Certification standards referencing critical digital competence for Indonesian TVET instructors could not, at present, draw on a locally grounded evidence base, and policy language implying otherwise would overstate what this mapping supports. Two paths follow: commissioning locally grounded research on this construct, or adopting a framework already validated elsewhere, most plausibly the Chinese- or European-context sources identified here, while flagging that local validation has not occurred. UNESCO-UNEVOC may find the regional distribution mapped here useful in directing research-capacity investment toward the settings found least represented, rather than already well-covered settings such as Western and Northern Europe.

3.2.6. Limitations

A single bibliographic database was searched. The specified backward and forward citation-chasing step had not been completed at the time of this analysis; it is expected to recover conference proceedings and regionally indexed journals outside the primary database's coverage, of the kind that carried at least one closely related study identified during protocol development but absent from the primary index. This incompleteness means the mapped corpus may under-represent research in venues with more limited international indexing, a pattern plausibly more consequential for regions outside those already well represented in the database's own coverage, which varies systematically by region and discipline (Mongeon & Paul-Hus, 2016). The 2013–2026 window and English-language restriction were deliberate scope decisions, but they mean non-English-language TVET literature, plausibly substantial in some less-represented regions, falls outside what this review can characterize.

Coverage of charted methodological detail was not uniform: a quality- or validity-related practice was reported in a majority, though not all, sources. A substantial share of potentially eligible records could not be retrieved in full text, most notably two cases gated behind publisher paywalls; because eligibility could not be confirmed, the mapped corpus may omit relevant evidence that broader institutional access would have captured.

The nine-category concept scheme and six-region context scheme reflect specific boundary decisions that another reviewer might draw differently at the margins. All categorizations were reviewed by the author before being treated as final, but an independently documented, source-by-source audit was not separately conducted for every assignment, a departure from the dual-coder verification recommended for evidence-synthesis coding decisions (Belur et al., 2018); a subsequent reviewer might reasonably resolve some boundary cases differently, particularly sources near the boundary between AI-specific literacy and explicit critical-reflective framing. The evidence gap map's granularity is likewise a mapping choice: the residual context category combining Africa, the Americas, and cross-regional studies groups settings with little in common beyond small individual representation, and multi-country studies were assigned to a single dominant region, which may understate genuinely cross-regional evidence.

Finally, this review's scope is bounded by design, not omission: it maps the extent, nature, and distribution of methodological approaches, not which approach is most effective, and the descriptive charting of validity practice was never intended as a quality gate, no source was excluded or weighted on that basis. No meta-analysis or pooled estimate was calculated at any stage.

3.2.7. Future Research Agenda

The directions proposed here follow directly from the empty and sparsely populated cells in the concept-by-context matrix compiled in this review, rather than from a general call for more research on critical digital literacy. Because that matrix specifies precisely which combinations of concept and setting remain unstudied, each direction below names a concrete research question and a methodology suited to answering it, positioned according to what it depends on rather than an unordered list of topics.

The most direct next step follows from the single most consequential gap identified: no source combined an explicit critical-reflective operationalization of digital literacy with an Indonesian or wider Southeast Asian setting. A feasible near-term study could ask to what extent TVET instructors in Indonesia and neighboring systems demonstrate this critical-reflective dimension, distinct from general digital-competence proficiency,

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using a mixed-methods design that adapts the critical-framed instruments identified here from Chinese and Ukrainian sources to the Southeast Asian TVET context, paired with qualitative interviews to capture locally grounded reflective practice an adapted quantitative scale alone would not surface. This study need not wait for new instrumentation, since adaptable tools already exist in the mapped literature, and would supply the first regional evidence against which later, more rigorously validated measures could eventually be compared.

Running in parallel, a second foundational direction concerns instrumentation itself. Because no source reported a formally validated instrument specific to critical digital literacy, as distinct from general scales such as DigCompEdu, a dedicated instrument-development study is warranted: item generation grounded in the technical-plus-reflective definition used here, followed by exploratory and then confirmatory factor analysis with a TVET-instructor sample, following established scale-development practice (Boateng et al., 2018). This work need not wait on full resolution of the nine-way conceptual fragmentation also identified here, but its item-writing stage should draw on whatever provisional consensus emerges from a companion Delphi study or concept-mapping exercise with TVET researchers and instructors, asking specifically how skills-based frameworks such as DigComp can be integrated with, or distinguished from, critical-pedagogy-based operationalizations. A third, independent near-term direction follows from AI-specific-construct sources being concentrated entirely in the two most recent years mapped, with no earlier baseline: a repeated cross-sectional or trend-survey design, re-administering a consistent measure at fixed intervals, would establish whether this reflects a genuine, continuing shift in how TVET instructors engage critically with generative-AI tools or a transient spike tied to recent public attention.

A lower-urgency direction addresses the population gap identified outside Europe: adapted competence framing for TVET instructors serving disability-inclusive or otherwise vulnerable learners was reported only in Western, Northern, and Southern European sources. A qualitative case-study design, following the approach documented there but applied to non-European, particularly non-formal, training settings, would ask what critical digital literacy needs and practices look like for comparable populations where no such study yet exists.

The longest-horizon direction, cross-cultural validation of a critical digital literacy instrument across the regional clusters this review's evidence gap map identified (Southeast Asia, East Asia, Europe, Eastern Europe/Central Asia), is deferred deliberately: a multi-group confirmatory factor analysis testing measurement invariance across these systems (Vandenberg & Lance, 2000) presupposes the instrument proposed above already exists and has seen use in more than one region. Only once that measurement groundwork and the regional trend data described above have accumulated would a future systematic review of intervention effectiveness for critical digital literacy training in TVET, not attempted here, have a sufficient measurement base to draw on.

4. Conclusion

This scoping review set out to characterize how research on critical digital literacy has been conducted among TVET instructors, a population and construct combination no prior synthesis had addressed as its central aim. The charted evidence points to a field still organized around a single dominant method: quantitative survey work substantially outweighs qualitative, configurational, and computational approaches, a pattern that carries particular weight for the small subset of sources explicitly framing a critical-reflective dimension, since few adopt a design capable of examining reflection in any depth. Instrumentation follows a comparable pattern, with named competence frameworks concentrated in specific regions rather than applied consistently. The evidence gap map built from this charting renders these imbalances visible at the level of individual concept-by-context pairings, most notably the absence of any source combining explicit critical-reflective framing with a Southeast Asian setting, despite that region's substantial share of the corpus. As a mapping exercise rather than an effectiveness synthesis, this review does not resolve which methodological approach performs best; it instead establishes, with more precision than previously available, where evidence exists and where it does not. Beyond this methodological account, the review offers a working picture of how unevenly the construct itself is operationalized. Nine distinct categories of concept definition coexist in the literature, from unframeworked general competence language through named structured frameworks to explicit critical or ethical framing, without a single charted source bringing a structured framework and an explicit critical dimension together. Documenting this fragmentation, rather than resolving it prematurely by imposing one preferred definition, is itself a contribution: it gives later instrument-development work a concrete starting point instead of an assumed consensus this mapping shows does not yet exist. A plurality of labeled definitions, rather than a single retrofitted one, is the more defensible reading of what the charted literature actually does. Taken together, these findings carry implications across three audiences. For research, the priority is adapting existing accounts of critical digital literacy to the workplace-linked character of TVET rather than importing general-education formulations unchanged, alongside the measurement development this mapping shows has not yet occurred. For practice, instructors and curriculum developers in settings such as Indonesian vocational high school, polytechnic, and VTC programs are shown where local professional-development work would currently have to adapt evidence from elsewhere rather than draw on anything locally validated. For policy, bodies such as Kemendikbudristek's Direktorat Vokasi and Kemnaker's public Vocational Training Centers (*Balai Latihan*

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Kerja) network are shown, just as plainly, where the evidence base is not yet strong enough to anchor certification or professional-standard decisions in critical-digital-literacy terms.

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Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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